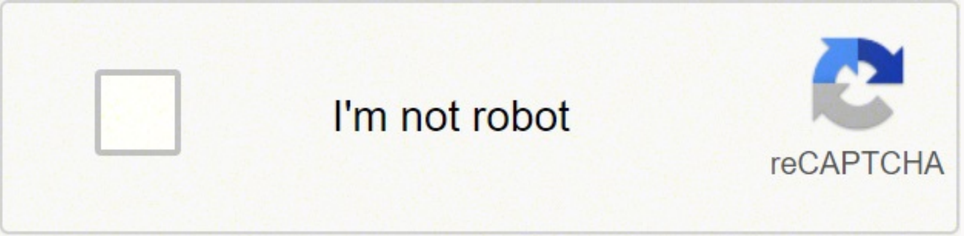

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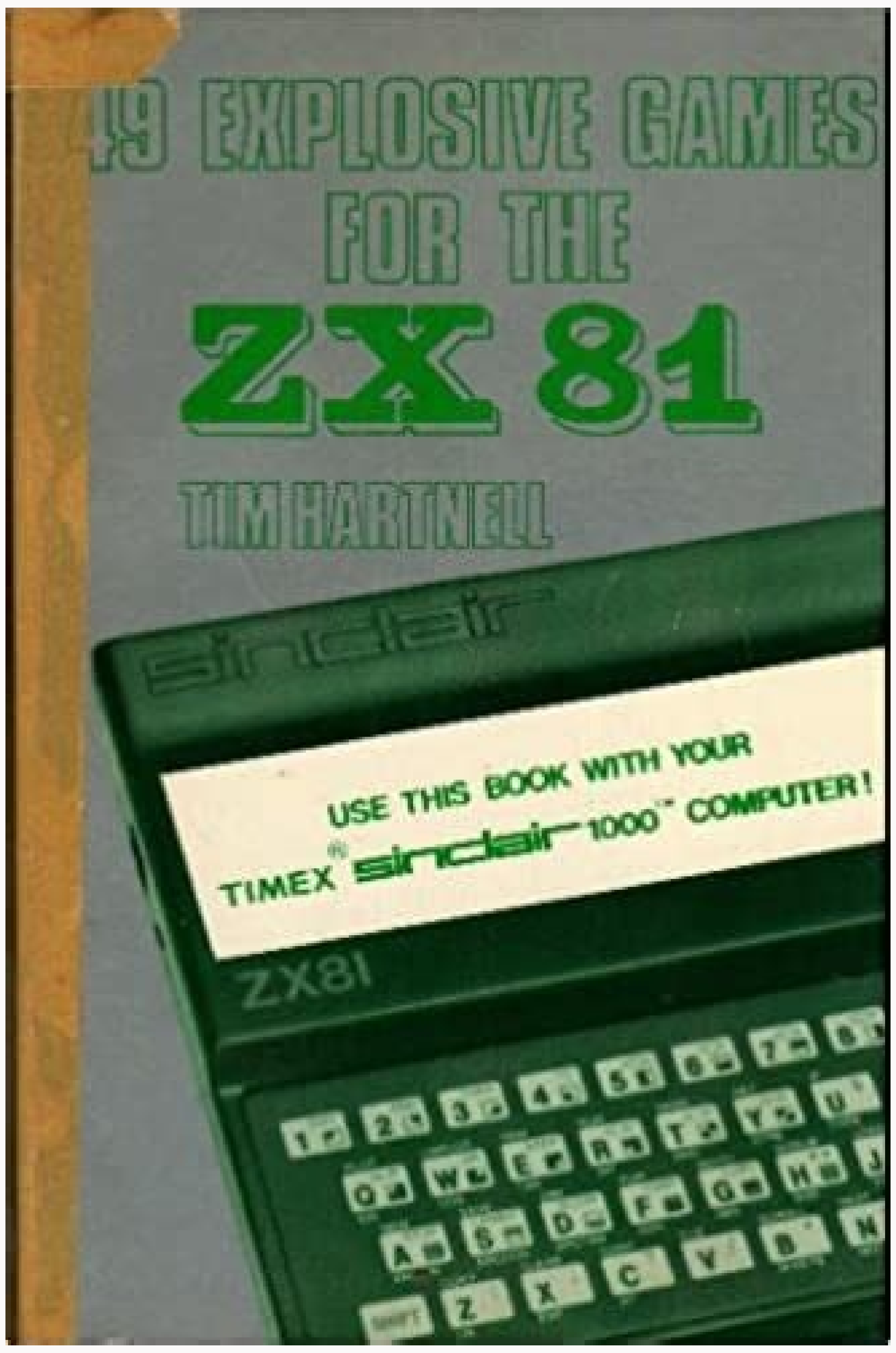

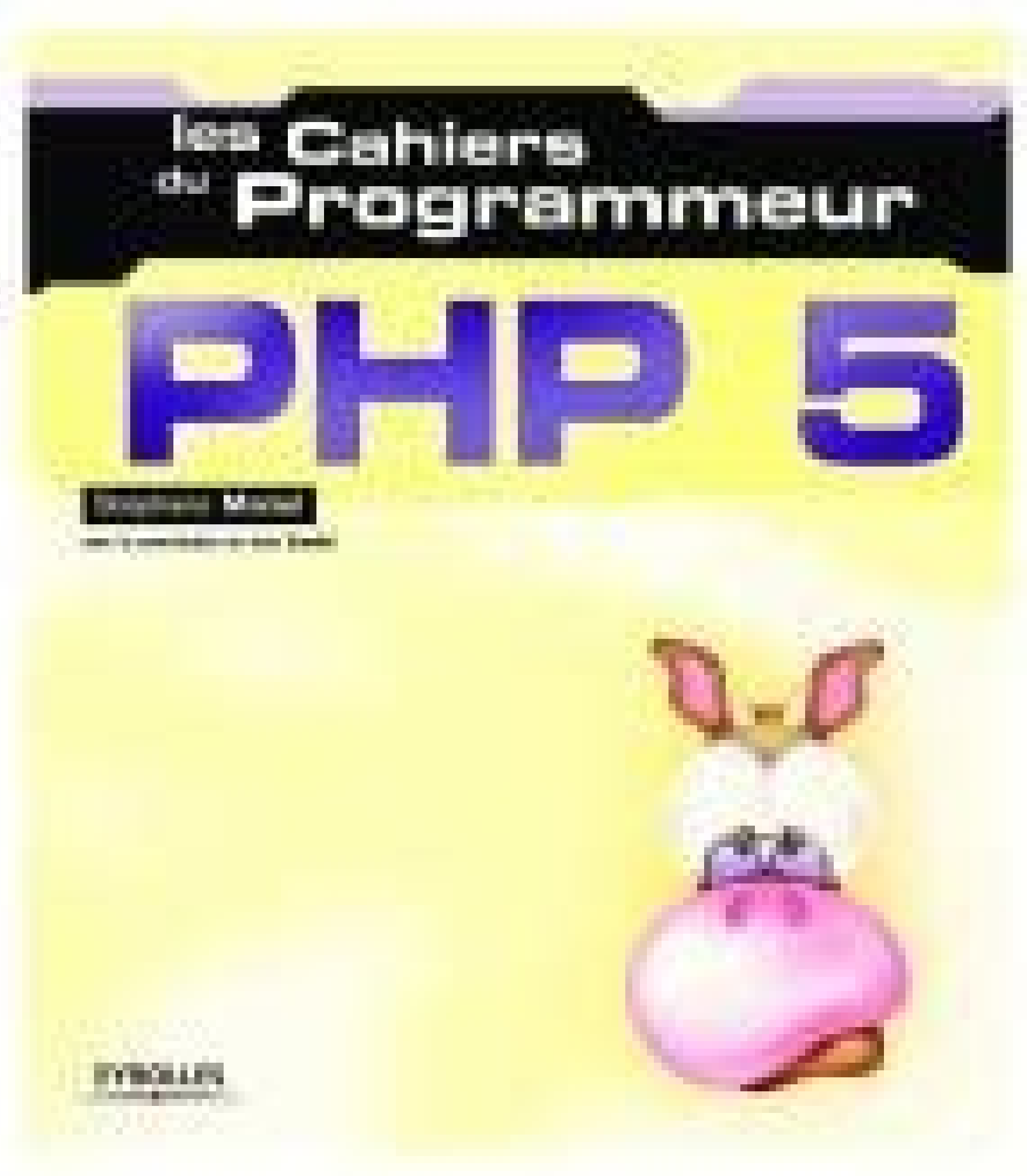

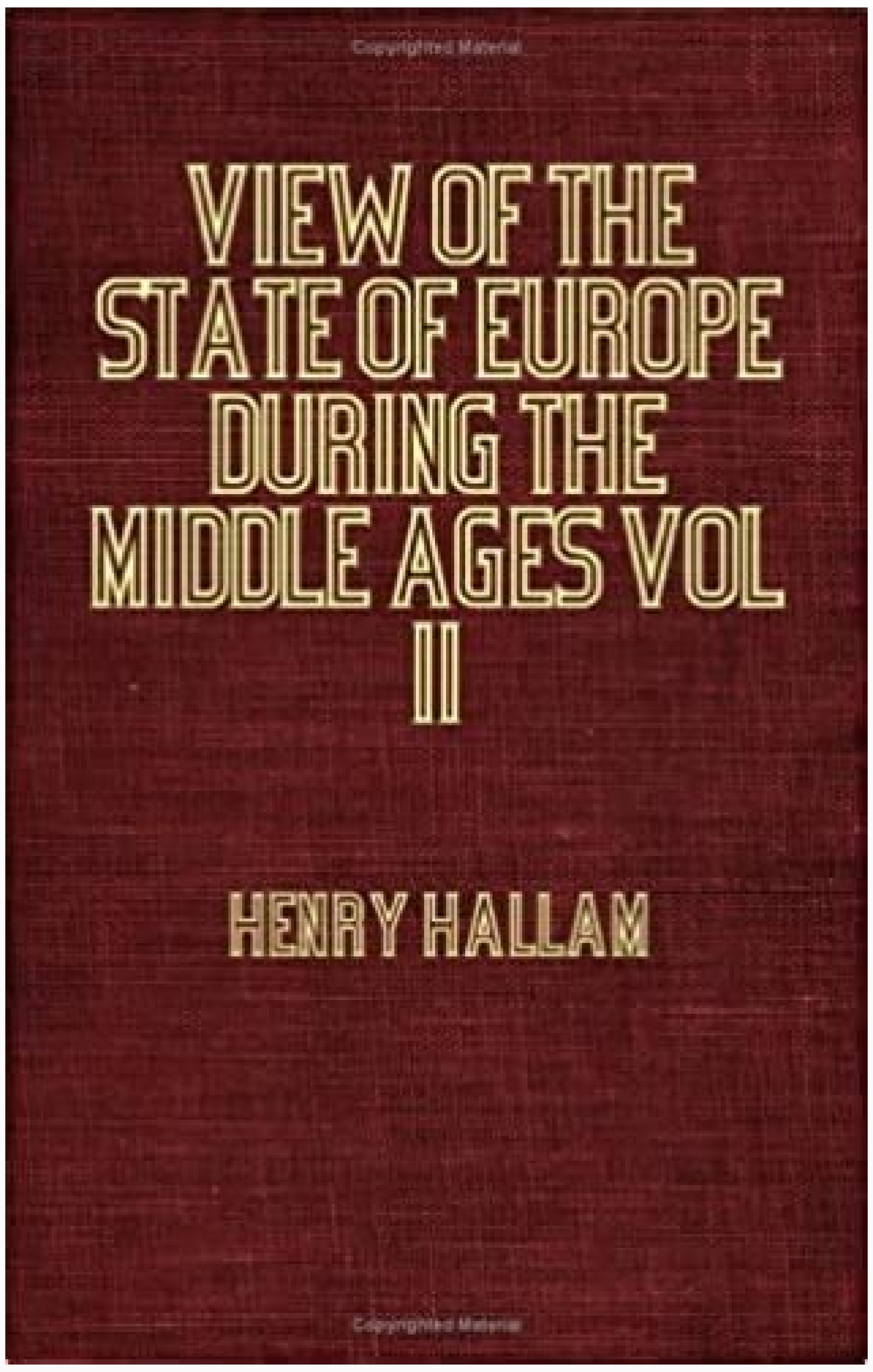

Objects first with java 6th edition online.

The project contains part of an application for a company producing bricks. M01B_BARN7367_06_SE_C01.indd 34 4/11/16 2:54 PM 1.5 Data types | 35 Figure 1.5 A method-call dialog Exercise 1.3 Try invoking the moveVertical , slowMoveVertical , and changeSize methods before you read on. streams Streams unify the processing of elements of a collection and other sets of data. The parameters of the move methods and the changeSize method are all of that type. Exercise 3.54 Add a subject line for an e-mail to mail items in the mail-system project. M16_BARN7367_06_SE_C16.indd 588 4/11/16 3:47 PM 16.4 Iterative development | 589 Exercise 16.12 For each of the classes in the project, look at the class interface and write a list of JUnit tests that should be used to test the functionality of the class. M04_BARN7367_06_SE_C04.indd 136 4/11/16 3:10 PM 4.6 Generic classes | 137 This means that an organizer does not duplicate information that is available to it from elsewhere. What is the significance of having different logging levels? If one name perfectly describes the use, it is reasonable to use it for both and to go through the trouble of using the this keyword in the assignment to resolve the name conflict. This approach also helps to deal with the frequent occurrence of mutual dependencies between concepts. The second limitation is like the first: a class method may not call an instance method from the class. It serves to provide a feel for what a class such as this might look like. } This can, of course, also be combined with the trim and toLowerCase methods. It does not check that the ticket price passed to its constructor is sensible. For instance, one restriction is that we cannot change what is stored in the collection while iterating over it, either by adding new items to it or removing items from it. Interaction with such a collaborator is usually transitory—just for the period of execution of the method—although the receiving object may choose to store the reference in one of its fields, for longer-term interaction. A complete list of primitive types is given in Appendix B. The timeTick method has an if-statement to check whether the hours should also be incremented. First, we create the menus. No display method is found in class PhotoPost. For this, we shall create a class called NewsFeed. 5.3 Concept lambda is a segment of code that can be stored and executed later. Call this method from printShortSummary to access the name for printing. Individual teachers can decide to use the book as it is, following our suggested sequence, or to branch out into sidetracks suggested by the hooks in the text. We think there is, and the second tool we use is one of the reasons . . . BlueJ BlueJ deserves much comment. If we did not have to take exceptions into account, then this would be written as follows: String filename = request-a-file-from-the-user; addressbook.saveToFile(filename); However, because the writing process could fail with an exception, the call to saveToFile must be placed within a try block to show that this has been taken into account. Is this too fundamental a change to graft onto the existing application? The same thing happens when any object variable is assigned to another. The first line in this method is frame = new JFrame("ImageViewer"); This statement creates a new frame and stores it in our instance variable for later use. In the next section, we discuss how values are received by an object from outside. If I speak of “my old car that is parked at home in my garage,” we can answer the questions above. This will open a text editor displaying the source code of the class. "); while(there is more text to write) { . Can logging be turned off and then on again? That’s all. The Canvas class should not need any modification. To this point, none of the methods we have looked at contain any declarations. In it, there is a class called Database (a fairly central class) that holds objects of type Student. What happens when you use the modulo operator with negative numbers? If the specified class cannot be found, the Java virtual machine will generate an error message similar to this one: Could not find or load main class game If you see a message like this, make sure that you have typed the class name correctly, and that the current directory actually contains this class. This code example, as discussed this far, is available in the book projects as project imageviewer0-2. F.2.5 Terminate The Terminate button aggressively finishes execution of the current program such that it cannot be resumed again. A public character variable that is used to indicate that the help command is 'h'. The same is true for every other component. Exercise 14.48 Review the InputReader class of tech-support-complete to check that you understand how it uses the Scanner class. Taxi-company (Chapter 16) The taxi example is a combination of a booking system, management system, and simulation. Inheritance is central to understanding and using object-oriented languages, and understanding it in detail is necessary to progress from here. This may seem strange at first. Exercise 3.55 Given the following class (only shown in fragments here), public class Screen { public Screen(int xRes, int yRes) { ... Sometimes there is one name that perfectly describes the use of a variable—it fits so well that we do not want to invent a different name for it. It is important to be able to distinguish among the different meanings of the word interface in a particular context. 14.8 Error recovery and avoidance So far, the main focus of this chapter has been on the problem of identifying errors in a server object and ensuring that any problem is reported back to the client if appropriate. A catch block names the type of exception it is designed to deal with in a pair of parentheses immediately following the catch word. This exercise illustrates the for-each loop really intended to be used with a separate index variable. This approach also does not scale well should we decide to introduce further sorts of special rooms, each requiring its own flag field and accessor method.7 With inheritance, we can do better and implement a solution that is even more flexible than this one. The relevant lines of code in the NewsFeed class are: for(Post post : posts) { post.display(); System.out.println(); } The for-each statement retrieves each post from the collection; the first statement inside its body tries to invoke the display method on the post. Find out why, and explain. H.4 Using a shared project Once a user has created a shared project in the repository, other team members can use this project. Alexander Graham Bell 12 minutes ago - 4 people like this. Is there a relationship between the two curves? We can also map natural-language selections such as “the first three” to program-related terminology. 7.3.4 Analyzing the log file The hourCounts array created in the constructor of LogAnalyzer is used to store an analysis of the access data. So, to be more precise, the rule that a user should not be allowed to know the internals of a class does not refer to the programmer of another class, but to the class itself. Here, we again encounter the concept of abstraction to help us deal with a large amount of information. Here follows a short description of each layout. It should reset total to be zero, but also return the value that was stored in total before it was reset. These two approaches conflict: we cannot concentrate on discussing important concepts first, and at the same time provide complete coverage of all topics encountered. Person p = null; try { p = database.lookup(details); System.out.println("The details belong to: " + p); } catch(Exception e) { // Handle any checked exceptions . Exercise 14.51 Review the LoglineTokenizer class of weblog-analyzer to see how it uses a Scanner to extract the integer values from log lines. Here, its effect is to calculate a value that is the sum of the number in the amount parameter and the number in the balance field. In the TicketMachine class, we have chosen to list the fields first, the constructors second, and finally the methods (Code 2.2). We have regularly used calls to the print and println methods of System.out to write text to the BlueJ terminal window. Remember: This suppression of detail is a benefit that abstraction gives us; it means that we can utilize ArrayList to write any number of different classes that require storage of an arbitrary number of objects. For a method signature to match the method call, both the name and the parameter list of the method must match. 15.3 Documentation After identifying the classes and their interfaces, and before starting to implement the methods of a class, the interface should be documented. 2.1 Ticket machines Train stations often provide ticket machines that print a ticket when a customer inserts the correct money for their fare. But what does this method do? Exercise 6.60 Create a canvas. A class method may only invoke other class methods defined in its class. In this chapter, we will not be concerning ourselves directly with format of the data sent in by the spotter. Now that we have a broad, external understanding of what this project does, we will look in detail at the implementation of the Rabbit, Fox, and Simulator classes. Variables like tracks and responseMap in these examples are called polymorphic variables, because they are capable of referring to objects of different, but related, types. That is what the this keyword is used for. After discovering the classes, we can use CRC cards and played-out scenarios to design the dependences and communication details between classes, and to flesh out details about each class’s responsibilities. Code 3.5 Fields and constructor of the MailItem class M03_BARN7367_06_SE_C03.indd 118 4/11/16 3:06 PM 3.13 Another example of object interaction | 119 3.13.2 The this keyword The only section we will discuss from the MailItem class is the constructor. If we enter these objects into the news feed1 and then invoke the first version of the news feed’s show method (the one without inheritance), it prints Leonardo da Vinci Had a great idea this morning. The field is composed of a fixed ■ number of locations, which are arranged in rows and columns. Local variable declarations look similar to field declarations, but they never have private or public as part of them. It is typical that the names of classes are singular rather than plural. You will need to modify the populate method to have some of your animals created at the start of a simulation. M12_BARN7367_06_SE_C12.indd 460 4/11/16 3:38 PM Chapter 13 Building Graphical User Interfaces Main concepts discussed in this chapter: ■ constructing GUIs ■ GUI layout ■ interface components ■ event handling Java constructs discussed in this chapter: JFrame, JLabel, JButton, JMenuBar, JMenu, JMenuItem, ActionEvent, Color, FlowLayout, BorderLayout, GridLayout, BoxLayout, Box , JOptionPane, EtchedBorder, EmptyBorder, anonymous inner classes 13.1 Introduction So far in this book, we have concentrated on writing applications with text-based interfaces. The Class class is a generic class—it has a type parameter specifying the specific class subtype we are referencing. You should also define a new color for your new animal class. Students studying with this book may be working as software professionals for the next 30 or 40 years of their life—it is a fairly safe bet that the majority of their work will not be in Java. This site may earn affiliate commissions from the links on this page. Another common use of Scanner is to read input from the “terminal” connected to a program. They have been tested with care, but are not guaranteed for any particular purpose. That is, the class name is followed by some extra information in angle brackets. To do this, choose the Java Class Libraries item from the BlueJ Help menu. We can write Java and run the compiler—which generates the machine code—and the computer can then read the machine code. Provide an accessor method for it called isCourseText. This is an important difference from the while loop. ■ They end with a semicolon. That is enough background for a start. There is no strong reason for preferring one style (using a JFrame instance) over the other (inheriting from JFrame). BlueJ is very clean and very targeting. This is intentional and not usually a problem.) Now it is the Show class’s turn. They implement the core actions of every object. On the other hand, the JTextField component allows a permanent text input area to be displayed within a GUI. Code 10.2 Source code of the PhotoPost class M10B_BARN7367_06_SE_C10.indd 366 4/11/16 3:32 PM 10.1 The network example | 367 Code 10.2 continued Source code of the PhotoPost class M10B_BARN7367_06_SE_C10.indd 367 4/11/16 3:32 PM 368 | Chapter 10 ■ Improving Structure with Inheritance Code 10.2 continued Source code of the PhotoPost class Next, let us examine the source code of the NewsFeed class (Code 10.3). The PopulationGenerator class should also define the colors for each type of animal. Code 5.1 shows the Sighting class we will be using to record details of each sighting report, from a single spotter for a particular animal, once the sighting details have been processed. If this level of detail is not required, then we can simplify the model by just “injecting” passengers into it according to some statistically reasonable pattern. M14_BARN7367_06_SE_C14.indd 514 4/11/16 3:43 PM 14.1 The address-book project | 515 There are two introductory versions of the address-book project for you to explore. Exercise 2.77 The String class defines a length accessor method with the following header: /** * Return the number of characters in this string. Figure F.1 The BlueJ debugger window Z06_BARN7367_06_SE_APPF.indd 621 4/11/16 3:54 PM 622 | Appendices The debugger window contains five display areas and five control buttons. Exercise 2.42 Create two ticket machines with differently priced tickets. The reason for this is largely historic—there does not seem to be a logical explanation for it. We shall investigate this in more detail in Chapter 12. } } (As a style guide, we usually write inner classes at the end of the enclosing class—after the methods.) Note that we have given the inner class private visibility to reinforce the sense that it is performing a task that is highly specific to the ImageViewer class and should not be considered independent of it. It also contains more associations of words to responses than are shown in this chapter. For now, we just go through the paragraph mechanically, picking out all nouns. This is the old style loop of next item/process. As with rabbits, a fox that is unable to move is considered dead through overcrowding. In particular, checked exceptions in Java require the use of throws clauses and try statements. It clearly indicates which classes are actually used by our class. In the vernacular of Java programs, the expression “class MessagePost extends class Post” could be used, because Java uses an extends keyword to define the inheritance relationship (as we shall see shortly). Two possible patterns of use are: switch(expression) { switch(expression) { case value: statements; case value1: break; case value2: case value: statements; case value3: break; statements; further cases possible break; default: statements; case value4: break; case value5; } statements; break; further cases possible default: statements; break; } Notes: ■ ■ A switch statement can have any number of case labels. As we suggested in Chapter 12, one of the common purposes of modeling is to help us learn something about the situation being modeled. For instance, you could introduce a Hunter class with the following properties. .); feed.addPost(message); feed.addPost(photo); Because of subtyping rules, we need only one method (with a parameter of type Post) to add both MessagePost and PhotoPost objects. Note also that ImageViewer does not implement ActionListener anymore (we removed its actionPerformed method), but the lambda expressions do. Note how the description includes details of how to use this class to start the game. We then create a label component (type JLabel) and add it to the content pane. It defines two lists (each based on class ArrayList) to hold the collection of message posts and the collection of photo posts. Take a look at Appendix C to find out what other operators are available. Every object involved must be from a class that implements the Serializable interface. Avoid abbreviations. Java Java was chosen because of both its language design and its popularity. They include at least Afrikaans, Catalan, Chinese, Czech, Danish, Dutch, English, French, German, Greek, Italian, Japanese, Korean, Portuguese, Russian, Slovak, Spanish, and Swedish. substitution Subtype objects may be used wherever objects of a supertype are expected. “Inverting” a color means replacing each color value x ith x. Create an object and then inspect its fields. The purpose of the statement is to assert something that should be true at this point in the method. It should store this information permanently so that it can be used later. Exercise 6.21 Look up the details of the SecureRandom class that is defined in the java.security package. While in principle it is possible to do this using a for-each loop, our practice and advice is not to use a for-each loop for tasks that might not need to process the whole collection. If so, how could you demonstrate this? Apart from this, we then need another object: an object representing the complete news feed that can hold a collection of message posts and a collection of photo posts. The SOUTH area is similar: another JPanel with a FlowLayout. The sound player includes an example of doing this. The more detailed a simulation is, the more accurate it may be in forecasting the behavior of the real system. Several of these features are unique to the BlueJ environment. We must declare in the class header that it implements the ActionListener interface. Because each animal can give birth to new animals, lists for these to be stored in are passed as parameters to the hunt and run methods of Fox and Rabbit. 15.7.2 Decorator The Decorator pattern deals with the problem of adding functionality to an existing object. A test for content equality asks whether two objects are the same internally—that is, whether the internal states of two objects are the same. Following is our next idea. But using inheritance is a static solution: once created, objects cannot change their behavior. All we need to do is provide an implementation for the apply method that manipulates an image (passed in as a parameter) using its getPixel and setPixel methods. Avoid ambiguity. M14_BARN7367_06_SE_C14.indd 516 4/11/16 3:43 PM 14.2 Defensive programming | 517 The problem with the removeDetails method is that it assumes that the key passed to it is a valid key for the address book. There is no absolute rule about exactly how far to go with the outline implementation in any particular application. After each step (when all the animals have had the chance to act), the new current state of the field is displayed on screen. Classes are the only things we have initially, so the first method that can be invoked must be a class method. Declaring the class abstract enforces this restriction. At this stage, no limits were put on the grid area (other than that coordinate values should be positive), but this raises the need in a later stage for something to record the boundaries of the area in which the company operates. Pitfall Comparing strings with the == operator can lead to unintended results. We shall discuss interfaces in much more detail later in this book. Exercise 12.40 Review the overriding rules for methods and fields discussed in Chapter 11. One of the most common errors in the code of beginning programmers is getting the curly brackets wrong—either by having them in the wrong place, or by having a bracket missing altogether. Once you understand how to use one of them, you can use them all. For further reading on input/output in Java, we recommend Oracle’s tutorial, which can be found online at: 14.9.1 Readers, writers, and streams Several of the classes of the java.io package fall into one of two main categories: those dealing with text files, and those dealing with binary files. It is a first, rudimentary implementation of our system. This is recommended, because it speeds up access and can work without an Internet connection. Another hair cutting M05_BARN7367_06_SE_C05.indd 182 4/11/16 3:13 PM first look at la das | 183 session. ... Closer inspection of the object’s pop-up menu shows that the method entries in the menu include the parameter types. Logical errors arise for several reasons, which may overlap in some situations: ■ ■ ■ The solution to a problem has been implemented incorrectly. Currently, because EventPost is a subclass of Post, it automatically inherits the likes and comments fields. Rewrite the listAllTracks and listByArtist methods of the MusicOrganizer class to use streams and lambdas. Because zero is not less than zero, the loop’s body will not be executed at all, which is what we want. Concept accessor methods return information about the state of an object. Exercise 6.14 Write some code (in BlueJ) to test the generation of random numbers. public Pet(String petsName) { } Exercise 2.22 Challenge exercise The following object creation will result in the constructor of the Date class being called. A private variable that is used to indicate a pass mark, with the integer value of 40. Code 4.2 Playing functionality of the MusicOrganizer class M04_BARN7367_06_SE_C04.indd 141 4/11/16 3:10 PM 142 | Chapter 4 ■ Grouping Objects Code 4.2 continued Playing functionality of the MusicOrganizer class Exercise 4.17 Create a MusicOrganizer object in the second version of our project. Figure 11.6 Method lookup with inheritance v1.display( ); Post display PhotoPost PhotoPost v1; instance of : PhotoPost M11_BARN7367_06_SE_C11.indd 399 4/11/16 3:35 PM 400 | Chapter 11 Figure 11.7 ■ More about Inheritance v1.display( ); Method lookup with polymorphism and overriding Post display PhotoPost Post v1; display instance of : PhotoPost This scenario illustrates how objects inherit methods. A method indicates what kinds of parameters it requires. Every container has a layout manager. The idea is that, when a ticket is printed, any money in the balance is transferred to the total. M03_BARN7367_06_SE_C03.indd 114 4/11/16 3:06 PM 3.12 Method calls | 115 Exercise 3.33 Given a variable Printer p1; which currently holds a reference to a printer object, and two methods inside the Printer class with the headers public void print(String filename, boolean doubleSided) public int getStatus(int delay) write two possible calls to each of these methods. Numerous hurdles of syntax and detail have to be overcome before A01_BARN7367_06_SE_FM.indd 18 4/15/16 6:10 PM Preface | 19 the first experience with a living object arises. Real objects first One of the reasons for choosing BlueJ was that it allows an approach where teachers truly deal with the important concepts first. Now I am talking about an object—about one particular example of a car. M02_BARN7367_06_SE_C02.indd 93 4/11/16 3:02 PM This page intentionally left blank Chapter 3 Object Interaction Main concepts discussed in this chapter: ■ abstraction ■ object diagrams ■ modularization ■ method calls ■ object creation ■ debuggers Java constructs discussed in this chapter: class types, logic operators (&&, ||), string concatenation, modulo operator (%), object construction (new), method calls (dot notation), this In the previous chapters, we have examined what objects are and how they are implemented. Code 13.4 shows the important differences from previous versions. autoboxing Autoboxing is performed automatically when a primitive-type value is used in a context requiring a wrapper type. This provides a quick preview of the documentation, but will not contain references to documentation of superclasses or used classes. One place where you can look is the online documentation of Oracle’s Java distribution. In particular, we discussed fields, constructors, and methods when we looked at class definitions. Describe in your own words what they do and the differences between them. In reaching a conclusion, you might like to consider the effect of substituting the values of class variables into the bodies of the methods that use them. What happens if you do not insert enough and then try to print a ticket? Predator–prey modeling There is a long history of trying to model predator–prey relationships mathematically before the invention of the computer, because they have economic, as well as environmental, importance. We want to have the ability to change between different views!) Exercise 12.64 Can you manage to have all three views active at the same time? H.1 Server setup The setup of the repository server should normally be done by an experienced administrator. You use a contacts list by looking up a name and getting a phone number. Looking at the animal-monitoring-v1 project that you have been working on, you may have noticed that there are two methods left using for-each loops that we have not rewritten yet using streams. As we discuss in Section 15.6, one additional benefit of prototyping is that it can give the developers insights into issues and problems that were not considered at an earlier stage. The two “+” operators are being used to construct a single actual parameter, in the form of a string, from three separate components: ■ ■ ■ M02_BARN7367_06_SE_C02.indd 68 the string literal: " # " (note the space character after the hash); the value of the price field (note that there are no quotes around the field name because we want the field’s value, not its name); the string literal: " cents." (note the space character before the word "cents"). Failure by the client to handle an exception will result in the application terminating immediately.1 In addition, the exception mechanism is independent of the return value of a method, so it can be used for all methods, irrespective of the return type. It is important to note that the change in Simulator to processing all the animals in a single list, rather than in separate lists, means that the simulation results in version 2 will not be identical to those in version 1. In general, it is preferable to avoid defining default methods in interfaces except for the purpose of adapting legacy code. String response = responder.generateResponse(); System.out.println(response); M06_BARN7367_06_SE_C06.indd 205 4/11/16 3:17 PM 206 | Chapter 6 ■ More-Sophisticated Behavior Thus, the loop repeatedly ■ reads some user input, ■ asks the responder to generate a response, and ■ prints out that response. The object diagram also shows another important detail: when a variable stores an object, the object is not stored in the variable directly, but rather an object reference is stored in the variable. For instance, if the value of the name field is “Helen”, then printDetails would print: The name of this person is Helen If you have managed to complete most or all of these exercises, then you might like to try creating a new project in BlueJ and making up your own class definition for a Person. 13.7.1 Buttons We now want to add functionality to the image viewer to change the size of the image. For example: import java.util.ArrayList; import java.util.HashSet; is better than import java.util.*; J.4.5 Always include a constructor (even if the body is empty) J.4.6 Always include a superclass constructor call In constructors of subclasses, do not rely on automatic insertion of a superclass call. PEARSON, and ALWAYS LEARNING are exclusive trademarks in the U.S. and/or other countries owned by Pearson Education, Inc. Try other numbers. We can see from this output that the display methods in MessagePost and in PhotoPost were executed, but not the one in Post. lifetime The lifetime of a variable describes how long the variable continues to exist before it is destroyed. We will meet some of these in Chapter 6. In short, fields should always be private. In this version, the response will still not depend on the user’s input (we’ll do that later), but at least it will vary the response and look a lot better. Do not be tempted to rush through it; take your time and study it thoroughly. public void setPrice(int cost) Exercise 2.32 Complete the body of the setPrice method so that it assigns the value of its parameter to the price field. This can be used to conduct any post-test housekeeping or clean-up operations, should they be needed. However, at this point we will only move alive, location, and field to the Animal superclass, and come back to discuss the age field later. Exercise 13.57 What is a tabbed pane? If so, try to correct them in your copy of the project. Most importantly, we start using collections of objects. Many of the listener interfaces associated with GUIs are functional interfaces and it will be appropriate to implement listeners using the lambda syntax. Tell me more. You may assume that there will always be an even number of lines (i.e., no missing responses). We will explore the mechanism behind polymorphic variables in detail in Chapters 10 and 11. Code 14.7 shows the revised constructor that will prevent an entry from ever having both name and phone fields blank. Display a large image and experiment with resizing the window. Z02_BARN7367_06_SE_APPB.indd 601 4/11/16 3:50 PM 602 | Appendices Because variables of the primitive types do not refer to objects, there are no methods associated with the primitive types. A change to a field or a method that is shared between different types of subclasses needs to be made only once. Compare the implementation of the method in Code 2.1 with that in Code 2.8 to see whether you can tell what those differences are. In this chapter, we will introduce some of the important classes from the class library, and further library classes will be introduced throughout the book. The content, however, should be more or less the same. In other words, it provides a way to describe the location of something on the Internet. The Animal class shows an example where a class does not implement an inherited interface method. Borders can be used to group components, or just to add some space between them. There are no functions to sort the displayed list of posts—for example, by date and time or by relevance. How important is this fact to the internal consistency of an AddressBook? A parameter and a field sharing a name is not really a problem in Java. 3 There is a shorter, more elegant way of doing this. Chapter 5 presents the first advanced section (a section that can be skipped if time is short): It is an introduction to functional programming constructs. This method correctly tests whether the contents of two String objects are the same. M06_BARN7367_06_SE_C06.indd 207 4/11/16 3:17 PM 208 | Chapter 6 ■ More-Sophisticated Behavior 6.3.1 Interfaces versus implementation You will see that the documentation includes different pieces of information. We always start out with the frame being invisible so that we can arrange all the components inside the frame without the construction process being visible on screen. Several possible problems and solutions are discussed, and Java’s exception-handling mechanism is discussed in detail. 15.7.4 Factory method The Factory method pattern provides an interface for creating objects, but lets subclasses decide which specific class of object is created. The class’s constructor contains only a call to this method. Exercise 3.45 Open the editor for the MailClient class and set a breakpoint at the first line of the printNextMailItem ethod as sho n in i ure Once you have set the breakpoint, invoke the printNextMailItem method on Juan’s mail client. Exercise 15.1 Review projects from earlier chapters in this book. If, for example, 24 is passed in as the roll-over limit, the display will roll over to 0 at that value. String number = contacts.get("Lisa Jones"); System.out.println(number); Note that you pass the key (the name “Lisa Jones”) to the get method in order to receive the value (the phone number). From the name, we can guess that this method should display a status message using the status label we created earlier. Exercise 6.10 Find the equals method in the documentation for class String. Provide sufficient taxis to enable multiple independent passengers to be picked up and taken to their destinations concurrently. protected Declaring a field or a method protected allows direct access to it from (direct or indirect) subclasses. The boxBounce method should have a parameter that specifies how many balls are in the box. Do you get an error? 6.2.1 Exploring the TechSupport system Exercise 6.1 Open and run the project tech-support-complete. When the collection must be changed during iteration, use an Iterator with a while loop or a for loop, not an integer index. Here, it is rewritten in the functional style, using the collect method. Mutator methods modify an object’s state. 3.14.3 Stepping into methods When stepping through the printNextMailItem method, we have seen two method calls to objects of our own classes. Exercise 12.36 Is it possible for a class that has no abstract methods to be defined as abstract? We could have easily moved the age field to Animal and provided for it there an accessor and a mutator that were called by subclass methods, such as incrementAge. We are currently not recording which user liked a post. We need to play through many more scenarios to get a better understanding of how the system should work. Both involve iterating over their respective lists, and making a test of each element to see if it fulfills a particular requirement. The name gives a hint about the meaning of the data expected. Now we can start to see the purpose of abstract methods. This is primarily because a programmer has little, if any, control over the environments in which their programs are run, but it also reflects the complexity and diversity of the environments in which programs are run. This makes it possible to use values from the primitive types where object types are required, through a process known as autoboxing. Names such as price, cost, title, and alive all tell you something useful about the information being stored in that variable. Bergin: “Fourteen Pedagogical Patterns for Teaching Computer Science,” Proceedings of the Fifth European Conference on Pattern Languages of Programs (EuroPLop 2000), Irsee, Germany, July 2000. Within the body of a void method, this difference is reflected in the fact that there is no return statement.2 Code 2.6 The insertMoney method In the body of insertMoney, there is a single statement that is another form of assignment statement. BlueJ supports both Subversion and CVS repositories. (We should emphasize that functional is not a contradiction to objectoriented: whether the functional material is included in the study, or the course emphasis 4/15/16 6:10 PM Preface | 17 is largely on imperative techniques, every reader of this book will emerge with a good understanding of object orientation!) Yet another way to approach the material is to skip the advanced sections initially, and cover them as a separate unit at a later time. M10B_BARN7367_06_SE_C10.indd 368 4/11/16 3:32 PM 10.1 The network example | 369 Code 10.3 Source code of the NewsFeed class M10B_BARN7367_06_SE_C10.indd 369 4/11/16 3:32 PM 370 | Chapter 10 ■ Improving Structure with Inheritance Code 10.3 continued Source code of the NewsFeed class This is by no means a complete application. /** * A class that maintains information on a book. 12 minutes ago. 12.2.1 The foxes-and-rabbits project Open the foxes-and-rabbits-v1 project. It is important to understand the similarities and differences between these three kinds. You will find the documentation for the class HashMap in the Java library documentation. For instance, a small, enclosed environment could lead to overcrowding and make it easy for the predators to locate their prey, or a polluted environment could reduce the stock of prey and prevent even a modest population of predators from surviving. Which is better? Most important from the viewpoint of a user of your class is to have documentation for the class and its public constructors and methods. This has been implemented as a targetLocation field in the superclass. Java 7 introduced two mainstream additions to the try statement: multi-catch and try-withresources, or automatic resource management (ARM). With the animal-monitoring project we might want to find all the sightings of a given animal. Once again, experiment via the editor. The program will then run forever. At the heart of object orientation are two concepts that we have to understand first: objects and classes. Each academic year adds new records to the collection, while the records of those who have left are moved to an archive collection. Before looking at the specific Java methods, we will discuss the basic idea of these functions. Nevertheless, in a little while we will see how all this works out in practice when we look at loops and iteration. ■ How do we react to user input? Identifying steps also helps in planning the timing of the development process. A wellknown example is weather forecasting: climate models in weather simulations have been M12_BARN7367_06_SE_C12.indd 417 4/11/16 3:37 PM 418 | Chapter 12 ■ Further Abstraction Techniques improved by adding more and more detail over the last few decades. D.4 Exceptions Throwing and catching exceptions provides another pair of constructs to alter control flow. Add an exception handler to the remove method of AddressBookTextInterface to catch and report occurrences of this exception. Exercise 2.5 Create another ticket machine for tickets of a different price; remember that you have to supply this value when you create the machine object. Doing this is no more complicated than adding the label. Consider the case of a web-browser asked to display a web page that does not exist, or a program that tries to write data to a disk that has no more space left. You should see a return value containing the price of the tickets that was set when this object was created. If it is less than three, then print an error message and leave the field unchanged. Can you explain why this is? Declaring a variable of type Vehicle states that this variable can hold vehicles. One ArrayList might store student-record objects, while another stores event reminders. Our main concerns will be on the aspects that most affect population size: birth, death, and food supply. Shuttles may collect several passengers from different locations on the same trip, taking them to similar locations (such as collecting several guests from different hotels and taking them to different terminals at the airport). This has to be in a static part of the class (initializations of static fields or static methods), because no instance will otherwise exist. For instance, a programmer would never knowingly try to get an item from a position in a list that does not exist, so when they do, it elicits an unchecked exception. When a constructor or method is called, the extra space for the parameter variables is created, and the external values copied into that space. Exercise 13.22 Experiment with other layout managers. Presumably there could be different-sized shuttles. In the case where a method expects an object as a parameter, the expected object’s class name is specified as the parameter type in the method signature. Code 2.9 The Student class M02_BARN7367_06_SE_C02.indd 83 4/11/16 3:02 PM 84 | Chapter 2 ■ Understanding Class Definitions Code 2.9 continued The Student class M02_BARN7367_06_SE_C02.indd 84 4/11/16 3:02 PM 2.21 Calling methods | 85 Code 2.9 continued The Student class In this small example, the pieces of information we wish to store for a student are their name, their student ID, and the number of course credits they have obtained so far. | 223 Using sets The Java standard library includes different variations of sets implemented in different classes. So far, we have interpreted the requirement that parameter types must match as meaning “must be of M10B_BARN7367_06_SE_C10.indd 381 4/11/16 3:32 PM 382 | Chapter 10 ■ Improving Structure with Inheritance the same type”—for instance, that the type name of an actual parameter must be the same as the type name of the corresponding formal parameter. See Section 3.13.2 for a way around this when necessary. Model/view separation This application uses a better model/view separation than the previous example. If the object in v is of another type, the runtime system will indicate an error (called a ClassCastException), and the program will stop.3 3 Exceptions are discussed in detail in Chapter 14. Ensure that you understand how movement of the taxi is effected through its act method. The most important are: FlowLayout, BorderLayout, GridLayout, and BoxLayout. */ Particular thought should be given to the first sentence of the main description for a class, interface, or method, as it is used in a separate summary at the top of the generated documentation. ■ Instead of just looking at Java statements, we can also type them. Having access to every item in the collection, however, does not mean we have to do the same thing to every one; we can be more selective than that. Exercise 4.27 Write a method in your version of the project that plays sa les of all the tracks a articular artist one after the other The listMatching method illustrates the basic structure you need for this method. Exercise 2.55 Write an assignment statement that will divide the value in total by the value in count and store the result in mean. That it does not has historical rather than logical reasons. Concrete subclasses of Event will then supply the specific details for the different event types. The more experienced you get as a software developer, the more time you will spend thinking about higher-level structure rather than about implementation of single methods. public int refundBalance() { balance = 0; return balance; } What tests can you run to demonstrate that it does not? The solution we chose was to have the company store a vehicle:passenger pairing in a map. Because the from parameter is defined in the constructor, and the from field is defined in the class, the parameter will be used. If the test is true, then we do one thing; otherwise, we do something different. Inheritance avoids code duplication not only in the server classes, but also in clients of those classes. This new class does not receive a name. In reality, the (dynamic) type of the collection may be ArrayList, in which case the iterator method returns an object of type ArrayListIterator. Chapter 15 discusses in more detail the next level of abstraction: How to structure a vaguely described problem into classes and methods. Admittedly, this does not yet look simpler than before, but we will get there in a moment. Unfortunately, knowing which category of exception to throw in any particular circumstance is not an exact science, but we can offer the following general advice: ■ ■ One rule of thumb is to use unchecked exceptions for situations that should lead to program failure—typically because it is suspected that there is a logical error in the program that will prevent it from continuing any further. This means that the last item in a collection has the index size-1. Is there a need to introduce further decoupling to the classes? Technically, what we are doing here is storing the Person object into a variable; we will discuss this in detail in the next chapter. Will the selection of a random-response still work properly? With the input cursor in the dialog entry field, click on one of the student objects; this enters the name of the student object into the parameter field of the enrollStudent method i ure 1.9). Essentially, the hashCode method returns an integer value that represents an object. The solution in the project tech-support-complete contains all these changes. Experiment with both versions to gain some experience with what the application can do. But this effort will be well rewarded from the greater variety of things we can achieve with them. Where a class implements multiple interfaces and two or more of the interfaces have a default method with the same signature then the implementing class must override that method—even if the alternative versions of the method are identical. Before doing anything else, call the getBalance method on it. return pickDefaultResponse(); } } In this code fragment, we look up the word entered by the user in our response map. Control transfers to here Transfer of control in a try statement 5 See Exercise 14.31 for an example of what can happen if a statement that might result in an exception is treated in isolation from the statements around it. Try in your project all of the layout managers mentioned above, and test whether they behave as expected. In the next section, we provide some further review material. A very nice aspect of our existing design was that we could set up the floor plan in a single spot, and the rest of the game was completely independent of it. Exercise 13.64 The application always resizes its frame in order to ensure that the full image is always visible. In all of the project examples in this book, we have used a particular commenting style that is recognized by the javadoc documentation tool, which is distributed as part of the JDK. We will discuss the details later in this chapter, but see what you can find out on your own before reading on. If we were trying to construct a car in software, using an object-oriented language, we would try to do what the car engineers do. Using javadoc with Java programs will help you to do this. This single instance is a mouse-listener object (it is indirectly a subtype of MouseListener) and so it can be passed to a GUI component's addMouseListener method. Figure 2.1 The BlueJ editor window M02_BARN7367_06_SE_C02.indd 51 4/11/16 3:02 PM 52 | Chapter 2 ■ Understanding Class Definitions Code 2.1 The TicketMachine class M02_BARN7367_06_SE_C02.indd 52 4/11/16 3:02 PM 2.3 The class header | 53 Code 2.1 continued The TicketMachine class 2.3 The class header The text of a class can be broken down into two main parts: a small outer wrapping that simply names the class (appearing on a green background), and a much larger inner part that does all the work. We will first investigate the printNextMailItem method. In the latter case, the uncaught exception could be an unchecked exception that does not require a catch block, for instance. You will need to provide an accessor method for responseMap. It is quite common to initialize local variables within their declaration. We can then call methods (increment, getValue) of that object to make it work for us. field Fields store data for an object to use. Check by pressing the Compile button to see if there is an error message. It also enables programmers to work on the implementation of several classes independently, without having to wait for the implementation of one class to be finished before implementation of another can begin. You should, however, attempt to do the exercises yourself first, before you look at the solution. Exercise 1.25 Look at the signature of the enrollStudent method. M12_BARN7367_06_SE_C12.indd 434 4/11/16 3:38 PM 12.3 Abstract classes | 435 Exercise 12.33 How has using inheritance improved the project so far? In this case, the outer wrapping appears as follows: public class TicketMachine { Inner part of the class omitted. We have encountered a small number of components (labels, buttons, menus, menu items), and we have discussed the handling of action events in quite some detail. Both primitive types and object types can be used as types, but there are situations in which they behave differently. Instances of class MessagePost will have all fields defined in class MessagePost and in class Post. All of the printing statements in the printTicket method are calls to the println method of the System.out object that is built into the Java language, and what appears between the round brackets is the parameter to each method call, as you might expect. | 113 This statement is a method call. What happens when you select a menu item? We have discussed the three main conceptual areas: creating GUI components, layout, and event handling. Thus, the statement may be wrong, and therefore not allowed. F.2.3 Step Into The Step Into button resumes execution at the current statement. multiple inheritance A situation in which a class inherits from more than one superclass is called multiple inheritance. The constructor of the LogAnalyzer class includes a statement to create an int array object: hourCounts = new int[24]; Once again, notice how different the syntax is from that of normal object creation. M10B_BARN7367_06_SE_C10.indd 371 4/11/16 3:32 PM 372 | Chapter 10 ■ Improving Structure with Inheritance Figure 10.5 shows a class diagram for this new structure. G.3 Creating a test method Test methods can be created interactively. This could be improved by splitting the Simulator into two classes: one class, Simulator, that runs the simulation and is completely decoupled from the concrete animal classes, and another class, PopulationGenerator (created and called by the simulator), that creates the population. Do species always disappear completely in some configurations? A01_BARN7367_06_SE_FM.indd 28 4/15/16 6:10 PM Part 1 Foundations of Object Orientation Chapter 1 Objects and Classes Chapter 2 Understanding Class Definitions Chapter 3 Object Interaction Chapter 4 Grouping Objects Chapter 5 Functional Processing of Collections (Advanced) Chapter 6 More-Sophisticated Behavior Chapter 7 Fixed-Size Collections—Arrays Chapter 8 Designing Classes Chapter 9 Well-Behaved Objects M01A_BARN7367_06_SE_P01.indd 29 4/11/16 2:37 PM This page intentionally left blank Chap ter 1 Objects and Classes Main concepts discussed in this chapter: ■ objects ■ classes ■ methods ■ parameters It's time to jump in and get started with our discussion of object-oriented programming. We can say that "a message post is a post" and "a photo post is a post." The purpose of using inheritance is now fairly obvious. The method should create a SupportSystem object and invoke the start method on it. When a file has been opened successfully, then the writer's write methods can be used to store characters—often in the form of strings—into the file. Both areas also include any variables inherited from superclasses. Consider the following statement: Vehicle v1 = new Car(); Concept The static type of a variable v is the type as declared in the source code in the variable declaration statement. However, parameter checking is primarily intended to protect a server object from incorrect usage by a client. Package java.util —Summary of the most important classes and interfaces interface Collection This interface provides the core set of methods for most of the collection-based classes defined in the java.util package, such as ArrayList, HashSet, and LinkedList. Find all occurrences of the view classes and interfaces, and trace all variables declared using any of these types. This way, the details of every element will be printed. TechSupport is a program intended to provide technical support for customers of the fictitious DodgySoft software company. A conditional statement allows us to take one of two possible actions based upon the result of a check or test. There are different types of events caused by different types of actions. We discussed the "and" operator && in Chapter 3, which only evaluates to true if both of its operands are true. Does this allow you to display images that would otherwise be too large for the screen? You will see the circle move 50 pixels to the right.2 The moveHorizontal method that was just called is written in such a way that it requires some more information to execute. For instance, List tracks = new LinkedList(); or Map responseMap = new HashMap(); Here, the variable is declared to be of type List, even though the object created and stored in it is of type LinkedList (and the same for Map and HashMap). BlueJ is a full Java environment. Standard events might be a user joining a group, a user becoming friends with another, or a user changing their profile picture. Z12_BARN7367_06_SE_APPL.indd 646 4/11/16 4:01 PM L: Concept Glossary | 647 object references Variables of object types store references to objects. 4.7 Numbering within collections When exploring the music-organizer-v1 project in the first few exercises, we noted that it was necessary to use parameter values starting at 0 to list and remove file names in the collection. Now, however, we are ready to have a look at the construction of GUIs. Some of the material in this chapter makes extensive use of the lambda expression feature that was introduced in Java 8. We make sure that it is initially false. Do you feel the order is appropriate? All classes for a project are placed inside this directory. Exercise 6.78 Why do you think the methods in the Math class are static? Figure 11.10 Alternative output from display (shaded areas printed by superclass method) Leonardo da Vinci 40 seconds ago - 2 people like this. This site details these new enhancements and provides the latest download. For instance, setLocation is private in both Fox and Rabbit, but cannot be kept private in Animal because Fox and Rabbit would not be able to call it. I wish that I had understood earlier what was happening. Exercise 1.21 Create an object of class Student. Figure 1.9 Adding a student to a LabClass Figure 1.10 Output of the LabClass class listing M01B_BARN7367_06_SE_C01.indd 44 4/11/16 2:54 PM 1.15 Summary | 45 As the exercises show, objects can be passed as parameters to methods of other objects. M16_BARN7367_06_SE_C16.indd 590 4/11/16 3:47 PM 16.4 Iterative development | 591 Exercise 16.17 Critically assess the list of steps we have outlined, with the following questions in mind. .) The parameter to this method will be a lambda—a piece of code—with the syntax as we have seen it above. Exercise 10.10 In what inheritance relationship might a touch pad and a mouse be? Attempt a recovery, if possible. Like formal parameters, local variables have a scope that is limited to the statements of the method to which they belong. GridView is identical to the previous SimulatorView class. Once we have done the exercise described above, writing each class's interface is easy. Once a color has been chosen, pixels are replaced with that color until a new color is chosen. We always have to call the pack method on the frame after we have added or resized components. Use large lists of objects for the tests, to make the results significant. Figure 13.1 AWT and Swing M13_BARN7367_06_SE_C13.indd 463 4/15/16 3:06 PM 464 | Chapter 13 ■ Building Graphical User Interfaces Figure 13.2 A simple imageviewer application Concept Image format Images can be stored in different formats. F.4 The Call Sequence display Figure F.5 shows the Call Sequence display, containing a sequence six methods deep. It keeps its own private count of how many items it is currently storing. M06_BARN7367_06_SE_C06.indd 211 4/11/16 3:17 PM 212 | Chapter 6 ■ More-Sophisticated Behavior them each time it is expected to reply. 4.9.3 A limitation of using strings By this point we can see that simply having file name strings containing all the details of the music track is not really satisfactory. We would have to do the same for a fourth type of post. Objects store data in fields (which also have types). These include systems that model traffic flows in a city, forecast weather, simulate the spread of infection, analyze the stock market, do environmental simulations, and much more. For the sake of simplicity, the first version of this project will simply work with the file names of individual music tracks. The shuttles are used to pick up individuals from different locations and transport them to their several destinations. Three classes are involved: JMenuBar—An object of this class represents a menu bar that can be displayed below the title bar at the top of a window (see Figure 13.3). Change the class back to how it was, and make sure that this clears the error when you compile it. Exercise 6.28 What happens when you add an entry to a map with a key that already exists in the map? The pen itself is invisible, but it will draw a line when moved on the canvas. 4.1 Building on themes from Chapter 3 As well as introducing new material on collections and iteration, we will also be revisiting two of the key themes that were introduced in Chapter 3: abstraction and object interaction. What are its parameters? You can enter a multiline text into a string by using "" in the string for the line break. If it is different, we have two distinct objects. Code 14.22 illustrates how a text file that is to be interpreted as containing integer data might be read in this way. 12.5.3 Selective drawing One way to implement the separation of visualization from acting is to change the way it is performed in the simulation. Take a look at the source code of the TicketMachine class by double-clicking its icon in the class diagram within BlueJ. A first (naïve and incorrect) attempt could look like this: Container contentPane = frame.getContentPane(); filenameLabel = new JLabel(); contentPane.add(filenameLabel); imagePanel = new ImagePanel(); contentPane.add(imagePanel); statusLabel = new JLabel("Version 1.0"); contentPane.add(statusLabel); The idea here is simple: we get the frame's content pane and add, one after the other, all three components that we wish to display. In a pipeline, the last operation must always be a terminal operation, and all others must be intermediate operations: source.inter1(. We can create a menu bar and use this method to attach our menu bar to the frame: JMenuBar menubar = new JMenuBar(); frame.setJMenuBar(menubar); Now we are ready to create a menu and add it to the menu bar: JMenu fileMenu = new JMenu("File"); menubar.add(fileMenu); These two lines create a menu labeled File and insert it into our menu bar. Furthermore, the methods' existence could invite unintended coupling to other classes. Add a mutator, borrow, to the class. So a listAllFiles method would also have to take that dynamic size into account in order to do its job. Listing subsets of the collection will be common: all the students taking first-year CS, or all the students due to graduate this year, for instance. However, the method should print the reference number only if it has been set—that is, if the refNumber string has a non-zero length. Components are arranged on screen with the help of containers and layout managers. The last line finally makes the frame visible on screen. It often does not provide an implementation for most of its methods. Exercise 2.17 Write in full the declaration for a field of type int whose name is status. Components are the individual parts that a GUI is built from. 1 The text for the message post is a two-line string. An object becomes an event listener by implementing one of several existing listener interfaces. We will discuss this in more detail later. 6 It is important to note that the input-output Stream classes in the java.io package are different from the Stream classes in the java.util.stream package. What kind of containers/layout managers do you think were used to create it? Exercise 14.15 In dealing with parameter errors, we have not printed any error messages. One of the most useful may be the section entitled Using Swing Components and in it the subsection How To . . . It contains these entries: How to Use Buttons, Check Boxes, and Radio Buttons; How to Use Labels; How to Make Dialogs; How to Use Panels; and so on. Exercise 13.79 Challenge exercise Have the position slider move as a track is being played. We will explain that in the next section. Exercise 15.11 Outline a prototype for your cinema-system example. Why are random numbers important for cryptographic security? Smith", "(998) 5488 0123"); As we saw with ArrayList, when declaring a HashMap variable and creating a HashMap object, we have to say what type of objects will be stored in the map and, additionally, what type of objects will be used for the key. file fulfill a similar role to the legacy File class. The Sighting class, however, is very straightforward. However, many individual programmers are constantly writing their own useful classes and making them available for other people to use. It is hard to grasp the concept of an object when all you ever see on the screen is lines of code! The diagram notation is a simple subset of UML, tailored to the needs of beginning students. Another engineer much further down the chain may spend her days thinking about the chemical composition necessary to produce the right materials to make the tires. 15.6.2 Iterative development One possibility to address the problems of the waterfall model is to use early prototyping and frequent client interaction in the development process. 11.2.1 Calling display from NewsFeed First, we investigate the problem of calling the display method from NewsFeed. A situation in which a class inherits from more than one superclass is called multiple inheritance 12.6 The scenario presented here uses a structure known as multiple inheritance. Instead, the price of tickets should be fixed at 1,000 cents. In this book, we present the imperative style first, and introduce the functional style in 'advanced' sections (such as this chapter). The imageviewer1-0 project, included in the book projects, contains an implementation of all the functionality discussed thus far. Even mid-range laptops and mobile phones now have processors with multiple cores, making parallel processing a real possibility on everyday devices. Then create a MessagePost object. Looking through the JOptionPane documentation, we find that there are static methods named showMessageDialog to do this. The eighth statement resets the balance to zero with a basic assignment statement, in preparation for the next customer. What happens? Methods with return values enable us to get information from an object via a method call. (Hint: It contains another method call to a method also called darker. Drawable actors must then inherit from both Actor and Drawable. Walkthroughs, print statements, and interactive testing are useful techniques for initial testing of newly written code, to investigate how a program segment works, or for debugging. This is done by using the Step Into command in the debugger instead of the Step command. The Local variables area displays the values of local variables and parameters of the currently executing method or constructor. In simple terms, serialization allows a whole object to be written to an external file in a single write operation and read back in at a later stage using a single read operation.9 This works with both simple objects and multi-component objects such as collections. 3.8.2 String concatenation The next method, getDisplayValue, also returns the display's value, but in a different format. When an object is created, so are the fields, and they persist for the lifetime of the object. Z07_BARN7367_06_SE_APPG.indd 625 4/11/16 3:55 PM 626 | Appendices Once recording has started, any object creations or method calls will form part of the code of the method being created. Draw a class diagram. The big question now is this: How do we write the class for such an object? The verbs describe "actions," such as writing, eating, etc. But notice that those three "audiences" for the notification will often be completely different. The cast operator consists of the name of a class or interface type written in parentheses in front of a variable or an expression. Concept sequence rather than language constructs One other aspect that distinguishes this book from many others is that it is structured along fundamental software development tasks, not necessarily according to the particular Java language constructs. Identifying what kinds of objects (and with these, classes) you should have in a software system for any given problem is not always easy, and we shall have a lot more to say about that later in this book. In general, we can say: because a message post is a post, a message-post object has everything that a post has, and more. 3.14.2 Single stepping When stopped at a breakpoint, clicking the Step button executes a single line of code and then stops again. The ability to read and understand source code is one of the most essential skills for a software developer, and we will need to apply it in every project we work on. } In this case, the client could establish for itself that it would be inappropriate to call the server's method. We can summarize the purpose of the remaining classes as follows: Field represents a two-dimensional enclosed field. Exercise 12.37 Could it ever make sense to define a class as abstract if it has no abstract methods? Find the documentation for this class. The consequence is likely to be an incomplete file. Code 13.6 Pattern for a simple filtering process The filter function itself operates on the image, so following responsibility-driven design guidelines, it should be implemented in the OFImage class. This offers the opportunity to make an assertion about the result value by ticking the Assert that box. The basic new idea is that we can pass a segment of code as a parameter to a method, which can then execute this piece of code later when it needs to. Exercise 4.7 Write assignments to the library, cs101, and track variables (which you defined in the previous three exercises) to create the appropriate ArrayList objects. Exercise 13.76 Modify the music player so that a double click on a list element in the track list starts playing that track. One way we could implement internal checking during development would be through the normal exception-throwing mechanism. To cover the latter case, the changeDetails method removes an old entry and replaces it with the revised details. 2 It executes the constructor of that class. Each entry is a key/value pair consisting of a name and a telephone number. We shall call this class Post. Java was designed to be reasonably easy to read for humans, not for computers. How does the info method differ from the warning method? Code 13.15 Using a nested GridLayout container inside a FlowLayout container Our buttons now look quite close to what we were aiming for. The key characteristic of definite iteration is that you can determine the number of iterations when the loop starts. Exercise 5.25 Write a method in the AnimalMonitor class that takes a single parameter, spotterID and returns a count of ho an si htin records ha e een ade the i en s otter se the strea s count method to do this. The split method can divide a string into separate substrings and return those in an array of strings. It uses the supposed key to retrieve the associated contact details: ContactDetails details = book.get(key); However, if the map does not have that particular key, then the details variable ends up containing null. We have also looked at some basic techniques for automating the testing process and performing simple debugging. 3.13 Concept A debugger is a software tool that helps in examining how an application executes. It may seem like a steep learning curve. (or equivalent) function, open the file docs/api/index.html. Experiment with different delays so you can observe the simulation behavior more clearly. Terms introduced in this chapter abstraction, modularization, divide and conquer, class diagram, object diagram, object reference, overloading, internal method call, external method call, dot notation, debugger, breakpoint M03_BARN7367_06_SE_C03.indd 125 4/11/16 3:06 PM 126 | Chapter 3 ■ Object Interaction Exercise 3.52 se the de u er to in esti ate the clock-display project. First, the setLayout method is used on the content pane to set the intended layout manager.4 The layout manager itself is an object, so we create an instance of BorderLayout and pass it to the setLayout method. However, BlueJ can be configured to use a local copy of the Java API documentation. This layout may seem very specialized at first—one wonders how often this is needed. However, we prefer to write the explicit assignments anyway. They are twofold: first, the while loop does not need to be related to a collection (we can loop on any condition that we can write as a boolean expression); second, even if we are using the loop to process the collection, we do not need to process every element—instead, we could stop earlier if we wanted to by including another component in the loop's condition that expresses why we would want to stop. Sometimes, though, we have made use of private methods. Our project processes reports of sightings of different types of animal, sent back by spotters from various different places. It maintains the order of items you insert into it. This might be overly conservative. The technique illustrated here makes it possible for each instance to use the value appropriate to its subclass type. In addition, its accuracy may surprise you; it would be a mistake to equate greater complexity with greater accuracy. If it is not greater than zero, then an error message is printed. The add method of an ArrayList stores an object in the list, and the size method tells us how many items are currently stored in it. Z12_BARN7367_06_SE_APPL.indd 645 4/11/16 4:01 PM 646 | Appendices library documentation The Java class library documentation shows details about all classes in the library. Figure 16.1 Noun and verb associations in the taxi company Nouns company taxi shuttle passenger location passenger-source vehicle M16_BARN7367_06_SE_C16.indd 581 Verbs operates taxis and shuttles receives a call schedules a vehicle transports a passenger transports one or more passengers calls the company picks up passenger arrives at pickup location notifies company of arrival notifies company of drop-off 4/11/16 3:47 PM 582 | Chapter 16 ■ A Case Study From that summary, it is clear that "taxi" and "shuttle" are distinct specializations of a more general vehicle class. Values for the mathematical constants e and π are defined here, along with trigonometric functions and others such as abs, min, max, and sqrt. They did this in version 8 of the language (Java 8, released in 2014). For this to work, however, it's important that the examples are well written and worth imitating. 4.9 Processing a whole collection At the end of the last section, we said that it would be useful to have a method in the music organizer that lists all of the file names stored in the collection. So we will start our exploration of the Java library by looking at a class that provides the simplest possible way of grouping objects, an unsorted but ordered flexible-sized list: ArrayList. It takes a single integer parameter and checks whether it is a valid index for the current state of the collection. This is unfortunate. M10B_BARN7367_06_SE_C10.indd 385 4/11/16 3:32 PM 386 | Chapter 10 ■ Improving Structure with Inheritance Now consider this code fragment, in which Bicycle is also a subclass of Vehicle: Vehicle v; Car c; Bicycle b; c = new Car(); v = c; // okay b = (Bicycle) c; // compile time error! b = (Bicycle) v; // runtime error! The last two assignments will both fail. What input causes an ActionListener associated with a JTextField to be notified? } public void clear(boolean invert) { ... In the case of a contacts list, this is done using alphabetical sorting. Exercise 12.30 In the current version of the simulation, the values of all similarly named class variables are different. In particular, it gives us a convenient means to associate a lambda expression with a type, for example to declare a variable that can hold a lambda. If so, make this change. Polymorphism appears in object-oriented languages in several contexts—polymorphic variables are just the first example. Alternatively, you can also simply click into the area next to the line of code where the breakpoint symbol appears, to set or clear breakpoints. Exercise 15.8 Make a new set of CRC cards for the classes you have identified. For instance: 0: 149 1: 149 2: 148 . . . 23: 166 When we compare this for loop to the for-each loop, we notice that the syntactic difference is in the section between the parentheses in the loop header. At the same time, we discuss iteration over collections, and have a first look at the for-each and while loops. We shall find that much of the total interaction in the system is explored by taking the fundamental scenario of trying to satisfy a passenger request to go from one location to another. How do we find out more information about the startsWith method or other methods of the String class? Libraries record details about the books and journals they own. The most important methods from OFImage for us are: ■ getPixel and setPixel to read and modify single pixels ■ getHeight and getWidth to find out about the image's size. Are there any steps missing? We can see that the makeDarker method in ImageViewer contains the part of the task that is related to the GUI (checking that we have an image loaded, displaying a status message, repainting the frame), whereas the darker method in OFImage includes the actual work of making each pixel in the image a bit darker. Code 14.18 An attempt at error recovery M14_BARN7367_06_SE_C14.indd 542 4/11/16 3:43 PM 14.8 Error recovery and avoidance | 543 Although this example illustrates recovery for a specific situation, the principles it illustrates are more general: ■ Anticipating an error, and recovering from it, will usually require a more complex flow of control than if an error cannot occur. If not, why not? private String author; private String title; /** * Set the author and title fields when this object * is constructed. We have to work out how to express the loop's condition in order to ensure that the loop stops at the right time. This version is available as the project imageviewer0-1a. Then check your understanding by experimenting within BlueJ. Java objects model objects from a problem domain. A breakpoint is a flag attached to a line of source code that will stop the execution of a method at that point when it is reached. Having done that, we return to the condition and re-evaluate it. Game is the name of the class that we want to start. The compiler cannot help us to ensure correctness in this case. In other words, even though class Animal does not implement the act method, it ensures that all existing animals have an implemented act method. Would it compile and run correctly? If we also follow the convention that unchecked exceptions should be used in those situations where we expect the result to be program termination—i.e., the exception is not going to be caught—then there is also nothing further to be discussed about what the method's caller should do, because it will do nothing and let the program fail. Exercise 12.60 Read the API description for the sort methods of the Collections class in the java.util package. Such references are not intended to imply any sponsorship, endorsement, authorization, or promotion of Pearson's products by the owners of such marks, or any relationship between the owner and Pearson Education, Inc. Methods contain statements, and initially we look at methods containing only simple arithmetic and printing statements. Terms introduced in this chapter: GUI, aWt, Swing, component, layout, event, event handling, event listener, frame, menu bar, menu, menu item, content pane, modal dialog, anonymous inner class M13_BARN7367_06_SE_C13.indd 509 4/15/16 3:07 PM 510 | Chapter 13 ■ Building Graphical User Interfaces Exercise 13.80 Add a GUI to the world-of-zuul project from Chapter 8. Run it on your computer. Running longer simulations is trivial. For this to work, we need another superclass called Drawable, which declares an abstract draw method. The PassengerSource class has been refactored significantly from the previous version, to better fit its role as an actor. Using this documentation is essential in order to make good use of library classes. One could write HashSet words = new HashSet(Arrays.asList(wordArray)); to replace all four lines of code. Exercise 13.27 Explain in detail how the darker method in OFImage works. This can greatly help in finding errors early and easily. One of the easiest ways to get to the bottom of this would be to split the single filter operation into three separate filters, and to print out fields of the remaining elements after each filtration step. In this method, a MailItem object is created in the first line of code: MailItem item = new MailItem(user, to, message); The idea here is that the mail item is used to encapsulate a mail message. Make changes to the removeDetails method to avoid a NullPointerException arising if the key value does not have a corresponding entry in the address book. For instance, the description identified various ways in which the taxi company might be contacted: by individuals, hotels, entertainment venues, and tourist organizations. Then create a square. Exercise 12.54 Redefine as an interface the abstract class Actor in your project. Exercise 2.74 Draw a picture of the form shown in Figure 2.3, representing the initial state of a Student object following its construction, with the following actual parameter values: new Student("Benjamin Jonson", "738321") Exercise 2.75 What would be returned by getLoginName for a student with name "Henry Moore" and id "557214"? M10B_BARN7367_06_SE_C10.indd 361 4/11/16 3:32 PM 362 | Chapter 10 ■ Improving Structure with Inheritance Once we have defined the MessagePost and PhotoPost classes, we can create as many post objects as we need—one object per message post or photo post that we want to store. It can be simpler to try to avoid the error in the first place, but this often requires collaboration between server and client. 3.8 Exercise 3.3 At what time(s) can an object diagram change? Charset can be found in the java.nio. This approach is shown in Code 12.8. Code 12.8 The canBreed method of Animal 3 This rule applies regardless of whether a field is static or not. For this reason, we usually want to be working with the BufferedReader class, which does define a readLine method. Exercise 6.22 Implement in your version of the tech-support system the random-response solution discussed here. Exercise 6.54 Properly document all classes in your version of the TechSupport project. Then additional features are gradually added (the software grows) in a controlled manner, and "finished" states (meaning states in which the software is completely usable and can be delivered to clients) are reached repeatedly and fairly frequently. Exercise 13.82 Design and build a GUI for a text editor. Or is there something else that is needed in the Actor class? (Remember: Constructing an object does two things—the object is being created, and the constructor is executed.) Calling the constructor works in a very similar fashion to calling methods. On the line above each in the full class definition, we have added a single line of text—a comment—for the benefit of human readers of the class definition: // The price of a ticket from this machine. The effect is identical to the inner-class version with the difference that we do not need to define separate named classes for the listeners and that the definition of the listener's methods is closer to the registration of the listener with the GUI component. Used again in Chapter 10 to add inheritance. That is exactly what the code does. Discuss the issues involved in this alternative design and, if you really feel like a challenge, try i le entin it ote that ou i ht need to find out a out the a a null keyword, which we don't cover until late in Chapter 4. Modularization is the process of dividing large things (problems) into smaller parts, while abstraction is the process of ignoring details to focus on the bigger picture. On the back of the card, note the instance fields that each class holds. If we again create and enter the objects described in Section 11.1, the output of the show method in our new version of the program is Had a great idea this morning. The idea is that each type has a Class object associated with it. The Taxi class implements the DrawableItem interface. In this theater, the first six rows have 20 seats, the next 10 rows have 22 seats, and the other rows have 26 seats. Exercise 1.19 Challenge exercise If you added your sunset to the end of the draw method (so that the sun goes down automatically when the picture is drawn), change this now. Many similar objects can be created from a single class. First, let us assume that we can build the class NumberDisplay, and then let us think a bit more about the complete clock display. The project foxes-and-rabbits-v1 provides a copy of the base version of the simulation for you to follow through the changes we make. You can type Java code here. The fields cannot be assigned to each other, even though their types were derived from the same ArrayList class. The Pallet class provides methods telling the height and weight of an individual pallet, according to the number of bricks on it. Exercise 12.26 Do you think it would be better for Simulator not to keep separate lists of foxes and rabbits, but to generate these lists again from the contents of the field at the beginning of each simulation step? Otherwise, an error will be reported. Exercise 3.11 What would happen if you replaced the ">=" operator in the test with ">" so that it reads if((replacementValue > 0) && (replacementValue < limit)) Exercise 3.12 What would happen if you replaced the && operator in the test with || so that it reads if((replacementValue >= 0) || (replacementValue < limit)) M03_BARN7367_06_SE_C03.indd 104 4/11/16 3:06 PM 3.8 The NumberDisplay class | 105 Exercise 3.13 Which of the following expressions return true? Computers, internally, work with a binary representation of a machine code, which looks quite different from Java. In that case, the logic of the application may not be properly implemented. One reason for this design decision is that it allows us to consider participants in the simulation that are not actually within the field—a representation for the weather might be one example of this. For instance, it is common to use a for loop when we wish to do something to every element in an array, such as printing the contents of each element. ■ Here are the two corresponding code fragments that express the full condition in both cases: int index = 0; boolean searching = true; while(index < files.size() && searching) 2 While there are ways to subvert this characteristic of a for-each loop, and they are used quite commonly, we consider them to be bad style and do not use them in our examples. The part of the application that we are prototyping here is the engine that stores and displays these posts. Although the fixed-size nature of arrays can be a significant disadvantage in many situations, they do have at least two compensating advantages over the flexible-size collection classes: Access to the items held in an array is often more efficient than access to the items in a comparable flexible-size collection. For instance, the getDetails method might also choose to throw this if the key string passed to it is a blank string (Code 14.6). It is important to distinguish between a throws clause in the header of a method, and the @throws javadoc comment that precedes the method; the latter is completely optional for both types of exception. (Do not delete the GridView class. We shall discuss only one small detail and leave the rest up to the reader to investigate. A client might have been programmed incorrectly, causing it to pass inappropriate parameter values to a server method. This serves two purposes: 1. We can now implement methods to handle menu items to do our various program tasks. For instance, it is questionable whether a full implementation of the MouseListener interface would be appropriate as an anonymous inner class, in view of the amount of code required; a named inner class would probably be preferable in terms of cohesion. Here is a description of the system: The program is an airport simulation system. The east and west components change in height but keep their width. Otherwise, the machine code version that the computer needs will not exist. Exercise 4.19 We know that the first file name is stored at index zero in the ArrayList, and the list stores the file names as strings, so could we write the body of listAllFiles along the following lines? The setBorder call on the content pane, with an EmptyBorder as a parameter, adds empty space around the outside of the frame. This is what gives a while loop its indefinite character—the re-evaluation process. Continue as normal. A FileReader object is often passed to the constructor of another reader class (such as a BufferedReader) rather than being used directly. 1.9 Java code When we program in Java, we essentially write down instructions to invoke methods on objects, just as we have done with our figure objects above. Experiment with resizing the frame. Then you say: Send me the next child. As the task of the analyze method is to count how many accesses were made during each hour period, the array needs 24 locations—one for each hour period in a 24-hour day. Is it possible for a listener to be notified of arbitrary changes to the text in the field? We can illustrate this principle with the following alternative version of the method body shown in Code 14.5: if(key == null) { throw new IllegalArgumentException("null key in getDetails"); } else { return book.get(key); } The absence of a return statement in the route that throws an exception is acceptable. If the constructor with no parameters is used, then the starting time displayed on the clock will be 00:00. Looking at the first few chapters, teachers used to a more sequential introduction will be surprised about the number of concepts touched on this early. This book confronts head-on the hardest concept to teach: objects. BlueJ is a Java development environment that is being developed and maintained by the Computing Education Research Group at the University of Kent in Canterbury, UK, A01_BARN7367_06_SE_FM.indd 17 4/15/16 6:10 PM 18 | Preface explicitly as an environment for teaching introductory object-oriented programming. M02_BARN7367_06_SE_C02.indd 82 4/11/16 3:02 PM 2.20 Reviewing a familiar example | 83 Exercise 2.72 Write a mutator method called setAge that takes a single parameter of type int and sets the value of a field called age. So it pays to become familiar with the contents of the library and how to use the most common classes. } 14.6 Defining new exception classes Where the standard exception classes do not satisfactorily describe the nature of an error condition, new, more-descriptive exception classes can be defined using inheritance. The method setTime takes two parameters—the hour and the minute—and sets the clock to the specified time. In fact, the header of each method tells us whether or not it returns a result, and what the type of the result is. At the end of the project, however, you will hopefully come to appreciate the value of these activities. Exercise 13.6 Add another menu called Help that contains a menu item named About ImageViewer. This, makes it easier to understand what is going on in the program. They can be initialized and used only within the body of their defining constructor or method. Code 10.1 shows the source code of the MessagePost class. There are two fundamental issues: ■ ■ We get errors in the MessagePost and PhotoPost classes, because we cannot access the superclass fields. Containers appear to the outside as a single component, but they can contain multiple other components. In particular, it will demonstrate the structure of typical simulations. ■ Next, we note on the Row card: Accepts reservation request for seat. We have introduced the concept of anonymous inner classes as an alternative modular, extendable technique for writing event listeners. If we ignore the issue of parallelization, streams do not actually enable us to do anything that we could not already program, using language features we have already met. Exercise 14.41 Read the API documentation for the Files class from the java.nio.file package. At this stage, we do not need to worry about how an ArrayList is able to support these features. Containers hold collections of components, and each container has a layout manager that takes care of arranging the components within the container's screen area. In this situation, typing CTRL-space will bring up a pop-up listing all methods in the interface of the object we are using in the call (Figure 6.7). Our first version will not be able to do that.) This modest, incremental approach is much more likely to lead to success than trying to implement everything all at once. While a Scanner can be used to break up String objects, it is also often used to read and convert the contents of files directly instead of using BufferedReader. Exercise 13.73 Add a reload capability to the music player that rereads the files from the audio folder. Typing these commands should have the same effect as invoking the same command from the object's menu. Vehicle is a superclass of Bicycle, and thus v can potentially hold a Bicycle object. Checking the instance variable declarations, we can see that the server object is declared of class MailServer. If you type green instead of "green", you will get an error message saying something like "Error: cannot find symbol - variable green." Java supports several other data types, including decimal numbers and characters. This class is available in the book projects as imageviewer0-1 (the number stands for version 0.1). The body of the method should print the following single line of output: Please insert the correct amount of money. class Collections Collections contains many useful static methods for manipulating collections. Exercise 4.14 Add a method called checkIndex to the MusicOrganizer class. They are: ■ You probably used an if-statement and the getActionCommand method to find out which item was activated. Z12_BARN7367_06_SE_APPL.indd 647 4/11/16 4:01 PM 648 | Appendices source code The source code of a class determines the structure and behavior (the fields and methods) of each of the objects of that class. As all exceptions are subtypes of the Exception class, the single block will catch everything, whether checked or unchecked. The system stores the customer's telephone number. It forces the user to deal with the dialog first. Image-viewer (Chapter 13) A simple image-viewing and -manipulation application. Exercise 10.4 Open the project network-v2. This is a significant feature that avoids having to read and write objects field by field. This will hopefully serve to capture the reader's interest, and also illustrate the variety of different contexts in which the concepts can be applied. The only difference is that one creates new Fox objects and the other creates new Rabbit objects. It is important to appreciate that casting between object types is completely different from casting between primitive types (Section B.2, above). For instance, the KeyListener, MouseListener and MouseMotionListener interfaces in the java.awt.event package all consist of more than one abstract method, and so we cannot use lambda expressions to supply their implementations. M07_BARN7367_06_SE_C07.indd 251 4/15/16 3:35 PM 252 | 7.2 Concept An array is a special type of collection that can store a fixed number of items. Therefore, except in a very limited set of circumstances, notifying the user is not a general solution to the problem of error reporting. A method propagates an exception simply by not including an exception handler to protect the statement that might throw it. This is called importing the class, and is done using the import statement. You can specify a float literal by putting an F or f after the number. The first parameter should be used to set the value of a field called name, and the second should set a field called age. M02_BARN7367_06_SE_C02.indd 53 4/11/16 3:02 PM 54 | Chapter 2 ■ Understanding Class Definitions Exercise 2.6 Write out what you think the outer wrappers of the Student and LabClass classes might look like; do not worry about the inner part. An interactive, text-based adventure game (World of Zuul) is used for this discussion. In this section, we will start to make such changes in order to improve the design and implementation of the simulation as a whole. For instance: public class Fox extends Animal implements Drawable { Body of class omitted. The exact appearance of the title bar depends on the underlying operating system. Things will become clearer as you read on. What is the type of v1? The same problems can be solved without these techniques, but functional constructs open some more elegant ways to achieve our goals. Describe what it does. The class is stored in a file with the suffix .class. We note that the message post's text, as well as the photo post's image filename and caption, are missing. Write down the header of that method. We shall briefly discuss the most important aspects of each of these classes in some more detail. As a user of a clock display, when we create a ClockDisplay object we assume that our clock display has hours and minutes. Even though the for loop is often used for definite iteration, the fact that it is controlled by a general boolean expression means that it is actually closer to the while loop than to the for-each loop. It is easy to see that what we would want to achieve is for every call to a display method of, say, a PhotoPost object, to result in both the display method of the Post class and that of the PhotoPost class being executed for the same object. This can be continued any number of times. Network (Chapter 10, 11) Part of a social network application. You can do this even if you have not introduced any new participant types. For this, Java provides the instanceof operator. The MailClient class is the most interesting, and we shall examine it in some detail. Exercise 13.23 Add the new menu and the menu items to your version of the image-viewer0-4 project, as described here. We also provide a brief introduction to how to perform textual input/output, as file processing is one of the situations where errors can easily arise. Darker makes the whole image darker, and lighter makes it lighter. You can find out more about the original program by searching the web for "Eliza" and "Weizenbaum." We will now start our more detailed exploration by using the tech-support1 project. Rather, it results in details about a file being stored in the File object if the external file exists. We have remedied that failing by making use of a conditional statement to check that the amount inserted has a value greater than zero: if(amount > 0) { balance = balance + amount; } else { System.out.println("Use a positive amount rather than: " + amount); } Concept A conditional statement takes one of two possible actions based upon the result of a test. Once you have started work with the library, you will quickly see that it enables you to perform many tasks more easily than you would otherwise have been able to. The default is different for different containers: the content pane of a JFrame, for example, has by default a BorderLayout, whereas JPanels use a FlowLayout by default. Abstraction in software The same principles of modularization and abstraction discussed in the previous section are used in software development. Exercise 6.55 Create a DrawDemo object and experiment with its various methods. The source code of a class is stored in a file ending in .java. (l, lowercase L, works as well but should be avoided because it can easily be mistaken for a one (1).) A number with a decimal point is of type double. The values passed to a constructor are used to set up an object's initial state, while the values passed to a method will be used to influence the overall effect of the M14_BARN7367_06_SE_C14.indd 517 4/11/16 3:43 PM 518 | Chapter 14 ■ Handling Errors method call and may change the state of the object and a result the method returns. In practice, we would have to use unchecked exceptions, because we could not expect regular client classes to include exception handlers for what are essentially internal server errors. Note that statements (mutators) need a semicolon at the end, while expressions (accessors) do not. This call is explained in Section 3.12.1. Then the clock display is ready to go. Exercise 13.66 As an alternative to using a JComboBox as in Exercise 13.65, use a tabbed pane (class JTabbedPane) to hold multiple open images. The source code is shown in Code 3.5. The new Java feature in this code fragment is the use of the this keyword: this.from = from; The whole line is an assignment statement. There are situations in which we might want to create a list of int values or a set of char values, for instance. Answer these questions in writing, and use the Java library documentation of Map and HashMap for your responses. For now, we can simply say that, if an error such as this were to occur in a running application, then the application would crash—i.e., terminate in an uncontrolled way—before it had completed its task. The previous two points enable different approaches to studying this book: if time permits, it can be read in the sequence it is presented, covering the full scope of material — including functional approaches as alternatives to imperative ones—as the problems are encountered which they address. In order to plan and understand Java programs, you need to be able to construct object diagrams on paper or in your head. We hope this makes clear that this book provides flexibility where readers want it, but also guidance where a reader has no clear preference: just read it in the sequence it is written. M03_BARN7367_06_SE_C03.indd 96 4/11/16 3:05 PM 3.4 Modularization in the clock example Concept Modularization is the process of dividing a whole into well-defined parts that can be built and examined separately, and that interact in welldefined ways. If the constructor of the class is defined to have parameters, then the actual parameters must be supplied in the new statement. Is it complete? Environmental simulations might involve modeling the weather, which, while it is clearly an actor, also might not require visualization in the field cells. Exercise 3.53 se the de u er to in esti ate the insertMoney method of the better-ticket-machine project from Chapter 2. Code I.1 shows part of a typical main description, taken from the Game class of the worldof-zuul project. Our current structure assumes that all acting participants in the simulation are animals and that they inherit from the Animal superclass. Instead, System.in is usually passed to the constructor of a Scanner. We also say that ClockDisplay depends on NumberDisplay. Both name and id are String objects, and the String class has a method, substring, with the following header: /** * Return a new string containing the characters from * beginIndex to (endIndex-1) from this string. Even though our main task in this chapter is to work with GUIs, we needed to step back and refactor our code before proceeding. The reason for this is simple. M14_BARN7367_06_SE_C14.indd 536 4/11/16 3:43 PM 14.6 Defining new exception classes | 537 Code 14.15 An exception class with extra diagnostic information The principle of including information that could support error recovery should be kept in mind particularly when defining new checked exception classes. One approach would be to add print statements to the core methods of classes such as Taxi and TaxiCompany. In this case, you would be more likely to be interested in the states of the objects rather than having something printed, so a consumer lambda that does nothing would be used as the parameter to peek, for instance: peek(r -> { }) 9.12 Choosing a debugging strategy We have seen that several different debugging and testing strategies exist: written and verbal walkthroughs, use of print statements (either temporary or permanent, with enabling switches), interactive testing using the object bench, writing your own test class, and using a dedicated unit test class. We go through several iterations of improving the internal class structure of the game and extending its functionality, and end with a long list of proposals for extensions that may be done as student projects. Display the news feed. Repeated attempts can be made by placing the try statement in a loop. Do you think this method should also include the check for a consistent size? This particularly applies when looking at collections and iteration. You should have seen something like the following printed in the BlueJ terminal window: ################## # The BlueJ Line # Ticket # 500 cents. In our example, "combining" means just to add them. Note, too, that the new class does not need a flag to indicate its special nature—its very type and distinctive behavior supply that information. The taxis are used to transport an individual (or small group) from one location to another. Remember to use the folder name as part of the file name. Inserting or deleting elements, however, can be much faster in the LinkedList. Barnes and Michael Kolling, University of Kent. We will assume that we have had several meetings with the cinema operators, during which they have described to us the functionality they expect from the system. Exercise 16.21 The next planned stage of the implementation is to provide multiple taxis to carry multiple passengers concurrently. 10.7 Subtyping The one thing we have not yet investigated is how the code in the NewsFeed class was changed when we modified our project to use inheritance. Exercise 14.8 Using the address-book-v1g project, create a new AddressBook object on the object bench. To a A01_BARN7367_06_SE_FM.indd 21 4/15/16 6:10 PM 22 | Preface certain extent a book can try to be both, but compromises have to be made at certain points. We will discuss the basic elements of class definitions: fields, constructors, and methods. Having the fields present but unused invites problems. ■ A customer calls to cancel a reservation. Concrete subclasses of abstract classes must override abstract methods to provide the missing method implementations. Either press the left mouse button in the breakpoint area to the left of the source text, or place the cursor on the line of code where the breakpoint should be and select Set/Clear Breakpoint from the editor's Tools menu. The ArrayList in the organizer would then become an ArrayList. It contains many static methods. It manages to solve one of the stickiest questions in writing a book about programming: how to deal with the mechanics of actually typing in and running a program. However, Java uses a different keyword—implements—for inheriting interfaces. This poses the problem of recognizing the keywords in the sentence that was entered by the user. We will discuss other incarnations of polymorphism in more detail in the next chapter. Now that we have discussed the difference between the interface and the implementation of a class (Section 6.3.1), we can more easily understand the purpose of these keywords. The TicketMachine class has three fields: price, balance, and total. Because that method is called on the input variable, which holds a String object, it must be a method of the String class. It has received a request to reserve a seat. Also, because the lambdas are in the scope of the enclosing class, they can make full use of the enclosing class in the implementation of their body, because they can access the enclosing class's private fields and methods. Exercise 3.1 Think again about the lab-classes project that we discussed in Chapter 1 and Chapter 2. Exercise 2.70 Correct the error in this method: public void getAge() { return age; } Exercise 2.71 Write an accessor method called getName that returns the value of a field called name, whose type is String. 2.16 Local variables So far, we have encountered two different sorts of variables: fields (instance variables) and parameters. Exercise 13.20 In BlueJ, invoke the Use Library Class function from the Tools menu. } What visibility do they have? Functional interface types allow lambdas to be assigned to variables or passed as actual parameters. M06_BARN7367_06_SE_C06.indd 235 4/11/16 3:17 PM 236 | Chapter 6 ■ More-Sophisticated Behavior Some of the methods in the classes Pen and Canvas refer to parameters of type Color. This chapter gives an introduction to the functional approach in general, and introduces a few of Java's language constructs. The source code is text that defines the details of the class. The project source code also includes the checked exception class NoMatchingDetailsException, which is currently unused. The first form is also known as a for-each loop and is used exclusively to iterate over elements of a collection. In their most common form they are closest to abstract classes in which all the methods are abstract. Exercise 6.11 Change your implementation to use the equals method instead of startsWith. You have probably noticed that it is not really possible to complete Exercise 4.19, because it depends on how many file names are in the list at the time they are printed. Thus, when one of the methods of the ClockDisplay object is called, it in turn calls a method of another object to do part of the task. What happens when you use those? M06_BARN7367_06_SE_C06.indd 243 4/11/16 3:17 PM 244 | 6.16 Chapter 6 ■ More-Sophisticated Behavior Executing without BlueJ When we finish writing a program, we might want to pass it on to someone else to use. Here, we do not attempt to give a complete overview of design patterns. Now that they are sibling classes of a shared superclass, a more appropriate visibility is protected, again indicating that this is a method that is not a part of an animal's general interface—at least at this stage of the project's development. Declaring a field or other variable of a class type does not automatically create an object of that type; instead, the field is initially empty. Does the appearance of the class diagram after each change give you a clue as to whether or not other orderings are possible? What content equality between two particular objects means is something that is defined by the objects' class. Exercise 14.23 Does a constructor have any means of indicating to a client that it cannot correctly set up the new object's state? Dialogs can be implemented in a similar way to our main JFrame. Exercise 14.25 Is SecurityException from the java.lang package a checked or an unchecked exception? If you are not sure, try changing TreeMap to HashMap and see if HashMap offers all of the required functionality. name of file ... Both are very important issues, and unfortunately the term interface is used for both. A digital alarm clock display is discussed that uses two number display objects to show hours and minutes. In this case, index will have been initialized to zero, and the call to the size method will return zero too. switch statement A switch statement selects a sequence of statements for execution from multiple different options. Exceptions prevent a client from simply ignoring the problem, and encourage programmers to try to find an alternative course of action as a workaround if something does go wrong. To add our magic transportation, we could modify this in a form similar to the following: if(currentRoom.getName().equals("Transporter room")) { nextRoom = getRandomRoom(); } else { nextRoom = currentRoom.getExit(direction); } The idea here is simple: we just check whether we are in the transporter room. What we are describing here are typical operations on a collection. 1 By default, this function accesses the documentation through the Internet. Exercise 3.23 What are all possible results of the expression (n % 5), where n is a positive integer variable? The cast does not transform the content-pane object into a JPanel. See if you can find them and fix them. Class objects are particularly useful if we want to know whether the type of two objects is the same. Worse than that, it could even use the diagnostic return value as if it were a normal return value, creating a difficult-to-diagnose logical error! ■ In some cases, we may be using the diagnostic value for two quite different purposes. 5.5.5 The reduce method The intermediate operations we have seen so far take a stream as input and output a stream. Exercise 12.69 Look at the code below. } Now imagine that we create three BouncingBall instances. M12_BARN7367_06_SE_C12.indd 445 4/11/16 3:38 PM 446 | Concept A Java interface is a specification of a type (in the form of a type name and a set of methods). Code 3.4 Implementation of the ClockDisplay class M03_BARN7367_06_SE_C03.indd 108 4/11/16 3:06 PM 3.9 The ClockDisplay class | 109 Code 3.4 continued Implementation of the ClockDisplay class M03_BARN7367_06_SE_C03.indd 109 4/11/16 3:06 PM 110 | Chapter 3 ■ Object Interaction Exercise 3.27 Open the clock-display project and create a ClockDisplay o ject selectin the follo in constructor new ClockDisplay() Call its getTime method to find out the initial time the clock has been set to. Here, a menu item is created, and the current object (the ImageViewer object itself) is registered as an action listener by passing this as a parameter to the addActionListener method. Row is now a collaborator. The arrows in the class diagram (usually drawn with hollow arrow heads) represent the inheritance relationship. The Rectangle constructor has two int parameters. A rabbit's behavior is defined in its run method, which in turn uses the giveBirth and incrementAge methods and implements the rabbit's movement. The class variable can be accessed from any of the class's instances. They had the following headers: public void addMessagePost(MessagePost message) public void addPhotoPost(PhotoPost photo) In our new version, we have a single method to serve the same purpose: public void addPost(Post post) The parameters in the original version are defined with the types MessagePost and PhotoPost, ensuring that we pass MessagePost and PhotoPost objects to these meth- ods, because actual parameter types must match the formal parameter types. Exercise 2.92 Add a further boolean field, courseText, to the Book class. This should change the color of the circle. Local variables allow us to calculate and store temporary values within a constructor or method. Good solutions are not always obvious, so design patterns describe structures that have proven useful over and over again for solving recurring classes of problems. Close the figures project if you still have it open, and open the project called house. The operating system then needs to know which method of which class to invoke to execute the complete program. To achieve this, we have to do two things: ■ create menu items for each filter with an associated menu listener ■ implement the actual filter operation First the menus. Add the necessary checks and throw statements. The fact that a shuttle is already carrying a passenger should not prevent it from being sent to pick up another. This requires a variation of the approach used in the previous section. Exercise 1.9 Figure 1.8 shows two different images. This is annoying in maintenance terms (for every additional menu item we have to add a new if-statement in actionPerformed); it also seems a waste of effort. Note how often a pair of square brackets is used with the variable. The user can type in a question, and the system responds. The constructor has a single formal parameter, cost, but the method has none—just a pair of empty parentheses. 3 In BlueJ, there is no need to explicitly save the text in the editor before closing. M13_BARN7367_06_SE_C13.indd 474 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 475 Getting to the current state (showing a frame with a label and a few menus) was hard work, and we had to discuss a lot of background concepts. a. We have seen that the class has a small outer layer that gives a name to the class, and a more substantial inner body containing fields, a constructor, and several methods. The break instruction after every case is needed, otherwise the execution "falls through" into the next label's statements. 13.5.6 Dialogs Our last task for this version is to add a Help menu that holds a menu item labeled About ImageViewer . . . When this item is selected, a dialog should pop up that displays some short information. The ImageFileManager class has a method to select and open an image, and the ImagePanel object has a method to display that image. add a method to handle the menu activation in ImageViewer 3. Every teacher who wants to prepare their students for the future should give them some understanding of functional aspects as well. Do you think the use of so many different utility classes is justified? At the time of the call post.display(); the static type of post is Post, while the dynamic type is either MessagePost or PhotoPost (Figure 11.3). The NewsFeed object could itself hold two collection objects (for example, of types ArrayList and ArrayList). It is also common in constructors, where a constructor's actions in setting up a new object fail and the constructor cannot recover from this. We can use the simulation to investigate the behavior of the system under certain circumstances or to investigate "what if " questions. A more dynamic solution is the use of a Decorator object. For using collections, the type of the collection (the second part) is the more important. 16.6 Taking things further We can only take you so far by presenting our own project ideas and showing you how we would develop them. 15.7.1 Structure of a pattern Descriptions of patterns are usually recorded using a template that contains some minimum information. Exercise 12.38 Which classes in the java.util package are abstract? We have defined the fields right at the start of the class definition (Code 2.3). The collect method is a terminal operation and so it will appear as the final operation in a pipeline of operations. As we know, code duplication is a sign of bad design and should be avoided. Code 13.2 An alternative structure for the ImageViewer class M13_BARN7367_06_SE_C13.indd 468 4/15/16 3:07 PM 13.4 The ImageViewer example | 469 13.4.4 Adding menus Our next step toward building a GUI is to add menus and menu items. You can also declare variables and write complete statements in the Code Pad. You can already see some of the simplifications that we have made in our model of rabbits: there is no attempt to distinguish males from females, for instance, and a rabbit could potentially give birth to a new litter at every simulation step once it is old enough. In Java. All of the interfaces are important and we describe only a small selection here. Code 13.11 Abstract class Filter: Superclass for all filters Once we have written the superclass, it is not hard to implement specific filters as subclasses. Can you think of any situations in which simply allowing a program to terminate could be very dangerous? ■ They can assume that server objects will operate in an essentially problematic environment in which all possible steps must be taken to prevent client objects from using them incorrectly. For this to work, a method getBreedingAge must be defined in class Animal. Closing the scope brings 4/11/16 3:02 PM 2.16 Local variables | 77 the indentation back. If you test it, you will notice that they are not! Why does this not work? However, when used in a context requiring an object type, autoboxing might be used to convert a primitive value to a corresponding object. A for loop has the following general form: for (initialization; condition; post-body action) { statements to be repeated } The following concrete example is taken from the printHourlyCounts method of the LogAnalyzer: for(int hour = 0; hour < hourCounts.length; hour++) { System.out.println(hour + ": " + hourCounts[hour]); } The result of this will be that the value of each element in the array is printed, preceded by its corresponding hour number. We really do not have enough information at this point to decide whether row should be an int or a class. Hint: The rules on polymorphic substitution apply to values returned from methods as well as in assignment and parameter passing. Breakpoints can be removed by the reverse process. If you are not careful, your code may generate a random number that is outside the valid indices of the ArrayList. It depends a lot on the relative frequency with which certain operations are performed and on some other factors. Identifying the underlying structure is known as parsing, while piecing the individual characters into separate data values is known as scanning. When creating a GridLayout, constructor parameters determine how many rows and columns we wish to have. This is an important feature of the while loop: the body might be executed zero times, rather than always at least once. It depicts what we have at the time of writing the program. Photo posts consist of an image and a caption. For instance, calling a method on a variable containing null is the result of a logical programming error that is completely avoidable, and the fact that NullPointerException is unchecked fits this model. ■ It returns the selected string as a method result, using the return statement. design pattern A design pattern is a description of a common computing problem and a description of a small set of classes and their interaction structure that helps to solve that problem. If we tried to access the MessagePost's message field from Post's display method, an error would be reported. */ public int getPrice() It is important to distinguish between method headers and field declarations, because they can look quite similar. Note that library classes do not appear in the BlueJ class diagram. If any of the words is recognized, we immediately return the associated response. The event type might be stored as an enumeration constant (see Chapter 8) or as a string describing the event. M12_BARN7367_06_SE_C12.indd 418 4/11/16 3:37 PM 12.2 The foxes-and-rabbits simulation | 419 simulations. Terms of use. They are responsible for ensuring that an object is set up properly when it is first created; in other words, for ensuring that an object is ready to be used immediately following its creation. Does it mean that it is full of passengers, or that it has enough pickup requests to fill it? We distinguish between the parameter names inside a constructor or method, and the parameter values outside, by referring to the names as formal parameters and the values as actual parameters. The fields have not yet been assigned any values; once they have, we can write each value into the box representing the field. We shall not discuss them here. You can create this class in the tech-support1 project, or you can create a new project for it. Should there be any dead animals in any of those places at that stage? Some time ago, DodgySoft had a technical support department with people sitting at telephones. Used again in Chapter 11 as an example for use of inheritance. Used here to discuss good class design, coupling, and cohesion. One error situation we addressed was that there might be no passenger found when a vehicle arrives at a pickup point. The command ends with a parameter list— an empty pair of parentheses if there are no parameters. It is a construct that we have not discussed before: inner classes. The ability to reuse existing software components is one of the great benefits that we get from the inheritance facility. Figure 5.2 l in a stream a to a A B M05_BARN7367_06_SE_C05.indd 188 3 map 1 C 4 D 1 E 2 F 3 4/11/16 3:13 PM trea s | 189 Concept the reduce function We can reduce a stream; reducing means to apply a function that takes a whole stream and deli ers a single result. We also just discussed that classes may have subclasses. We fully expect teachers to discuss some of these questions in class, or students to research the answers as homework exercises. It prints out all details, but in a different order from what we wanted. Some configuration options are available through the Preferences dialog in the BlueJ system, but many more configuration options are accessible by editing the "BlueJ definitions file." The location of that file is /lib/bluej.defs, where is the folder where the BlueJ system is installed.1 1 On Mac OS, the bluej.defs file is inside the application bundle. The @see tag has several different forms and may be used in any documentation comment. We want to add a Filter menu that contains some filters that change the image's appearance. So, why do we need to write our own class at all? This version of the try statement is only appropriate for objects of classes that implement the AutoCloseable interface, defined in the java.lang package. Then it calls updateDisplay to update the display string accordingly, just as the constructor does. You should see the values in the object inspector change. With others, such as the ticket price, it is not that simple, as we do not know the price that tickets from 1 While this description is a slight simplification of the full Java rule, it fits the general rule we will use in the majority of code in this book. Tell me more . We use finished as a flag that becomes true when we want to end the loop (and with it, the whole program). 10.7.2 Subtyping and assignment When we want to assign an object to a variable, the type of the object must match the type of the variable. Test classes are annotated with in the class diagram, and they have a color distinct from ordinary classes. We could easily change the layout of the rooms, and everything would still work—high score for maintainability! With our current solution, though, this is broken. Nest within it a Rotate menu that allows the image to be rotated either 90 or 180 degrees, clockwise or counterclockwise. As you explore the source code of the taxi-company-later-stage project, you will find illustrations of many of the topics we have covered in the second half of this book: inheritance, polymorphism, abstract classes, interfaces, and error handling. In practice, the most likely scenario usually lies somewhere in between. Concept anonymous inner classes are a useful construct for implementing event listeners that are not functional interfaces. Issues of code inheritance, subtyping, polymorphic method calls, and overriding are discussed in detail. In this example, we have printed an error message, then provided at least one response in case of a complete failure to read anything. Figure 10.10 shows some randomly chosen classes to illustrate this. ■ In moving these methods, we have to think about the most appropriate visibility for them. For instance, a method throwing a checked IOException from the java.io package might have the following header:4 public void saveToFile(String destinationFile) throws IOException It is permitted to use a throws clause for unchecked exceptions, but the compiler does not require one. Which option is easier? Exercise 12.21 Following from the previous exercise, if a fox eats multiple rabbits at a single step, there are several different possibilities as to how we can model its food level. One pair starts at 0, increases by 1 each hour, and rolls back to 0 after reaching its limit of 23. In this chapter, we shall build a small application from three objects and arrange for methods to call other methods to achieve their goal. In this particular implementation, we have not tried to provide an accurate biological model of real foxes and rabbits; rather, we are simply trying to illustrate the principles of typical predator–prey simulations. Z11_BARN7367_06_SE_APPK.indd 639 4/11/16 3:59 PM 640 | Appendices Package java.nio.file —Summary of the most important classes and interfaces interface Path The Path interface provides the key methods for accessing information about a file in the file system. Close the editor. 99 + 3 "cat" + "fish" "cat" + 9 9 + 3 + "cat" "cat" + 3 + 9 "catfish".substring(3,4) "catfish".substring(3,8) Did you learn anything you did not expect from the exercise? We discuss those in Chapter 12. If a class is well described (that is, if its interface is well written) then a programmer does not need to see the source code to be able to use the class. The first obvious extension for our simulation is the addition of new animals. This should have a void return type and take no parameters. 10.6 Advantages of inheritance (so far) We have seen several advantages of using inheritance for the network application. M11_BARN7367_06_SE_C11.indd 391 4/11/16 3:34 PM 392 | Chapter 11 ■ More about Inheritance The photo post: Alexander Graham Bell [experiment.jpg] I think I might call this thing 'telephone'. Does it matter at all how the single field is split? 3.8.3 The modulo operator The last method in the NumberDisplay class increments the display value by 1. The empty lists are created in the constructor. Your screen is made up of a grid of single pixels. ImagePanel is a subclass of JComponent. In addition, we can see that the initialization part is executed only once—immediately before the condition is tested for the first time. ■ On arrival at a pickup location, a Vehicle must Notify the company of pickup arrival, with TaxiCompany as a collaborator; TaxiCompany must Receive notification of pickup arrival. Test. There is a famous case of what is known as "the first computer bug"—a real bug (a moth, in fact)—which was found inside the ark co uter race urra o er an earl co utin ioneer in lo ook still exists in the National Museum of American History of the Smithsonian Institute that shows an entry with this moth taped into the book and the remark "first actual case of bug being found." The wording, however, suggests that the term "bug" had been in use before this real one caused trouble in the Mark II. 11.8 Object equality: equals and hashCode It is often necessary to determine whether two objects are "the same." The Object class defines two methods, equals and hashCode, that have a close link with determining similarity. The test obj instanceof MyClass returns true if the dynamic type of obj is MyClass or any subclass of MyClass. For example, suppose we have pairs of name and alias strings that we wish to format in a particular way, such as "Michelangelo Merisi (AKA Caravaggio)". The solution discussed here is also in the book projects under the name tech-support2. In Code 14.12, the single catch block will handle every exception thrown by the protected statements. The Color class defines static references to suitable black, white, and gray objects. So the default behavior gives the effect of a subclass method completely hiding (i.e., overriding) the superclass version of the same method. The first six statements are responsible for printing what you see in the BlueJ terminal window: five lines of text and a sixth blank line. This can be somewhat restrictive, because the relationship between a superclass and its subclasses is clearly closer than it is with other classes. Where in the first version (Code 10.3) everything had to be done twice, it now exists only once. if(perform a test on one of the parameters) { Print an error message if the test gave a true result } See Appendix D for further details of the different types of if-statements, if necessary. class Objects are created from classes. The solution is to refactor the class hierarchy. These techniques can make your program simpler, but they make learning more work—there are simply more different constructs to master. The ImageFileManager class offers three methods: one to read a named image file from disk and return it as an OFImage, one to write an OFImage file to disk, and one to open a file-chooser dialog to let a user select an image to open. It is therefore important to write good class documentation for our own classes as well. Modify the definitions of warmer and cooler so that they use the value of increment rather than an explicit value of 5.0. Before proceeding further with this exercise, check that everything works as before. Enhance the user interface so that the details of an existing entry may be changed. Interfaces are discussed in the next section. Fields can store values that can vary over time, so they are also known as variables. Justify your answers. Was your prediction correct? Therefore, it is essential to consider both testing and debugging to be normal activities within the overall development process. Although we did not have to record any statistics at this stage, it was simple and convenient to have vehicles record a count of the number of steps for which they are idle. Exercise 3.26 Rewrite the increment method without the modulo operator, using an if-statement. There are at least two possible ways to organize this in the implementation. This implies that a for-each loop is inappropriate for use when searching, because it will complete its full set of iterations.2 In real search situations, we have to take into account the fact that the search might fail: we might run out of places to look. 6.10.1 Maintaining usage counts Combining a map with autoboxing provides an easy way to maintain usage counts of objects. Functional constructs have other advantages—more elegant expression for certain problems and often clearer readability—but it is the ability to deal with parallelism that will ensure that functional aspects of programming are going to stay with us for a long time to come. Code 2.5 The getPrice method Concept Methods consist of two parts: a header and a body. type Parameters have types. There are occasions when we need to rediscover the distinctive dynamic type of an object rather than dealing with a shared supertype. * Users can walk around some scenery. The area at the bottom of the screen where the object is shown is called the object bench. ■ We note on the Row class: Stores collection of seats. We shall start by looking at error handling from the point of view of the server class. There are several different ways that you might think of tackling this: ■ ■ ■ You could modify the Parser class to store each line of input in a list and then write out the list at the end of the game. We might also extend the simulation to include plants eaten by the rabbits, or even some aspects of the weather. Let us assume it does two things: find the requested row and then make a reservation request with the seat number to the Row object. A class method is defined by adding the keyword static in front of the type name in the method's header: public static int getNumberOfDaysThisMonth() { ... interface BinaryOperator The BinaryOperator interface takes two parameters of its parameterized type and returns a result of the same type. We get an error in the NewsFeed class, because it cannot find the display method. By comparing the output that appears with the statements that produced it, it is easy to see that a statement such as System.out.println("# The BlueJ Line"); literally prints the string that appears between the matching pair of double-quote characters. If so, what is it called, and what are its parameters and return type? 2 A pixel is a single dot on your screen. This is a very misguided picture. The reason that for is used for both of them is, again, a historical accident. They are not accessible from anywhere outside that block. Figure 11.8 public Access levels: private, protected, and public Client SomeClass Subclass1 private Subclass2 protected 5 In Java, this rule is not as clear-cut as described here, because Java includes an additional level of visibility, called package level, but with no associated keyword. Class Post has a display method that prints out all the fields that are declared in Post (those common to message posts and photo posts), and the subclasses MessagePost and PhotoPost print out the fields specific to MessagePost and PhotoPost objects, respectively. To learn to develop Java programs, we need to learn how to write class definitions, including fields and methods, and how to put these classes together well. What natural processes do you think we are modeling that cause the number of foxes to increase or decrease? The class diagram shows the static view. This should mean that post.display() ought to work, because, whatever it is—MessagePost or PhotoPost—we know that it does have a display method. We usually refer to a particular object as an instance. Its effect is that the Post constructor is executed as part of the MessagePost constructor's execution. What further methods and/or fields would need to be added to TicketMachine to allow this kind of functionality? 4.10.3 Searching a collection Searching is one of the most important forms of iteration you will encounter. In this example, we create a new subtype of MouseAdapter that overrides the mousePressed method. M12_BARN7367_06_SE_C12.indd 425 4/11/16 3:38 PM 426 | Chapter 12 ■ Further Abstraction Techniques 12.2.3 The Fox class There is a lot of similarity between the Fox and the Rabbit classes, so only the distinctive elements of Fox are shown in Code 12.2. Code 12.2 The Fox class M12_BARN7367_06_SE_C12.indd 426 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 427 Code 12.2 continued The Fox class For foxes, the hunt method is invoked at each step and defines their behavior. We are aware that some instructors will choose to cover some topics that we do not discuss in detail. In Section 4.9, we introduced the first variant, the for-each loop, as a convenient means to iterate over a flexible-size collection. The main options are either to print an error message using System.out or System.err or to display an error message alert window. Test the empty case too. In other words, it allows different special cases of objects (instances of subclasses) to be treated uniformly (as instances of the supertype). Chapters and sections covering this new material are, however, clearly marked as "advanced," and are structured in a manner that they can safely be skipped on first reading (or left out altogether). Does the simulation still compile? It can, however, be extended in many directions by interested readers. The Observer pattern provides one way of achieving this model/view separation. Note that the same variable name can be used for the exception object in each case. There will be no separate details of title, artist, playing time, etc. Interfaces can be used to provide a specification for a class (or part of an application) without stating anything about the concrete implementation. This is done via the central repository. The minimal Java program to create and call an object typically includes ■ ■ writing a class; writing a main method, including concepts such as static methods, parameters, and arrays in the signature; ■ a statement to create the object ("new"); ■ an assignment to a variable; ■ the variable declaration, including variable type; ■ a method call, using dot notation; ■ possibly a parameter list. Typically, to make it useful, a class should override this method. interface Supplier The Supplier interface takes no parameter and returns a result of its parameterized type. This style is also commonly seen. When a button is clicked or a menu item is selected, the component raises an ActionEvent. M03_BARN7367_06_SE_C03.indd 124 4/11/16 3:06 PM 3.16 Summary 3.16 | 125 Summary In this chapter, we have discussed how a problem can be divided into sub-problems. Concept A local variable is a variable declared and used within a single method. They can be used to continue or interrupt the execution of the program. From the point of view of a user of the ClockDisplay class, the creation of the NumberDisplay objects is implicit. We will think about what classes we should create to solve our problem, and how exactly they should interact. Did this give you new insights? The type of our files field was declared as: ArrayList The class we are using here is simply called ArrayList, but it requires a second type to be specified as a parameter when it is used to declare fields or other variables. As we did not specify any layout, the container (the content pane) uses a default behavior. event handling The term event handling refers to the task of reacting to user events, such as mouse-button clicks or keyboard input. Some constructs specific to Java have been deliberately left out of the discussion. Code 10.5 shows the full source code of class NewsFeed. The class String is an example of such a class. M14_BARN7367_06_SE_C14.indd 546 4/11/16 3:43 PM ile ased in ut out ut | 547 14.9.3 File output There are three steps involved in storing data in a file: 1. One way for the getDetails method to indicate that the key is invalid or not in use is to have it return a null value instead of a ContactDetails object (Code 14.4). So it is important to understand what we have seen of this so far: that the index values start at zero; that the objects are numbered sequentially; and that there are usually no gaps in the index values of consecutive objects in the collection. For instance, do error messages printed to the terminal seem appropriate with the GUI version of the project? At what points would a vehicle move between the lists? It is strongly recommended to use them only for very short classes and for well-established code idioms. When we want parallelism, we just use an appropriate collection, and all the hard parallel processing code is hidden inside the collection class ritten for us ur code looks short and si le uddenl usin all our cores in our la to eco es ossi le ith er little e tra effort e ill not discuss arallel ro ra in uch in this ook o e er it is interestin to know that mastering lambdas and streams prepares you well to progress to using concurrent collection classes later on. Imagine that we want to add two more transporter rooms, so that our game has three different transporter locations. Why do you think this is? Prior to the introduction of default methods in Java 8, the issue appeared to be clearer: if a type needed elements of concrete implementation—such as instance fields, constructors, or method bodies—then an abstract class would have to be used. One enhancement that we might like to make is the introduction of human predators to the simulation, as either hunters or trappers. It is important to understand that this is not the end of the story. It is just more of the same menu-creation code that we already wrote for our existing menu. Most people writing Java programs will constantly check the libraries to see if someone has already written a class that they can make use of. So we use ArrayList at the head of the MusicOrganizer class to define a files field: private ArrayList files; Here, we see a new construct: the mention of String in angle brackets: . We will use the term "method lookup" in this book. Now call the insertMoney method (Code 2.6) and give a non-zero positive amount of money as the actual parameter. Among these are consumer, supplier and predicate interfaces, as well as those for binary operators, for instance. For now, we just observe how the use of a polymorphic variable helps us simplify our show method. The following code will find the phone number for Lisa Jones and print it out. Scenarios are also referred to as use cases. Location represents a two-dimensional position within the field, specified by a row and a column value. Preventing a NullPointerException in removeDetails is relatively easy, and Code 14.2 illustrates how this can be done. As we seek to solve the smaller problems, we might find that we need to also break up some of them. Exercise 16.18 Are the completion criteria (tests on completion) for each stage sufficiently obvious? Method calls in Java are polymorphic. If yes, what will it print? Figure 3.1 A display of a digital clock M03_BARN7367_06_SE_C03.indd 95 11:03 4/11/16 3:05 PM 96 | Chapter 3 3.2 ■ Object Interaction Abstraction and modularization A first idea might be to implement the whole clock display in a single class. The customer chooses seats 13 and 14 in row 12. Exercise 13.72 Add a new component to display details of the current track when one is playing. Which sections are common to all class descriptions? Provide accessor and mutator methods for it and use these in Fox and Rabbit rather than in direct accesses to the field. If we find an entry, we use this entry as the response. Code 13.7 The filter method in the ImageViewer class M13_BARN7367_06_SE_C13.indd 485 4/15/16 3:07 PM 486 | Chapter 13 ■ Building Graphical User Interfaces Code 13.7 continued The filter method in the ImageViewer class Code 13.8 Implementation of a filter in the OFImage class Exercise 13.24 What does the method call frame.repaint() do, which you can see in the makeDarker method? Chapter 1 also gives a first look at some source code. Exercise 3.24 What are all possible results of the expression (n % m), where n and m are positive integer variables? People often think it means that something is printed by the program. We would, for instance, write List myList = new ArrayList(); Figure 12.5 List The List interface and its subclasses implements ArrayList M12_BARN7367_06_SE_C12.indd 450 implements LinkedList 4/11/16 3:38 PM 12.6 Interfaces | 451 Note that the polymorphic variable's type is just List of Type. Thus, it can be used as a neighboring room for another room or be held in the Game object as the current room. Some teachers may not be familiar with the iterative approach. For example, we address functional collection processing as soon as we encounter collections. This is useful for any objects that are ever to be textually represented in the user interface, but also helps for all other objects; they can then easily be printed out for debugging purposes, for instance. This was fairly straightforward so far, and we could now go ahead and design the rest that is still missing. These represent logical programming errors in the client that could clearly be avoided by simple prior tests in the client. Theater B has 32 rows. Exercise 6.39 Challenge exercise Read the footnote about the Arrays. So we might add the following paragraph to the description: The system stores details about passenger requests that cannot be satisfied. While we have seen the foundations of inheritance, there are still numerous important details that we have not yet investigated. We have also written a short method, called timeString, to convert this number into a relative time string, such as "5 minutes ago." In our final application, the system would have to use real time rather than system time, but again, system time is good enough for our prototype for now. Exercise 12.29 Candidate methods for placement in a superclass are those that are identical in all subclasses. On the other hand, it seems illogical and is annoying. Exercise 3.14 Write an expression using boolean variables a and b that evaluates to true when a and b are either both true or both false. In this case, it states that calling this method will return a result of type String. We have tried this approach with students many times. ■ The search fails after exhausting all possibilities. The idea is that the user can click anywhere on the image to change a pixel to a specific color. If we access the breeding age with a method rather than a field, we can get around the problems associated with the age-dependent properties. All of this is important, but we have omitted one aspect of the task: finding the classes. Instead, we precede it with the new keyword to create a single instance of this class. When we encounter new operators and methods, it often helps to try out with different examples what they do. In their most general form, expressions are things that compute values, but in this case, the expression consists of just a single variable, whose value is copied into the price variable. You change an attribute of an object (such as its size) by calling a method on that object. Casting almost always involves loss of information—for example, when converting from a floating-point type to an integer type. If it has a parameter, the type and name of that parameter M01B_BARN7367_06_SE_C01.indd 35 4/11/16 2:54 PM 36 | Chapter 1 ■ Objects and Classes is displayed. It supplies the commonly recurring types that are associated with lambdas and method references. This is exactly the sort of technique we described in Section 14.3.2. M14_BARN7367_06_SE_C14.indd 550 4/11/16 3:43 PM ile ased in ut out ut | 551 Code 14.21 Reading from a text file with a BufferedReader There is an even simpler way of reading a complete file of text without having to use a BufferedReader. M14_BARN7367_06_SE_C14.indd 529 4/11/16 3:43 PM 530 | Chapter 14 ■ Handling Errors 14.5.1 Checked exceptions: the throws clause Concept A checked exception is a type of exception whose use will require extra checks from the compiler. Java's relational operators are: == equal to != not equal to < less than greater than >= greater than or equal to The binary logical operators combine two boolean expressions to produce another boolean value. The fact that the field's value would be meaningless gives us a clue as to how we can get around this problem and, as a result, move more of the similar methods from the subclasses to the superclass. This assumes that the details represent a new contact, and not a change of details for an existing one. It handles multiple taxis and passengers, and a GUI provides a progressive view of the movements of both (Figure 16.2). 1.10 Exercise 1.12 In the Code Pad, type the code shown above to create a Person object and call its makeVisible and moveRight methods. That support is based on the assertion facility we have been discussing in this section. The pickup location and destination could be decided when the Passenger is created. Exercise 6.62 In class DrawDemo, create a new method named drawTriangle. When an object is inspected, an object inspector is displayed. Note that ArrayList and ArrayList are different types. Once you have implemented some more filters of your own, you should change the version number of your project to "version 2.1." 13.7 ImageViewer 3.0: more interface components Before we leave the image-viewer project behind us, we want to add a few last improvements, and in the process look at two more GUI components: buttons and borders. We can also record class Show as a collaborator. map A map is a collection that stores key/value pairs as entries. Exercise 5.20 dd a ethod to AnimalMonitor that takes three parameters: animal, spotterID, and dayID, and returns a count of how many sightings of the i en ani al ere ade the s otter on a articular da Exercise 5.21 dd a ethod to AnimalMonitor that takes two parameters—spotterID and dayID—and returns a String containing the names of the animals seen by the spotter on a particular day. Figure F.3 Active control buttons at a breakpoint F.2.1 Halt The Halt button is active when the program is running, thus allowing execution to be interrupted should that be necessary. HashMap is a specialization of a Map, which you will also find documented. (Note that the for loop is different from the for-each loop.) 7.3 A log-file analyzer Web servers typically maintain log files of client accesses to the web pages that they store. M13_BARN7367_06_SE_C13.indd 502 4/15/16 3:07 PM 13.8 Inner classes | 503 Figure 13.12 Scope coloring with an anonymous inner class It is worth emphasizing some observations about anonymous inner classes that are also shared with lambdas. One of the commands is go, which is M11_BARN7367_06_SE_C11.indd 410 4/11/16 3:35 PM 11.11 Another example of inheritance with overriding | 411 implemented in the goRoom method. M13_BARN7367_06_SE_C13.indd 503 4/15/16 3:07 PM 504 | 13.9 Chapter 13 ■ Building Graphical User Interfaces Further extensions Programming GUIs with Swing is a big subject area. 3.12 Method calls 3.12.1 Internal method calls The last line of the first ClockDisplay constructor consists of the statement updateDisplay(); M03_BARN7367_06_SE_C03.indd 112 4/11/16 3:06 PM 3.12 Method calls Concept Methods can call other methods of the same class as part of their implementation. There are at least three important features of the ArrayList class that you should observe: ■ ■ ■ M04_BARN7367_06_SE_C04.indd 135 It is able to increase its internal capacity as required: as more items are added, it simply makes enough room for them. The components are not resized, and the layout will not wrap components when resized (Figure 13.8). Using the terminal's Record method calls function, we can see that the sequence of creating a person object and calling its makeVisible and moveRight methods looks like this in Java text form: Person person1 = new Person(); person1.makeVisible(); person1.moveRight(); M01B_BARN7367_06_SE_C01.indd 39 4/11/16 2:54 PM | 40 Chapter 1 ■ Objects and Classes Here, we can observe several things: We can see what creating an object and giving it a name looks like. To compile a source file named Game.java, use the command javac Game.java This command will compile the Game class and any other classes it depends on. First create a MailServer object. Assume you want to model a traffic simulation. We shall discuss how to catch an exception in Section 14.5.2. 14.4.4 Using unchecked exceptions Concept An unchecked exception is a type of exception whose use will not require checks from the compiler. Rather, we discuss a small number of patterns to give readers an impression of the benefits of using design patterns, and then we leave it up to the reader to continue the study of patterns in other literature. Once we have more than one view implementation, we can easily replace the current view with another or, as we have in our example, even display two views at the same time. We continue by adding a label to the content pane: Container contentPane = frame.getContentPane(); JLabel label = new JLabel("I am a label."); contentPane.add(label); The first line gets the content pane from the frame. We start with a stream, and we end up with a single result. You will create your own classes that contain elements such as fields, constructors, methods, assignment statements, and conditional statements. We shall discuss it in more detail later.) When an object of class Circle is created, the object will automatically have these fields. We want to reuse good bits of work, and we want to enable others to understand what we have done. We have looked at a functional style for processing streams of data. Particular thanks are due to our editor, Tracy Johnson, and to Camille Trentacoste and Carole Snyder, who supported us through the writing and production process. Exercise 2.73 Write a method called printDetails for a class that has a field of type String called name. This is just one particular example of what are known as predator–prey 1 In this particular case, by the way, size does matter: the size of a natural park has a significant impact on its usefulness as a habitat for animals. They are revisited later in a different context, and understanding deepens as the reader continues through the chapters. class File The File class provides an object representation for files and folders (directories) in an external file system. } As in this case, if a class both extends a class and implements an interface, then the extends clause must be written first in the class header. This will be similar in style to the introduction of an act method when decoupling the simulator from individual actor types in the foxes-and-rabbits project in Chapter 12. There are two alternative styles for implementing event listeners: either a single object listens for events from many different event sources, or each distinct event source is assigned its own unique listener. These will, after a brief look at the complete program, start with a very simple initial version of the project, then gradually develop and implement the complete solution. It takes students from their very first steps all the way through to some very sophisticated concepts. There are many free or inexpensive text editors around. Rather, we are seeking to reinforce those topics that have been covered in the second half of the book, such as inheritance, abstraction techniques, error handling, and application design. Check that the number of files returned by numberOfFiles matches the number you stored. Next, we come to the most interesting scenario: method lookup with a polymorphic variable and method overriding (Figure 11.7). The subclasses (LinkedList and ArrayList) provide two completely different structural implementations of the same interface. We discuss this below. In a situation such as this one, we say that the class MessagePost inherits from class Post. Instead, a good Java programmer should know: ■ ■ some of the most important classes and their methods from the library by name (ArrayList is one of those important ones) and how to find out about other classes and look up the details (such as methods and parameters). In other words, we can declare the variable to be of a more abstract type, such as List, Map, or Set, rather than the more concrete type—ArrayList, LinkedList, HashMap, TreeSet, etc. For details, see Appendix A. Several other people have helped make BlueJ what it is: Bruce Quig, Davin McCall, and Andrew Patterson in Australia, and Ian Utting, Poul Henriksen, and Neil Brown in England. This is one important use of interfaces, but there are others. The Actor and Animal classes are abstract, while Rabbit, Fox, and Hunter are concrete classes. In a similar style, we can use the debugger to observe one object creating another. So, in the example from the insertMoney method, following the test of an inserted amount we shall only either add the amount to the balance or print the error message. It has only one method, and that always returns the same string. Two details are worth noting. When a Java program is started, the name of the class is specified as a parameter of the start command, and the name of the method is main. In this case, the numeric value is a subtraction that has been placed in parentheses to indicate that it is the resulting value we wish to concatenate with the two strings. Here are some examples that use array expressions in different places: labels[5] = "Quit"; double half = readings[0] / 2; System.out.println(people[3].getName()); machines[0] = new TicketMachine(500); Using an array index on the left-hand side of an assignment is the array equivalent of a mutator (or set method), because the contents of the array will be changed. Customers could call to get advice and help with their technical problems with the DodgySoft software products. Like any worthwhile activity, it takes time and practice to become proficient at it. What happens if you call makeInvisible twice? For the time being, here are the basic operations we will have in the initial version of our organizer: ■ ■ It allows tracks to be added to the collection. In both cases, what we write inside the loop when the keys are finally found will mean the loop conditions "flip" from true to false the next time they are evaluated. There are different people involved: staff members, students, teaching staff, support staff, tutors, technical-support staff, and student technicians. The right-hand side is called an expression. However, don't forget to return null if there are no rabbits to eat. Can a static method be called from another static method? Note that the class has to be compiled to do this. Because the method has no body, it can never be executed. Why is there no call to updateDisplay in the second constructor, for instance? The relational operators usually combine a pair of arithmetic operands, although the tests for equality and inequality are also used with object references. Every object will have space for each field declared in its class. Keeping things simple at this stage will help to avoid obscuring the key concepts we are trying to illustrate, which are the creation and usage of a collection object. ■ Recovery will often involve having to try again. M02_BARN7367_06_SE_C02.indd 86 4/11/16 3:02 PM eri entin 2.22 ith e ressions the ode Pad | 87 Experimenting with expressions: the Code Pad In the previous sections, we have seen various expressions to achieve various computations, such as the total + price calculation in the ticket machine and the name. However, using anonymous inner classes can make code quite hard to read. Code 12.3 illustrates some of its main features. Modify the removeDetails method of AddressBook so that it throws this exception if its key parameter is not a key that is in use. Some classes are fairly obvious and easy to discover. We should, however, generalize this a bit: maybe not all participants in the simulation will be animals. Exercise 5.10 Rewrite the printSightingsOf method in your AnimalMonitor class to use strea s and la das as sho n a o e Test to ake sure the project still works as before. Provide a GUI to display the activities of all active vehicles and passengers within the simulation. It is for this reason that a Java compiler will include assert statements in the compiled code only if requested to do so. We will not examine how this works internally at this point, but just note that the InputReader has a getInput method that returns a string. Example: try { ... var.doSomething(); ... } catch(EOFException | FileNotFoundException e) { ... } Automatic resource management—also known as "try-with-resource"—recognizes that try statements are often used to protect statements that use resources that should be closed when their use is complete, both upon success and failure. Will the following code compile? The temperature field should be set to the value 15.0 in the constructor. Note that animals created at the start of the simulation are given a random initial age. As only a single passenger was required for this stage, development of the PassengerSource class was deferred to a later stage. In this situation, we declare class constants. BlueJ has a built-in debugger that is much simpler. Once we know how to create GUIs with Java, we can develop much-better-looking programs. In contrast, objects of a different class may have different fields. Thus, the display shows the time from 00:00 (midnight) to 23:59 (one minute before midnight). For instance, when a birth event occurs, the event marking that animal's death from old age will be scheduled. We do not need a very long description to be able to illustrate this technique. For example: ■ ■ Consumer interfaces relate to lambdas with a void return type. The following declares a string-array variable and makes it refer to an array that has a capacity of 10 strings: String[] names = new String[10]; It is important to note that the creation of the array assigned to names does not actually create 10 strings. We can use a question mark in place of the type parameter—Class—if we want to declare a variable that can hold all class objects of all types. If you want a space, you have to include it yourself within one of the strings. (Did they surprise you?) Explain why the results are what they are. The result of executing the first line of the printNextMailItem method is shown in Figure 3.7. We can see that execution has moved on by one line (a small black arrow next to the line of source code indicates the current position), and the local variable list in the debugger window indicates that a local variable item has been created, and an object assigned to it. This is done using the standard Java image I/O methods from the ImageIO class (package javax.imageio). We will also need to know whether an actor is still active or not. You can find it online at or by doing a web search for its title. She wants to know whether she can reserve another seat next to the ones she already has. M14_BARN7367_06_SE_C14.indd 522 4/11/16 3:43 PM 14.4 Exception-throwing principles | 523 Clearly, an out-of-bounds value cannot be used where all values from the return type already have valid meanings to the client. Book website: All projects used as discussion examples and exercises in this book are available for download on the book's website, at . This is where functional programming enters the picture. At each step a taxi either moves toward a target location or remains idle (Code 16.2). Here, the getDetails method is throwing an exception to indicate that passing a null value for the key does not make sense because it is not a valid key. The display shows hours and minutes, separated by a colon (Figure 3.1). Thus, inheritance allows us to create two classes that are quite similar, while avoiding the need to write the identical part twice. This way, the method can deal with 1, 3, or 75 balls—any number you want. If we have a class that has been written specifically to play audio files, then our organizer class would not need to know anything about how to do that; it could simply hand over the name of the file to the player class and leave it to do the rest. TaxiCompany responsibility: Pass passenger to vehicle; Vehicle responsibility: Receive passenger, with Passenger added as a collaborator to Vehicle. We are now talking about user interfaces—the part of an application that is visible on screen for the user to interact with. The statement simply has no effect, and the input string remains unchanged. 2.3.1 Keywords The words "public" and "class" are part of the Java language, whereas the word "TicketMachine" is not—the person writing the class has chosen that particular name. ■ Add the count to the variable. All of them are applied to a stream to process it in a certain way. int is another keyword and represents the data type integer. This means that Set is actually provided as a marker interface to enable class ArrayList ArrayList is an implementation of the List interface that uses an array to provide efficient collection implementers to indicate that their classes fulfill this particular restriction. If, for example, the type of the comment list is changed from ArrayList to ArrayList (so that more details can be stored), this change has to be made once in the MessagePost class and again in the PhotoPost class. 12.5 Multiple inheritance 12.5.1 An Actor class In this section, we discuss some possible future extensions and some programming constructs to support these. M13_BARN7367_06_SE_C13.indd 467 4/15/16 3:07 PM 468 | Chapter 13 ■ Building Graphical User Interfaces 13.4.3 An alternative structure We have chosen to develop our application by creating a JFrame object as an attribute of the ImageViewer and populating it with further GUI components that are created outside the frame object. If we need an additional menu item, we just add code to create the item and its listener, as well as the method that handles its function. Documentation for library classes The Java standard class library is extensive. We can see that the body of the makeFrame method contains, very tightly packed, a (strange-looking) class definition, which has a single method definition with a short body. 4/11/16 3:10 PM 136 | Chapter 4 ■ Grouping Objects Figure 4.1 A MusicOrganizer containing two file names myMusic: MusicOrganizer : ArrayList files : String : String "MorningBlues.mp3" "DontGo.mp3" Figure 4.2 A MusicOrganizer containing three file names myMusic: MusicOrganizer : ArrayList files : String : String : String "MorningBlues.mp3" "DontGo.mp3" "MatchBoxBlues.mp3" We notice that the MusicOrganizer object looks quite simple—it has only a single field that stores an object of type ArrayList. This section does indeed declare a variable that is then used for each collection element in turn. The class contains three fields, named from, to, and message. These were issues such as object structure and interaction, class design, and code quality. Source code in the class can access (read and set) this kind of variable, just as it can an instance variable. That feature was covered in detail in Chapter 5 of this book—a chapter that we designated as "Advanced" for that particular point in the book. In fact, as we have illustrated, a HashSet is actually much closer in usage to an ArrayList. The visual representation of each vehicle's location could also help. Then the expression "0" + value "adds" a string and an integer (because the type of value is integer). Therefore, rather than simply programming around the problem in the server and leaving it at that, it is good practice for the server to make some effort to indicate that a problem has arisen, either to the client itself or to a human user or programmer. Classes are the templates for objects, defining the fields and methods that each instance possesses. The engineer in the car company abstracts from the details of the tire manufacture to be able to concentrate on the details of the construction of, say, the wheel. Bricks (Chapter 9) A simple debugging exercise; models filling pallets with bricks for simple computations. Each class may have an explicitly declared superclass, or it inherits implicitly from the class Object. Apart from the annoying fact that we have to write everything twice (or copy and paste, then go through and fix all the differences), there are often problems associated with maintaining duplicated code. So they decided to use the same keyword for both loops. However, the toString method in class Object guarantees that this method is always available for any class.) The output appears properly with all details, because each possible dynamic type (MessagePost and PhotoPost) overrides the toString method and the dynamic method lookup ensures that the redefined method is executed. Code 13.15 shows this solution. A first look at lambdas Central to the new functional style of processing a collection is the concept of a lambda. To help you appreciate why this might be, it is worth considering two issues associated with the use of return values as failure or error indicators: Unfortunately, there is no way to require the client to check the return value for its diagnostic properties. M11_BARN7367_06_SE_C11.indd 408 4/11/16 3:35 PM 11.10 The instanceof operator | 409 Exercise 11.6 The version of display shown in Code 11.2 produces the output shown in Figure 11.9. Reorder the statements in the method in your version of the network project so that it prints the details as shown in Figure 11.10. Over the past several years Java has become widely used in the teaching of programming. The more we do this, the more the code-duplication problem increases, and the harder it becomes to make changes later. Prototypes of the systems are built that do not do much, but give an impression of what the system would look like and what it would do, and clients comment regularly on the design and functionality. And each of these has many attributes and methods. Using unchecked exceptions means that the client does not have to use a try statement when it has already established that the exception will not be thrown. Terms introduced in this chapter: object, class, instance, method, signature, parameter, type, state, source code, return value, compiler M01B_BARN7367_06_SE_C01.indd 45 4/11/16 2:54 PM 46 | Chapter 1 ■ Objects and Classes Exercise 1.30 In this chapter we have mentioned the data types int and String. Central to the design of an object-oriented software system is the decision about the classes to use for its implementation and the communication structures between these classes. In the next section, we shall investigate the separation of visualization from acting, as a further extension to our simulation framework. Chapter 3 then enlarges the picture to discuss interaction of multiple objects. The most used borders are BevelBorder, CompoundBorder, EmptyBorder, EtchedBorder, and TitledBorder. Later, we introduce conditional statements that allow choices between different actions to be made within methods. Here is the relevant section of the code: if(value < 10) { return "0" + value; } else { return "" + value; } Note that the zero ("0") is written in double quotes. Writing good JUnit tests for our classes ensures that errors are detected early, and they give a good indication which part of the system an error originates in, making the resulting debugging task much easier. It can always be applied when the state of one or more objects depends on the state of another object. Z04_BARN7367_06_SE_APPD.indd 611 4/11/16 3:52 PM 612 | Appendices D.3.1 While The while loop executes a block of statements as long as a given expression evaluates to true. Take a look at what happens when you call it. The Adjust menu could also contain menu items that invoke the existing Larger and Smaller functionality, for instance. One of them is visualization of class structure. On the other hand, you can simply leave the clock to work internally as a 24-hour clock but change the display string of the clock display to show 4:23 or 4:23pm when the internal value is 16:23. In this case, you have a free choice over its name. Visiting each animal in the list is what constitutes a single simulation step. E.1 Executing without BlueJ Usually, when applications are delivered to end users, they are executed differently than from within BlueJ. Figure 12.3 shows a class diagram for this part of the simulation. You can insert several separate amounts of money into the machine, just like you might insert multiple coins or bills into a real machine. For instance, consider the following example: String key = database.search(zipCode); ContactDetails university = contacts.getDetails(key); If the database search fails, then the key it returns may well be either blank or null. Test your class by creating some instances and calling the methods. Typically, what you have to do in that case is to read the class's implementation and figure out what it does. In the following chapter, we shall see extensive use of this feature when implementing graphical user interfaces. constructor Constructors allow each object to be set up properly when it is first created. Older versions of the Java language did not contain the for-each loop, and when it was finally introduced, Java designers did not want to introduce a new keyword at this stage, because this could cause problems with existing programs. Then we could more easily match titles separately from artists. The teacher is doing much of the work for you. In Java, constants are defined with the keyword final. This new string is returned as the method's result. Inner classes can generally be used in some cases to improve cohesion in larger projects. In contrast to using inheritance, decorators can be added to existing objects. To do this, we use the Code Pad. What about having idle taxis move to a central location, ready for their next pickup, in order to reduce potential waiting times? A See Also section is added to the item being commented. Create an instance of MusicPlayerGUI, and experiment with the application. We briefly introduce the concept of abstraction. writer.write(next piece of text); . * @param spotter The ID of the spotter. Exercise 2.49 In the figures project we looked at in Chapter 1 we used a boolean field to control a feature of the circle objects. Its popularity ensures an immense pool of support resources. The changes are: ■ ■ ■ The input variable receiving the result from reader.getInput() is now of type HashSet. We can summarize the most significant features of interfaces as follows: ■ The keyword interface is used instead of class in the header of the declaration. Exercise 2.58 Why does the following version of refundBalance not give the same results as the original? But we now have an additional class: Picture. Random and pseudo-random Generating random numbers on a computer is actually not as easy to do as one might initially think. M13_BARN7367_06_SE_C13.indd 499 4/15/16 3:07 PM 500 | Chapter 13 ■ Building Graphical User Interfaces Fortunately, Java provides a construct that mitigates all of these problems. We will then have the program randomly choose one of 2 Unfortunately, Java's implementation of strings means that using = = will often misleadingly give the "right" answer when comparing two different String objects with identical contents. 7 In fact, its read method returns each character as an int value rather than as a char, because it uses an out-of-bounds value, -1, to indicate the end of the file. Our goal is quite simple. In this case, the information required is the distance—how far the circle should be moved. Use the approach we have outlined in this chapter to implement a simulation of a building with one or more elevators. The Swing framework itself and some of its components raise events when something happens that other objects may be interested in. To distribute applications to others, it is often easier if the whole application is stored in a single file. Therefore, we have designed a structure that—we hope—allows different approaches, depending on the preference of the learner or teacher. Code 13.12 shows an example. Exercise 2.45 Implement a method, empty, that simulates the effect of removing all money from the machine. Furthermore, when discussing features of interfaces in this chapter we will often ignore the case of non-abstract methods for the sake of simplicity. However, because opening a file that we know exists still requires a potential exception to be handled, many programmers do not bother with checking first. We will not discuss the implementation of all of these steps in detail, but we will complete the application to a point where you should be able to add the remaining functionality yourself. What happened? Exercise 3.4 Write a definition of a field named tutor that can hold a reference to an object of type Instructor. Examine the code that you had to write in the actionPerformed method for Exercise 13.9. There are several problems. Code 16.1 An outline of the Vehicle class M16_BARN7367_06_SE_C16.indd 585 4/11/16 3:47 PM 586 | Chapter 16 ■ A Case Study Code 16.1 continued An outline of the Vehicle class M16_BARN7367_06_SE_C16.indd 586 4/11/16 3:47 PM 16.3 Class design | 587 Code 16.1 continued An outline of the Vehicle class The process of creating the outline project raised a number of issues. Exception thrown from here 2. Classes such as ArrayList and LinkedList implement List. However, its single abstract method is called run. Even though the original edition is 40 years old, it makes for entertaining and very enlightening reading. Exercise 13.3 Another often-used Swing component is a button (type JButton). This makes it clear which object to change when, for example, a moveRight method is invoked. 14.9.5 Scanner: parsing input So far, we have treated input largely as unstructured lines of text, for which BufferedReader is the ideal class. The scrollbars only become visible when necessary. Code 14.19 Writing to a text file 14.9.4 The try-with-resource statement It is important to close a file once it is finished, and there is a version of the try statement that simplifies the task of ensuring this happens. This method lets you type a line of input in the terminal, then returns whatever you typed as a method result. This is reasonable, because throwing an exception is an indication of the throwing method's inability to continue normal execution, which includes not being able to return a valid result. The example discussed in this chapter, even though it contains a lot of detail, is only a brief introduction to GUI programming. Fortunately, the Java library is quite well documented. The compiler is not that smart. J.1.2 Class names start with a capital letter J.1.3 Class names are singular nouns J.1.4 Method and variable names start with lowercase letters All three—class, method, and variable names—use capital letters to begin each word after the first in order to increase readability of compound identifiers, e.g. numberOfItems. Code 11.3 shows the changed source code. state Objects have state. Exercise 16.22 Review the way in which vehicle:passenger associations are stored in the assignments' map in TaxiCompany. You can use the fillDefaultResponses method as a pattern, but you will need to make some changes to its logic, because there are two strings to be read for each entry rather than one—the keyword and the response. In this and the next few exercises, you will add features to the class outline. Shows are at an assigned date and time and are scheduled for a theater where they are screened. Also experiment with file names that do not exist. We analyze the problem, and then we design a solution. Explore this project a bit more. Another rule of thumb is to use unchecked exceptions for situations that could reasonably be avoided. Adding event handlers to buttons is identical to adding them to menu items. Many different methodologies have been described in the literature and are used in practice for this task. The WEST area of a BorderLayout can hold only one component, but we have two buttons. We are still concerned with understanding how objects create other objects, and how objects call each other's methods. Instead, class methods are restricted to accessing class variables from their class. No attempt is made to assign vehicles on the basis of their distance from a pickup location. An exception class is unchecked if it is a subclass of the RuntimeException class, defined in the java.lang package. On the other hand, both constructors and methods may have any number of formal parameters, including none. } Each of the first two lines in the constructor creates a new NumberDisplay object and assigns it to a variable. An alternative to the code above (where we called getDetails() within the System.out.println call) would be to map the Sighting object to the details string first. The legal range for the value, as discussed above, is zero to one less than the limit. Store the names of a few audio files into it—they are simply strings. ■ A private static field is defined and initialized with the (sole) instance of the parser. Inheritance is a powerful construct that can be used to create solutions to a variety of different problems. Familiarize yourself with its interface, but you do not need to understand or modify its implementation. Each of these positions may be empty, so it may hold fewer than five components. Such failures are rare, but still possible. Key methods are get, put, remove, and size. This way, the Game object does not need to remember all the transporter rooms—the rooms themselves do. One tool we will now look at is a debugger. Some observations are worth noting: ■ ■ ■ ■ M11_BARN7367_06_SE_C11.indd 400 No special lookup rules are used for method lookup in cases where the dynamic type is not equal to the static type. It is tempting to define a BREEDING_AGE field in the Animal class and assume that its value will be overridden by similarly named fields in the subclasses. The objects of a fixture may be re-created on the object bench by selecting Test Fixture to Object Bench from the test class's menu. U G B Z X u; g; b; z; x; The following assignments are all legal (assume that they all compile). This combined value is then assigned to the balance field. We should now also be able to understand the remaining three methods of the Clock Display class (see Code 3.4). Using get, instead, we would have had to write something like: Integer counter = counts.get(word); if(counter == null) { counts.put(word, 1); } else { counts.put(word, counter + 1); } Notice how autoboxing and unboxing are used multiple times in these examples. Which interfaces are mentioned in the descriptions? What if you first resize the frame and then open an image? Code 5.2 The AnimalMonitor class M05_BARN7367_06_SE_C05.indd 180 4/11/16 3:13 PM 5.2 Monitoring animal populations | 181 Code 5.2 continued The AnimalMonitor class So far, this code, uses the imperative collection processing techniques introduced in Chapter 4. Note that we have not yet discussed enough for you to understand the implementation of the MailServer class, so you can ignore this for now. They have no effect on the functionality of the class. Try the following pencil-and-paper exercises as a way of checking that you are becoming used to the terminology that we have introduced in this chapter. The Animal subclasses then implement the act method and become concrete classes. 16.3 Class design In this section, we shall start to make the move from a high-level abstract design on paper to a concrete outline design within a BlueJ project. The first of the details is the declaration String filename; this declares a new local variable filename that will be used to hold the list elements in order. Exercise 1.2 What happens if you call moveDown twice? If it is, then it is okay to print a ticket. For our new airport, we need to know whether we can operate with two runways or whether we need three. Doing this will cause the compiler to believe that the object is a Car, and it will not report an error. While protected access can be applied to any member of a class, it is usually reserved for methods and constructors. The Java API has undergone a number of evolutions over the years, reflecting the increasing diversity of environments in which Java programs have come to be used. Explain exactly how the views are used in the Simulator class. Chapter 7 ■ Fixed-Size Collections—Arrays Arrays A fixed-size collection is called an array. Remember that we defined act as abstract in Animal because having a body for the method would be meaningless. The essential feature of this technique is that we need to describe the common features only once. Thus, maps are ideal for a one-way lookup, where we know the lookup key and need to know a value associated with this key. This removes the other errors encountered above (we shall come back to those below). accessor method Accessor methods return information about the state of an object. This method should have a void return type, and its body should simply set the total field to zero. A tearDown method, with the annotation @After, is called following each test method. Having a large frame is not always desirable. Translating these ideas into Java code is equally easy. Open the better-ticket-machine project. Without it, one will no longer be able to become a master programmer. One distinguishing effect of a mutator is that an object will often exhibit slightly different behavior before and after it is called. The header of changeName states: void changeName(String replacementName) The word void indicates that this method does not return any result. public interface Monitor { private static final int THRESHOLD = 50; private int value; public Monitor (int initial); void update(int reading); int getThreshold() { return THRESHOLD; } ... However, we need access to the content pane for other reasons later anyway, so we do the adding of components to the content pane at this point as well. This method draws a rectangle (the "box") on screen and one or more balls inside the box. Here is a possible series of development steps for the taxi company application: ■ ■ ■ ■ ■ ■ Enable a single passenger to be picked up and taken to her destination by a single taxi. So if you look at the list of methods for ArrayList, you will see methods such as: boolean add(E o) E get(int index) This tells us that the type of objects we can add to an ArrayList depends on the type used to parameterize it, and the type of the objects returned from its get method depends on this type in the same way. The same method call may at different times invoke different methods, depending on the dynamic type of the variable used to make that call. It is marked with the keyword abstract. Documentation allows you to communicate your intentions to human readers in the form of a natural-language, high-level overview, rather than forcing them to read relatively low-level source code. Reading class documentation The class String is one of the classes of the standard Java class library. The DrawDemo class provides a few small examples of how to use a pen object to produce a drawing on screen. This tool automates the generation of class documentation in the form of HTML pages in a consistent style. Exercise 2.27 Try removing the return statement from the body of getPrice. Exercise 10.12 Assume that we have four classes: Person, Teacher, Student, and PhDStudent. We will shortly try to improve this. 12.11 Summary of inheritance In Chapters 10 through 12, we have discussed many different aspects of inheritance techniques. M14_BARN7367_06_SE_C14.indd 530 4/11/16 3:43 PM 14.5 Exception handling | 531 Code 14.9 An exception handler Any number of statements can be included in a try block, so we tend to place there not just the single statement that could fail, but all of the statements that are related to it in some way. There are a number of standard character sets, such as US-ASCII and ISO-8859-1, and more details can be found in the API documentation for Charset. A for-each loop has two parts: a loop header (the first line of the loop statement) and a loop body following the header. It does so in two slightly different ways. Add any further tests you feel are appropriate at this stage of the development, to form the basis of a set of tests to be used during future development. In this for loop, the parentheses contain three separate sections, separated by semicolons. In the Simulator class, we have used separate typed lists of foxes and rabbits and per-list iteration code to implement each simulation step. Just like lambdas and named inner classes, anonymous inner classes are able to access the fields and methods of their enclosing classes. The Files class has exists and isReadable methods, which make attempting to open a file less likely to fail if we use them first. In many simulation scenarios, however, actors spend large numbers of time steps doing nothing— typically, waiting for something to happen that requires some action on their part. superclass constructor The constructor of a subclass must always invoke the constructor of its superclass as its first statement. So the numeric value of price is converted into a string and joined to its two surrounding strings. Without such a great team none of this could work. ■ Obtain the count from the identified sighting (the mapping step). Because computers operate in a very well-defined, deterministic way that relies on the fact that all computation is predictable and repeatable, they provide little space for real random behavior. If there are three, then three println statements would be required; if there are four, then four statements would be needed; and so on. Only the display methods in the subclasses (MessagePost and PhotoPost) are executed when posts are printed out, leading to incomplete listings. The north and south components keep their height, and only the width changes. This ensures that other classes can call these methods. The scenario is again similar to the one before, but there are two changes: ■ ■ The declared type of the variable v1 is now Post, not PhotoPost. Type name B.2 Minimum Maximum byte −128 127 short −32768 32767 int −2147483648 2147483647 long −9223372036854775808 9223372036854775807 Positive minimum Positive maximum float 1.4e−45 3.4028235e38 double 4.9e−324 1.7976931348623157e308 Casting of primitive types Sometimes it is necessary to convert a value of one primitive type to a value of another primitive type—typically, a value from a type with a particular range of values to one with a smaller range. For now, write the method body with a single statement that prints out only the username. The method bodies, containing the Java statements, and most fields are part of the implementation. Disabled components are usually displayed in light gray and do not react to input. Although the initial design work was best done in a group, it is now time to split it up. However, in the fourth statement, the actual parameter to println is a little more complicated and requires some more explanation: System.out.println(" # " + price + " cents."); What it does is print out the price of the ticket, with some extra characters on either side of the amount. Note Code 13.16 Adding spacing with gaps and borders M13_BARN7367_06_SE_C13.indd 498 4/15/16 3:07 PM 13.8 Inner classes | 499 that we now cast the contentPane to a JPanel, as the supertype Container does not have the setBorder method.5 Creating the BorderLayout with two int parameters adds spacing between the components that it lays out. The reason is that a JPanel uses, by default, a FlowLayout, and a FlowLayout arranges its components horizontally. Exercise 3.35 List all of the external method calls that are made in the draw method of Picture on the Triangle object called roof. It is important to notice that there is no explicit loop statement in this version, unlike in the previous version—the iteration is handled implicitly by the forEach method. Java calls its libraries packages. We now have to play through exactly how the seat reservation works. The reason why we could shorten the source code is that, in the new version, we can use the type Post where we previously used MessagePost and PhotoPost. As a result, the second statement will not be executed either. Code 6.1 The SupportSystem source code M06_BARN7367_06_SE_C06.indd 203 4/11/16 3:17 PM 204 | Chapter 6 ■ More-Sophisticated Behavior Code 6.1 continued The SupportSystem source code Looking at Code 6.2, we see that the Responder class is trivial. This means that primitive-type values can be added directly to a collection: M06_BARN7367_06_SE_C06.indd 227 private ArrayList markList; ... Some of these are quite challenging programming exercises. Formal parameters are defined in the header of a constructor or method. 12.4 More abstract methods When we created the Animal superclass in Section 12.3.1, we did this by identifying common elements of the subclasses, but we chose not to move the age field and the methods associated with it. 6.2 The TechSupport system As always, we shall explore these issues with an example. Remember that a polymorphic variable is one that can store objects of varying types (every object variable in Java is potentially polymorphic). Does the size of the city have an impact on the effectiveness of this approach? The following exercises give you some ideas, and obviously there are many more possibilities. Exercise 12.16 Experiment with different combinations of settings (breeding age, maximum age, breeding probability, litter size, etc.) for foxes and rabbits. The compiler informs us that it cannot find a display method for the post. When you do this, you will get an error message and the program will terminate. The one entirely new area we shall have to look at is layout: how to arrange the components in the frame. 14.3.1 Notifying the user The most obvious way in which an object might respond when it detects something wrong is to try to notify the application's user in some way. M14_BARN7367_06_SE_C14.indd 548 4/11/16 3:43 PM ile ased in ut out ut | 549 Code 14.20 Writing to a text file using a trywith-resource statement Exercise 14.44 Modify the world-of-zuul project so that it writes a script of user input to a text file as a record of the game. ■ Arrays are able to store either objects or primitive-type values. Include an appropriate getPages accessor method for this field. M13_BARN7367_06_SE_C13.indd 507 4/15/16 3:07 PM 508 | Chapter 13 ■ Building Graphical User Interfaces Other elements demonstrated in this example are the use of a slider (which does not do much), and the use of color (in the list) for changing the look of an application. As we have seen in Section 4.4.2, when creating objects of generic classes and assigning them to a variable, we need to specify the generic types (here) only once on the left hand side of the assignment, and can use the diamond operator in the object construction on the right; the generic types used for the object construction are then copied from the variable declaration. The part enclosed by parentheses (int distance) is the information about the required parameter. Create a method called printShortSummary in the MessagePost class. Run the testChange method of AddressBookDemo after doing so. M06_BARN7367_06_SE_C06.indd 219 4/11/16 3:17 PM 220 | Chapter 6 ■ More-Sophisticated Behavior HashMap contacts = new HashMap(); contacts.put("Charles Nguyen", "(531) 9392 4587"); contacts.put("Lisa Jones", "(402) 4536 4674"); contacts.put("William H. The AddressBookFileHandler class defines the methods saveToFile and readFromFile to illustrate the serialization process. Data types A type specifies what kind of data can be passed to a parameter. This should be of type int, and its initial value should be passed to the single constructor, along with the author and title strings. class BufferedWriter BufferedWriter is a class that provides buffered character-based output. Both provide access to the same version of AddressBook, as shown in Code 14.1. The address-book-v1t project provides a text-based user interface, similar in style to the interface of the zuul game discussed in Chapter 8. The inserted call is equivalent to writing super(); Inserting this call automatically works only if the superclass has a constructor without parameters (because the compiler cannot guess what parameter values should be passed). The static type of post is Post, and Post does not have a display method. You will see that you need to read the documentation of both to understand what a HashMap is and how it works. You do not need to examine the source code at this stage. Other significant methods defined by this class are clone and hashCode. MusicFilePlayer can be used essentially as a library class; instances are created along with the name of the MP3 file to be played. Discuss whether these could have a significant impact on the accuracy of the simulation. Exercise 3.20 Explain the modulo operator. Now run the first few steps again, and you should see the original simulation repeated. The project we use for this chapter is a simulation. ■ Getting back to the Theater class, we have not yet worked out exactly how it should react to the seat reservation request. Why do you think this might be? This is enough for us to discuss design problems and possible improvements. Exercise 13.52 Add a menu to the project that allows a 'brush size' to be specified for the pixel editor. Ensure that the simulation works in a similar manner as before. We essentially make every separate item call a single method, only to write tedious code in that method to call separate methods for every item from there. We pass a bit of code to the collection and say "Do this to each element in the collection." The code structure looks something like this: Concept In the functional style of collection processing, we do not retrie e each element to operate on it. Auction (Chapter 4) An auction system. 15.7.5 Observer In the discussions of several of the projects in this book, we have tried to separate the internal model of the application from the way it is presented on screen (the view). Finally, we can add menu items to the menu. This is not surprising, because their purpose is similar: both are used to store information about news-feed posts, and the different types of post have a lot in common. Concept result. However, only the decision to throw an exception will actively prevent the client's programmer from ignoring the consequences of method failure. Thus, if we want to include the index of each file name in the listing, then we would have to declare our own local integer variable (position, say) so that we can write in the body of the loop something like: System.out.println(position + ": " + filename); See if you can complete a version of listAllFiles to do this. Refer to the documentation to be certain what each method does. It has no predetermined limit on the number of tracks it can store, aside from the memory limit of the machine on which it is run. } public int numberOfPixels() { ... You should supplement this discussion with a thorough reading of the source code. The type name is omitted from the labels. A void return type means that the method does not return any value to its caller. The box in the TicketMachine object in Figure 2.4, labeled "TicketMachine (constructor)," represents additional space for the object that is created only when the constructor executes. Thus, we achieve the same as before, but we need to define the fields username, timestamp, likes, and comments only once, while being able to use them in two different places. A contacts list contains entries, and each entry is a pair: a name and a phone number. If a method, for example, is public, it can be invoked from within the same class or from any other class. We shall see examples of more-complicated expressions later in this chapter. Exercise 14.21 Do you think that a call to the search method that finds no matches requires an error notification? However, you should never use = = between String objects when you want to compare their contents. Tip You can recall previously used commands in the Code Pad by using the up arrow. Z04_BARN7367_06_SE_APPD.indd 609 4/11/16 3:52 PM 610 | Appendices Examples: if(field.size() == 0) { System.out.println("The field is empty."); } if(number < 0) { reportError(); } else { processNumber(number); } It is very common to link if-else statements together by placing a second if-else in the else part of the first. When the vehicle notifies the company that it has arrived, the company passes the corresponding passenger to it. Exercise 13.40 Add an invert filter that inverts each color. Some layout managers also accept constructor parameters that define their spacing, and the layout manager will then create the requested space between components. Its scope and lifetime are limited to that of the method. Writing a prototype should be possible quickly, and development of client classes can then continue using the prototype until the class is implemented. We deal with it by refactoring our code. If control reaches the end of the try block, then the catch blocks are skipped and the finally clause is executed. What about between the type of vehicle and "driver"? In effect, you are now performing the role of the ClockDisplay object. The user of a program just starts the program (which typically creates a first object), and all other objects are created—directly or indirectly—by that object. Can you write the constructor's header? ." This is, in fact, not very interesting at all, and not very convincing when trying to pretend that we have a technical-support person sitting at the other end of the dialog. Specifically, it should not contain anything that is part of the application logic. In this book you will not find traditional chapter titles such as "Primitive data types" or "Control structures." Structuring by fundamental development tasks allows us to present a more general introduction that is not driven by intricacies of the particular programming language utilized. Exercise 2.82 Add the following: t1.insertMoney(500); What would you expect the following to return? Instead, this book assumes the use of BlueJ and is able to integrate the tasks of understanding the concepts with the mechanics of how students can explore them. Code 4.4 Printing selected items from the collection M04_BARN7367_06_SE_C04.indd 146 4/11/16 3:10 PM 4.9 Processing a whole collection | 147 Using an if-statement and the boolean result of the contains method of the String class, we can "filter" which file names are to be printed and which are not. Exercise 6.85 Implement this version of the getSightingsOf method in your own animal-monitoring project. We want to add a Help menu that contains an About ImageViewer item. Note that both methods make sure that their parameter value is in the range of valid index values [0 . It is important to note that we are undertaking a process of refactoring and that these changes should not change the essential characteristics of the simulation as seen from a user's viewpoint. We could, perhaps, define a class with a lot of individual fields to cover a fixed but very large number of items, but programs typically have a need for a more general solution than this provides. It does not provide a method body for this method, which makes Animal itself abstract (it must include the abstract keyword in the class header). As we are not going to play the files at this stage, any file na es ill do althou h there is a sa le of audio files in the audio folder of the chapter that you might like to use. (This essential principle was illustrated in Exercise 3.8.) The difference between internal and external method calls is clear—the presence of an object name followed by a dot tells us that the method being called is part of another object. Exercise 2.36 Write down exactly what will be printed by the following statement: System.out.println("My cat has green eyes."); Exercise 2.37 Add a method called prompt to the TicketMachine class. It covers issues ranging from writing clear code (including style and commenting) to testing and debugging. Each of the GUI's elements has many methods for modifying the component's look or behavior—you should look through the documentation for any component that interests you and experiment with modifying some properties of that component. localizing change One of the main goals of a good class design is that of localizing change: making changes to one class should have minimal effects on other classes. The public keyword declares an element of a class (a field or method) to be part of the interface (i.e., publicly visible); the private keyword declares it to be part of the implementation (i.e., hidden from outside access). The toUpperCase method, as well as other string methods, does not modify the original string, but instead returns a new string that is similar to the original one, with some changes applied (here, with characters changed to uppercase). Exercise 3.48 Call the same method (printNextMailItem) again. Clients then communicate with the Decorator instead of with the original object directly (without a need to know about this substitution). Now we can read the assignment statement again: this.from = from; This statement, as we can see now, has the following effect: field named from = parameter named from; In other words, it assigns the value from the parameter to the field with the same name. What the software growth model does not try to do is design the complete software system right from the start. Write an equivalent expression (one that evaluates to true at exactly the same values for a and b) without using the && operator. Experiment with its methods. Input/output is an area where exceptions are likely to occur. See the "Logic operators" note that follows for details. The relevant section of source code we find in the class reads String input = reader.getInput(); if(input.startsWith("bye")) { finished = true; } If you understand these pieces in isolation, then it is a good idea to look again at the complete start method in Code 6.1 and see whether you can understand everything together. Be careful with word processors, though. Source files can be edited with any text editor. For instance, we would always choose to define a class as Cinema rather than Cinemas. We can get around this problem by explicitly telling the type system that the variable v holds a Car object. 1.11 Concept The source code of a class determines the structure and behavior (the fields and methods) of each of the objects of that class. From the other limitations of interfaces—no constructors and no instance fields—it should be clear that the functionality possible in a default method is strictly limited, since there is no state that can be examined or manipulated directly by them. Add to this the first three letters of the name of the town or city where you were born. However, for a checked exception, the compiler requires that the propagating method include a throws clause, even though it does not itself create and throw the exception. This involves detailed discussion of what the classes should be that implement our application, how they interact, and how responsibilities should be distributed. If one of the operands of a plus operation is a string and the other is not, then the other operand is automatically converted to a string, and then a string concatenation is performed. The second principle—not being allowed to know—is different. Exercise 3.32 Identify the similarities and differences between the two constructors. Then go on to create some other objects and call their methods. We have done this with relatively little coding effort, because we have been able to piggyback on the functionality provided by library classes: ArrayList from the standard Java library, and a music player that uses a third-party class library. And it is the growing popularity of functional programming that is driving this change. Exercise 11.14 In the same situation as before (class Student, no toString method), will the following lines compile? Its definition is "closer" to the statement that uses it. This continues all the way up the inheritance hierarchy to the Object class, until a method is found. M06_BARN7367_06_SE_C06.indd 239 4/11/16 3:17 PM 240 | Chapter 6 ■ More-Sophisticated Behavior Exercise 6.73 In class BouncingBall, you will find a definition of gravity (a simple integer). What color is a car? Exercise 6.5 Is there a method in the String class that returns the number of characters in the string? What exactly does it do? M16_BARN7367_06_SE_C16.indd 579 4/11/16 3:47 PM 580 | Chapter 16 ■ A Case Study The company operates both individual taxis and shuttles. Object methods: toString In Chapter 10, we mentioned that the universal superclass, Object, implements some methods that are then part of all objects. It is sufficient to appreciate just how useful this ability is. Despite the debugger's apparent lack of sophistication, this is enough to give us a great deal of information. ■ Return the sum that has been accumulated in the variable over the course of the iteration. The Test Results window will detail the success or failure of each method. We have seen how this approach results in structures of objects working together to solve a common task. As a result, the object originally at index number 2 has changed to 1, whereas the object at index number 0 remains unchanged. Exercise 14.30 Make use of NoMatchingDetailsException in the changeDetails method of AddressBook. Hitting Return enters the selected method call into our source code. In effect, if we create an ArrayList object and then the documentation tells us that the object has the following two methods: boolean add(String o) String get(int index) whereas if we create an ArrayList object, then it will have these two methods: boolean add(Student o) Student get(int index) We will ask you to look at the documentation for further parameterized types in later sections in this chapter. Exercise 6.30 How do you check whether a given key is contained in a map? The display method in this version is implemented in the Post class, not in MessagePost and PhotoPost (Figure 11.1). M03_BARN7367_06_SE_C03.indd 110 4/11/16 3:06 PM 3.10 Objects creating objects 3.10 Concept Object creation. Recall that every time a field, parameter, or local variable has been introduced for the first time in the source, it has had a type name in front of it, such as int or String. M11_BARN7367_06_SE_C11.indd 392 4/11/16 3:34 PM 11.2 Static type and dynamic type Figure 11.1 | 393 NewsFeed Display, version 1: display method in superclass Post ... Test your version to ensure that it behaves in exactly the same way as the original version. Do you notice any significant differences in the population dynamics between the two scenarios? As you should now have come to expect, we see a close connection between the body of the constructor and the fields of the class, because the constructor is responsible for initializing the fields of each instance. The system is supposed to mimic the responses a technical-support person might give. The first principle—not need to know—has to do with abstraction and modularization as discussed in Chapter 3. There are various sources of information available to help you continue. The reverse operation—unboxing—is also performed automatically when a wrappertype object is used in a context that requires a value of the corresponding primitive type. Exercise 13.55 What do CardLayout and GroupLayout have to offer that is different from the layout managers we have discussed in this chapter? You will find that it has a generateResponse method that always returns the string "That sounds interesting. Discuss this. The constructor is currently fairly forgiving of the parameter values it receives: it does not reject null values but replaces them with empty strings. Use inheritance to avoid code duplication between students and instructors (both have a name, contact details, etc.). Exercise 16.19 If you have not already done so, take a thorough look through the implementation in the taxi-company-stage-one project. That doesn't mean, however, that we cannot change the states of objects already within the collection. When we inherit from ("extend") concrete classes, we do both: we inherit the implementation and the type. ■ ■ ■ M15_BARN7367_06_SE_C15.indd 561 We assume that three shows come up: one at 5:30 p.m., one at 9:00 p.m., and one at 11:30 p.m. The employee informs the customer of the times, and the customer chooses the one at 9:00 p.m. So the employee wants to check the details of that show (whether it is sold out, which theater it runs at, etc.). Recognizing the classes for the implementation is now trivial. ++ −− (parameters) ++ −− + − ! new (cast) * / + − > >>> >= >= >= &= |= ^= Boolean expressions In boolean expressions, operators are used to combine operands to produce a value of either true or false. Concept Mutator methods change the state of an object. The add method stores each new item at the end of the list. An example from our collection of animal sightings could be to select the sightings of elephants out of all sightings recorded. It ensures that the observers' update method is called whenever the observed entity (the field) invokes its inherited notify method. The cinema wants to call all customers that have reserved a seat for that show. Exercise 16.5 Create physical CRC cards for the nouns/classes identified in this section, in order to be able to work through the scenarios suggested by the project description. List those of its methods that depend on the types used to parameterize it. For the time being, however, we will explore how to use lambdas with our collections. stream package and read about the count, findFirst, and max methods. 6.3.2 Using library-class methods Back to our TechSupport system. Hint: You will need a local variable declaration of position in the method, as well as a statement to update its value by one inside the for-each loop. Each operation in the pipeline defines what is to be done with a single element of the sequence. 6.14.1 The static keyword Concept Classes can have fields. Why didn't we move incrementAge and canBreed into Animal, then? */ public void discount(int amount) { ... ■ Concept Abstract subclass. This suggests that a further responsibility is Store a collection of vehicles, with Collection and Vehicle as collaborators. From the nature of the matching process, it follows that the order of catch blocks in a single try statement matters, and that a catch block for one exception type cannot follow a block for one of its supertypes (because the earlier supertype block will always match before the subtype block is checked). The first is the type of the parameter to the lambda (record, in our case). ■ The object constructs the collaborator for itself. A full description of the many different classes in the java.io and java.nio packages is beyond the scope of this book, but we shall provide some fundamental examples within the context of several of the projects we have already seen. Prototyping allows us to M15_BARN7367_06_SE_C15.indd 567 4/11/16 3:45 PM 568 | Concept prototyping is the construction of a partially working system in which some functions of the application are simulated. However, because the username field is private in the Post class, it will be necessary to add a public getUserName method to Post. Since their knowledge level changes as they work their way forward, revisiting important topics later allows them to gain a deeper understanding overall. Event-driven simulations Summary of inheritance Summary 440 442 445 453 455 455 456 457 458 Building Graphical User Interfaces 461 Introduction Components, layout, and event handling AWT and Swing The ImageViewer example ImageViewer 1.0: the first complete version ImageViewer 2.0: improving program structure ImageViewer 3.0: more interface components Inner classes Further extensions Another example: MusicPlayer Summary 461 462 463 463 475 489 495 499 504 506 509 Handling Errors 511 The address-book project Defensive programming Server error reporting Exception-throwing principles Exception handling Defining new exception classes Using assertions Error recovery and avoidance File-based input/output Summary 512 516 519 523 529 536 538 541 544 555 Designing Applications 557 Analysis and design Class design Documentation 557 564 566 4/15/16 6:10 PM Contents 15.4 15.5 15.6 15.7 15.8 | 11 Cooperation Prototyping Software growth Using design patterns Summary 567 567 568 570 576 A Case Study 579 The case study Analysis and design Class design Iterative development Another example Taking things further 579 580 584 589 598 598 Appendix A: Working with a BlueJ Project 599 A.1 A.2 A.3 A.4 A.5 A.6 A.7 Installing BlueJ Opening a project The BlueJ debugger Configuring BlueJ Changing the interface language Using local API documentation Changing the new class templates 599 599 599 599 600 600 600 Java Data Types 601 Primitive types Casting of primitive types Object types Wrapper classes Casting of object types 601 602 602 603 603 Operators 605 Arithmetic expressions Boolean expressions Short-circuit operators 605 606 607 Java Control Structures 609 Control structures Selection statements 609 609 Chapter 16 16.1 16.2 16.3 16.4 16.5 16.6 Appendix B: B.1 B.2 B.3 B.4 B.5 Appendix C: C.1 C.2 C.3 Appendix D: D.1 D.2 A01_BARN7367_06_SE_FM.indd 11 4/15/16 6:10 PM 12 | Contents D.3 D.4 D.5 Appendix E: E.1 E.2 E.3 Appendix F: F.1 F.2 F.3 F.4 F.5 Appendix G: G.1 G.2 G.3 G.4 G.5 G.6 Appendix H: H.1 H.2 H.3 H.4 H.5 H.6 Appendix I: I.1 I.2 Appendix J: J.1 J.2 A01_BARN7367_06_SE_FM.indd 12 Loops Exceptions Assertions 611 613 615 Running Java without BlueJ 617 Executing without BlueJ Creating executable .jar files Developing without BlueJ 617 619 619 Using the Debugger 621 Breakpoints The control buttons The variable displays The Call Sequence display The Threads display 622 622 623 624 624 JUnit Unit-Testing Tools 625 Enabling unit-testing functionality Creating a test class Creating a test method Test assertions Running tests Fixtures 625 625 625 626 626 626 Teamwork Tools 627 Server setup Enabling teamwork functionality Sharing a project Using a shared project Update and commit More information 627 627 627 627 628 628 Javadoc 629 Documentation comments BlueJ support for javadoc 629 631 Program Style Guide 633 Naming Layout 633 633 4/15/16 6:10 PM Contents J.3 J.4 J.5 Appendix K: K.1 K.2 K.3 K.4 K.5 K.6 Appendix L: Index A01_BARN7367_06_SE_FM.indd 13 | 13 Documentation Language-use restrictions Code idioms 634 635 636 Important Library Classes 637 The java.lang package The java.util package The java.io and java.nio.file packages The java.util.function package The java.net package Other important packages 637 638 639 640 640 641 Concept Glossary 643 649 4/15/16 6:10 PM Foreword by James Gosling, creator of Java Watching my daughter Kate and her middle-school classmates struggle through a Java course using a commercial IDE was a painful experience. debugger A debugger is a software tool that helps in examining how an application executes. Chapters 10 and 11 introduce inheritance and polymorphism, with many of the related detailed issues. Key methods are next and hasNext. As we progress in this book, the examples we use and the programs we build will get more and more complex. Enter it into the news feed. Code 3.1 Class for a twodigit number display Concept Classes define types. We have then used this example to introduce abstract classes and interfaces as constructs that allow us to create further abstractions and develop more-flexible applications. There is no disadvantage to it, and it serves well to document what is actually happening. To help us maintain an overview in complex programs, we try to identify subcomponents that we can program as independent entities. He can give his name and the show, but has forgotten the seat numbers. The variable must be declared outside the loop. J.4.4 Import classes separately Importing statements explicitly naming every class are preferred over importing whole packages. If you completed Exercise 11.3, you will have noticed that this solution works, but is not perfect yet. Concept Boolean expressions have only two possible values: true and false. You will notice that the type of the expected parameter is Student. The full name or qualified name of a class is the name of its package, followed by a dot, followed by the class name. 11.6 Concept Method polymorphism. Learning to program requires a mix of some theory and a lot of practice. We will follow that convention in this book. It is used to describe the publicly visible part of a class (which is how we have just been using it here), but it also has other meanings. Why or why not? The most obvious one is code duplication. The constructor and the two get methods are also the same as before. If the type is a class, the field can hold objects of that class. Note what the calls to getBalance return in each case. The header of getName (as shown in the object's pop-up menu) is defined as String getName() The word String before the method name specifies the return type. As there, the program finds and plays MP3 files stored in the audio folder inside the chapter folder (one level up from the project folder). Object interaction For the next section, we shall work with a different example project. Clock-display (Chapter 3) An implementation of a display for a digital clock; illustrates the concepts of abstraction, modularization, and object interaction. Note The word interface has several meanings in the context of programming and Java. Object types are those defined by classes. It contains the classes exactly as we have discussed them here. Parameters are another sort of variable, just as fields are, so they are also used to hold data. Conversely, the writer of the server class might argue that it is obviously wrong to try to remove details with an invalid key. Find descriptions of each of these, and identify at least one example application for each. This ensures that it cannot accidentally be changed later. The shows have to be added to the system. For a full picture, they can be read in sequence, where they are, and you will learn the alternative constructs as you go along. Many varied kinds of processing of streams can be achieved with only three different kinds of functions: filter, map, and reduce. } There are two things worth noting here. Watch the displayString field in the inspector. Putting up with a bit of code duplication may be easier in the short term than doing careful refactoring. You can use the runLongSimulation method to do this. However, numerous problems have been discovered with this model over the years. The server name and access details need to be specified in a dialog; ask your administrator (the one who set up the repository) for the details to fill in here. Can you call the inherited methods (for example, addComment)? Some other object-oriented languages also provide mechanisms to inherit code without inheriting the type. We shall spend most of our time looking at the LogAnalyzer class, as it contains examples of both creating and using an array (Code 7.1). What sort of return type should it have? You might like to think of a method call as being a form of question to an object, and the return value from the method being the object's answer to that question. This is the meaning of unchecked: the compiler does not apply special checks, either on the method in which an unchecked exception is thrown or on the place from which the method is called. In other words, they should start with the comment symbol "/**". ■ Again, contrary to the rule for super calls in constructors, the super call in methods may occur anywhere within that method. Usually, as we work on GUIs, we continue to read about details that we did not know before and become experts over time. This need to match against both method name and parameter lists is important, because there may be more than one method of the same name in a class—if that method is overloaded. This is still a very crude method, because it does not pick up any of the meaning of the user's input, nor does it recognize a context. In this case, some of the classes are easy to identify. In it create a class named NameGenerator. How can you define exactly how a string should be split? Could a vehicle ever need to have multiple associations recorded for it? For instance, users might press a button on the physical machine to select a discounted ticket price. information hiding Information hiding is a principle that states that internal details of a class's implementation should be hidden from other classes. The affect of applying this reduce method then is to initialize a running total to zero, add each element of the stream to it, and return the total at the end. ■ The statements in the catch block are key to setting up the recovery attempt. This means that nested menus can be created by placing one JMenu inside another. array An array is a special type of collection that can store a fixed number of elements. Students can almost "feel" what it means to create an object, call a method, pass a parameter, or receive a return value. One purpose is to tell the client whether its request was successful or not. Exercise 6.88 The following code fragment attempts to print out a string in uppercase letters: public void printUpper(String s) { s.toUpperCase(); System.out.println(s); } This code, however, does not work. Accessor methods with boolean return values are often called isSomething(. . .)—for example, isEmpty(). It is your choice how the details are formatted. In particular, we will see that operations on streams eliminate the need to write explicit loops when processing a collection—just as we see in the rewrite of the printList method in Exercise 5.6. Exercise 5.6 Modify your own printList method as discussed here: try out all the s nta ariations for la das that e ha e sho n eco ile and test the roject ith each ariation to check that ou ha e the s nta correct We have already seen some of that with the forEach method; in the remainder of this chapter we will explore the filter, map, and reduce methods defined on streams. For instance, it would be wrong to combine assertions with removal of details, as follows, in the address book: // Error: don't use assert with normal processing! assert book.remove(details.getName()) != null; assert book.remove(details.getPhone()) != null; Exercise 14.36 Open the address-book-assert project. With the inspector open, call the object's methods. Code 12.9 The Actor interface A class can inherit from an interface in a similar way to that for inheriting from a class. Exercise 12.5 Use the reset method to create a new starting state for the simulation, and then run it again. Tags can be used in two forms: block tags and in-line tags. Specified by: length in interface CharSequence Returns: the length of the sequence of characters represented by this object. However, from a writer's point of view, the creation is explicit because they have to write the code to make it happen. Notice that we are not being too ambitious in this first version. We need to add two methods for instance, makeLarger and makeSmaller, to do the actual work, and we need to add action listeners to the buttons that invoke these methods. This is a big step forward, but it does not solve all our problems. To illustrate this, consider that when we are printing the details of a sighting, we are only actually interested in the string returned from the getDetails method, and not the Sighting object itself. A class may contain more than one constructor, or more than one method of the same name, as long as each has a distinctive set of parameter types. This style of simulation is sometimes called time-based, or synchronous, simulation. Instead, define a mutator for it with the following header: public void setRefNumber(String ref) The body of this method should assign the value of the parameter to the refNumber field. It does not provide us with the index position of an element, but we don't always need that, so that is not necessarily a problem. Then there is an engineer (maybe in a different company) who designs the spark plug. Exercise 2.83 Below is the outline for a Book class, which can be found in the book-exercise project. It will leave each component at its preferred size and center them horizontally. Exercise 2.78 Challenge exercise Modify the getLoginName method of Student so that it always generates a login name, even if either the name or the id field is not strictly long enough. 12.3 Abstract classes Chapter 10 introduced concepts such as inheritance and polymorphism that we ought to be able to exploit in the simulation application. When dealing with collections and iterating over them, it is worth bearing two things in mind: ■ ■ A for-each loop provides a general control structure for iterating over different types of collection. Java calls these top-level windows frames. Take the first three letters of your last name. 2.17 Fields, parameters, and local variables With the introduction of amountToRefund in the refundBalance method, we have now seen three different kinds of variables: fields, formal parameters, and local variables. For this exercise, you should use a collection to store the balls. Here is a hypothetical hashCode method that uses the values of an integer field called count and a String field called name to calculate the code: public int hashCode() { int result = 17; // An arbitrary starting value. As a consequence, if a customer inserts more money than the price of the ticket, then some money will be left in the balance that could be used toward the price of a second ticket. The Instance variables area displays the values of that particular object's instance variables. The Actor class would serve as a superclass to all kinds of simulation participants, independent of what they are. The class is divided into three parts that show (in this order from the top) the class name, the fields, and the methods. This is exactly the sort of situation for which BlueJ is a perfect fit. This function reverses the last operation. This is dangerous! We will soon move on to developing this system in Java, and if details are left unanswered, it is very likely that ad hoc decisions will be made at implementation time that could later turn out to be poor choices. Overriding methods in subclasses take precedence over superclass methods. In addition, we might find that some of our original assumptions were wrong or that our design is inadequate in some way. This ensures that it cannot be called from outside the class, and thus client classes cannot create new instances. Concepts discussed in earlier chapters (such as reliability, data structures, class design, testing, and extendibility) are applied again in a new context. On the negative side, there is always the risk of making implementation decisions too early: for instance, committing to particular sorts of data structures that might be better left until later or, as we did here, choosing to reject the Observer pattern in favor of the more direct approach. The main binary arithmetic operations are: + addition − subtraction * multiplication / division % modulus, or remainder after division The results of both division and modulus operations depend on whether their operands are integers or floating-point values. The newly born animals are then added to the master lists at the end of the step. For instance, as more money is inserted into a ticket machine, we shall want to change the value stored in the balance field. Then select Record method calls from the terminal's Options menu. The implementation of the updateDisplay method will be discussed below. The objects from the problem domain vary with the program you are writing. In the current version, the user input is returned by the InputReader as a single string. This may work with a small student project, but it creates problems in real-world projects. A selection statement provides a decision point at which a choice is made to follow one route through the body of a method or constructor rather than another route. Note that a Map does not return an Iterator, but its keySet method returns a Set of the keys, and its values method returns a Collection of the objects in the map. If the required condition is met then we will go on to process the element in some way. In the printNextMailItem method, the MailClient object made a call to a MailServer object to retrieve the next mail item. ■ Now the theater has accepted a request to make a reservation. This is commonly used in filter operations. The major difference between shuttles and taxis is that a shuttle has to be concerned with multiple passengers, whereas a taxi has to be concerned with only one. Instead, we would create a class that does it for us. Exercise 5.12 Write a method that uses two filter calls to print details of all the sightings of a particular animal made on a particular day—the method takes the animal name and day ID as parameters. For cases where parts of both are useful, we can inherit from abstract classes; here, we inherit the type and a partial implementation. This more advanced stage can be found in the taxi-company-later-stage project. Of particular importance are the methods toString, equals, and hashCode which Object defines. Since we often won't be particularly concerned about whether the collection is an ArrayList, a LinkedList, or some other form of list type we have not met before, we can ask the Collector to return the collection in the form of the polymorphic type List. Key methods are getContent, getFile, getHost, getPath, and openStream. The collaborator will be for the exclusive use of the constructing object, unless it is passed to another object in one of the previous two ways. We will take this approach a step further, and also discuss how to prepare our own classes so that other people can use them in the same way as they would use standard library classes. We do not always make perfect design decisions at the start, and applications grow and requirements change. ################## This is the longest method we have seen so far, so we shall break it down into more manageable pieces: ■ ■ ■ ■ ■ M02_BARN7367_06_SE_C02.indd 67 The header indicates that the method has a void return type, and that it takes no parameters. However, rather than being overwhelmed by the magnitude of the overall task, we can make things more manageable by identifying M16_BARN7367_06_SE_C16.indd 589 4/11/16 3:47 PM 590 | Chapter 16 ■ A Case Study some discrete steps to take toward the ultimate goal and undertaking a process of iterative development. That means we enter the body of the loop and look in the next place on our mental list. If you are not sure, experiment with the source of the Animal class in the foxes-and-rabbits-v2 project. An additional question is how to treat the traditional style of programming in those areas where functional constructs are now available: should they be replaced, or do both need to be covered? Test it to confirm that it is tolerant of extra space around the word "bye". An essential question in all cases of this kind will be, of course, "How good is the simulation?" One can "prove" just about anything with an ill-designed simulation. ■ On arrival at a passenger's destination, a Vehicle has responsibilities to Offload passenger and Notify the company of passenger arrival. For animals, for example, we can M12_BARN7367_06_SE_C12.indd 436 4/11/16 3:38 PM 12.3 Abstract classes Concept An abstract method definition consists of a method header without a method body. If, for example, a customer requests four seats together in the same row, it might be easier to find four adjacent seats if we have them all arranged by rows. See Code 14.13. Code 3.4 shows the complete source code of the ClockDisplay class, which can be found in the clock-display project. Read the documentation of the get and put methods of class HashMap again and see whether the explanation matches your current understanding. Another engineer, on the other hand, whose job is to design the engine (team of), think of the many parts of an engine: the cylinders, the injection mechanism, the carburetor, the electronics, etc. Random, Set, and Map are examples of classes that we encounter in this chapter. M14_BARN7367_06_SE_C14.indd 541 4/11/16 3:43 PM 542 | Chapter 14 ■ Handling Errors 14.8.1 Error recovery The first requirement of successful error recovery is that clients take note of any error notifications that they receive. Any set of declarations and statements between a pair of matching curly brackets is known as a block. ■ These five classes together (Simulator, Fox, Rabbit, Field, and Location) provide the model for the simulation. class Math Math is a class containing only static fields and methods. Code 7.1 The log-file analyzer M07_BARN7367_06_SE_C07.indd 253 4/15/16 3:35 PM 254 | Chapter 7 ■ Fixed-Size Collections—Arrays Code 7.1 continued The log-file analyzer The analyzer currently uses only part of the data stored in a server's log line. The responsibilities of each class should be evaluated according to the class design principles discussed in Chapter 8: Responsibility-Driven Design, Coupling, and Cohesion. If not, then we decide that the two objects cannot be equal. This makes storage and retrieval of persistent data a relatively simple process in Java. Z12_BARN7367_06_SE_APPL.indd 643 4/11/16 4:01 PM 644 | Appendices class cohesion A cohesive class represents one well-defined entity. This project represents a naïve implementation of an automated ticket machine. Instead of adding the ImagePanel directly to the content pane, place the panel in a JScrollPane and add the scroll pane to the content pane. Values can be looked up by providing the key. For this exercise, we shall first build a clock with a European-style 24-hour display. In this book, we will present both, so that the two reinforce each other. Exercise 7.5 What is wrong with the following array declarations? Find the method that computes the maximum of two integer numbers. M03_BARN7367_06_SE_C03.indd 123 4/11/16 3:06 PM 124 | 3.15 Chapter 3 ■ Object Interaction Method calling revisited In the experiments in Section 3.14, we have seen another example of object interaction similar to one we saw before: objects calling methods of other objects. overriding A subclass can override a method implementation. For instance, instead of cutting the hair themselves, they could decide to sub-contract the task to a separate person for each individual child, so that every child's hair is cut at the same time. The three methods of the MusicPlayer class we shall be using are playSample, startPlaying, and stop. This information is very useful when it comes to making informed decisions about the right concrete class to use in a particular setting. Exercise 11.12 In the same situation as in the previous exercise, if both classes have an implementation of getName, which one will be executed? Fields are also known as instance variables. Code 6.6 shows the new version of the start method from the SupportSystem class. In the diagram, the variable is shown as a white box, and the object reference is shown as an arrow. If the class is found but does not contain a main method (or the main method does not have the right signature), you will see a message similar to this one: Main method not found in class Game, please define the main method as: public static void main(String[] args) In that case, make sure that the class you want to execute has a correct main method. Here is the structure of a while loop where boolean condition and loop body are pseudocode, but all the rest is the Java syntax: while(boolean condition) { loop body } The loop is introduced with the keyword while, which is followed by a boolean condition. Using inheritance Inheritance is a mechanism that provides us with a solution to our problem of duplication. However, if the collaborator is stored in a field, then the collaboration is likely to last the full lifetime of the creating object. It is always enclosed by a matching pair of curly brackets: "{" and "}". If objects are added or removed from anywhere other than the last position in the list, then following items have to be moved to make space or close the gap. It is common to have fields whose values change often, such as balance and total, and others that change rarely or not at all, such as price. Instead of implementing the car as a single, monolithic object, we would first construct separate objects for an engine, gearbox, wheel, seat, and so on, and then assemble the car object from those smaller objects. System.out.println("# " + "price" + " cents."); Exercise 2.39 What about the following version? Does this change the operation of the method? What can we do? Let us look at some code. You can later retrieve them in the same order. If the horizontal space is not enough to fit all components, they wrap around to a second line. This is typical for the use of library classes. Compile. We implement an Eliza-like dialog system and a graphical simulation of a bouncing ball to apply these classes. Simple accessor methods should be named getSomething(. . .). Exercise 13.25 We can see a call to a method showStatus, which is clearly an internal method call. MailItem is fairly trivial. That is normal, and you will gradually improve with experience. Exercise 12.9 After having run the simulation for a while, call the static reset method of the Randomizer class, and then the reset method of the Simulator object. In BlueJ, the source code of a class can be viewed by selecting the Open Editor function from the class's pop-up menu, or by double-clicking the class icon. The implementation of the display method is found in the class and executed. So we made our own subclass that adds these two methods. Both are equally valid and reflect choices of expression we will have to make when writing real loops. Does the number of foxes change if you call the simulateOneStep method just once? Exercise 10.2 Try the following. Before attempting these exercises, be sure that you have a good understanding of how ticket machines behave and how that behavior is implemented through the fields, constructor, and methods of the class. The selected value is displayed, and the selection can be accessed through a pop-up menu. Code 13.4 ImageViewer class with ImagePanel M13_BARN7367_06_SE_C13.indd 476 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 477 Code 13.4 continued ImageViewer class with ImagePanel When comparing this code with the previous version, we note that there are only two small changes: In method makeFrame, we now create and add an ImagePanel component instead of a JLabel. It is important that each step in an iterative development represent a clearly identifiable point in the evolution of the application toward the overall requirements. Variables that have a class as their type can store objects of that class. The static requireNonNull method of the java.util.Objects class provides a convenient shorthand for testing an expression and throwing an exception if the expression is null. Discuss. These techniques were not available in the Java language prior to version 8. Often when different team members work on different classes, not all classes take the same amount of time to be completed. Local variables will appear in this area only once they have been initialized, as it is only at that point that they come into existence within the virtual machine. You can find it in the book projects under the name tech-support1. So far, it has appeared as if most classes we have seen do not have a superclass. The outline already defines two fields and a constructor to initialize the fields. If price is greater than budget, then print the message "Too expensive"; otherwise print the message "Just right". Code 6.8 shows part of the WordCounter class that can be found in the tech-support-analysis project. Many more improvements to this application are possible. To each menu item, we add an action listener, using lambda expressions as we discussed for the other menu items. This allows polymorphic variables and method calls. The second form of for loop executes as long as a condition evaluates to true. They divide the car into independent modules (wheel, engine, gear box, seat, steering wheel, etc.) and get separate people to work on separate modules independently. You should carefully study this project and compare it with your own solutions. Exercise 6.36 How would you call the split method if you wanted to split a string at either space or tab characters? Object serialization is a much more reliable process. This is only part of the truth, in fact, because an object of a subclass can be used wherever its superclass type is required. Subclasses of Error are usually reserved for runtime-system errors rather than errors over which the programmer has control. 6.12.2 Private methods and public fields Most methods we have seen so far were public. There are two aspects to this topic: reading class library descriptions (especially class interfaces) and writing them. Alternatively, open the imageviewer0-2 project and carefully examine the source code. There is nothing really new in this. We should expect quite different followup actions from a client in these different situations. In a direct complement to "get" methods, these are often called "set" methods, although the TicketMachine does not have any of those, at this stage. It follows that checked exceptions should be used where there may be a possibility of the client effecting a recovery. .).inter3(. It does not allow multiple inheritance of classes, but provides another construct, called an "interface," that allows a limited form of multiple inheritance. In practice, this has to be decided by a combination of such things as what we are trying to discover, what events we are simulating, and how much real time is available to run the simulation. Step through the method again, as before. The value of 24 is the size of the array, and not a constructor parameter. Exercise 3.40 Assume a class Tree has a field of type Triangle called leaves and a field of type Square called trunk. display MessagePost 11.2 PhotoPost Static type and dynamic type Trying to solve the problem of developing a complete polymorphic display method leads us into a discussion of static and dynamic types and method lookup. Playing through the scenarios mentioned here could take several hours. 4 people like this. The reason for this is mostly historical: arrays are the oldest collection structure in programming languages, and syntax for dealing with arrays has developed over many decades. Michael would like to thank Davin and Neil who have done such excellent work in building and maintaining BlueJ and our community web sites. The bricks project provides a chance for you to try out those techniques with a new scenario. A BoxLayout lays out multiple components either vertically or horizontally. This will be an extension of the Responder class in our project. It gets easier from now on—really! Understanding the event handling for menu items was probably the most difficult detail we had to master for our example. Because the constructor is automatically executed when a ClockDisplay object is created, the NumberDisplay objects will automatically be created at the same time. Exercise 11.9 Discuss how inheritance could be used in the zuul project to implement a player and a monster class. Exercise 13.18 Look at the of the calculator roject used in ha ter 9 (Figure 9.6). M12_BARN7367_06_SE_C12.indd 449 4/11/16 3:38 PM 450 | Chapter 12 ■ Further Abstraction Techniques In our example, even though Actor is now an interface, we can still declare an Actor variable in the Simulator class. At this stage, you need only fill in the class names. Terms introduced in this chapter: analysis and design, verb/noun method, CrC card, scenario, use case, method stub, design pattern M15_BARN7367_06_SE_C15.indd 576 4/11/16 3:45 PM 15.8 Summary | 577 Exercise 15.18 Assume that you have a school management system for your school. This is conceptually easy but contains one tricky detail: How do we arrange to react to user actions, such as the selection of a menu item? Such a contacts list might be used on a mobile phone or in an e-mail program, for instance. This procedure is known as method lookup, method binding, or method dispatch. Because what we are trying to do with these loop constructs is typically more complex than just iterating over a complete collection from beginning to end, they require a little more effort to understand. A value of zero has a special meaning here, standing for "as many as necessary." Thus, we can create a single column GridLayout by using 0 as the number of rows and 1 as the number of columns. An important point to note, however, is that our computer model needs to be able to restart the sequence for each new passenger as soon as each fresh request is received, even if a previous request has not yet run to completion. So we add the responsibility to Shuttle to Choose next target location, with a Collection collaborator to maintain the set of possible target locations to choose from. What distinguishes class methods from instance methods is that class methods can be invoked without an instance—having the class is enough. You do not need to define any methods in the class and the shapes do not have to be made visible. The decision should be made mainly on the basis of readability: use the version that you find easier to read and understand. In BlueJ, this project comment is accessible through the text note displayed in the top left corner of the class diagram. For more complex problems, that, is too simplistic. As a consequence, state changes to an object via a formal parameter will persist, after the method has completed, in the actual parameter. Make a record of all scenarios you have played through. Exercise 2.57 Modify your answer to the previous exercise so that the message includes the value of your budget if the price is too high. Exercise 12.7 In the source code of the Simulator class, find the simulate method. M05_BARN7367_06_SE_C05.indd 184 4/11/16 3:13 PM 5.4 The forEach method of collections | 185 The parameter of the forEach is a lambda. superclass A superclass is a class that is extended by another class. (Have a look at the documentation of class Color as well; we shall need it later.) OFImage is implemented as a subclass of the Java standard class BufferedImage (from package java.awt.image). Navigate to the projects folder and select a project. 11.5 super call in methods Now that we know in detail how overridden methods are executed, we can understand the solution to the problem. To execute it, use the command java Game Note that this command does not include the .class suffix. D.2 Selection statements D.2.1 if-else The if-else statement has two main forms, both of which are controlled by the evaluation of a boolean expression: if(expression) { statements } if(expression) { statements } else { statements } In the first form, the value of the boolean expression is used to decide whether or not to execute the statements. This pane is the Code Pad. In the second form, the expression is used to choose between two alternative sets of statements, only one of which will be executed. To do this, you can check Appendix B, or look it up in another Java book or in an online Java language manual. Pay close attention to the following "Pitfall" comment. As you review the classes in the taxi-company-outline project, you may feel that we have gone too far in this case, or maybe even not far enough. The filter function takes a stream, selects some of it elements, and creates a new stream with only the selected elements (Figure 5.1). } 2 In fact, Java does allow void methods to contain a special form of return statement in which there is no return value. Exercise 11.10 Could (or should) inheritance be used to create an inheritance relationship (super-, sub-, or sibling class) between a character in the game and an item? To achieve this in Java, we need to know about two things: how to cut a single string containing a whole sentence into words, and how to use sets. The term "polymorphic" (literally, many shapes) refers to the fact that a variable can hold objects of different types (namely, the declared type or any subtype of the declared type). Inheritance has a number of other advantages, which we discuss below. For instance, if we are seeking to answer questions about the profitability of running taxis in this area, then we must ensure that we can obtain information from the model that will help us assess profitability. M05_BARN7367_06_SE_C05.indd 183 4/11/16 3:13 PM 184 | Chapter 5 ■ unctional Processin of ollections d anced We will encounter lambdas and function parameters several times later in this book, for example when we introduce functional interfaces in Chapter 12 and when we write graphical user interfaces (GUIs) in Chapter 13. As such, many of its methods take an index parameter: for instance, add, get, remove, and set. */ public void printList() { sightings.forEach((Sighting record) -> { System.out.println(record.getDetails()); }); } The body of this new version of printList consists of a single statement (even though it spans six lines), which is a call to the forEach method of the sightings list. In this example, we will first introduce only some of the problems that are addressed by using inheritance structures, and discuss further uses and advantages of inheritance and polymorphism as we progress through this chapter. M01B_BARN7367_06_SE_C01.indd 41 4/11/16 2:54 PM 42 | Chapter 1 ■ Objects and Classes About compilation When people write computer programs, they typically use a "higher-level" programming language such as Java. Your search will model an indefinite iteration, because there will be many different places to look, and you cannot predict in advance how many places you will have to search before you find the keys; after all, if you could predict that, you would go straight to where they are! So you will do something like mentally composing a list of possible places they could be, and then visit each place in turn until you find them. It should * really be extended to make it more interesting! * To play this game, create an instance of this class and call * the "play" method. We say that the scope of a parameter is restricted to the body of the constructor or method in which it is declared. One of the primary reasons for this is the change in computing hardware available, and also the changing nature of problems we wish to tackle. Nonetheless, this book isn't about BlueJ. Exercise 16.13 The taxi-company-outline project defines a Demo class to create a pair of PassengerSource and TaxiCompany objects. Read them again. The last of these points is the only remaining problem. Exercise 14.53 What happens if you change the definition of a class by, say, adding an extra field, and then try to read back serialized objects created from the previous version of the class? Exercise 5.11 Write a method in the AnimalMonitor class to print details of all the sightings recorded on a particular dayID, which is passed as a parameter to the method. The body contains those statements that we wish to perform over and over again. This means that we first have to establish that the type of the object passed as a parameter is the same as that of the object it is being compared with. 12.2 The foxes-and-rabbits simulation The simulation scenario we have chosen to work with in this chapter uses the freeway example from above as its basis. It is quite straightforward to decide that we should have a class MessagePost to represent message posts, and a class PhotoPost to represent photo posts. Discovery will be in the server's method, and recovery will be in the client. A sequence of user interactions with the class diagram and object bench are recorded, then captured as a sequence of Java statements and declarations in a method of the test class. Given suitable tools, these logs enable web service managers to extract and analyze useful information such as: ■ which are the most popular pages they provide ■ which sites brought users to this one ■ whether other sites appear to have broken links to this site's pages ■ how much data is being delivered to clients ■ the busiest periods over the course of a day, a week, or a month Such information might help administrators to determine, for instance, whether they need to upgrade to more-powerful server machines, or when the quietest periods are in order to schedule maintenance activities. Do you observe a change? In fact, this is not strictly the case, as Java allows an exception to be propagated from the client method to the caller of the client method, and possibly beyond. We can compare this with the original source shown in Code 10.3. Code 10.5 Source code of the NewsFeed class (second version) M10B_BARN7367_06_SE_C10.indd 380 4/11/16 3:32 PM 10.7 Subtyping | 381 Code 10.5 Source code of the NewsFeed class (second version) Concept Subtype As an analog to the class hierarchy, types form a type hierarchy. Give some examples. What assumptions are made within it? However, using a simple test of the search result, the exception can be avoided, and the real problem of a failed zip code search can be addressed instead: String key = database.search(zipCode); if(key != null && !key.isEmpty()) { ContactDetails university = contacts.getDetails(key); . The method then returns the remembered value of the balance. Which are not? So post instanceof MessagePost returns true only if post is a MessagePost, as opposed to a PhotoPost, for instance. This usually involves replacing the cast with a polymorphic method call (more about this will be covered in the next chapter). This fits perfectly with the legal indices for an ArrayList. The sort of loop structures that result occur again and again in practical programming situations. 10.2 Concept Inheritance allows us to define one class as an extension of another. This project is the complete solution that we will have developed by the end of this chapter. The City object defines the dimensions of the city's grid and holds a collection of all the items of interest that are in the city—the vehicles and the passengers. Mail items can be received by a mail client from the server one at a time, using a method in the mail client. We refer to this in the preface as an "iterative approach." One particular advantage of the approach is that it will help you to gradually deepen your understanding of topics as you work your way through the book. If you were to create such a system, at what point in the development process of the cinema system would you introduce changes? | 383 fulfill the request perfectly well by giving them a fountain pen or a ballpoint pen. This was a concrete class, and it provided the implementation of a grid-based view of the field. A stream provides useful methods to manipulate these data sets. Sun has very generously supported BlueJ for many years, and when Oracle acquired Sun this support has continued. There are other possibilities. Interactive components (those that can react to user input) generate events when they are activated by a user. All of these interfaces extend the Function interface, whose single abstract method is called apply. As we become more experienced and move on to design larger software systems, the implementation of single classes is not the most difficult problem any more. for loop An iterative control structure that is often used when an index variable is required to select consecutive elements from a collection, such as an ArrayList or an array. Eliza The idea of the TechSupport project is based on the ground-breaking artificial intelligence program, Eliza, developed by Joseph Weizenbaum at Massachusetts Institute of Technology in the 1960s. Code 14.17 shows the consistentSize method, whose purpose is to ensure that the numberOfEntries field accurately represents the number of unique details in the address book. Our ticket machines work by customers "inserting" money into them and then requesting a ticket to be printed. Now, back to our digital clock. Exercise 6.43 Add more word/response mappings into your application. Code 4.4 shows a method to list only those file names in the collection that contain a particular string. Or it could have a collection of rows (each row being a separate object), and rows, in turn, hold seats. The value of increment should be set to 5.0 in the constructor. The idea is similar to what we saw in Chapter 9 with JUnit testing, where we asserted the results we expected from method calls, and the JUnit framework tested whether or not those assertions were confirmed. Figure 10.4 BlueJ class diagram of network NewsFeed MessagePost PhotoPost M10B_BARN7367_06_SE_C10.indd 362 4/11/16 3:32 PM 10.1 The network example | 363 In practice, to implement the full network application, we would have more classes to handle things such as saving the data to a database and providing a user interface, most likely through a web browser. A method with a non-void return type must have at least one return statement in its body; this will often be the final statement. Instead of explaining more about this here, we suggest that the curious reader dip into Chapter 1—things will quickly become clear then. We shall explain the reason for this numbering in due course. ■ A new movie is scheduled for screening. If the checks are computationally "expensive" to make, then duplication may be undesirable or prohibitive. The only problem is that we did not specify exactly how these three components should be arranged. The full version of a method to search for the first file name matching a given search string can be seen in Code 4.6 (music-organizer-v4). While these classes are not, strictly speaking, a part of the language, some of them are so closely associated with writing Java programs that they are often thought of in that way. (If you have done Exercise 11.2, you already have a similar implementation of this design in your own version.) M11_BARN7367_06_SE_C11.indd 397 4/11/16 3:34 PM 398 | Chapter 11 ■ More about Inheritance The technique we are using here is called overriding (sometimes it is also referred to as redefinition). The frame is then filled with various components that provide information and functionality to the user. image format Images can be stored in different formats. ■ We can now add to the Seat card: Accepts reservations. Code 13.3 shows the source code for this in context. * * "World of Zuul" is a very simple, text-based adventure game. The check for ending the application is done using the contains method of the HashSet class, rather than a String method. We can think of text files as containing data in a form similar to Java's char type—typically simple, linebased, human-readable alphanumeric information. If it were necessary to know all internals of all classes we need to use, we would never finish implementing large systems. Whatever type is "added" to a string is automatically converted to a string and then concatenated. We want to change that by adjusting the text read in from a user so that these variations are all recognized as "bye". M12_BARN7367_06_SE_C12.indd 420 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 421 The Randomizer class provides us with a degree of control over random aspects of the simulation, such as when new animals are born. That means that the value 0 is included in the possible results, whereas the specified value for n is not. Exercise 10.1 Open the project network-v1. 4.7.1 The effect of removal on numbering As well as adding items to a collection, it is common to want to remove items, as we saw with the removeFile method in Code 4.1. The ArrayList class has a remove method that takes the index of the object to be removed. In our example, the purpose of this method call is to update the display string. In the following sections, we shall see how the constructor and methods use those fields to implement the behavior of naïve ticket machines. The other rolls back to 0 after reaching its limit of 59. On Linux, the package dependencies will automatically install the right JDK version when you install BlueJ, if necessary. The classes have been developed to the point where a taxi picks up and delivers a passenger to their destination. 9.13 Putting the techniques into practice This chapter has described several techniques that can be used either to understand a new program or to test for errors in a program. Next follows a simple accessor method for the current display value (getValue). | 111 Objects creating objects The first question we have to ask ourselves is: Where do the NumberDisplay objects used by the ClockDisplay come from? (This might be implemented later by using an ArrayList, a LinkedList, a HashSet, or some other form of collection with additional methods appropriate to showings. Edit the source of the TicketMachine class to make the change, and then close the editor window. It provides information that would allow us to determine which hours of the day, on average, tend to be the busiest or quietest for the server. 3.6 Class diagrams versus object diagrams The structure described in the previous section (one ClockDisplay object holding two NumberDisplay objects) can be visualized in an object diagram as shown in Figure 3.3a. We want to see three components above each other: a label at the top, the image in the middle, and another label at the bottom. The value can be incremented, but, if the value reaches the limit, it rolls over to zero. If you are not sure, change act to be a concrete method in the Animal class by giving it a method body with no statements. What is the purpose of the ImageViewer parameter that we used in the constructor call above? It contains a section titled Creating a GUI with JFC/Swing (. The more modern Path interface and Files class (note the plural name) in java.nio. Create a MessagePost object. The line item.print(); calls the print method of the item object. Most of all: Have fun! M16_BARN7367_06_SE_C16.indd 598 4/11/16 3:48 PM APPendix A A.1 Working with a BlueJ Project Installing BlueJ To work with BlueJ, you must download and install the BlueJ system. That car is red, it doesn't go very fast, and it is in my garage. What we have here is the requirement to do something several times, but the number of times depends upon circumstances that may vary—in this case, the size of the collection. However, after making these changes, it becomes fairly easy to "plug in" other views for the simulation by providing further implementations of the SimulatorView interface. So we can include the index in the listing if we wish. Before we start experimenting with the debugger, we will take a look at the example we will use for debugging: a simulation of an e-mail system. We have also been able to do this with relatively little knowledge of the internal workings of these library classes; it was sufficient to know the names, parameter types, and return types of the key methods. This condition works even if the list is completely empty. Inheriting from JFrame In this example, we are demonstrating the alternative popular version of creating frames that we mentioned at the start of the chapter. Do you think that many of the existing methods would need to be changed as well? They are, among other things: Concept The interface of a class describes what a class does and how it can be used without showing the implementation. This is also a collaborator.) The theater should probably know about the exact number and arrangement of seats it has. 9 This is a simplification, because objects can also be written and read across a network, for instance, and not just within a file system. In object-oriented languages, we can substitute a subclass object where a superclass object is expected, because the subclass object is a special case of the superclass. The overall structure, tone, and approach of the book is unchanged; it has worked very well in the past, and there is no reason to deviate from it. It is a real abstract class that provides a partial implementation with instance fields, a constructor and many methods with bodies. Of course, we have the choice to write out the contents of objects as text strings, but the process of reading the text back in again, converting the data to the correct types, and restoring the exact state of a complex set of objects is often difficult, if not impossible. ■ 2 We won't define how much time a "step" actually represents. They are declared by using a combination of the static and final keywords. The forEach method will then execute the lambda for each list element, passing each list element as a parameter to the lambda in turn. No listing in a central method is required. From where does the passenger's pickup location originate? debugging Debugging is the attempt to pinpoint and fix the source of an error. We call the declared type of the variable the static type, because it is declared in the source code—the static representation of the program. However, it is preferable to associate closely the pickup location with the passenger. If the attempt to open the file fails for any reason, then the constructor will throw an IOException. Similarly, if it is already on its way to a pickup, it could still accept a further pickup request. We concentrate mainly on building the GUI. 10.4.2 Inheritance and initialization When we create an object, the constructor of that object takes care of initializing all object fields to some reasonable state. Assume that we want to implement this task so that the player is automatically transported to a random room when she tries to leave the magic transporter room. We call methods that change the state of their object mutator methods (or just mutators). (David John), 1959 June 7- author. Figure 15.1 A CRC card Class name Collaborators Responsibilities Exercise 15.2 Make CRC cards for the classes in the cinema booking system. A Counter stores a current count for one type of animal to assist with the counting. It is better suited to introductory teaching than other environments for a variety of reasons: ■ ■ ■ ■ The user interface is much simpler. Code 6.7 shows the solution. We shall use this proper terminology from now on. Once the try statement is completed, the close method will be called automatically on the resource. Whenever a value of a primitive type is used in a context that requires an object type, the compiler uses autoboxing to automatically wrap the primitive-type value in an appropriate wrapper object. Let us dissect the loop in a little more detail. We see how objects can collaborate by invoking each other's methods to perform a common task. Instead, we have to do this ourselves, using the get method of the ArrayList. The MusicPlayer class has a getLength method. For this stage, only taxis needed to be actors, through their Vehicle superclass. M14_BARN7367_06_SE_C14.indd 538 4/11/16 3:43 PM 14.7 Using assertions | 539 Code 14.16 Using assertions for internal consistency checks Concept An assertion is a statement of a fact that should be true in normal program execution. Consider how the timeTick method would be coded in this case, for instance. To do this, pay attention to the field definitions close to the top of the class. We extend and improve an address book application to illustrate the concepts. Just changing the text on the menu item would have the effect that the program does not work anymore. While someone might be concerned with designing the interior passenger space, someone else may work on developing the fabric that will eventually be used to cover the seats. They could also be read out of sequence (skip them now, but come back to them later) if you are short of time and want to make progress with other constructs first. Exercise 14.22 What combinations of parameter values would it be inappropriate to pass to the constructor of the ContactDetails class? The cinema employee starts using the booking system to find and reserve two seats. The same is true for other classes in larger software projects. The body of the constructor should assign the value of its parameter to a field called code. Some elements are filtered out. Draw an object diagram. Try this out in the LogfileReader class of the weblog-analyzer project from Chapter 7. A JPanel can be inserted as a component into the frame's content pane, and then more components can be laid out inside the JPanel. However, here we shall approach this problem slightly differently. Section 2.7 noted that a method body (or, in general, a block) can contain both declarations and statements. Include the super() call explicitly, even if it would work without it. Enable a single passenger to be picked up and taken to his destination by a single shuttle. This may sound obvious, but it is not uncommon for a programmer to assume that a method call will not fail, and so not bother to check the return value. This makes them fundamentally different from instance variables (the fields we have dealt with so far). The main example is an implementation of a ticket machine. M01B_BARN7367_06_SE_C01.indd 32 4/11/16 2:54 PM 1.3 Calling methods | 33 Figure 1.2 An object on the object bench from the pop-up menu. We shall look at the remaining details of this class later. The name of the test class is determined automatically by adding Test as a suffix to the name of the associated class. (If you are familiar with the "zip" compression format, it might be interesting to know that the format is, in fact, the same. Such an error is called an index-out-of-bounds error. Exercise 2.15 In the following field declaration from the TicketMachine class private int price; does it matter which order the three words appear in? Code 14.15 shows a new checked exception class that is defined in the address-book-v3t project. If so, do you understand why? The printWelcome and printGoodbye methods are examples of this. The methods implemented here are not complete for an application of this kind, but have been implemented to show examples of these different kinds of list processing. Remember that the condition as a whole must evaluate to true if we want to continue looking, and false if we want to stop looking, for any reason. One detail of the removal process to be aware of is that it can change the index values at which other objects in the collection are stored. Or we could write EventPost without inheriting from Post. 6.3 Concept The Java class library documentation shows details about all classes in the library. In a normal Java program, you may well have hundreds or thousands of objects. So a responsibility of PassengerSource is Create a passenger, and a collaborator is Passenger. What is the return type of this method? If the boolean expression in an assert statement evaluates to true, then the assert statement has no further effect. The large frame on the right is used to display details of a selected package or class. The rest of this method consists of a declaration of a boolean variable and a while loop. Forgetting to think through a part of the system before starting the class design and implementation can cause a large amount of work later, when an already partially implemented system would have to be changed. Exercise 5.28 Read about the limit and skip methods of streams and de ise so e ethods of our o n to ake use of the 5.6 Summary In this chapter, we have introduced some new concepts that are relatively advanced for this stage of the book, but that are closely associated with the concepts covered in Chapter 4. Both of these advantages reduce the coupling between different parts of a program, which is a good thing and something we explore more deeply in Chapter 8. Using the Step command in the debugger, we have used abstraction: we have viewed the print method of the item class as a single instruction, and we could observe that its effect is to print out the details (sender, recipient, and message) of the mail item. Where this is the case, the parameter types will closely match the types of the corresponding fields. The public, static, and final keywords may be omitted, therefore; they are assumed automatically. The instance we are dealing with is of class PhotoPost—that is all that matters. The cast operator consists of the name of a primitive type written in parentheses in front of a variable or an expression. 3.13.1 The mail-system example We start by investigating the functionality of the mail-system project. (You may have noticed that the notion of objects and classes is blurred when playing through CRC 4/11/16 3:45 PM 562 | Chapter 15 ■ Designing Applications scenarios. for(variable-declaration : collection) { statements } Example: for(String note : list) { System.out.println(note); } No associated index value is made available for the elements of the collection. So far, filters never change the image size, and we want to leave it like that. (Understanding what the expected functionality is, describing it, and agreeing about it with a client is a significant problem in itself. But number 2 looks suspicious. 1.15 Summary In this chapter, we have explored the basics of classes and objects. However, we will start by examining the mechanism of the simulation, without being too critical of its implementation. That makes for very specialized usage of lambdas. A taxi will have been free only if it was not already on its way to either a pickup or a destination location. A circle, for example, has a "diameter" field, while a triangle has fields for "width" and "height." The reason is that the number, types, and names of fields are defined in a class, not in an object. Exercise 6.53 Find out about and describe other javadoc key symbols. It can be used to insert the elements resulting from a stream operation back into a new collection. Visualizing these important concepts is a great help to both teachers and students. Call listFile(0) and listFile(1) to show the two files. Exercise 6.23 What happens when you add more (or fewer) possible responses to the responses list? 4/11/16 3:59 PM K: Important Library Classes K.6 | 641 Other important packages Other important packages are: java.awt java.awt.event javax.swing javax.swing.event These are used extensively when writing graphical user interfaces (GUIs), and they contain many useful classes that a GUI programmer should become familiar with. If a subclass does not provide an implementation for an inherited abstract method, it is itself abstract, and no instances may be created. Once again, at this point the behavior of taxis and shuttles will differ. M13_BARN7367_06_SE_C13.indd 495 4/15/16 3:07 PM 496 | Chapter 13 ■ Building Graphical User Interfaces Figure 13.11 Image viewer with toolbar buttons When we try this out, we see that it works partially but does not look as expected. Temptation is to define all variables as fields, because they can be accessed from anywhere in the class. If your indentation is completely out, use BlueJ's "Auto-layout" function (find it in the editor menu!) to fix it. Explain in detail. In a well-designed application, this is quite independent of the underlying logic of the application, so it can be done independently of designing the class structure for the rest of the project. Here is an example that prints out all even numbers from 0 up to 30: int index = 0; while(index This chapter introduces some advanced concepts. So we could abbreviate the first two statements of refundBalance as int amountToRefund = balance; but it is still important to keep in mind that there are two steps going on here: declaring the variable amountToRefund, and giving it an initial value. There are many situations were we want to repeat a block of statements that does not involve a collection at all. A prototype is a version of the application where one part is simulated in order to experiment with other parts. This method in Java is actually called forEach. Chapter 2 opens up class definitions and investigates how Java source code is written to create behavior of objects. The method returns the index of the item as its result. I.1 Documentation comments The elements of a class to be documented are the class definition as a whole, its fields, constructors, and methods. We will have a lot more to say about duplication of functionality in later chapters. The reason for the first sort of error is that the fields in Post have private access, and so are inaccessible to any other class—including subclasses. 5.2 Monitoring animal populations As before, we will use an example program to introduce and discuss the new constructs. M14_BARN7367_06_SE_C14.indd 524 4/11/16 3:43 PM 14.4 Exception-throwing principles | 525 Figure 14.1 Throwable The exception class hierarchy standard library classes user-defined classes Error Exception MyCheckedException RuntimeException MyUncheckedException Slightly simplified, the difference is this: checked exceptions are intended for cases where the client should expect that an operation could fail (for example, if it tries to write to a disk, it should anticipate that the disk could be full). Closely associated with collections is the need to iterate over the elements they contain. We will use this as a basis to gradually make changes to replace the list processing code with functional constructs. Each of the pixels can Figure 13.4 ImageViewer The class structure of the image viewer application ImagePanel ImageFileManager OFimage M13_BARN7367_06_SE_C13.indd 475 4/15/16 3:07 PM 476 | Chapter 13 ■ Building Graphical User Interfaces have a color. M02_BARN7367_06_SE_C02.indd 61 4/11/16 3:02 PM 62 | Chapter 2 ■ Understanding Class Definitions 2.5.1 Choosing variable names One of the things you might have noticed is that the variable names we use for fields and parameters have a close connection with the purpose of the variable. Once this has been achieved, classes with method stubs can be coded in Java and the classes' interfaces can be documented. System.out is of type java.io.PrintStream and maps to what is often called the standard output destination. How should it decide which vehicle to send when there may be more than one available? Notice that after the map function has been applied, we are no longer dealing with a stream of Sighting objects, but with a stream of integer values. 4.9.4 Summary of the for-each loop The for-each loop is always used to iterate over a collection. After the two number displays have been created, the display string is set to show the time indicated by the number display objects. Table of contents : Citation preview Objects First with Java™ A Practical Introduction Using BlueJ David J. The library consists of thousands of classes, many of which are generally useful for your work, and many of which you may probably never use. 16.2.3 Scenarios The taxi company does not actually represent a very complex application. Exercise 13.9 Add three private methods to your class, named openFile, saveFile, and quit. This is signified by the pair of parentheses with nothing between them. Some objects cannot be constructed unless extra information is provided. 13.2 Components, layout, and event handling The details involved in creating GUIs are extensive. The types of the parameters and result may be all different, so this is a generalization of the BinaryOperator interface. It would, for example, be fairly easy to write a text-based interface for the music player, effectively replacing the MusicPlayerGUI class and leaving the MusicPlayer class unchanged. You can access it at Following are some of the most common things people like to configure. This field can store a reference number for a library, for example. Javadoc recognizes around 20 tags, of which we discuss only the most important here (Table I.1). M16_BARN7367_06_SE_C16.indd 580 4/11/16 3:47 PM 16.2 Analysis and design | 581 One refinement that is commonly needed in the list of nouns is to identify any synonyms: different words used for the same entity. Code 11.2 illustrates this idea with the display method of the PhotoPost class. Note In Java, all fields are automatically initialized to a default value if they are not explicitly initialized. Even if you anticipate using the same variable in two or more methods, define a separate version locally to each method until you are absolutely sure that persistence between method calls is justified. At each time step, each actor in the simulation was asked to act—i.e., take the actions appropriate to its current state. Exercise 3.17 Does the getDisplayValue method work correctly in all circumstances? In Chapter 12, we shall see some techniques that allow us to make sure that Post objects cannot be created directly, but only MessagePost or PhotoPost objects. BlueJ displays only the static view. The reason is that the word "car" in this context refers to the class car; we are talking about cars in general, not about one particular car. We can simulate this by replacing each color component of each pixel that has a value v of less than ith v. Methods have two parts: a header and a body. The effects are not all positive, however. In this new class, we override the getExit method and change its implementation so that it returns a random room: public class TransporterRoom extends Room { /** * Return a random room, independent of the direction * parameter. This shows that class names can be used as types. The key to building goodlooking and well-behaved interfaces lies in one last detail: layouts can be nested. The formula— allegedly—is this: Your Star Wars first name: 1. Furthermore, modern input/output has moved beyond a program simply accessing its local file store to a networked environment in which connectivity to the resources being accessed may be fragile and inconsistent—for example, when in a mobile environment. Z02_BARN7367_06_SE_APPB.indd 602 4/11/16 3:50 PM B: Java Data Types | 603 Arrays behave like object types; they also have reference semantics. Second, the Object class can define some methods that are then automatically available for every existing object. It starts with a normal class definition and defines Post's fields in the usual way. Figure 2.3 shows a ticket-machine object after the constructor has executed. If you were unsure how to complete any of the previous exercises, look back over earlier sections in this chapter and the source code of TicketMachine to revise what you were unclear about. A large Java program will have many classes, each with many methods that call each other in many different ways. It provides information about how to use the class. (Remember that you must import java.util.HashMap.) In this class, implement two methods: public void enterNumber(String name, String number) and public String lookupNumber(String name) The methods should use the put and get methods of the HashMap class to implement their functionality. Select Show Terminal from the View menu and select Record method calls, as you did with the figures project in Chapter 1. You frequently have to look up the API documentation for the Swing classes; it is not possible to work without it. You can then work on the local copy. We can work on improving the application later. In addition, it contains the same three fields to maintain object state, and these have been declared in the same way. 13.3 | 463 something happens when a user clicks a button. For example, the result of the division 27 / 4 can be expressed in integer numbers as result = 6, remainder = 3 The modulo operator returns just the remainder of such a division. Alternatively, we could impose a ceiling on the fox's food level. 13.4 The ImageViewer example As always, we shall discuss the new concepts by using an example. By a widely followed convention, we always start class names with an uppercase letter. The resource object is created in a new parenthesized section immediately after the try word. This should give you enough background to experiment with input/output in your own projects. Both constructors and methods may take parameters, but only methods may have a return type. Exercise 5.1 Open the animal-monitoring-v1 project and create an instance of the AnimalMonitor class. ■ 5 Using a cast in this way only works because the dynamic type of the content pane is already JPanel. This avoids having to write two different follow-up actions depending on whether the key was in use or not. The InputReader class in the tech-support-complete project of Chapter 6 uses this approach to read questions from the user: Scanner reader = new Scanner(System.in); . The same principle applies with most other programming languages, which also tend to have libraries M04_BARN7367_06_SE_C04.indd 129 4/11/16 3:10 PM 130 | Chapter 4 ■ Grouping Objects of useful classes. The ability to pass code as a parameter was new in Java 8, and it allows us to do some very useful things. Loose coupling is good, because it makes a maintenance programmer's job much easier. Images of vehicles and people are provided in the images folder within the project folder for this purpose. As we explore the internal details of the class in this section, we shall see why this is so. There are two aspects to this: ■ Choosing the color to place on the image. One assertion we could make about it is that the address book should contain the same number of entries at the end of the method as it did at the start. Find out what they are and what they are used for. 13.4.6 Centralized receipt of events In order to make our ImageViewer object the single listener to all events from the menu, we have to do three things: 1. Exercise 13.50 All Swing components have a setEnabled(boolean) method that can enable and disable the component. Java uses packages to arrange library classes into groups that belong together. Once we have a solution to this problem, then we can continue with the design of individual classes and start thinking about their implementation. It would do so by telling the Seat object that it is now reserved. 1 A01_BARN7367_06_SE_FM.indd 19 The "Early Bird" pattern, in J. Exercise 13.48 Add lambda event handlers to the two buttons that invoke the two new methods. The brighter components (value of 128 or more) we leave unchanged. What this means is that we can often create a subclass of an Adapter class, rather than implementing the full interface, and just override the one or two methods that we need for a particular task. Define the mutators warmer and cooler, whose effect is to increase or decrease the value of temperature by 5.0° respectively. For example, to enter the word red as a string, type "red" The method-call dialog also includes a section of text called a comment above the method header. The following exercises will help to illustrate why a local variable is needed here, as we try to write the refundBalance method without one. One part of the program has requested information from an object via a method call, and the return value is the way the object has of passing that information back to the caller. /** * Reduce price by the given amount. For instance, ensure that a Passenger is never created with pickup and destination locations that are the same; ensure that a taxi is never requested to go to a pickup when it already has a target location; etc. When calling methods interactively that expect parameters of the Color class, we have to refer to the class slightly differently. Each time before the statement is executed, the variable filename is set to hold one of the list elements: first the one at index 0, then the one at index 1, and so on. This is not what is meant by multiple inheritance. It is available for free download from . M14_BARN7367_06_SE_C14.indd 552 4/11/16 3:43 PM ile ased in ut out ut | 553 Code 14.22 Reading integer data with Scanner Note that this method does not guarantee to read the whole file. You should include only animals whose sighting count is greater than zero, but don't worry about excluding duplicate names if multiple non-zero sighting records were made of a particular animal. Exercise 13.62 Implement a reload function that discards all changes to the current image and reloads it from disk. This is logical, because instance fields are associated with individual objects. Could they be written as instance methods? modularization Modularization is the process of dividing a whole into well-defined parts that can be built and examined separately and that interact in well-defined ways. In our project, an example is to replace every sighting object in the original stream with the number of animals spotted in this sighting. Our class won't actually store the file details; instead, it will delegate that responsibility to the standard ArrayList library class, which will save us a lot of work. This ensures that objects of different classes can react distinctly to the same method call. Exercise 12.58 Which methods do ArrayList and LinkedList have that are not defined in the List interface? They provide a distinctive feature that has a big impact on programs involving sets of similar classes. In this book, we will not be able to cover all details of all of the possible things you can do with them, but we shall discuss the general principles and a good number of examples. For now, we shall start with a relatively simple example. In a large project, this process helps us to identify the interfaces between components. 1.12 Another example In this chapter, we have already discussed a large number of new concepts. The logical value of the clock's display (the current time) is stored in these NumberDisplay objects. Is it accurate? A list can hold an arbitrary number of values, and one or more can be selected. OFImage is a class to represent an image that we want to display and manipulate. For example: while(condition) { statements } if(condition) { statements } else { statements } J.2.5 Always use braces in control structures Braces are used in if statements and loops even if the body is only a single statement. We have done this so that all the GUI construction code is at a welldefined place and is easy to find later (cohesion!). Also, the functions for entering and editing data, as well as searching for data and displaying it, are not flexible enough for what we would want from a real program. The class has one instance variable of type JFrame. where xyz should be replaced by the value held in the price field when the method is called. That way, access to the documentation is faster and you can use the documentation without being online. How do we achieve this? It is important to distinguish between an array-variable declaration and a similar-looking simple-variable declaration: M07_BARN7367_06_SE_C07.indd 254 4/15/16 3:35 PM 7.3 A log-file analyzer | 255 int hour; // A single int variable. The purpose of this exercise is only to give you an idea of what we plan to achieve. Usually, this is done by double-clicking an application icon, or by entering the name of the application on a command line. However, it does have the corresponding disadvantage of making missing pieces of code potentially harder to spot, because the compiler will not point out the loose ends. If we use a library class, it follows that we will be writing code that creates instances of those classes, and then our objects will be interacting with the library objects. We can illustrate this with the ContactDetails class. So we shall then proceed to describe a more sophisticated version of the ticket machine that represents a significant improvement. However, this clearly duplicates information, which risks creating inconsistency. In that case, we did not define the constants, but instead used constants defined in another class. @throws IllegalLimitException If limit is less than 1. (Think of the variable as a garage: if someone tells you that you may park a vehicle in a garage, you would think that parking either a car or a bicycle in the garage would be okay.) This principle is known as substitution. ■ ■ A conditional statement gives us a means to perform a test and then, on the basis of the result of that test, perform one or the other of two distinct actions. The most straightforward solution that comes to mind first for many people is to deal with this in the Game class, which implements the player's commands. Code 14.9 illustrates how we would tend to write this, anticipating possible failure. M02_BARN7367_06_SE_C02.indd 63 4/11/16 3:02 PM 64 | Chapter 2 ■ Understanding Class Definitions There are at least two significant differences between the headers of the TicketMachine constructor and the getPrice method: public TicketMachine(int cost) public int getPrice() ■ ■ The method has a return type of int; the constructor has no return type. It then has to iterate over these words and check each of them with our map of known words. ■ For our image viewer, we shall create one menu bar, and several menus and menu items. 16.4.2 A first stage For the first stage, we want to be able to create a single passenger, have them picked up by a single taxi, and have them delivered to their destination. Fields are also known as instance variables, because the word variable is used as a general term for things that store data in a program. Exercise 6.19 Add a method to your RandomTester class that takes a parameter max and generates a random number in the range 1 to max (inclusive). Exercise 13.8 Add another menu item called Save. Exercise 12.15 Does increasing the maximum age for foxes lead to a significantly higher numbers of foxes throughout a simulation, or is the rabbit population more likely to be reduced to zero as a result? Assuming that we develop a clever scheduling algorithm for our simulation to decide which vehicle should take which call, or that we have worked out a good scheme for deciding where to send the vehicles to wait while they are idle, we might decide to use the same algorithms when the company actually operates in the new area. assignment statement Assignment statements store the value represented by the righthand side of the statement in the variable named on the left. 12.6.4 Interfaces as types When a class implements an interface, it often does not inherit any implementation from it. What can you deduce from your answer to this? Consider the following contrived call to getDetails: AddressDetails details = contacts.getDetails(null); // The following statement will not be reached. The larger a problem, the more important is a good application structure. H.3 Sharing a project To create a shared project, one team member creates the project as a standard BlueJ project. Two things can greatly help in avoiding this kind of error: ■ M02_BARN7367_06_SE_C02.indd 76 Pay attention to proper indentation of your code. This will open a web browser displaying the main page of the Java API (Application Programming Interface) documentation.1 The web browser will display three frames. As with library classes, we want to see just the public interface of the class, instead of the implementation. These are not very relevant to the present discussion, so we shall skip describing those for now, and concentrate on a more detailed discussion of the core classes mentioned here. This helps to distinguish what we are talking about. Create a Number- Display object with limit 6 in the Code Pad by typing NumberDisplay nd = new NumberDisplay(6); Then call its getValue, setValue, and increment methods in the Code Pad (e.g., by typing nd.getValue()). Here, we can type in expressions, which will then be immediately evaluated and the results displayed. When we create a MessagePost object, we pass two parameters to the message post's constructor: the name of the author and the message text. The constructor of Tree takes no parameters and its constructor creates the Triangle and Square objects for its fields sin the figures project from Chapter 1, create a simple Tree class to fit this description. This is discussed in the next section. Remember: The interface of a class is the set of details that another programmer using the class needs to see. Once the catch block has been completed, control does not return to the statement that caused the exception. We could leave everything as it is and decide to never display the likes count or comments for event posts—just ignore the fields. Text posts consist of a message of arbitrary length, possibly spanning multiple lines. For instance, int val = (int) mean; If mean is a variable of type double containing the value 3.9, then the statement above would store the integer value 3 (conversion by truncation) in the variable val. Here, we make use of a detail that we have not mentioned before: classes define types. M12_BARN7367_06_SE_C12.indd 442 4/11/16 3:38 PM 12.5 Multiple inheritance | 443 As we consider the potential for introducing further actors into the simulation, it is worth revealing why we chose to store details of the animals in both a Field object and an Animal list. 4/15/16 6:10 PM 20 | Preface In this book we touch on all of the important topics several times, both within the same chapter and across different chapters. From this collection, each element will be assigned to the loop variable in turn; and for each of those assignments, the loop body is executed once. In the examples so far, the only data type we have seen has been int. We can introduce a new superclass for all posts that have comments attached (named CommentedPost), which is a subclass of Post (Figure 10.8). Instead, an organizer delegates the responsibility for keeping track of the number of items to its ArrayList object. What is the best way for a server to report problems when they occur? Take the first two letters of your mother's maiden name. One of M02_BARN7367_06_SE_C02.indd 73 4/11/16 3:02 PM 74 | Chapter 2 ■ Understanding Class Definitions those missing checks was on the amount of money inserted by a customer, as it was possible for a negative amount of money to be inserted. In particular, we need to be able to determine when each step has been completed. This work will pay off in the long run by making all further changes easier. Using one anywhere else represents the equivalent of an accessor (or get method). In practice, it is frequently the case that constants apply to all instances of a class. On the face of it, this should be a relatively simple container for a twodimensional position within a rectangular grid. Implement both versions. 4/11/16 3:02 PM 56 | Chapter 2 ■ Understanding Class Definitions Code 2.3 The fields of the TicketMachine class Fields are small amounts of space inside an object that can be used to store data persistently. We then execute the statement v1.display(); When this statement executes, the display method is invoked in the following steps: 1. In other words, responsibility for the overall time-keeping task is divided up between the ClockDisplay class and the NumberDisplay class. } M14_BARN7367_06_SE_C14.indd 535 4/11/16 3:43 PM 536 | Chapter 14 ■ Handling Errors catch(Exception e) { Report and recover from the exception here. Describe your observations. The previous two chapters have discussed the most important aspects of inheritance in application design, but several more advanced uses and problems have been ignored so far. M02_BARN7367_06_SE_C02.indd 59 4/11/16 3:02 PM 60 | Chapter 2 ■ Understanding Class Definitions Figure 2.3 A TicketMachine object after initialization (created for 500cent tickets) 2.5 ticketMa1: TicketMachine price 500 balance 0 total 0 Parameters: receiving data Constructors and methods play quite different roles in the life of an object, but the way in which both receive values from outside is the same: via parameters. Its header is void changeSize(int newHeight, int newWidth) Here is an example of a method with more than one parameter. interface The interface of a class describes what a class does and how it can be used without showing the implementation. The previous SimulatorView class, now called GridView, is specified to implement the new SimulatorView interface: public class GridView extends JFrame implements SimulatorView { ... Could the simulation be used to model competing taxi companies operating in the same area of the city? They are both sets, so they behave in the same way. This is known as overloading a constructor or method. overloading A class may contain more than one constructor, or more than one method of the same name, as long as each has a distinctive set of parameter types. One of the most commonly known is often referred to as the waterfall model (because activity progresses from one level to the next, like water in a cascading waterfall—there is no going back). The description typically needs to be only a few paragraphs in length. VideoNotes allow for self-paced instruction with easy navigation including the ability to select, play, rewind, fast-forward, and stop within each VideoNote exercise. 12.10 Event-driven simulations The style of simulation we have used in this chapter has the characteristic of time passing in discrete, equal-length steps. As we develop the music-organizer project in later sections, we will eventually move towards a better structure by introducing a Track class. The actual observers (the viewers) can then get a new, updated state from the field and redisplay. If so, what does this suggest about the degrees of encapsulation and coupling that were present in the original version? The Decorator passes the method calls on to the enclosed object, but it may perform additional actions. You can use your own mp3 files by placing them into the audio folder. We will look at how the get and remove methods work in Section 4.7, though you will probably get some idea beforehand simply by reading through the code of the listFile and removeFile methods. It defines the appropriate fields, sets in its constructor all the data items that are not expected to change over time, and provides accessor and mutator methods where appropriate. This gives us an additional class: the collection. The expression this refers to the current object. Each subtype of MouseListener or MouseAdapter created in this way represents a unique anonymous class. Exercise 6.61 How do you clear the whole canvas? The expression and case labels may be of an enumerated type. Then you can drop a new file into the folder and load it without having to quit the player. prototyping Prototyping is the construction of a partially working system in which some functions of the application are simulated. Just as class variables belong to the class rather than to an instance, so do class methods. Those for professional developers have a large number of functions for sophisticated examination of many facets of an application. In particular, we shall illustrate the following common tasks: ■ obtaining information about a file from the file system ■ writing textual output to a file with the FileWriter class ■ reading textual input from a file with the FileReader and BufferedReader classes ■ anticipating IOException exceptions ■ parsing input with the Scanner class In addition, we look at reading and writing binary versions of objects as a brief introduction to Java's serialization feature. Z12_BARN7367_06_SE_APPL.indd 648 4/11/16 4:01 PM walkthroughs, 343–48 while loop, 149–51, 152, 205, 261 Wolfram, Stephen, 271 Wolfram code, 271 world-of-zuul game, 284–320 code duplication, 288–91 cohesion, 287, 306–8 decoupling, 317–19 Z13_BARN7367_06_SE_IDX.indd 666 enumerated types, 314–17 extensions, 291–93 implicit coupling, 302–5 inheritance, 410 localizing change, 301–2 refactoring, 310–14 language independence, 314–19 responsibility-driven design, 298–301 wrapper class, 227–29 writers, 545–46 writing maintainability, 324 4/11/16 7:44 PM This takes the form return; and simply causes the method to exit without executing any further code. Interfaces cleanly separate the type specification from the implementation, and this creates less coupling. The header of the overriding method will not contain the default keyword, since that is only used in interfaces. Thus, they already fit the most abstract definition of an interface perfectly: they contain no instance fields, no constructors, and no method bodies. As we start by introducing the most basic features of classes, we shall quickly find that this implementation is deficient in a number of ways. The more experienced a software engineer becomes, the more time he or she will spend designing application structures rather than just writing code. M13_BARN7367_06_SE_C13.indd 483 4/15/16 3:07 PM 484 | Chapter 13 ■ Building Graphical User Interfaces Exercise 13.21 Implement and test the code shown above in your version of the project. It might happen every now and then that we have to add classes for implementation reasons that we initially overlooked. You can use the method currentTimeMillis from class System to help with the time measurement. We shall now add code to this first version to: ■ declare a field of type Random to hold the random number generator; ■ declare a field of type ArrayList to hold our possible responses; ■ create the Random and ArrayList objects in the Responder constructor; ■ fill the responses list with some phrases; ■ select and return a random phrase when generateResponse is called. This method (getNextMailItem) returned a value—an object of type MailItem. A.6 Using local API documentation You can use a local copy of the Java class library (API) documentation. Justify your answer. The list values in this example are strings, but other types are possible. method calling Objects can communicate by calling each other's methods. You can find the BlueJ tutorial in BlueJ's Help menu. I.2 BlueJ support for javadoc If a project has been commented using the javadoc style, then BlueJ provides support for generating the complete HTML documentation. For a subclass to be concrete, it must provide implementations for all inherited abstract methods. In designing this book we have tried to use a lot of different example projects. In this case, the println method is void so the lambda's return type is void. It is worth looking at the unusual syntax again for a moment. Its key methods are append, insert, and toString. Several observations can be made here. That is not a problem if the Post class defines a getAuthor method, but this will find both message and photo posts. M13_BARN7367_06_SE_C13.indd 504 4/15/16 3:07 PM 13.9 Further extensions | 505 This is where we shall leave the discussion of the image-viewer example. In fact, we could even rewrite the statistics-gathering class, FieldStats, as an Actor—it too acts once every step. Much of the material in this book was developed in discussions with John. There is no single answer to this question, and the most appropriate answer will often depend upon the context in which a particular server object is being used. One can get away with that for a short while, but for projects that are intended to survive for a longer time, this is bound to create problems. M12_BARN7367_06_SE_C12.indd 440 4/11/16 3:38 PM 12.4 More abstract methods | 441 The canBreed method has been moved to Animal and rewritten to use the value returned from a method call rather than the value of a class variable. Exercise 13.75 Modify the slider so that the start and end (and possibly other tick marks) are labeled with numbers. In any subject area, having a variety of sources of information available is very helpful, for teachers and students alike. We shall discuss each of these areas in much more detail later in this chapter. This is important to ensure that all of the output is actually written to the external file system. At this point, we assume that you already know how to start BlueJ and open the example projects. Objects may be categorized. 11.11 Another example of inheritance with overriding To discuss another example of a similar use of inheritance, we go back to a project from Chapter 8: the zuul project. Exercise 6.50 Print counts of only those words that are not already keys in the responseMap in the Responder class. This means that a responsibility of Vehicle will be Indicate whether free. The machine stores as a balance the amount of money inserted. In all our previous examples, we assumed that we more or less know what the classes are that we should use to solve our problems. It is useful to identify at an early stage what we wish to learn, because the resulting goals may well have an influence on the design we produce. ■ ■ ■ ■ ■ M16_BARN7367_06_SE_C16.indd 582 We have decided that a passenger source creates all new passenger objects for the system. M06_BARN7367_06_SE_C06.indd 250 4/11/16 3:17 PM ChApter 7 Fixed-Size Collections—Arrays Main concepts discussed in this chapter: ■ arrays ■ for loop Java constructs discussed in this chapter: array, for loop, ++, conditional operator, ?: The main focus of this chapter is the use of array objects for fixed-size collections and the for loop. It is important to appreciate that newly scheduled events will not always be placed at the end of the current queue; they will often have to be inserted somewhere before the end, in order to keep the queue in time order. You might wonder why there is a need for local variables if we have fields. Note that the reason for the error is that the class name, NumberDisplay, has been used incorrectly to try to call the getValue method, rather than the variable name nd. Scenarios similar to key searching are common in programming situations. A delicate balance exists between such species. The two main problems with both approaches are: ■ ■ M14_BARN7367_06_SE_C14.indd 519 They assume that the application is being used by a human user who will see the error message. Create a class, Heater, that contains a single field, temperature whose type is double-precision floating point—see Appendix B, Section B.1, for the Java type name that corresponds to this description. This would make it possible to "observe" the movement of a taxi by inspection. For proficient programmers, this is a great thing. This is the style in which constants are defined most of the time. It is common for class definitions to contain alternative versions of constructors or methods that provide various ways of achieving a particular task via their distinctive sets of parameters. M06_BARN7367_06_SE_C06.indd 234 4/11/16 3:17 PM 6.13 Learning about classes from their interfaces | 235 Figure 6.4 DrawDemo The scribble project Pen Canvas 6.13.1 The scribble demo The scribble project provides three classes: DrawDemo, Pen, and Canvas (Figure 6.4). 15.7.3 Singleton A common situation in many programs is to have an object of which there should be only a single instance. For instance, suppose that the company running the TechSupport system is receiving complaints from its customers that some of its answers bear no relation to the question being asked. Z12_BARN7367_06_SE_APPL.indd 644 4/11/16 4:01 PM L: Concept Glossary | 645 exception An exception is an object representing details of a program failure. Exercise 6.12 Find the class Random in the Java class library documentation. Or maybe we should create a Customer object as soon as someone makes a reservation, and store the Customer object with the seat once M15_BARN7367_06_SE_C15.indd 562 4/11/16 3:45 PM 15.1 Analysis and design | 563 the seat has been reserved? 2.1.1 Exploring the behavior of a naïve ticket machine Concept Object creation: Some objects cannot be constructed unless extra information is provided. This is the order that we shall follow in all of our examples. The reason is that we want to display the value as a two-digit string. If so, how would you do it, and would it be the same way for each error? If so, what was it? We must call the addActionListener method of the menu item to register the ImageViewer object as a listener. class Object All classes have Object as a superclass at the root of their class hierarchy. The for-each loop is sometimes referred to as the "enhanced for loop." M07_BARN7367_06_SE_C07.indd 258 4/15/16 3:35 PM 7.4 The for loop ■ ■ | 259 we wish to execute a set of statements a fixed number of times we need a variable inside the loop whose value changes by a fixed amount—typically increasing by 1—on each iteration The for loop is well suited to situations requiring definite iteration. The most interesting piece of code is the method in the middle: start. Another is that Java has become commercially very important. If it is an array for objects, then the array will contain null values for all elements. */ public void printSightingsOf(String animal) { sightings.stream() .filter(s -> animal.equals(s.getAnimal())) .forEach(s -> System.out.println(s.getDetails())); } M05_BARN7367_06_SE_C05.indd 191 4/11/16 3:13 PM 192 | Chapter 5 ■ unctional Processin of ollections d anced It is important to know that each operation of the stream leaves its input stream unmodified. While you do this, make sure to have a window open showing you the documentation of the Pen class (either the editor window in Documentation view or a webbrowser window showing the project documentation). The import statement has the form import qualified-class-name; Because the Java library contains several thousand classes, some structure is needed in the organization of the library to make it easier to deal with the large number of classes. If the loop in such a situation does not contain an output statement, the program will appear to "hang": it seems to do nothing, and does not respond to any mouse clicks or key presses. There are two aspects to this. The first requirement of the compiler is that a method throwing a checked exception must declare that it does so in a throws clause added to the method's header. BlueJ includes teamwork support tools based on a source-code-repository model. The foxes-and-rabbits project from Chapter 12, for example, has a class SimulatorView that includes an inner class FieldView. One last question remains: Why are we doing this at all? Book-exercise (Chapter 2) Storing details of a book. In other words, to make this call work, class Post must have a display method, so we appear to be back to our original problem without having made any progress. (Remember that the exclamation mark is a not operator!) The main part of the loop—the part that is done repeatedly while we wish to continue— consists of three statements if we strip it of the check for the exit condition: String input = reader.getInput(); ... Once the executable .jar file has been created, it can be executed by double-clicking it. M04_BARN7367_06_SE_C04.indd 137 4/11/16 3:10 PM 138 | Chapter 4 ■ Grouping Objects Generic classes are used for a variety of purposes; we will encounter more of them later in the book. It is often the case that a simplified model of something can provide greater insight and understanding than a more complex one, from which it is often difficult to isolate the underlying mechanisms—or even be sure that the model is valid. A ticket machine does not need to perform any calculations to be able to answer that, because it keeps the answer in its price field. In summary, instead of having the image-viewer object listen to all action events, we create separate listeners for each possible event—defined by a lambda—where each listener listens to one single event type. If it is able to find a rabbit in an adjacent location, then the rabbit is killed and the fox's food level is increased. This method can now contain the code of our previous version of generateResponse, which randomly picks one of the default responses (as shown in Code 6.3). Instances of checked subclasses of IOException may be thrown at times to provide more detailed diagnostic information, such as FileNotFoundException and EOFException. For instance, we might want to only list the music by a particular artist, or need to find all the music with a particular phrase in the title. But then we are back to code duplication for the username and timestamp fields and their methods. If the condition is false, we say that the assertion fails. */ The comment start symbol must have two asterisks to be recognized as a javadoc comment. Each container that holds components, such as the content pane, has an associated layout manager that takes care of arranging the components within that container. You now have a list of students. ■ Provide all remaining functionality, including full statistical data. They often use the class JDialog to display the frame. All of this information is persistent during their time as a student, even if some of it changes during that time (the number of credits). Before we start with the debugger, set up a scenario we can use to investigate (Exercise 3.44). Calls to nonprivate instance methods from within a superclass are always evaluated in the wider context of the object's dynamic type. This enables us to create very flexible structures by overriding methods. Edit the details in the project description—the text note you see in the diagram. Exercise 12.71 Challenge exercise Sometimes class/interface pairs exist in the Java standard library that define exactly the same methods. Figure 10.5 Post MessagePost and PhotoPost inheriting from Post username timestamp likes comments like unlike addComment getTimeStamp display MessagePost message getText M10B_BARN7367_06_SE_C10.indd 372 PhotoPost filename caption getImageFile getCaption 4/11/16 3:32 PM 10.3 Inheritance hierarchies | 373 The same holds true for methods: instances of subclasses have all methods defined in both the superclass and the subclass. ■ On receipt of a pickup location, the behavior of taxis and shuttles may well differ. If you do, great. Now call removeFile(0) and then listFile(0). Is the empty method a mutator or an accessor? This chapter is both long and important. Exercise 14.43 Is it possible to determine anything about the contents of a particular file using the Files class? The most obvious difference between the two styles is that, in an event-based simulation, time passes in uneven amounts. Every mail client has an associated user name. Exercise 14.9 For a programmer, the easiest response to an error situation arising is to allow the program to terminate (i.e., to "crash"). Exercise 3.37 Remove the following two statements from the draw method of Picture window.changeColor("black"); sun.changeColor("yellow"); and make the color setting, instead, via a single call to an internal method called setColor (which you need to create). The body of the main method can theoretically contain any statements you like. multiple instances Many similar objects can be created from a single class. When developing a class, assert statements can be used to provide internal consistency checking. This technique is sometimes referred to as divide and conquer. @return A random number in the range 1 to limit (inclusive). Notice, however, that the parameter of the equals method is of type Object, so a test of the fields will make sense only if we are comparing fields of the same type. | 377 The keyword super is a call from the subclass constructor to the constructor of the superclass. The keyword for introduces the loop. The UML style defines how fields and methods are shown in a class diagram. Are there configurations that are stable—i.e., that produce a balance of numbers for a significant length of time? The idea of this project is to simulate the act of users sending mail items to each other. Numbers 1 and 2—implementing the interface and defining its method—ensure that our object is a subtype of ActionListener. Try to identify the concepts discussed in the figures example in this context. What was that feature? In this case, we choose to return a value that cannot possibly represent a valid location in the collection—a negative value. That is, send a essa e fro o hie to uan Then in oke the printNextMailItem message of uan s ail client a ain te for ard as efore This ti e hen ou reach the line item.print(); use the Step Into command instead of the Step command. In the next section, we discuss how to fix this. These start with the character pair "/*" and end with the pair "*/". The additional values that some methods require are called parameters. When calling the getName method of the Student class, we notice something new: methods may return a result value. An alternative structure for this top level would be to define ImageViewer as a subclass of JFrame and populate it internally. Your Star Wars last name: 1. Exercise 15.17 Late in the development of a project, you find that two teams who have been working independently on two parts of an application have implemented incompatible classes. The resulting situation is shown in Figure 6.8. As we can see from the diagram, the instance variables (xPosition and yPosition) are stored in each object. In order to do this, the body of the constructor contains the following assignment statement: price = cost; Concept assignment statements store the value represented by the righthand side of the statement in the variable named on the left. Input/output is used as a case study where error-handling is an essential requirement. At each step of the simulation, a hunter moves to a random location anywhere in the field and fires a fixed number of shots into random target locations around the field. Again, stated in another way, once the loop starts, you know for sure how many times the body will be executed—this will be equal to the size of the collection. We shall do three things to improve the look of our GUI: ■ ■ ■ add some empty space around the outside of the frame add spacing between the components of the frame add a line around the image The code to do this is shown in Code 13.16. In the following sections, we shall also meet other kinds of variables in addition to fields, but they will all share the same fundamental purpose of storing data. The setUp method has the annotation @Before in the test class and the method is automatically executed before the run of any test method, so all objects in a fixture are available for all tests. What do you observe about the inherited methods? The similarity in behavior of these two displays might then lead us to abstract away even further from viewing the hours display and minutes display distinctly. Exercise 12.41 The changes made in this section have removed the dependencies (couplings) of the simulateOneStep method on the Fox and Rabbit classes. Individually, these smaller problems are likely to be both less complex and more manageable than the one big problem, but together they should combine to form the whole. An important element of animal conservation and the protection of endangered species is the ability to monitor population numbers, and to detect when levels are healthy or in decline. As a result, all objects of a given class have the same methods. At this stage, it is not important to read the source, but mainly to execute the existing project to get an understanding of what it does. If an item is at index p, then "the next" one will be at index (p+1) and "the previous" one is now at index (p–1). This should then be initialized to contain the difference between price and balance. ■ ■ ■ ■ The for-each loop iterates through all posts and places them in a variable with the static type Post. ■ Exercise 15.4 Play this scenario through on your cards (with a group of people, if possible). This ensures that one class does not depend on exactly how another class is implemented. Implement this method in your version of the imageviewer0-4 project. You can, of course, also open your own images. For instance, suppose that instead of playing every track by our chosen artist, we just wanted to find the first one and play it, without going any further. Using common terminology, we say that these M01B_BARN7367_06_SE_C01.indd 33 4/11/16 2:54 PM 34 | Chapter 1 ■ Objects and Classes Figure 1.3 An object's pop-up menu, listing its operations Figure 1.4 A drawing of a circle methods are called or invoked. G.4 Test assertions While recording a test method, any method calls that return a result will bring up a Method Result window. Note that at runtime, a matching method should definitely be found, or else the class would not have compiled. You can set a breakpoint by opening the BlueJ editor, selecting the appropriate line (in our case, the first line of the printNextMailItem method) and then selecting Set/Clear Breakpoint from the Tools menu of the editor. */ public String substring(int beginIndex, int endIndex) M02_BARN7367_06_SE_C02.indd 85 4/11/16 3:02 PM 86 | Chapter 2 ■ Understanding Class Definitions An index value of zero represents the first character of a string, so getLoginName takes the first four characters of the name string and the first three characters of the id string, then concatenates them together to form a new string. Write them once using diamond notation and once without diamond notation, specifying the full type. Variables of object types store references to objects. 15.1.1 The verb/noun method Concept verb/noun Classes in a system roughly correspond to nouns in the system's description. The dynamic type is either MessagePost or PhotoPost. Thus, the moveHorizontal method is more flexible than the moveRight and moveLeft methods. Looking at the source code of the class ClockDisplay, you will notice that we just create a NumberDisplay object without being particularly interested in what that object looks like internally. Examine it. Explain what it does and how it does it. Therefore, it is vital that a server object knows whether it can trust parameter values to be valid, or whether it needs to check their validity for itself. Java classes concerned with processing text files are known as readers and writers, whereas those concerned with binary files are known as stream handlers.6 In the main, we shall focus on readers and writers. The idea is simple: instead of defining the MessagePost and PhotoPost classes completely independently, we first define a class that contains everything these two have in common. This is why we can pass an object of type MessagePost to a method that has a parameter of type Post. A container is a Swing component that can hold arbitrary groups of other components—rather like an ArrayList can hold an arbitrary collection of objects. The Decorator is an object that encloses an existing object and can be used instead of the original (it usually implements 5 Design Patterns: Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Addison-Wesley, 1995. Types such as int, boolean, char, double, and long are the most common primitive types. Exercise 13.33 Implement the showAbout method in your ImageViewer class, using a call to a showMessageDialog method. Exercise 12.17 Experiment with different sizes of fields. It gives information about the source code and presents the static view of a program. The file is opened. Even when using a supertype variable to make a method call, overriding enables us to ensure that specialized methods are invoked for every particular subtype. Test it. As always, we will discuss the important aspects using an example. A clean object-oriented approach provides strong support for teamwork, because it allows for the separation of the problem into loosely coupled components (classes) that can be implemented independently. for(Object st : myList) { System.out.println(st); } Exercise 11.16 Write a few lines of code that result in a situation where a variable x has the static type T and the dynamic type D. Write down a list of possible future changes. In the old style, you say to the teacher: Send me the first child. Concept Methods can call methods of other objects using dot notation. But more detail increases the complexity of the model and the requirements for both more computing power and more programmer time. So a collaborator of Passenger is Location, and a responsibility will be Provide pickup location. 4/11/16 3:02 PM 2.4 Fields, constructors, and methods ■ | 57 All three fields are of type int. M14_BARN7367_06_SE_C14.indd 515 4/11/16 3:43 PM 516 | 14.2 Chapter 14 ■ Handling Errors Defensive programming 14.2.1 Client–server interaction An AddressBook is a typical server object, initiating no actions on its own behalf; all of its activities are driven by client requests. The differences primarily affect file size and the quality of the image. ■ A show is canceled. Which method is found first and executed is determined by the dynamic type, not the static type. The second is designed to test that a passenger M16_BARN7367_06_SE_C16.indd 594 4/11/16 3:48 PM 16.4 Iterative development | 595 is picked up and delivered to her destination in the correct number of steps, and that the taxi becomes free again immediately afterwards. The color will be chosen via a JColorChooser dialog, which will appear when the user presses a mouse button with the Shift key held down, and the pixel to be replaced is chosen by pressing the mouse without the Shift key. Note that we do not intend right now to make the implementation complete in any sense. We add a JPanel to the frame's WEST area (as we know, a JPanel is a container), and then place the two buttons in the JPanel. At this point, all of the sightings from all the different spotters and areas are held together in a single collection. This is, of course, exactly what we need to do to initialize the object properly. In practice, Java offers many more methods on streams, and we will see some of them later in this book. And so it continues, until there are no more children left. This link between lambdas and functional interfaces is important. Exercise 13.71 Change the colors of the other components (foreground and background colors) to suit the new main image. Figure 4.1 illustrates how a MusicOrganizer object might appear with two filename strings stored in it. The first approach is easy to introduce to a method that would otherwise have a void return type, such as removeDetails. Exercise 10.14 What has to change in the NewsFeed class when another Post subclass (for example, a class EventPost) is added? We might wish to arrange discounts for hotels that provide large numbers of customers or send publicity material to entertainment venues that do not. Once a class name has been imported from a package in this way, we can use that class just as if it were one of our own classes. Objects that want to listen to these events must implement the ActionListener interface from the java.awt.event package. A smooth filter replaces every pixel value with the average of its neighboring pixels and itself (nine pixels in total). For instance, your animal might compete with foxes as a predator on the rabbit population, or your animal might prey on foxes but not on rabbits. Primitive types are not associated with classes and do not have methods. Exercise 14.29 The address-book-v3t project includes some throwing of unchecked exceptions if parameter values are null. M06_BARN7367_06_SE_C06.indd 226 4/11/16 3:17 PM 6.10 Autoboxing and wrapper classes | 227 Exercise 6.45 Sometimes two words (or variations of a word) are mapped to the same response. Type the following in the Code Pad: TicketMachine t1 = new TicketMachine(1000); t1.getBalance() t1.insertMoney(500); t1.getBalance() Take care to type these lines exactly as they appear here; pay particular attention to whether or not there is a semicolon at the end of the line. A frame consists of three parts: the title bar, an optional menu bar, and the content pane (Figure 13.3). Alternatively, a test class may be created by selecting the New Class . . . button and choosing Unit Test for the class type. Writing applications that make optimal use of concurrent processing and multiple processors is very, very difficult. Exercise 14.10 Many commercially sold programs contain errors that are not handled properly in the software and cause them to crash. For now, we will concentrate on the SupportSystem class. This is mirrored in BlueJ: right-clicking on an abstract class in the class diagram will not list any constructors in the pop-up menu. The annotation @FunctionalInterface may be included with the declaration to allow the compiler to check that the interface conforms to the rules for functional interfaces. Exercise 12.1 Create a Simulator object, using the constructor without parameters, and you should see an initial state of the simulation similar to that in Figure 12.2. The more numerous rectangles represent the rabbits. The power of abstraction is that we don't usually need to know much (if anything, indeed!) about what the class looks like inside to be able to use it effectively. It was less trouble to write, and it is safer. But we decide against it. The most-used container is the class JPanel. Can a user be prevented from editing the text in the field? If, for example, we call toString on a PhotoPost object, we receive a string similar to this: M11_BARN7367_06_SE_C11.indd 402 4/11/16 3:35 PM 11.7 Object methods: toString | 403 The return value simply shows the object's class name and a magic number.2 Exercise 11.5 You can easily try this out. t2.getBalance() Did you get the answer you expected? Consider this: In what kind of inheritance relationship are Rectangle and Square? M14_BARN7367_06_SE_C14.indd 531 4/11/16 3:43 PM 532 | Chapter 14 ■ Handling Errors Statements in a try block are known as protected statements. This is a typical programming error that catches even experienced programmers from time to time. In particular, the input of the user does not influence the response in any way. The goRoom method could then use the following code segment: if(currentRoom.isTransporterRoom()) { nextRoom = getRandomRoom(); } else { nextRoom = currentRoom.getExit(direction); } Now we can add as many transporter rooms as we like; there is no need for any more changes to the Game class. The left operand is always an object reference, and the right operand is always the name of a class. G.5 Running tests Individual test methods can be run by selecting them from the pop-up menu associated with the test class. Nevertheless, we recommend that javadoc documentation be included for both checked and unchecked exceptions. We would then be faced with the issue of whether to remove these internal checks once the development process has been completed, in order to avoid the potentially high cost of runtime checks that are almost certainly bound to pass. It is again called nextInt, but it has a parameter to specify the range of numbers that we would like to use. System.out.println(files.get(0)); System.out.println(files.get(1)); System.out.println(files.get(2)); etc. This scenario is similar, but this time the PhotoPost class has a superclass Post, and the display method is defined only in the superclass (Figure 11.6). This may seem mysterious at first but it is based on the same principles we described in Chapter 11 in using the dynamic type of an object to determine which version of a method is called at runtime. Typically, the client expects a superclass or an interface of the actual object's dynamic type, and the factory method provides specializations. (Look this method up in the documentation.) The HashSet class has to be imported using an import statement (not shown here). Selecting a different line of the sequence will update the contents of the other display areas. If you have attempted Exercise 12.51 then you will have touched on this already. M03_BARN7367_06_SE_C03.indd 105 4/11/16 3:06 PM 106 | Chapter 3 ■ Object Interaction The plus operator (+) has different meanings, depending on the type of its operands. Increase or decrease the gravity value; compile and run the bouncing ball demo again. M03_BARN7367_06_SE_C03.indd 121 4/11/16 3:06 PM 122 | Chapter 3 ■ Object Interaction Note that there is no local variable yet. We have to remember to increment the counter variable (index) ourselves, in order to ensure that the loop condition will eventually become false when we have reached the end of the list. In unlucky cases, they can be almost unfixable (short of starting all over again). In Chapter 4 we continue by building more extensive structures of objects and pick up again on the themes of abstraction and object interaction from the preceding chapters. M03_BARN7367_06_SE_C03.indd 100 4/11/16 3:06 PM 3.8 The NumberDisplay class | 101 Code 3.3 shows the complete source code of the class NumberDisplay. 10.7.3 Subtyping and parameter passing Passing a parameter (that is, assigning an actual parameter to a formal parameter variable) behaves in exactly the same way as an assignment to a variable. In our version in the animal-monitoring-v1 project, this method was written in the iterative style, using a for-each loop. Now let us look at iterating over all elements: for(String item : mySet) { do something with that item } Again, these statements are the same as the ones we used to iterate over an ArrayList in Chapter 4. In Java, this is called protected access and is provided by the protected keyword as an alternative to public and private. This is often because the client, who knows the problem domain, does not know much about computing, and because the software engineers, who know how to program, have only limited knowledge of the problem domain. In practice, this single scenario will be broken down into a number of steps that are followed in sequence, from the initial call to the final drop-off. The Factory method is specialized in subclasses to return specialized instances to the "official" return type. This is because the multiplicity is achieved by creating multiple instances of a class. A01_BARN7367_06_SE_FM.indd 25 4/15/16 6:10 PM 26 | List of Projects Discussed in Detail in This Book Animal-monitoring (Chapter 5, 6) A system to monitor animal populations, e.g., in a national park. When calling, for example, the moveHorizontal method as shown in Figure 1.5, the dialog displays the line near the top. awt, java.awt.event, and javax.swing.1 We need many of the classes in these packages for all Swing applications we create, so we shall always import the three packages completely in our GUI programs. Inheritance hierarchies Inheritance can be used much more generally than shown in the example above. Make sure that you run it a sufficient number of times—with different initial states, of course! Exercise 12.24 If an initial random age is set for rabbits but not foxes, the rabbit population will tend to grow large while the fox population remains very small. Bricks are delivered to customers on pallets (stacks of bricks). The user interface may be a GUI (graphical user interface) with menus and buttons, it can be text based, or we can decide to run the application using the BlueJ method-call mechanism. More generally, it makes sense to make filtering part of a method that could select different types of animal, so here is how we would rewrite the printSightingsOf method of our original project in a stream-based version: /** * Print details of all the sightings of the given animal. Exercise 12.59 Write a class that can make comparisons between the efficiency of the common methods from the List interface in the ArrayList and LinkedList classes such as add, get, and remove. Exercise 10.17 Draw an inheritance hierarchy representing parts of a computer system (processor, memory, disk drive, DVD drive, printer, scanner, keyboard, mouse, etc.). The new techniques that were added are streams and lambdas (sometimes also called closures). If it has no free vehicles, it does not operate any form of queuing system. Exercise 3.2 At what time(s) can a class diagram change? It compiles, and it can be executed, even though it is not perfect yet. This issue of access rights between super- and subclasses is one we will discuss further in Chapter 11, when we introduce the protected modifier. For instance, the outer wrapping that names the class is the same, because we have chosen to give this class the same name. Much of this definition will already be familiar to you from our discussion of the naïve ticket machine. Assume that there are plenty of free seats. When the timeTick method is called, it first executes the statement minutes.increment(); M03_BARN7367_06_SE_C03.indd 113 4/11/16 3:06 PM 114 | Chapter 3 ■ Object Interaction This statement calls the increment method of the minutes object. Exercise 3.21 What is the result of the expression (8 % 3)? The question then arises, "Where is execution resumed in the caller?" A try statement provides the answer: if an exception arises from a statement called in the try block, then execution is resumed in the corresponding catch block. The dynamic type is often only known at runtime, so the compiler has no other choice but to use the static type if it wants to do any checks at compile time. M11_BARN7367_06_SE_C11.indd 415 4/11/16 3:35 PM This page intentionally left blank ChApTer 12 Further Abstraction Techniques Main concepts discussed in this chapter: ■ abstract classes ■ multiple inheritance ■ interfaces Java constructs discussed in this chapter: abstract, implements, interface In this chapter, we examine further inheritance-related techniques that can be used to enhance class structures and improve maintainability and extensibility. The Fox and Rabbit classes provide simple models of the behavior of a predator and prey, respectively. Figure 15.1 illustrates the layout of a CRC card. A parameter is used as a sort of temporary messenger, carrying data originating from outside the constructor or method, and making it available inside it. Exercise 6.48 What does the putIfAbsent method of HashMap do? You will notice that this time you are prompted not only for a name of the instance, but also for some other parameters. It typically provides functions to stop and start a program at selected points in the source code, and to examine the values of variables. For example, if a Java systems programmer makes an improvement to the implementation of the ArrayList class, you would hope that you would not need to change your code using this class. The implementation is also referred to as the private part of a class. If it is not, then we print an error message instead. Or would you throw that one away and start again from scratch? Therefore, it will not have the potential to simulate accurately many aspects of nature, but some of the simulation's characteristics are nonetheless interesting. (It could, of course, be modified to be applied to a part of an image, but we are not doing that just yet.) The three filters are named darker, lighter, and threshold. Exercise 2.2 What value is returned if you get the machine's balance after it has printed a ticket? You will see that the post has no associated comments. This will be the topic of the next section, as we introduce the first of several Java loopcontrol structures. Try the other shapes too: create a few triangles, squares, and persons. Combo boxes The sound player presents an example of using a JComboBox. They can be used for sending mail items from one mail client to another (using the sendMailItem method) and receiving messages (using the getNextMailItem or printNextMailItem methods). Inner classes are classes that are declared textually inside another class: class EnclosingClass { ... We can choose to do the same thing to each item (as we did M04_BARN7367_06_SE_C04.indd 147 4/11/16 3:10 PM 148 | Chapter 4 ■ Grouping Objects when printing the full listing) or we can be selective and filter the list (as we did when we printed only a subset of the collection). Here, we start slowly, initially with something much simpler, and we work our way to the complete application step by step. All GUI programming in Java is done through the use of dedicated standard class libraries. We can easily get the system time from the Java system, as a long value in milliseconds. There are two aspects here: ■ ■ The reduce method has two parameters. Just as the natural units for writing text are characters and strings, the obvious units for reading text are characters and lines. Here, we will look at a system to monitor animal populations. It is particularly important to note that we use the name of an object here and not the name of a class. It does not have to be the first statement. The wrapper class for int, for example, is called Integer. } if(!(obj instanceof Student)) { return false; // Not the same type. If a class is changed, then we should take the time to run regression tests in order to establish that it still works as it should; it is easy to forget to do that. Furthermore, the items stored in a collection instance would, themselves, be objects. In this particular simulation, most of the actors will have had something to do at each time step: move, breed, and eat. The implementations of the GridView and GraphView classes are fairly complex, and we do not expect you to fully understand them at this stage. Find and read the sections later in this chapter about class aria les and class ethods lain in our o n ords ho this orks Exercise 6.40 Challenge exercise What are examples of other methods that the Arrays class provides? With BlueJ, this is not a problem. The parts that the model is built up from are the objects that appear in the problem domain. We consider this good style, because it avoids the possibility of misinterpretation and confusion in case a reader is not aware of the automatic code generation. Pair programming is also one of the elements of a technique known as Extreme Programming. Exercise 12.65 Find out some more about how event-driven simulations differ from time-based simulations. Application design is not something that comes before the programming—it is (the most important part of) programming! Mistakes in the code itself can later be fixed fairly easily. M05_BARN7367_06_SE_C05.indd 193 4/11/16 3:13 PM 194 | Chapter 5 ■ unctional Processin of ollections d anced The complete code for the example given above—selecting all animals of a given type, then mapping to the number of animals in each sighting, and finally adding all numbers—is as follows: public int getCount(String animal) { return sightings.stream() .filter(sighting -> animal.equals(sighting.getAnimal())) .map(sighting -> sighting.getCount()) .reduce(0, (total, count) -> return total + count); } We can see that the parameters to the reduce method look a bit more elaborate than for the filter and map methods. For example, if you are a university student, then your university ro a l has students first ear students second ear students rofessors, tutors, office personnel, etc. The importance of writing documentation in software development A01_BARN7367_06_SE_FM.indd 22 4/15/16 6:10 PM Preface | 23 projects is discussed, and we end by practicing how to write suitable documentation for our own classes. (Hint: What use does a JTextField make of a Document object?) You can find an example of a JTextField in the calculator project in Chapter 9. The sendMessage method in the MailClient class shows a good example. A.3 The BlueJ debugger Information on using the BlueJ debugger may be found in Appendix F and in the BlueJ Tutorial. This is something to look out for when Show objects are created. Each booking is for a particular show (that is, the screening of a given movie at a certain time). 6.15.2 Limitations of class methods Because class methods are associated with a class rather than an instance, they have two important limitations. Step Into will step into the method being called and stop at the first line inside that method. We might guess, simply from seeing the name of the method, that it tests whether the input string starts with the word "bye". A method to print out the details of a sighting might look like this: public void printSighting(Sighting record) { System.out.println(record.getDetails()); } The equivalent lambda looks like this: (Sighting record) -> { System.out.println(record.getDetails()); } You can now easily see the differences and the similarities. In reporting the exception, it is helpful to include details of the key that caused the error. Note that the interface does not show the source code that implements the class. We introduce issues of good class design, including concepts such as responsibility-driven design, coupling, cohesion, and refactoring. 16.2.1 Discovering classes The following (singular versions of) nouns are present in the description: company, taxi, shuttle, individual, location, destination, hotel, entertainment venue, tourist organization, vehicle, fare, pickup location, driver, and passenger. Which one will be executed when we call this method? 9.14 Summary When writing software, we should anticipate that it will contain logical errors. Is it acceptable? When working with legacy code, an equivalent Path object may be created from a File object via the toPath method of File. The object referred to is stored outside the referring object, and the object reference links the two. Inheritance binds the classes closer together, and changing the superclass can more easily break the subclass. Draw a type hierarchy (classes and interfaces) to represent this situation. Code 13.1 shows a complete class (already named ImageViewer in preparation for things to come) that shows a frame on screen. Bookmark it. The only method that takes some effort to understand is move, where the ball changes its position to the next position in its path. Scrollbars Another component demonstrated in this example is the use of scrollbars. You will, for example, see classes named Button and JButton, Frame and JFrame, Menu and JMenu, and so on. For instance, we will likely want to add to the collection, but we also might want to reduce it—say if we have duplicates or want to raise money for additional purchases. There are usually three distinct ways in which this happens, and these often represent three different patterns of object interaction: ■ M16_BARN7367_06_SE_C16.indd 584 A collaborator is received as an argument to a constructor. class diagram The class diagram shows the classes of an application and the relationships between them. Note that we are stumbling about the double meaning of the word interface again here. Examine how this is done. Adding the creation of a TransporterRoom to the setup of the floor plan is (almost) enough to make it work. M10B_BARN7367_06_SE_C10.indd 379 4/11/16 3:32 PM 380 | Chapter 10 ■ ■ ■ Improving Structure with Inheritance Easier maintenance Maintaining the application becomes easier, because the relationship between the classes is clearly expressed. We can now also rephrase our discussion about the call to the post's display method in the NewsFeed class. The command line starting the program can, however, define arguments: java Game 2 Fred Every word after the class name in this command line will be read as a separate String and be passed into the main method as an element in the string array. They are therefore referred to as pseudo-random numbers. In short, using collections in Java is quite similar for different types of collections. Many software development teams have realized after the fact that time saved at the design stage had to be spent many times over to fix mistakes or omissions that were not discovered early enough. s1 = s1 = p1 = t1 = s1 = phd1 M10B_BARN7367_06_SE_C10.indd 383 p1 p2 s1; s1; phd1; = s1; 4/11/16 3:32 PM 384 | Chapter 10 ■ Improving Structure with Inheritance Exercise 10.13 Test your answers to the previous question by creating barebones versions of the classes mentioned in that exercise and trying it out in BlueJ. The class now needs to be compiled by clicking the Compile button. Note that this is an abstract class, as the apply method has to be abstract at this level, but the getName method can be fully implemented so it is not an interface. Java does not provide such a construct. M02_BARN7367_06_SE_C02.indd 78 4/11/16 3:02 PM 2.17 Fields, parameters, and local variables | 79 Exercise 2.59 What happens if you try to compile the TicketMachine class with the following version of refundBalance? First, and most importantly, John Rosenberg must be mentioned. The person playing the booking system should ask the person playing the show to tell them the required details. Object is a class from the Java standard library that serves as a superclass for all objects. This principle is called information hiding. Simulation is one option. For strings shorter than the required length, use the whole string. Class methods can be invoked from the class's pop-up menu. Use of the instanceof operator is often followed immediately by a cast of the object reference to the identified type. Although we will shortly show some slight modifications to the syntax used here, it does illustrate a typical use of lambdas, and the fundamental ideas will be repeated in all future examples: ■ A lambda starts with a list of parameters; ■ An arrow symbol follows the parameters; ■ Statements to be executed follow the arrow symbol. Then we try to use those subcomponents as if they were simple parts, without being concerned about their inner complexities. The next few lines of code create a HashSet and copy the words from the array into the set before returning the set.3 Exercise 6.35 The split method is more powerful than it first seems from our example. If canBreed is moved to Animal, for instance, then the compiler will need to have access to a value for the subtype-specific breeding age in class Animal. The picture can show anything you like, but should at least include some shapes, different colors, and text. Every serious textbook must attempt to prepare them for something more fundamental than the language flavor of the day. Let us look at an example. M02_BARN7367_06_SE_C02.indd 88 4/11/16 3:02 PM 2.23 Summary | 89 Exercise 2.80 Open the Code Pad in the better-ticket-machine project. When a module is built, they use abstraction. Abstract classes may contain abstract methods. Each field location can hold an animal, or it can be empty. Instead of understanding and changing many classes, she may only need to understand and change one class. 5.5 Streams The forEach method of ArrayList (and related collection classes) is just one particular example of a method that makes use of the streams feature introduced in Java 8. The java.net package The java.net package contains classes and interfaces supporting networked applications. Unfortunately, the Java language does not make this noble goal very easy. Exercise 14.28 UnsupportedOperationException is an unchecked exception defined in the java.lang package. Because TransporterRoom is a subclass of Room, it can be used everywhere a Room object is expected. Most of our ro ra s ill just use one core ost of the ti e and the rest of the a aila le rocessin o er is asted Learnin to rite code to use all cores is a er ad anced su ject and an ro ra ers ne er aster it B usin la das and o in the loo into the collection e can no otentiall use collections that handle the parallel processing for us. This feature allows us to use this class for both hour and minute displays. Are "vehicle" and "taxi" synonyms in this context? This is not a requirement in current versions. It specifies that the definition originating in the closest enclosing block will always be used. Many of the changes this time can, on the surface, be attributed to a new version of Java: Java 8. NumberDisplay.getValue() Take a careful look at this error message and try to remember it because you will likely encounter something similar on numerous future occasions. If we can do that, then we can pass the whole set to the Responder, which can then check every word in the set to see whether it is known and has an associated response. We investigate this first by examining the addPost method. In our code, we have passed 0 for this parameter. Close the house project if you still have it open, and open the lab-classes project. We use the name minutes rather than NumberDisplay. This also gives us a chance to experiment a bit with buttons, containers, and layout managers. Exercise 14.47 Modify the Responder class of the tech-support-io project so that it reads the associations between keywords and responses from a text file, rather than initializing responseMap with strings written into the source code in the fillResponseMap method. What if you now translated the interface into another language? As with a contacts list, reverse lookup in a map is possible, but it takes a comparatively long time. It is a very common task for a maintenance programmer to later change or extend the implementation of a class to make improvements or fix bugs. M02_BARN7367_06_SE_C02.indd 75 4/11/16 3:02 PM 76 | Chapter 2 ■ Understanding Class Definitions The printing of the error message follows exactly the same pattern as we saw for printing the price of tickets in the printTicket method; it is just a little more verbose. Hint: Use if-statements of the following form (that is, having no else part) to print the error messages. M14_BARN7367_06_SE_C14.indd 556 4/11/16 3:43 PM ChApter 15 Designing Applications Main concepts discussed in this chapter: ■ discovering classes ■ designing interfaces ■ CRC cards ■ patterns Java constructs discussed in this chapter: (No new Java constructs are introduced in this chapter.) In previous chapters of this book, we have described how to write good classes. ■ Try the following exercises to gain an understanding of how the simulation operates before reading about its implementation. This style of syntax is completely unlike any you will have met in previous chapters of this book, so make sure that you take some time to understand this first example of a lambda in action. Code 15.3 A use of the Factory method From the client's point of view (in the code shown in Code 15.3), we are dealing with objects of type Collection and Iterator. You will note that getting even a single character wrong will cause the command to fail. Exercise 13.37 Challenge exercise You might have observed that the apply methods of all of the Filter subclasses have a very similar structure: iterate over the whole image and change the value of each pixel independently of surrounding pixels. Exercise 2.53 So far, we have introduced you to two arithmetic operators, + and −, that can be used in arithmetic expressions in Java. The answer is six: three fields and three parameters. Random access to elements in the middle of the list, for example, is much faster with the ArrayList. The class of the object is found (following the "instance of " reference). ■ Mail items can be sent from one mail client to another via a method in the mail-client class. Alexander Graham Bell [experiment.jpg] I think I might call this thing 'telephone'. The code is shown in Code 13.9. Note that we have introduced a string constant named VERSION to hold the current version number. Which of these classes must have a definition of method getName for this code to compile? The user of a class does not need to know about the implementation. Each of those is represented by a Java class in the Swing library, and each lays out in different ways the components under its control. Exercise 14.8 illustrates one of the ways in which this is the case, and how things can go wrong. Exercise 4.15 Write an alternative version of checkIndex called validIndex. The objects are then removed from the bench. 12.6.1 An Actor interface Code 12.9 shows Actor defined as an interface type. There we saw that a stream of numbers could be reduced to a single number; here we will reduce a stream of objects to a single object, which is another collection. Key methods are add, remove, and size. class Files Files is a class that provides static methods to query attributes of files and directories (folders), as well as to manipulate the file system— e.g., creating directories and changing file permissions. To help your understanding of the following discussion, make sure that you have called this method on a ticket machine. SupportSystem declares two instance fields to hold an InputReader and a Responder object, and it assigns those two objects in its constructor. We always consider assignment statements by first examining the calculation on the right-hand side of the assignment symbol. In general, it is a good idea to always include explicit superclass calls in your constructors, even if it is one that the compiler could generate automatically. M11_BARN7367_06_SE_C11.indd 411 4/11/16 3:35 PM 412 | Chapter 11 ■ More about Inheritance The question, therefore, is: Can we find a solution that does not require a change to the command implementation each time we add a new transporter room? Leaving out the comments, it reads public String generateResponse() { int index = randomGenerator.nextInt(responses.size()); return responses.get(index); } The first line of code in this method does three things: ■ It gets the size of the response list by calling its size method. A Taxi will simply Go to passenger destination. We can find an example in the Java input/output library. These are interesting questions, and we will try to work out the best solution by playing through more scenarios. Furthermore, even the most thoroughly tested program may fail as a result of circumstances beyond the programmer's control. The programs and applications presented in this book have been included for their instructional value. Static utility methods such as Arrays.sort and Collections.sort can then provide efficient sorting in such cases, for instance. Will it matter which type is returned? filter We can filter a stream to select only specific elements. There are similarities in this accumulation idea to the stream reduce operation we covered in the previous chapter. This is known as substitution. In the sound player, the combo box is used to select a particular ordering for the tracks—by artist, title, etc. We shall leave it largely to the reader to study this method, except for one detail that we want to discuss here. However, we do not do this interactively by choosing methods from a menu with the mouse, but instead we type the commands down in textual form. Deal with this by mapping synonyms or related expressions to the same string, so that you do not need multiple entries in the response map for the same response. There is no way to avoid this; when we create animal instances, we have to specify exactly what kind of animal to create. That is not always necessary at this stage, but it does mean that undertaking incremental development at the next stage will be a little easier. There are several points at which we could start, but one of the most obvious weaknesses is that no attempt has been made to exploit the advantages of inheritance in the implementation of the Fox and Rabbit classes, which share a lot of common elements. An exception interrupts the execution of the caller's statements, and hence any statements immediately following the problem statement will not be executed. To do this, we will use an ArrayList to store some response strings, generate a random integer number, and use the random number as an index into the response list to pick one of our phrases. The FlowLayout can also be set to align components left or right. Access modifiers define the visibility of a field, constructor, or method. Overriding is a situation where a method is defined in a superclass (method display in class Post in this example), and a method with exactly the same signature is defined in the subclass. Exercise 13.41 Add a smooth filter that "smoothes" the image. Was it well suited to being controlled by a type with only two different values? For instance, suppose we wish to delete from the sightings list all of those Sighting records where the count is zero. However, further investigation of the String class's documentation suggests a possible solution, because it describes a method named toLowerCase. Passing that result directly to the getDetails method will produce a runtime exception. The main BlueJ window will then contain a number of extra buttons that are active when a project is open. All have worked on BlueJ for many years, improving and extending the design and implementation in addition to their other work commitments. Every Swing component can have a border. Much of this improvement has been made possible through advances in computer technology. BufferedImage gives us most of the functionality we want (it also represents an image as a two-dimensional array), but it does not have methods to set or get a pixel using a Color object (it uses different formats for this, which we do not want to use). How might this be used in an implementation of the java.util.Iterator interface to prevent removal of items from a collection that is being iterated over? Exercise 4.28 Write out the header of a for-each loop to process an ArrayList called tracks. This is because they fail to appreciate that good documentation focuses on high-level issues such as what a class or method does rather than on low-level issues such as exactly how it is done. However, most of these are just variations of the three operations introduced here, even though they have different names. Read the project comment (by double-clicking the text icon in the class diagram) for more information. For instance: balance += amount; M02_BARN7367_06_SE_C02.indd 66 4/11/16 3:02 PM 2.9 Printing from methods | 67 Exercise 2.34 Is the increase method a mutator? If an assertion is made, this will be encoded as a method call in the test method which is intended to lead to an AssertionError if the test fails. In addition, where recovery is either not possible or not attempted, ensuring that the exception's toString method is overridden to include appropriate information will help in diagnosing the reason for the error. To do this, we simply write code in the constructor of the ClockDisplay that creates and stores two NumberDisplay objects. Exercise 10.19 Draw an inheritance hierarchy of AbstractList and all its (direct and indirect) subclasses as they are defined in the Java standard library. Figure 4.3 Index numbers of elements in a collection myMusic: MusicOrganizer : ArrayList files M04_BARN7367_06_SE_C04.indd 138 0 1 2 : String : String "MorningBlues.mp3" "DontGo.mp3" : String "MatchBoxBlues.mp3" 4/11/16 3:10 PM 4.7 Numbering within collections | 139 Exercise 4.8 If a collection stores 10 objects, what value would be returned from a call to its size method? Java systems include a tool called javadoc that can be used to generate such an interface description from source files. This new structure is more flexible because it allows easier addition of non-animal actors. The user variable stores the string "juan", and the server variable stores a reference to another object. When we inherit from ("implement") interfaces, we separate the two: we inherit a type but (usually) no implementation. The statements inside the loop body are repeated for each item in the associated collection, and the iteration stops when we reach the end of the collection. Do you find any errors in the docu entation Some elements of the documentation, such as names and parameters of methods, can always be extracted from the source code. The Java API supports input/output of both textual and binary data via readers, writers, and streams. Exercise 5.14 Rewrite the printSightingsBy method in your project as discussed a o e Exercise 5.15 Write a method to print the counts of all sightings of a particular animal. } catch(RuntimeException e) { // Handle any unchecked exceptions . This is called an external method call. There is, however, one other aspect we should investigate: the current solution is not very nice in terms of maintainability and extendibility. Exercise 4.1 Open the music-organizer-v1 project in BlueJ and create a MusicOrganizer object. Using the canvas's methods interactively, draw a red circle near the center of the canvas. First, however, we shall briefly introduce a bit more background and terminology. 10.3 Concept Classes that are linked through inheritance relationships form an inheritance hierarchy. A lambda is an anonymous function that takes zero or more parameters and has a block of code that performs the same role as a method body. This stipulation, or contract, can be found in the description of hashCode in the API documentation of the Object class.3 It is beyond the scope of this book to describe in detail a suitable technique for calculating hash codes, but we recommend that the interested reader see Joshua Bloch's Effective Java, whose technique we use here.4 Essentially, an integer value should be computed making use of the values of the fields that are compared by the overridden equals method. M03_BARN7367_06_SE_C03.indd 102 4/11/16 3:06 PM 3.8 The NumberDisplay class | 103 Exercise 3.7 Select Show Code Pad from the View menu. As we know, the simple types—such as int, boolean, and char—are separate from object types. Classes are declared abstract by inserting the keyword abstract into the class header. Exercise 3.8 What error message do you see in the Code Pad if you type the following? In such cases, the client will be forced to check whether the operation was successful. The first limitation is that a class method may not access any instance fields defined in the class. It runs on top of Oracle's Java Development Kit, and makes use of the standard compiler and virtual machine. He might have conducted complex studies to determine exactly what kind of metal to use for the contacts, or what kind of material and production process to use for the insulation. Code 13.14 shows the code to do this. As such, they act as temporary rather than permanent storage locations. We do this using a cast operator: c = (Car) v; // okay The cast operator consists of the name of a type (here, Car) written in parentheses in front of a variable or an expression. The variable tracks could refer to either an ArrayList or a LinkedList, while responseMap could refer to a HashMap or a TreeMap. If the parameter is not valid, then it should print an error message saying what the valid range is. The reason why cars are successfully built is that the engineers use modularization and abstraction. There is almost no difference, except that we create a HashSet this time instead of an ArrayList. Java's solution to this problem is wrapper classes. It must, then, provide method definitions for both of them by overriding the methods, or the class itself must be declared abstract. In this situation, objects of the subclass have two methods with the same name and header: one inherited from the superclass and one from the subclass. It is responsible for returning an integer value to match the int return type in the method's header. The relevant source code is JLabel image = new JLabel(new ImageIcon("title.jpg")); This statement will load an image file named "title.jpg" from the project directory, create an icon with that image, and then create a JLabel that displays the icon. One kind of entity you then have to deal with is cars. To enter commands, you can choose between different possibilities: you can leave the input text-based and use a text field (class JTextField) to type commands, or you can use buttons for command entry. The following table details minimum and maximum values available in the numerical types. Exercise 13.60 Implement an undo function in your image viewer. From these natural-language concepts, we can see that, in a description of a programming problem, the nouns will often correspond to classes and objects, whereas the verbs will correspond to the things those objects do—that is, to methods. class String Strings are an important feature of many applications, and they receive special treatment in Java. Once the end of a single catch block is reached, execution continues following the last catch block. Software design patterns were made popular by a book published in 1995 that describes a set of patterns, their applications, and benefits.5 This book is still today one of the most important works about design patterns. Let us assume we want to find out how many elephant sightings we have recorded. This will usually be the result of inappropriate parameter values being passed to a constructor. A01_BARN7367_06_SE_FM.indd 20 4/15/16 6:10 PM Preface | 21 Chapters also often include several questions suggesting discussion material related to the topic, but not discussed in this book. The static type is the declared type, while the dynamic type is the type of the object currently stored in the variable. The nextInt (int n) method M06_BARN7367_06_SE_C06.indd 213 4/11/16 3:17 PM 214 | Chapter 6 ■ More-Sophisticated Behavior in the Java library Random class, for example, specifies that it generates a number from 0 (inclusive) to n (exclusive). The plan is that we shall have a set of words that are likely to occur in typical questions, and we will associate these words with particular responses. for(initialization; condition; increment) { statements } Example: for(int i = 0; i < text.size(); i++) { System.out.println(text.get(i)); } Both types of for loop are commonly used to execute the body of the loop a definite number of times—for instance, once for each element in a collection—although a for loop is actually closer in effect to a while loop than to a for-each loop. (What relationship are they to each other?) Exercise 12.70 Assume that you want to model people in a university to implement a course management system. M10B_BARN7367_06_SE_C10.indd 378 4/11/16 3:32 PM 10.6 Advantages of inheritance (so far) | 379 Figure 10.8 Post Adding more post types to network username timestamp * methods not shown * CommentedPost EventPost likes comments eventType * * MessagePost message * PhotoPost filename caption * Classes that are not intended to be used to create instances, but whose purpose is exclusively to serve as superclasses for other classes (such as Post and CommentedPost), are called abstract classes. Indeed, the compiler will indicate an error if any statements are written following a throw statement, because they could never be executed. Does it need to take any parameters? To do this, we write a method public void swap(int i1, int i2) { int tmp = i1; i1 = i2; i2 = tmp; } Then we call this method with our a and b variables: swap(a, b); Are a and b swapped after this call? This kind of either/or decision should be familiar from situations in everyday life: for instance, if I have enough money left, then I shall go out for a meal; otherwise, I shall stay home and watch a movie. Take a look at the code of the Randomizer class to see if you can work out why this might be. If we were to forget to increment the index variable (the last line in the loop body), the loop condition would never become false, and the loop would iterate indefinitely. 14.7 Using assertions 14.7.1 Internal consistency checks When we design or implement a class, we often have an intuitive sense of things that should be true at a given point in the execution, but rarely state them formally. So, just as the ClockDisplay created NumberDisplay objects for its two fields, here we see the constructor of the MusicOrganizer creating an object of type ArrayList and storing it in the files field. Z08_BARN7367_06_SE_APPH.indd 627 4/11/16 3:56 PM 628 | H.5 Appendices Update and commit Every now and then, the various copies of the project that team members have on their local disks need to be synchronized. We will see this principle in action when we start making use of the library classes that are available in Java. For instance, Car c = (Car) veh; If the declared (i.e., static) type of variable veh is Vehicle and Car is a subclass of Vehicle, then this statement will compile. However, efficiency concerns come much later, and only when we have either very large collections or applications in which performance is critical. This degree of coupling cannot be avoided, but it would be more palatable if we could find a way to identify its existence more clearly among the multiple classes of a project. If you have not yet read that chapter, we recommend that you now do so in order to familiarise yourself with the syntax and usage of lambda expressions. This models the effect of a predator that kills prey regardless of whether it is hungry or not. Exercise 11.13 Assume that you write a class Student that does not have a declared superclass. This form of transformation between input stream and output stream is very common with the map function. We discussed how this enabled us to do something that would otherwise be hard to achieve (in this case, storing an arbitrary number of objects). These are known as class variables or static variables. If a class implementing both interfaces overrides this method by calling both default versions then the overriding method might be defined as follows: public void reset() { Actor.super.reset(); Drawable.super.reset(); } In other words, an implementing class that overrides an inherited default method can call that default method using the syntax: InterFaceName.super.methodName(. . .) Exercise 12.57 Challenge exercise Add a non-animal actor to the simulation. In the book projects, you will find a third version of this project: foxes-and-rabbits-graph. Another approach is captured in the notion that good software is not designed, it is grown. We do not believe that there is a single right answer for this; various sequences are possible. Although the sort of testing strategies discussed in Chapter 9 can help us identify and eliminate many logical errors before our programs are put to use, experience suggests that program failures will continue to occur. This project contains only one class— TicketMachine—which you will be able to explore in a similar way to the examples we discussed in Chapter 1. A method with parameters will receive data passed to it from the method’s caller, and will then use that data to help it perform a particular task. The reason for this is that, in the general case, it needs to be clear exactly which of the alternative implementations should be inherited by the class. You will often nest various containers inside other containers to create exactly the look you want. A list, for example, will keep all elements entered in the desired order, provides access to elements by index, and can contain the same element multiple times. You can find more details of conditional statements and the form their tests can take in Appendix D. abstraction Abstraction is the ability to ignore details of parts, to focus attention on a higher level of a problem. The task is to create a system that can be used by a company operating cinemas to handle bookings of seats for movie screenings. Do you notice a change in the class diagram? Overall, this class is fairly straightforward, although it does illustrate a few new features of Java. This is because a programmer may have little direct control over the external environment in which their code is executed. Now that we have been introduced to abstract classes and interfaces, we can see why these particular names have been chosen. One way to look at it is to consider it as consisting of a single display with four digits (two digits for the hours, two for the minutes). The information in the brackets tells us that when we use these classes, we must supply one or more type names in angle brackets to complete M06_BARN7367_06_SE_C06.indd 216 4/11/16 3:17 PM 6.5 Packages and import | 217 the definition. Two of the main flaws are that it assumes that developers understand the full extent of the system’s functionality in detail from the start, and that the system does not change after delivery. Terms introduced in this chapter: syntax error, logical error, testing, debugging, unit testing, JUnit, positive testing, negative testing, regression testing, manual walkthrough, call sequence M09_BARN7367_06_SE_C09.indd 355 4/11/16 3:28 PM M09_BARN7367_06_SE_C09.indd 356 4/11/16 3:28 PM Part 2 Application Structures Chapter 10 Improving Structure with Inheritance Chapter 11 More about Inheritance Chapter 12 Further Abstraction Techniques Chapter 13 Building Graphical User Interfaces Chapter 14 Handling Errors Chapter 15 Designing Applications Chapter 16 A Case Study M10A_BARN7367_06_SE_P02.indd 357 4/11/16 3:29 PM This page intentionally left blank Chapter 10 Improving Structure with Inheritance Main concepts discussed in this chapter: ■ inheritance ■ substitution ■ subtyping ■ polymorphic variables Java constructs discussed in this chapter: extends, super (in constructor), cast, Object In this chapter, we introduce some additional object-oriented constructs to improve the general structure of our applications. This JPanel was then placed into another JPanel with a FlowLayout so that the grid did not extend over the full height of the WEST area. Exercise 12.42 Open and run the foxes-and-rabbits-graph project. Find a description and summarize. This illustrates the important principle that inheritance is a one-way street: MessagePost inherits the fields of Post, but Post still does not know anything about fields in its subclasses. A checked exception class is one that is a subclass of Exception, but not of RuntimeException . The String type indicates that a section of text (for example, a word or a sentence) is expected. If, on the other hand, you want to have a different starting time, you can set that up by using the second constructor. If a software developer wants to progress to more interesting problems and starts to work professionally on real-life applications, it is not unusual to work with dozens of other people on an application over several years. class variable, static variable Classes can have fields. Exercise 15.15 Do you think it would be possible to design a “generic” booking system that could be adapted or customized for use in a wide range of different organizations with booking needs? For software design patterns, the solution is typically a description of a small set of classes and their interactions. 2. 5.3.1 Processing a collection with a lambda When we were processing our collections in Chapter 4, we wrote a loop to retrieve the collection elements one by one, and then we did something to each element. A debugger is a program that lets programmers execute an application one step at a time. Do this by defining a method in the Tree class called setup and include a call to this method in the constructor of Tree. 2.2 Examining a class definition The exercises at the end of the previous section reveal that TicketMachine objects only behave in the way we expect them to if we insert the exact amount of money to match the price of a ticket. The new class GraphView, which produces the line graph, is an example of this. It is worth noting that this almost makes it appear as if primitive types can be stored in collections. A seat reservation is clearly attached to a particular show, so the CinemaBookingSystem should probably tell the show about the reservation; it delegates the actual task of making the reservation to the Show object. M03_BARN7367_06_SE_C03.indd 126 4/11/16 3:06 PM 3.16 Summary | 127 Exercise 3.57 Write the code for the timeTick method in ClockDisplay that dis la s hours inutes and seconds or e en i le ent the hole class if ou ish Exercise 3.58 Discuss whether the current design of the ClockDisplay class would support the display of hours, minutes, seconds, tenths of a second, and hundredths of a second. The plants as food would influence the population of rabbits (in effect, rabbits become predators of the plants), and the growth of the plants might be influenced by the weather. We use this feature in the original SimulatorView class to associate each animal type with a color in the field. Note especially the lines JMenuItem openItem = new JMenuItem("Open"); openItem.addActionListener(this); M13_BARN7367_06_SE_C13.indd 470 4/15/16 3:07 PM 13.4 The ImageViewer example | 471 Code 13.3 Adding an action listener to a menu item in the code example. class HashMap HashMap is an implementation of the Map interface. Exercise 12.55 Are the fields in the following interface class fields or instance fields? A super call only has to be made when it is necessary to access the superclass version of an overridden method. This might be used if the check involves significant computation. Which parts are useful? Next, let us have a look at the source code of class PhotoPost: public class PhotoPost extends Post { private String filename; private String caption; // Constructors and methods omitted. The counts are stored in a map of String to Integer objects. If we want our input variable to be changed, then we have to assign this new object back into the variable (discarding the original one), like this: input = input.toUpperCase(); The new object could also be assigned to another variable or processed in other ways. (A clause matches if the dynamic type of the exception object being thrown is assignment-compatible with the declared exception type in the catch clause.) The finally clause is optional. While the formatting isn’t pretty (because, in the text terminal, we don’t have formatting options available), all the information is there, and we can imagine how the show method might be adapted later to show the data in a nicer formatting in a different user interface. Exercise 16.4 Identify the nouns from any extensions you have added to the system, and make any necessary simplifications. Concept The complete source code that defines a class is called the implementation of that class. Because we are using the statement animal.act(newAnimals); and the variable animal is of type Animal, this will compile only if Animal defines an act method—as we saw in Chapter 11. Z01_BARN7367_06_SE_APPA.indd 600 4/11/16 3:48 PM AppenDix B Java Data Types Java’s type system is based on two distinct kinds of types: primitive types, and object types. This is because the exception-matching process that looks for an appropriate catch block simply checks that the exception object is an instance of the type named in the block. If the key is not valid, then the method should do nothing. Rather, we must state in our source code that we would like to use a class from the library. Most of the operators are either binary operators (taking a left and a right operand) or unary operators (taking a single operand). Do a web search for “pair programming” or “extreme programming” to find out more. Thus, 42 + 12 adds those two numbers, and the result is 54. Therefore, object interaction will figure highly in this chapter, also. Look at the dialog you see on screen. We do not use that term here because it is often used to denote a more formal way of describing scenarios. You can use the currentTimeMillis method of the System class for getting hold of the start and finish time of your test methods. K.4 The java.util.function package The java.util.function package contains only interfaces. There is no object in our simulation (or in nature) that is just an animal and not also an instance of a more specific subclass. The Files class provides a large number of static methods for querying the attributes of a Path object. We shall discuss these questions under the keywords components, layout, and event handling. For the hour display, we will create a NumberDisplay with limit 24; for the minute display, we will create one with limit 60. However, as we saw in Chapter 10, intelligent use of inheritance should also simplify the client class—in this case, Simulator. For this situation, anonymous inner classes provide a syntactical shortcut: they let us define a class and create a single instance of this class, all in one step. There is a risk that they could be inconsistent with each other. Lab-classes (Chapter 1, 2, 10) A simple example with classes of students; illustrates objects, fields, and methods. public Book(String title, double price) Exercise 2.20 Can you guess what types some of the Book class’s fields might be, from the parameters in its constructor? 1.7 Concept Objects have state. In keeping with the theme that this chapter explores, more advanced Java concepts, you are encouraged to read through the full source code of the project to find things that we have not explored in detail yet, and to use them for your own personal development. Exercise 12.28 Identify the similarities and differences between the Fox and Rabbit classes. You should now have a situation corresponding to Figure 11.4, with display methods in three classes. The formal Java rules governing the use of exceptions are significantly different for unchecked and checked exceptions, and we shall outline the differences in detail in Sections 14.4.4 and 14.5.1, respectively. } M06_BARN7367_06_SE_C06.indd 242 4/11/16 3:17 PM 6.15 Class methods | 243 Such a method can then be called by specifying the name of the class in which it is defined, before the dot in the usual dot notation. In that version, we have also added a Save As function to the file menu so that images can be saved back to disk. But we have already established that we do not want to execute an Animal’s act method, so that is not a problem. The reason for having both options is that methods are actually used for different purposes. The BufferedReader implements the same interface and can be used instead of an unbuffered Reader, but it adds to the basic behavior of a Reader. Using abstraction, we can view the print method as a single command. In practice, casting is very rarely needed in a well-structured, object-oriented program. The Post constructor initializes the post’s fields, and then returns to the MessagePost constructor, which initializes the remaining field defined in the MessagePost class. take action on a mouse pressed event ... For this we need to use the collect method of a stream. M12_BARN7367_06_SE_C12.indd 438 4/11/16 3:38 PM 12.3 Abstract classes | 439 Exercise 12.39 Can you tell from the API documentation for an abstract class which (if any) of its methods are abstract? The first example was two constants used in the Pen class to define the size of the “random squiggle” (go back to the project and find them!) The second example was the use of the color constants in that project, such as Color.RED. If so, what were they? We shall not discuss all of them right now, but rather come back to this issue later. The reason is readability of source code. We use Class/Responsibilities/Collaborators (CRC) cards to approach this problem, while designing a cinema booking system. Never use default (package private) access. Calculator (Chapter 9) An implementation of a desk calculator. Exercise 4.10 What is the index of the last item stored in a collection of 15 objects? Each card is divided into three areas: one area at the top left, where the name of the class is written; one area below this, to note responsibilities of the class; and one area to the right for writing collaborators of this class (classes that this one uses). ■ Predicate interfaces return a boolean result. The prototype has implementations of all method stubs, but instead of containing full, final implementations, the prototype only simulates the functionality. Note that the condition could actually evaluate to false on the very first M04_BARN7367_06_SE_C04.indd 149 4/11/16 3:10 PM 150 | Chapter 4 ■ Grouping Objects time it is tested. It should look something like Figure 2.1. The complete text of the class is shown in Code 2.1. By looking at the text of the class definition piece by piece, we can flesh out some of the object-oriented concepts that discussed in Chapter 1. In contrast, a shuttle has to deal with multiple passengers. We can make these abstract notions clearer by looking at an example. I wish it had been around for my daughter last year. } The class Hunter inherits the methods of all interfaces (act and draw, in this case) as abstract methods. An everyday example of a map is a contacts list. The annotation @Override may be added before the version in the subclass to make it clear that a new version of an inherited method is being defined. A compiler option allows assertion statements to be rendered inactive in production code without having to remove them from the program source. Thus, the types defined by the classes can have subtypes. What types of object are created by the constructor of Picture? Do you feel that it already supports this functionality? Ours is not. The ArrayList class, for example, can be used to specify an ArrayList of String, an ArrayList of Person, an ArrayList of Rectangle, or an ArrayList of any other class that we have available. Object diagrams were discussed in Section 3.6. The three classes have different degrees of complexity. Try it out. It would be much nicer if we could make every menu item call a separate method directly. We shall only discuss block tags, as these are the most commonly used. Methods exist to indicate whether a file is readable and/or writeable, and whether it is a file or a folder. Do you think the same type could be used for both of its parameters? Terms introduced in this chapter: static type, dynamic type, overriding, redefinition, method lookup, method dispatch, method polymorphism, protected M11_BARN7367_06_SE_C11.indd 413 4/11/16 3:35 PM 414 | Chapter 11 ■ More about Inheritance Exercise 11.11 Assume that you see the following lines of code: Device dev = new Printer(); dev.getName(); Printer is a subclass of Device. Make separate lists of the fields, methods, and constructors, and distinguish between the class variables (static fields) and instance variables. Next, we look at method lookup with inheritance. In real life, it is often the case that a ticket machine offers a selection of different types of ticket, from which customers choose the one they want. Once we have defined this class, we can just create two objects of the class with different limits to construct the entire clock display. The printDetails method should print out a string of the form “The name of this person is”, followed by the value of the name field. 12.6.3 Multiple inheritance of interfaces As mentioned above, Java allows any class to extend at most one other class. That takes place in a separate stage using the new operator, as with other objects. Does this version compile? Exercise 16.28 Adapt the vehicle classes so that records are kept of the amount of time spent traveling to pickup locations and passenger destinations. Unfortunately, the standard Java library does not have a class that is suitable for playing mp3 files, which is the audio format we want to work with. Because the line with the breakpoint contains the declaration of the only local variable and that line has not yet been executed, no local variable exists at the moment. This second point becomes interesting a bit later, and we shall discuss this in more detail in the next chapter. Exercise 4.3 Create a MusicOrganizer and add two file names to it. We will discuss subtyping in more detail in the next chapter. The display method is defined in class Post and then redefined (overridden) in class PhotoPost. The scroll pane itself is then placed into its parent container. We would build a complete clock display by having an object that has, internally, two number displays (one for the hours, and one for the minutes). try { statements } catch(exception-type name) { statements } finally { statements } Z04_BARN7367_06_SE_APPD.indd 613 4/11/16 3:52 PM 614 | Appendices Example: try { FileWriter writer = new FileWriter("foo.txt"); writer.write(text); writer.close(); } catch(IOException e) { Debug.reportError("Writing text to file failed."); Debug.reportError("The exception is: " + e); } An exception statement may have any number of catch clauses. This time, we shall use the TechSupport application. This will not be the case with a search. There, the superclass version of display had a useful job to do: print the fields defined in the superclass. More-detailed comments, often spanning several lines, are usually written in the form of multiline comments. But once we are reasonably familiar with a class in general, code completion is a great aid for more easily recalling details of a method and entering the call into our source. It is probably best to treat it as a library class: open the editor and switch to the documentation view. Thus, the range for the display value would be 0 to 23. Here, in this chapter, we shall only point out a few selected aspects of the application that are worth focusing on. The pack method will recalculate the frame layout and redraw the frame so that the size change is properly handled. That ensures that each circle has a color, for instance, and each can have a different color (Figure 1.7). A scope (also called a block) is a unit of code usually indicated by a pair of curly brackets. In practice, exceptions to the above characterizations are quite common. The following sections describe how to set breakpoints, how to control program execution, and the purpose of each of the display areas. We can reuse the code that we have written for photo posts and message posts (in the Post class) so that it M10B_BARN7367_06_SE_C10.indd 377 4/11/16 3:32 PM 378 | Chapter 10 ■ Improving Structure with Inheritance Figure 10.7 Post Network items with an EventPost class username timestamp likes comments * methods not shown * MessagePost message * Concept Inheritance allows us to reuse previously written classes in a new context. To help in understanding these concepts, we shall now revisit them in a different context. Later in this chapter, we shall be discussing exceptions in detail. 13.5.3 Layout First, we shall work on the task of adding two text labels to our interface: one at the top that is used to display the filename of the image currently displayed, and one at the bottom that is used for various status messages. For instance, there are no round brackets for a constructor’s parameters, because an array object does not have a constructor. Exercise 1.14 How do you think the Picture class draws the picture? One is declared by using the protected keyword as access modifier; the other one is used if no access modifier at all is declared. M12_BARN7367_06_SE_C12.indd 432 4/11/16 3:38 PM 12.3 Abstract classes | 433 Exercise 12.27 Write a test to ensure that, at the end of a simulation step, there is no animal (dead or alive) in the field that is not in one of the lists and vice versa. ■ The classes SimulatorView, FieldStats, and Counter provide a graphical display of the simulation. It is time to look again at some code for our ImageViewer application. M03_BARN7367_06_SE_C03.indd 103 4/11/16 3:06 PM 104 | Chapter 3 ■ Object Interaction 3.8.1 The logical operators The following mutator method setValue is interesting because it tries to make sure that the starting value of a NumberDisplay object is always valid. M03_BARN7367_06_SE_C03.indd 107 4/11/16 3:06 PM | 108 Chapter 3 ■ Object Interaction Exercise 3.22 Try out the expression (8 % 3) in the Code Pad. In the case where the value is greater than 9, we have used a little trick: return "" + value; Here, we concatenate value with an empty string. Exercise 2.51 Is it possible to remove the else part of the if-statement in the printTicket method (i.e., remove the word else and the block attached to it)? A BufferedReader is created via the static newBufferedReader method of the Files class. collection A collection object can store an arbitrary number of other objects. Exercise 14.49 Read the API documentation for the Scanner class in the java.util package. One of the major advantages this has over using a special return value is that it is (almost) impossible for a client to ignore the fact that an exception has been thrown and carry on regardless. Before we investigate in detail the effects of using an abstract method, we shall introduce more formally the concept of an abstract class. Here is a segment of the source code of the Post class: public class Post { private String username; // username of the post’s author private long timestamp; private int likes; private ArrayList comments; // Constructors and methods omitted. In fact, it is not gone—it has just been moved into the doThisForEachElement method—but it has disappeared from our own code; we do not need to write it every time anymore. As we have seen, the visualization is quite separate from the simulation logic (the field and the actors), and different visualization views are possible. Nesting containers, using combinations of different layout managers, is a common way to achieve the desired combination of component size and juxtaposition. So the responsibility of Taxi is Go to pickup location. 16.4 Iterative development We obviously still have quite a long way to go from the outline implementation developed in taxi-company-outline to the final version. To do this, open the bluej.defs file and find the line that reads bluej.language=english Change it to one of the other available languages. Should it therefore be public in Animal? The teacher would just pass on the instructions you gave them. Imagine, for instance, that you have lost your keys and you need to find them before you can leave the house. Exercise 6.7 Find the trim method in the String class’s documentation. Once again, it illustrates external method calls. The assert keyword is followed by a boolean expression. We note on the Theater card: Stores rows. .")) { // Entry successfully removed. A method stub is a placeholder for the method that has the correct signature and an empty method body.2 Many students find doing this in detail tedious. Here, the software development iterates several times through an analysis/design/prototype -implementation–client-feedback cycle. Its three core methods are hasNext, next, and remove. Exercise 12.47 Move the incrementAge method from Fox and Rabbit to Animal by providing an abstract getMaxAge method in Animal and concrete versions in Fox and Rabbit. (Remember: Type checking is done with the static type. Finally, in order to reinforce the concepts introduced in this chapter, we take a look at the internals of the lab-classes example encountered in Chapter 1. If that were necessary, no car could ever be built. What does this tell you about the name of an accessor method and the name of the field associated with it? In this project, we have also improved the openFile method to include better notification of errors. In effect, the person representing a class is representing its instances too. We are strong believers in learning by reading and imitating good examples. M11_BARN7367_06_SE_C11.indd 403 4/11/16 3:35 PM 404 | Chapter 11 ■ More about Inheritance Code 11.3 continued toString method for Post and MessagePost Ultimately, we would plan on removing the display methods completely from these classes. So both of the following examples give the result 100: (205 − 5) / 2 2 * (47 + 3) Z03_BARN7367_06_SE_APPC.indd 605 4/11/16 3:51 PM 606 | Appendices The main unary operators are −, !, ++, −−, [], and new. M06_BARN7367_06_SE_C06.indd 200 4/11/16 3:17 PM 6.2 The TechSupport system | 201 In effect, each programmer should be able to use the classes of other team members as if they were library classes, making informed use of them without the need to know how they work internally. We do not expect everyone to be able to solve this at the moment. Exercise 6.24 What is a HashMap? All we needed to know was the name of the class, the names of the methods, the parameters and return types of those methods, and what exactly these methods do. In our example, the display method is found in class Post, and will be executed. The body of the loop can be as complicated as we like. The purpose of the outline implementation is not to create a fully working project, but to record the design of the outline structure of the application (which has been developed through the CRC card activities earlier). What is the one situation in which it makes a difference to the behavior of the method? These two calls take care of printing these sections of text at the appropriate times. This book is an introduction to object-oriented programming for beginners. So, if an EOFException is thrown, then control will transfer to the first catch block, and if a FileNotFoundException is thrown, then control will transfer to the second. If its useShared field is set to true, then a single Random object is shared between all of the simulation objects. We have included the call here for clarity and readability. Exercise 6.2 Investigate the String documentation. They do not neatly fit the existing assumption of purely animal-based actors. If you then type sum on a line by itself (with no semicolon), you will see the value it currently stores. This would be the result of a programming error, so we defined the unchecked MissingPassengerException class. M15_BARN7367_06_SE_C15.indd 569 4/11/16 3:45 PM 570 | Chapter 15 ■ Designing Applications designing for extensibility, documentation, coding for understandability, and many other issues we have mentioned in this book take their importance from the fact that we know there will be others coming after us who have to adapt and extend our code. The right-hand side should be read as if it were parenthesized as follows: (reader.getInput()) . Similarly, if the left operand of || is true, then the right operand is not evaluated. The value stored in a field can be changed from its initial value if required. What typically happens is that, as each event occurs, a fresh event is scheduled for some point in the future. Code completion is a function that is available in BlueJ’s editor when the cursor is behind the dot of a method call. Any changes you make to the Post class should be visible only to its subclasses. This creates the opportunity for direct experimentation with objects, with little overhead in the environment. Going forward, we will often prefer the functional style, because it is more concise and more elegant. In this chapter, we shall continue to use the network example to explore the most important of the remaining issues surrounding inheritance and polymorphism. If we write a software development environment, we might want only a single compiler or a single debugger. Exercise 3.41 Challenge exercise Complete the Tree class described in the previous exercise, by having the constructor move the trunk square beneath the leaves triangle and then make both shapes visible. The time stamp is stored as a single number, of type long. When we feel uncomfortable about a situation such as this one, it is often a good indicator that there may be a better alternative approach. The integer expression specifies the size of the array—that is, the fixed number of items that can be stored in it. Such factors help to keep our motivation high. They are often used where the compiler can easily infer the full call of a method without having to specify its details explicitly. The list elements are not automatically fetched out of the collection and assigned to a variable for us. What they provide are alternative ways of initializing a ClockDisplay object. } else { Deal with the zipcode error . By ExtremeTech Staff on January 23, 2002 at 9:08 am This site may earn affiliate commissions from the links on this page. One of the distinguishing features of constructors is that they have the same name as the class in which they are defined—TicketMachine in this case. This could be done in different ways, for example by adding all elements together, or selecting just the smallest element from the stream. A novice certainly does not have to master all of functional programming, but a basic understanding of what it is—and what we can achieve with it—is rapidly becoming essential. Planes take off and land on runways. Another is that locations have not been given a detailed concrete form, so movement has no effect. Here, we start by adding three simple filters. Exercise 12.73 Use the API documentation for the AbstractList class to write a concrete class that maintains an unmodifiable list. It uses the extends keyword to define itself as a subclass of Post and defines its own additional fields. Now, from the Database class, you need to get access to a student’s street, city, and zip code. In this book, we will use the terms “superclass” and “subclass” to refer to the classes in an inheritance relationship. How is it changed? Here we have illustrated only the simplest examples for the use of method references. We shall not discuss this hierarchy here, because it is described in detail at various easily accessible places. We do not yet have a NumberDisplay object. 16.3.5 Some remaining issues One of the major issues that we have not attempted to tackle yet is how to organize the sequencing of the various activities: passenger requests, vehicle movements, and so on. Exercise 3.10 What happens when the setValue method is called with an illegal value? If the marine simulation were to involve modeling food supplies for the fish, then we would probably not want to visualize plankton populations—either because the numbers are too vast, or because their size is too small. Is an identical simulation run this time? A for-each loop provides definite iteration; given the state of a particular collection, the M04_BARN7367_06_SE_C04.indd 148 4/11/16 3:10 PM 4.10 Indefinite iteration | 149 loop body will be executed the number of times that exactly matches the size of that collection. When we try to move the display method from Post to the subclasses, we notice that the project does not compile any more. Look through the source of AddressBookDemo to check that you understand the tests, and then try out each of the test methods. private boolean alive; private Person tutor; private Game game; Exercise 2.14 From what you know about the naming conventions for classes, which of the type names in Exercises 2.12 and 2.13 would you say are class names? The number of items stored in a collection will vary from time to time. M05_BARN7367_06_SE_C05.indd 177 4/11/16 3:13 PM 178 | Chapter 5 ■ unctional Processin of ollections d anced Another class of language is functional languages; these have been around for a long time, and they use a different style of programming. The get methods of a ticket machine perform similar tasks: returning the value of one of their object’s fields. This serves our intention discussed above: we stated that we 4/11/16 3:38 PM 438 | Chapter 12 ■ Further Abstraction Techniques did not want instances of class Animal created directly—this class serves only as a superclass. Here are some possible scenarios: The system has to be set up for a new cinema. One of these parts may be a spark plug. The structure of the overall system—the complex relationships between classes—becomes harder to design and to understand than the code of individual classes. It is worth pointing out that Set has no implication to enforce this restriction. An index is an integer expression written between square brackets following the name of an array variable. We have to look more closely at how this is done in classes that inherit from other classes. Exercise 16.20 Do you feel that the TaxiCompany object should keep separate lists of those vehicles that are free and those that are not, to improve the efficiency of its scheduling? This, however, is outside the scope of this book and can be studied in other courses and other books.) Here is the description we wrote for our cinema booking system: The cinema booking system should store seat bookings for multiple theaters. Using the information from the online tutorial, you can add numerous interface components. After answering in writing, open the calculator-gui project and check your answer by reading the code. 10.1.2 Network source code So far, the design of the three current classes (MessagePost, PhotoPost, and NewsFeed) has been very straightforward. In class RandomTester, implement two methods: printOneRandom (which prints out one rando nu er and printMultiRandom(int howMany) (which has a parameter to specify how many numbers you want, and then prints out the appropriate number of random numbers). Read the documentation on the JScrollPane class. In Chapter 16 we to bring everything together and integrate topics from the previous chapters of the book. We also want to M03_BARN7367_06_SE_C03.indd 119 4/11/16 3:06 PM 120 | Chapter 3 ■ Object Interaction use it for the field, where it is useful as a reminder for the implementer of the class, indicating what the field is used for. In particular, it defines the checked exception class IOException as a general indicator that something has gone wrong with an input/output operation, and almost any input/output operation must anticipate that one of these might be thrown. Confirm dialog: This dialog usually asks a question and has buttons for the user to make a selection—for example, Yes, No, and Cancel. M06_BARN7367_06_SE_C06.indd 212 4/11/16 3:17 PM 6.4 Adding random behavior | 213 The following illustrates the code needed to generate and print a random integer number: Random randomGenerator; randomGenerator = new Random(); int index = randomGenerator.nextInt(); System.out.println(index); This code fragment creates a new instance of the Random class and stores it in the randomGenerator variable. At runtime, however, the Java system will check that it really is a Car. Otherwise, the subclass will itself be abstract. The sequence of numbers generated is determined by a seed value, which may be passed to a constructor or set via a call to setSeed. A Simulation class now manages the actors, much as it did in the foxes-and-rabbits project. This means that we can use methods either to change an object’s state, or to find out about its state. In this appendix, we briefly summarize details of some classes and interfaces from the most important packages of the Java API. You may have noticed that substantial parts of the application may actually be useful once the expansion is in operation. 3.5 Implementing the clock display As discussed above, in order to build the clock display, we will first build a two-digit number display. Java will not allow this, and an error will be reported if you try to compile this statement. Should it be possible to use these as regression tests durin the ne t sta es or ould the re uire su stantial chan es Exercise 16.25 Implement additional tests and further test classes that you feel are necessary to increase your level of confidence in the current implementation. Customers can reserve seats and are given a row number and a seat number. We have already discussed the problems associated with code duplication in Chapter 8. Exercise 6.64 Write a method drawPolygon(int n) that draws a regular polygon with n sides (thus, n=3 draws a triangle, n=4 draws a square, etc.). Exercise 1.1 Create another circle. E.3 Developing without BlueJ If you want not only to execute but also develop your programs without BlueJ, you will need to edit and compile the classes. Try the following exercises to get a feel for what is possible at this early stage. Student st = new Student(); System.out.println(st); M11_BARN7367_06_SE_C11.indd 414 4/11/16 3:35 PM 11.12 Summary | 415 Exercise 11.15 Assume that your class Student overrides toString so that it returns the student’s name. Exercise 9.38 Open the bricks project. More recently, pair programming has been suggested as an alternative that is intended to produce better-quality code (code with better structure and fewer bugs). Note that the findFood method currently returns the location of the single rabbit that is eaten, so you will need to return the location of one of the eaten rabbits in your version. From Square, you can create many squares. We are now going to introduce a third kind. Exercise 6.82 Add a main method to your SupportSystem class in the tech-support project. That will make it easier to choose a track by its position in the list. Within BlueJ, the difference is most noticeable in that no return-value dialog is shown following a call to a void method. The outer wrapping contains the class header, whose main purpose is to provide a name for the class. For example, you could write: if(event.getActionCommand().equals("Open")) ... One should take a single parameter that specifies the price, and the other should take no parameter and set the price to be a default value of your choosing. serialization Serialization allows whole objects, and object hierarchies, to be read and written in a single operation. Classes implement this interface in order to be able to participate in the serialization process. We also might want to arrange it in some way—by date of acquisition or value, perhaps. Designing and implementing programs is an exciting and creative activity. Exercise 2.48 Rewrite the if-else statement so that the method still behaves correctly but the error message is printed if the boolean expression is true but the balance is increased if the expression is false. 15.2 Class design Now it is time for the next big step: moving from CRC cards to Java classes. A for-each loop cannot be used if the collection is to be modified while it is being iterated over. You also have to make sure to work with a temporary copy of the image while you process it, because the result is not correct if you work on a single image. By varying and combining these, we can do most of what we will ever need. M02_BARN7367_06_SE_C02.indd 50 4/11/16 3:02 PM 2.2 Examining a class definition | 51 Exercise 2.4 Try to obtain a good understanding of a ticket machine’s behavior by interacting with it on the object bench before we start looking, in the next section, at how the TicketMachine class is implemented. Concept abstraction is the ability to ignore details of parts, to focus attention on a higher level of a problem. This level of integrity is not possible if fields are made public. Iteration over a HashMap is usually a two-stage process: obtain the set of keys via its keySet method, and then iterate over the keys. Exercise 2.35 Complete the following method, whose purpose is to subtract the value of its parameter from a field named price. An example of this pattern can be seen in Code 14.19. Is this a good solution? In a real software project, deciding what classes to use to implement a solution to a problem can be one of the most difficult tasks. This statement creates an array object that is able to store 24 separate integer values and makes the hourCounts array variable refer to that object. scenarios Scenarios (also known as “use cases”) can be used to get an understanding of the interactions in a system. In fact, the majority of the classes’ source code is identical, with only a few differences. Figure 4.4 illustrates the way in which some of the index values of items in an ArrayList are changed by the removal of an item from the middle of the list. One such manual is at datatypes.html Exercise 1.31 What are the types of the following values? Exercise 12.32 The Randomizer class provides us with a way to control whether the “random” elements of the simulation are repeatable or not. This rule means that we are not allowed to store an int-type expression in a String-type variable, for instance. We recommend that a throws clause be used only to list the checked exceptions thrown by a method. Every single class (with the sole exception of the Object class itself) inherits from Object, either directly or indirectly. We used the Class type in defining the SimulatorView interface in the previous section. The five positions are named CENTER, NORTH, SOUTH, EAST, and WEST. Would you expect to get an error? The direction in which the rabbit moves is randomly chosen, and breeding occurs randomly, controlled by the class variable BREEDING_PROBABILITY. Chapter 6 ■ More-Sophisticated Behavior It is not uncommon for commercial applications to consist of hundreds of thousands of lines of code in several thousand classes. Creating these labels is easy—they are both simple JLabel instances. Tutors and student technicians are interesting: tutors are students who have been hired to do some teaching, and student technicians are students who have been hired to help with the technical support. ■ The interface provides everything we need to know to make use of this method. This is typical for abstract classes, and it is reflected in Java constructs. Package java.io —Summary of the most important classes and interfaces interface Serializable The Serializable interface is an empty interface requiring no code to be written in an implementing class. Hint: The LogEntry class of the weblog-analyzer project in Chapter 7 implements this interface. An object diagram for this model is shown in Figure 10.3. Figure 10.3 Objects in the network application : NewsFeed : ArrayList messages photos : MessagePost : MessagePost : MessagePost : MessagePost : ArrayList : PhotoPost : PhotoPost : PhotoPost : PhotoPost The corresponding class diagram, as BlueJ displays it, is shown in Figure 10.4. Note that BlueJ shows a slightly simplified diagram: classes from the standard Java library (ArrayList in this case) are not shown. The airport works as follows: There are multiple runways. Exercise 2.89 Modify your printDetails method to include printing the reference number. Read the DrawDemo source code and describe (in writing) how each method works. Though still in beta and not yet fully optimized for performance, the newest version release of Java, Java 2 Standard Edition 1.4, offers an incremental, yet important, release armed with features that simplify deployment on both browsers and standalone applications. M15_BARN7367_06_SE_C15.indd 568 4/11/16 3:45 PM 15.6 Software growth | 569 This is probably the most traditional, conservative model of software development, and it has been in widespread use for a long time. Similarly: Car c2 = new Bicycle(); // this is an error! This is also an illegal statement. However, this could be at the expense of being able to take type-specific recovery actions. When inheriting a complete implementation, we can choose to add or override methods. We can use the simplified syntax for lambda expressions that allows us to leave out the parameter type for lambdas with a single parameter and the curly brackets for a single statement body. Subclasses inherit all fields and methods of a superclass. Code 14.2 Guarding against an invalid key in removeDetails If we examine all the methods of AddressBook, we find that there are other places where we could make similar improvements: The addDetails method should check that its actual parameter is not null. Exercise 2.3 Experiment with inserting different amounts of money before printing tickets. We can find out more details about it by reading the library documentation for the String class. And it is the renaissance of the functional ideas in modern programming generally—not only the existence of Java 8—that makes it timely to cover these aspects in a modern edition of a programming textbook. An error message, or an error window, will go completely unnoticed. To find out more, do a web search for “first computer bug”—you will even find pictures of the moth! Debuggers vary widely in complexity. Any method found in a superclass can be invoked on a subclass object and will correctly be found and executed. M14_BARN7367_06_SE_C14.indd 511 4/11/16 3:43 PM 512 | Chapter 14 ■ Handling Errors In this chapter, we look at how to anticipate potential errors and how to respond to error situations as they arise during the execution of a program. Whenever a value of a primitive type is used in a context that requires a wrapper type, the compiler automatically wraps the primitive-type value in an appropriate wrapper object. } } rite so e lines of a a code that create a Screen object. The only question is how to arrange them on screen. Thus, the computed random number gives us a perfect index to randomly access one from the complete set of the list’s elements. When we introduced inheritance in Chapter 10, we emphasized two great benefits of inheritance: 1. When it is necessary to alter the normal order of evaluation, parentheses can be used. This function will cause all our method calls (in their textual form) to be written to the terminal. Note that the response string in the source code spans several lines but is concatenated with the + operator, so a single string is entered as a value into the HashMap. This allows users to pass in additional arguments. Figure 11.11 Output from display mixing subclass and superclass details (shaded areas represent superclass details) 11.10 Leonardo da Vinci Had a great idea this morning. Before the loop starts, an initialization statement is executed exactly once. For the rest of the chapter, we can concentrate on fine-tuning and improving what we’ve got. Because the request might fail—there may be no vehicles free—a success or failure indication should be returned to the passenger source. It does not have a method body. Instead, we shall briefly present the application at a later stage, and we encourage you to complete the rest from there. content pane, menu bar Components are placed in a frame by adding them to the frame’s menu bar, or content pane. The test uses the greater-than operator, “>”, to compare the value in amount against zero. To achieve this, we can now define a new subclass of Post named EventPost (Figure 10.7). M02_BARN7367_06_SE_C02.indd 62 4/11/16 3:02 PM 2.7 Methods 2.7 | 63 Methods The TicketMachine class has four methods: getPrice, getBalance, insertMoney, and printTicket. J.4.2 Fields may not be public (except for final fields) J.4.3 Always use an access modifier Specify all fields and methods as either private, public, or protected. Once that has been corrected, the tests could be rerun and eventually the peek operations removed. Consider the following lines of code: Student st = new Student(); String s = st.toString(); Will these lines compile? M13_BARN7367_06_SE_C13.indd 471 4/15/16 3:07 PM 472 | Chapter 13 ■ Building Graphical User Interfaces The effect of registering our object as a listener with the menu item is that our own actionPerformed method will be called by the menu item each time the item is activated. Another important contribution that made the creation of BlueJ and this book possible was very generous support first from Sun Microsystems and now from Oracle. Key methods are canRead, canWrite, createNewFile, createTempFile, getName, getParent, getPath, isDirectory, isFile, and listFiles. The variable filename will be local to the body of the loop. Here the terminal operation is a forEach that results in the sightings that survived the previous filtering process being printed. In this case, the args array would contain two elements, which are the strings "2" and "Fred". The whole problem could easily be avoided just by giving the fields and the parameters different names. display MessagePost ... while(expression) { statements } Examples: System.out.print("Please enter a filename: "); input = readInput(); while(input == null) { System.out.print("Please try again: "); input = readInput(); } int index = 0; boolean found = false; while(!found && index < list.size()) { if(list.get(index).equals(item)) { found = true; } else { index++; } } D.3.2 do-while The do-while loop executes a block of statements as long as a given expression evaluates to true. In our example in Code 13.3, we register the same listener object for both menu items. Does the Simulator class compile? We can create new exception types by creating subclasses in this hierarchy (Figure 14.1). The following version does this: List result = sightings.stream() .filter(record -> animal == record.getAnimal()) .peek(r -> System.out.println(r.getAnimal()) .filter(record -> area == record.getArea() .peek(r -> System.out.println(r.getArea()) .filter(record -> spotter == record.getSpotter()) .peek(r -> System.out.println(r.getDetails()) .collect(Collectors.toList()); From this version you would be quite likely to find that the first filter operation is not passing on any records to the next, because the test for string equality has not been made using the equals method. It also has to be static, because no objects exist when we start off. Before we call our project “version 1.0,” however, and thus declare it finished for the first time, we want to add a few more improvements (see Figure 13.2). If instead you see an error message, then you have mistyped the command. These details include the exact time of the event, the state of the modifier keys (the shift, control, and meta keys), a “command string,” and more. And then we note a new collaborator: Seat. 6.6 Using maps for associations We now have a solution to our technical-support system that generates random responses. HashSet mySet = new HashSet(); mySet.add("one"); mySet.add("two"); mySet.add("three"); Compare this code with the statements needed to enter elements into an ArrayList. This is another example of common terminology that we shall use from now on. Create a BallDemo object and execute its bounce method. A formal parameter is available to an object only within the body of a constructor or method that declares it. It does not matter what the source of the data is—we can view any of these as a stream, then use the same techniques and methods to process the elements. []int counts; boolean[5000] occupied; 7.3.2 Creating array objects The next thing to look at is how an array variable is associated with an array object. Before reading further, try the following exercises to see whether we can easily write such a method with the Java that we already know. ■ ■ It does not check to ensure that the customer inserts sensible amounts of money. The hasNext method tells the analyzer whether there is at least one more entry in the log file, and the next method then returns a LogEntry object containing the values from the next log line. To do this, it would be nice if people could use it without the need to start BlueJ. It follows that if we want to remember the cost of tickets held in the cost parameter, we must store the value somewhere persistent—that is, in the price field. There are at least four errors in this project. This can be processed as a stream, converted to a String array, or collected in an ArrayList, say, as required. We now assume that we are in a situation where it is our task to create a new application from scratch. So using an if-statement in the body to select the files we want should be easy. Fields have class scope: they are accessible throughout the whole class, so they can be used within any of the constructors or methods of the class in which they are defined. The methods can read files in the standard JPEG and PNG formats, and the save method will write files in JPEG format. comment Comments are inserted into the source code of a class to provide explanations to human readers. What happens when getLoginName is called on this student? Prior to Java 8, all methods in an interface had to be abstract, but the following non-abstract method types are also now available in interfaces: ■ Methods marked with the default keyword have a method body. Up to now, we have seen various types of parameters—integers, strings, objects—but all these were pieces of data, not pieces of code. It also defines the types for these fields. The default case is optional. The methods implement the behavior of an object; they provide its functionality. This is a practice we discourage, because it makes the termination criteria of the loop misleading, and clarity is always preferred. Do this by analyzing the nine pixels in a three-by-three square around each pixel (similar to the smooth filter), and then set the value of the middle pixel to the difference between the highest and the lowest value found. Person p1 = new Student(); Person p2 = new PhDStudent(); PhDStudent phd1 = new Student(); Teacher t1 = new Person(); Student s1 = new PhDStudent(); b. The Class class has nothing specifically to do with interfaces; it is a general feature of Java, but we just happen to be meeting it for the first time here. If it isn’t caught, then the program will simply terminate with an indication that an uncaught IllegalArgumentException has been thrown. In this project, we use the field displayString to simulate the actual display device of the clock (as you could see in Exercise 3.28). Exercise 13.10 If you have done Exercise 13.6 (adding a Help menu), make sure that its menu item also gets handled appropriately. This, however, we will test a bit later. The relevant code looks like this: imagePanel = new ImagePanel(); imagePanel.addMouseListener(new MouseAdapter() { public void mousePressed(MouseEvent e) { ... Many methods, though, have a void return type and return nothing, but they still perform a useful task within the context of their object. class IOException IOException is a checked exception class that is at the root of the exception hierarchy of most input/output exceptions. The cards show us the complete set of classes we need. All of these fields must be correctly initialized, and Code 10.4 shows the code segments that are used to achieve this in Java. Currently, we will always get messages first, in the order in which they were entered, followed by the photos. Formal parameters and local variables persist only for the period that a constructor or method executes. It has the two fields discussed above (Section 3.5), one constructor, and four methods (getValue, setValue, getDisplayValue, and increment). The threshold filter turns the image into a grayscale picture with only a few preset shades of gray. This topic will also be discussed in this chapter. Different probabilities are used to decide whether a particular location will contain one of these animals. 4 Note that the keyword here is throws and not throw. The List interface specifies the full functionality of a list, without constraining its underlying structural implementation. All existing exception classes support the inclusion of a diagnostic string passed to a constructor. Exercise 16.14 Do you feel that we should have developed the source code further at this stage, to enable at least one pickup request to succeed? We shall do this in all our GUI examples. ■ 1 We anticipate that this will have an extended use later in the development of the application as it should enable the company to schedule vehicles on the basis of which is closest to the pickup point. A server can throw an exception if something goes wrong. Therefore, using interfaces leads to a more flexible and more extensible structure. If it implements the right interface, it can register itself with a component it wants to listen to. This will produce a solution that is closest to the basic pattern we have outlined in the discussion above. Components are represented by objects. Now let us look at the SupportSystem class a bit more closely. ■ ■ ■ ■ A01_BARN7367_06_SE_FM.indd 16 We have not replaced the “old-style” techniques. This text is taken from a template and can be changed to suit your preferences. The last method, named show, prints a list of all message and photo posts to the text terminal. Exercise 2.12 What do you think is the type of each of the following fields? What effect does this have when you construct ticket-machine objects within BlueJ? We have the following definition of the addPost method in class NewsFeed: public void addPost(Post post) { . You can doubleclick this symbol to inspect it or drag it onto the object bench for further use. If the latter is the case, this card can now be removed. We shall not, however, explain them completely—that is left as an investigation for the curious reader. Because new post types can be defined as subclasses of Post, only the code that is actually different from Post has to be added. Code 15.1 The Singleton pattern M15_BARN7367_06_SE_C15.indd 572 4/11/16 3:45 PM 15.7 Using design patterns | 573 In this pattern: ■ The constructor is private so that instances can be created only by the class itself. We also investigate the laboratory class example from Chapter 1 a bit further. The statement used in the client to print the post could now look as follows: System.out.println(post.toString()); In fact, the System.out.print and System.out.println methods are special in this respect: if the parameter to one of the methods is not a String object, then the method automatically invokes the object’s toString method. At runtime, however, it turns out that the object in v is not a Bicycle but a Car, and the program will terminate prematurely. We shall see an example of this later. M11_BARN7367_06_SE_C11.indd 407 4/11/16 3:35 PM 408 | Chapter 11 ■ More about Inheritance Code 11.5 An example of a protected method Concepts Declaring a field or a method protected allows direct access to it from (direct or indirect) subclasses. M11_BARN7367_06_SE_C11.indd 396 4/11/16 3:34 PM 11.3 Overriding | 397 Code 11.1 Source code of the display methods in all three classes Concept Overriding A subclass can override a method implementation. Implement this in your version. This process of abstraction has brought with it an increased flexibility that may allow us to widen even further the scope of what we might do with a general simulation framework. At this level, we simply assume that increment will correctly increment the display’s value, without being concerned with how it does it. 10.9 The collection hierarchy The Java library uses inheritance extensively in the definition of the collections classes. This method is all about identifying classes and objects, and the associations and interactions between them. Other standard features include the Java Cryptography Extension (JCE), Java Secure Socket Extension (JSSE), and the Java Authentication and Authorization Service (JAAS). 2 people like this. The data is stored into it in the analyzeHourlyData method, and displayed from it in the printHourlyCounts method. This is the finally clause (Code 14.14), and it is often omitted. Exercise 12.34 Although the body of the loop in Code 12.6 no longer deals with the Fox and Rabbit types, it still deals with the Animal type. Automaton (Chapter 7) A series of examples of a cellular automaton. If you have done all the exercises, you should now have a version of the project that can open images, apply filters, display status messages, and display a dialog. The structure is as follows: boolean finished = false; while(!finished) { do something if(exit condition) { finished = true; } else { do something more } } This code pattern is a variation of the while-loop idiom discussed in Section 4.10. The pattern of providing two implementations for a single interface, however, is important here, and you should make sure that you understand this aspect. What error message do you get when you now press the Compile button? The image filters are the first step toward image manipulation. } M12_BARN7367_06_SE_C12.indd 447 4/11/16 3:38 PM 448 | Chapter 12 ■ Further Abstraction Techniques 12.6.2 Default methods in interfaces A method marked as default in an interface will have a method body, which is inherited by all implementing classes. We M04_BARN7367_06_SE_C04.indd 143 4/11/16 3:10 PM | 144 Chapter 4 ■ Grouping Objects shall meet this sort of requirement in nearly every program we write, and most programming languages have several ways to deal with it through the use of loop statements, which are also known as iterative control structures. We can understand the shortcomings of this solution when we think about another maintenance change. You will see a dialog appear that prompts you for some input (Figure 1.5). For example: bluej.language=spanish Comments in the file list all available languages. . The lines method of the Files class takes a Path parameter and returns the contents of the file in the form of a Stream. That is, make the sun go down slowly. Read the class documentation for the min, max, and sort methods, for instance. In the actionPerformed method, we simply print out the command string of the item to demonstrate that this scheme works. Both examples serve to discuss how to build graphical user interfaces (GUIs). It is important not to exclude any nouns straight away; we do not yet have enough information to make an informed decision. And finally, setting an EtchedBorder for the imagePanel adds a line with an “etched” look around the image. This will be the case if a value from the return type’s range is available to act as an error diagnostic value. The class Animal is a different case. Exercise 13.53 Override further methods of the MouseAdapter class to permit free-hand drawing on the image panel. The most common sequence transformations are performed via the filter, map, and reduce methods. Try applying multiple filters, one after another. 3 Adding an amount to the value in a variable is so common that there is a special compound assignment operator to do this: +=. M07_BARN7367_06_SE_C07.indd 257 4/15/16 3:35 PM 258 | Chapter 7 ■ Fixed-Size Collections—Arrays The LogfileReader class is quite complex, and we suggest that you do not spend too much time investigating its implementation. But the second half is missing—nothing happens yet when a user selects a menu. There are four cases of method references: a) A reference to a constructor, as we have used here: ArrayList::new (Note that, strictly speaking, a constructor is not actually a method.) This is a shorthand for the lambda: () -> new ArrayList() b) A reference to a method call on a particular object: System.out::println This would be a shorthand for the lambda: str –> System.out.println(str) Note that System.out is a public static variable of the System class and the parameter str would be supplied by the context in which the method reference is used, for instance, as the terminal operation of a stream pipeline: forEach(System.out::println) c) A reference to a static method: Math::abs This would be a shorthand for: x –> Math.abs(x) The parameter x would be supplied by the context in which the method reference is used, for instance, as part of the mapping of a stream: map(Math::abs) d) A reference to an instance method of a particular type: String::length This would be shorthand for: str –> str.length() Once again, str would be supplied by context. Exercise 6.25 HashMap is a parameterized class. The three most important logical operators are and, or, and not The are ritten in a a as && (and) || (or) ! (not) The expression a && b is true if both a and b are true, and false in all other cases. Highly extendable, makes a great open-ended student project. This can be useful to force buttons, for example, to have the same width. Exercise 13.2 Find the documentation for class JFrame. In more recent versions of Java, a shift has taken place from a number of classes in the java.io package to those in the java.nio hierarchy, although without completely superseding everything in java.io. Code 13.2 shows the equivalent of Code 13.1 in this style. But there are many situations where we want to repeat some actions, but we cannot predict in advance exactly how many times that might be. You will notice that ++ and −− appear in each of the top two rows in Table C.1. Those in the top row take a single operand on their left, while those in the second row take a single operand on their right. What might the reason be for having them both? We leave this as an exercise for the reader. Exercise 13.47 In your project, add two method stubs named makeLarger and makeSmaller. If we think through the requirements of other similar simulation scenarios, then we might come up with ideas for additional features that we could introduce. M15_BARN7367_06_SE_C15.indd 566 4/11/16 3:45 PM 15.5 Prototyping | 567 Exercise 15.9 Create a BlueJ project for the cinema booking system. Let us introduce some terminology to make it easier to talk about this issue: ■ ■ Concept The dynamic type of a variable v is the type of the object that is currently stored in v. Consider carefully whether to continue with the listener as an anonymous inner class, or whether to make it a named inner class. On receipt of a request, the TaxiCompany has a responsibility to Schedule a vehicle. We need to add the following parts: ■ ■ ■ We create a new menu (class JMenu) named Filter and add it to the menu bar. For modal dialogs with a standard structure, however, there are some convenience methods in class JOptionPane that make it very easy to show such dialogs. When it is a listener, it will get notified about any of the events it listens to. What sort of information is available on files/paths? Animal, in our new structure in Figure 12.4, inherits the abstract method act from Actor. 13.5.5 Image filters Two things remain to be done before our first image-viewer version is finished: adding some image filters, and adding a Help menu. Within BlueJ, you decide the value and enter it into a dialog box. The new String is then stored in the input variable because we have no further use for the old one. Library of Congress Cataloging-in-Publication Data Names: Barnes, David J. It ensures that potential problems with early design ideas are discovered before much time is invested in implementation. For instance, the constructor of class NumberDisplay was defined to expect one integer parameter: public NumberDisplay(int rollOverLimit) Thus, the new operation for the NumberDisplay class, which calls this constructor, must provide one actual parameter of type int to match the defined constructor header: new NumberDisplay(24); This is the same as for methods discussed in Section 2.5. With this constructor, we have achieved what we wanted: if someone now creates a ClockDisplay object, M03_BARN7367_06_SE_C03.indd 111 4/11/16 3:06 PM 112 | Chapter 3 ■ Object Interaction the ClockDisplay constructor will automatically execute and create two NumberDisplay objects. For instance, IntPredicate. Indeed, the main description for a method will often only need to be a single sentence, such as /** * Create a new passenger with distinct pickup and * destination locations. The first loop we will introduce to list the files is a special one for use with collections, which completely avoids the need to use an index variable at all: this is called a for-each loop. The contents and ordering of the stream cannot be changed—changes require the creation of a new stream. The problem for us is that it looks so complex that we do not want to write it directly. Leonardo da Vinci 40 seconds ago - 2 people like this. ■ Our openFile method has now been changed to actually open and display an image file. The curious reader may like to experiment with this project; however, it will not be discussed in this book. We have borrowed the concept of actors from the foxes-and-rabbits project of Chapter 12. World-of-zuul (Chapter 8, 11, 14) A text-based, interactive adventure game. This is a subclass of Error (see Figure 14.1) and is part of the hierarchy regarded as representing unrecoverable errors—hence, no handler should be provided in clients. In real-world projects, these different classes are often written by different people. Do you have a problem with our software?” Now, whenever somebody enters a question containing the word “slow”, we can look up and print out this response. Complete source code for all projects is included. This means that primitive-type values can be added directly to a collection, for instance. The principles we need to understand can be divided into three topic areas: ■ What kinds of elements can we show on screen? This means that items already in the list may have their index numbers increased when a new item is added. It will probably not be safe for a server class to assume that its clients will make the necessary checks that avoid an exception. Using a dedicated unit test class can solve these problems. These objects must be represented in the computer model being created. In our example, the type MessagePost is a subtype of type Post. Exercise 3.44 et u a scenario for in esti ation reate a ail ser er then create two mail clients for the users "Sophie" and “Juan” (you should name the instances sophie and juan as well so that you can better distinguish them on the object bench). This facility is an invaluable aid in understanding the underlying concepts and language details. Another good reason for having a private method is for a task that is needed (as a subtask) in several of a class’s methods. These situations produce what is called reference equality. That is exactly what the new collections in Java 8 can do for you. Methods can, in fact, have any number of parameters. Consider the case of a newly born rabbit in our simulation, for instance. This means that we shall have to work on a number of different classes: Location, Taxi, and TaxiCompany, for certain, and possibly others. This is not an exact method; we might find later that we need a few additional classes or that some of our nouns are not needed. In this case, the resource is associated with a file. As a result, all the JFrame methods we need to call (such as getContentPane, setJMenuBar, pack, setVisible, and so on) can now be called as internal (inherited) methods. (Or you would have to find all places in the code where this string was used and change them all—a tedious and error-prone procedure.) Having a central dispatch method (such as our actionPerformed) is not a nice structure at all. Then look at the documentation for some other classes. Which methods in the java.util.List interface have default implementations? This makes our life easier. The issue in this particular case boils down to whether it is significant for the survival of a species to have a single, connected habitat area, or whether two disjoint areas (with the same total size as the other) are just as good. This indicates that each can store a single whole-number value, which is reasonable given that we wish them to store numbers that represent amounts of money in cents. Which are the busiest times of the day? M05_BARN7367_06_SE_C05.indd 187 4/11/16 3:13 PM 188 | Chapter 5 ■ unctional Processin of ollections d anced Figure 5.1 l in a filter to a stream A B filter A C C D F E F Concept the map function We can map a stream to a new stream, where each element of the original stream is replaced with a new element deri ed fro the original. 6.9 Finishing the TechSupport system To put everything together, we also have to adjust the SupportSystem and Responder classes to deal correctly with a set of words rather than a single string. Class constants are constant class fields. We have now covered the basics of all important areas of GUI programming. There should be a non-editable text area to display text output. Once we understand how it works, we shall be in a good position to make some improvements. much more significant role, primarily because they change the value of one or more fields of a ticket-machine object each time they are called. But let us start at the beginning. Figure 4.4 Index number changes following removal of an item myMusic: MusicOrganizer : ArrayList files M04_BARN7367_06_SE_C04.indd 139 0 1 : String : String "MorningBlues.mp3" "MatchBoxBlues.mp3" 4/11/16 3:10 PM 140 | Chapter 4 ■ Grouping Objects 4.7.2 The general utility of numbering with collections The use of integer index values to access objects in a collection is something that we will see over and over again—not just with ArrayLists but also with several different types of collections. The reason for not moving these is that, although several of the remaining method bodies in Fox and Rabbit contain textually identical statements, their use of class variables with different values means that they cannot be moved directly to the superclass. Exercise 6.4 Is there a method in the String class that tests whether a string ends with a given suffix? 5.5.1 Filters, maps and reductions We noted above that the contents of a stream cannot be modified, so changes require a new stream to be created. Exercise 10.6 In order to illustrate that a subclass can access non-private elements of its superclass without any special syntax, try the following slightly artificial modification to the MessagePost and Post classes. The interface of several classes implemented by one team is slightly different from the interface the other team is expecting to use. Exercise 6.56 Create a Pen object interactively using its default constructor (the constructor without parameters). Exercise 13.38 Add a grayscale filter to your project. Constructors never have a return type of any sort—not even void. parameter Methods can have parameters to provide additional information for a task. Assignment statements work by taking the value of what appears on the right-hand side of the operator and copying that value into the variable on the left-hand side. A particular reason for avoiding this situation is that partial mutation of an object is likely to leave it in an inconsistent state for future use. * @return A random room. This enables the Java system to find the class without using an import statement. Let us experiment with this a bit more, this time by writing code in a class instead of using interactive calls. These two diagrams offer different views of the same application. The music player is implemented across three classes: MusicPlayerGUI, MusicPlayer, and MusicFilePlayer. Or three times? M01B_BARN7367_06_SE_C01.indd 47 4/11/16 2:54 PM This page intentionally left blank Chapter 2 Understanding Class Definitions Main concepts discussed in this chapter: ■ fields ■ methods (accessor, mutator) ■ constructors ■ assignment and conditional statement ■ parameters Java constructs discussed in this chapter: field, constructor, comment, parameter, assignment (=), block, return statement, void, compound assignment operators (+=, −=), if-statement In this chapter, we take our first proper look at the source code of a class. It is prefixed with the keyword abstract. Exercise 9.37 Open your project again and add better testing by replacing Hacker's test class with a unit test class attached to the CalcEngine. See the ObjectInputStream and ObjectOutputStream classes for further information. Eventually, we want not only to be able to open and display images, but also to be able to manipulate them and save them back to disk. Iterate over the list and determine which sighting records relate to the particular animal we are interested in (the filtering step). In a similar manner, Java method calls are polymorphic, because they may invoke different methods at different times. 3 Note carefully the double meaning of the term designing interfaces here! Above, we were talking about the interfaces of single classes (a set of public methods); now, we talk about the user interface—what the user sees on screen to interact with the application. ■ We often create just a single instance of a listener class, and a full-blown external class will often look like overkill for this sort of usage pattern. The int return type of getPrice is a form of promise that the body of the method will do something that ultimately results in an integer value being calculated and returned as the method’s result. What we have here is an example of indefinite iteration: the (search) action will be repeated an unpredictable number of times, until the task is complete. You will notice that both versions cause the system to exit. Strictly speaking, exception classes are always subclasses of the Throwable class that is defined in the java.lang package. This capability is an important feature of the while loop. Recently, though, business has not been going so well, and DodgySoft decided to get rid of the technical support department to save money. If an exception is thrown in the try block but not caught, then the finally clause is still executed. Sometimes we need a little more control, and Java provides a different loop construct to let us do more: the while loop. When assigned to a variable, only the reference is copied, not the object. Primitive types are all predefined in the Java language. We have already seen this idea in practice in Chapter 4, where we used ArrayList by parameterizing it with type names such as String. Good style, however, dictates that the length of the main method should be kept to a minimum. M02_BARN7367_06_SE_C02.indd 91 4/11/16 3:02 PM 92 | Chapter 2 ■ Understanding Class Definitions Exercise 2.87 Add a method, printDetails, to the Book class. (If you are feeling impatient, you could always create a NumberDisplay object with a lower limit!) Exercise 3.6 Create a second NumberDisplay object with a limit of 60, and give it the name minutes. At the level of class structures, both these goals can be served by using design patterns. Hooks are pointers, often in the form of questions that raise the topic and give references to an appendix or outside material. Z02_BARN7367_06_SE_APPB.indd 603 4/11/16 3:50 PM This page intentionally left blank Appendix C C.1 Operators Arithmetic expressions Java has a considerable number of operators available for both arithmetic and logical expressions. This is significantly different from all other return types. 14.5.2 Anticipating exceptions: the try statement The second requirement, when using checked exceptions, is that a caller of a method, that throws a checked exception must make provision for dealing with the exception. For instance, an if-else statement can be used to select from among several alternative sets of statements if the else part contains a nested if-else statement, and a for loop can be used to loop an indefinite number of times. On inspecting different objects, you will notice that objects of the same class all have the same fields. The address book provides two ways to retrieve entries: the getDetails method takes a name or phone number as the key and returns the matching details; the search method returns an array of all those details that start with a given search string (for instance, the search string “084” would return all entries with phone numbers having that prefix). Exercise 6.51 Use BlueJ’s Project Documentation function to generate documentation for your TechSupport project. A significant feature of all of these collection types is that their capacity is flexible—we never have to specify how many items a particular collection will hold, and the number of items stored can be varied arbitrarily throughout the life of the collection. */ The main description for a method should be kept fairly general, without going into a lot of detail about how the method is implemented. Each factory would, of course, produce a different kind of actor, but the Simulator talks to them via the ActorFactory interface. Primitive types and object types Java knows two very different kinds of type: primitive types and object types. The constructor should take a single parameter of type String called moduleCode. In the computing education community, a well-known educational design pattern exists that states that important concepts should be taught early and often.1 It is very tempting for textbook authors to try and say everything about a topic at the point where it is introduced. Exercise 7.1 Explore the weblog-analyzer project by creating a LogAnalyzer object and calling its analyzeHourlyData method. M11_BARN7367_06_SE_C11.indd 412 4/11/16 3:35 PM 11.12 Summary | 413 The elegance of this solution lies in the fact that no change at all is needed in either the original Game or Room classes! We can simply add this class to the existing game, and the goRoom method will continue to work as it is. Chapter 13 develops an image viewer and a graphical user interface for the music organizer (first encountered in Chapter 4). They are evaluated in order of appearance, and only the first matching clause is executed. or its affiliates, authors, licensees or distributors. BlueJ helps by distinguishing different kinds of scopes with different colors. 4.5 Object structures with collections To understand how a collection object such as an ArrayList operates, it is helpful to examine an object diagram. Figure 6.6 A spiral drawn on the canvas M06_BARN7367_06_SE_C06.indd 237 4/11/16 3:17 PM 238 | Chapter 6 ■ More-Sophisticated Behavior Figure 6.7 Code completion When the code completion pop-up is displayed, we can type the beginning of the method name to narrow down the method list. M06_BARN7367_06_SE_C06.indd 218 4/11/16 3:17 PM 6.6 Using maps for associations | 219 To do this, we will use a HashMap. M14_BARN7367_06_SE_C14.indd 540 4/11/16 3:43 PM 14.8 Error recovery and avoidance | 541 Exercise 14.38 The changeDetails method of AddressBook currently has no assert statements. M14_BARN7367_06_SE_C14.indd 518 4/11/16 3:43 PM 14.3 Server error reporting | 519 Exercise 14.16 Are there any further checks you feel we should make on the parameters of other methods, to prevent an AddressBook object from functioning incorrectly? Other parts, such as comments describing the class, methods, and parameters, need more attention, as they can easily be forgotten, be incomplete, or be incorrect. In the mouse-listener code above, this is done with the code fragment new MouseAdapter() { public void mousePressed(MouseEvent e) { ... The state is represented by storing values in fields. the filter function Concept We can filter a stream to select only specific elements. For instance, in a large city, is it better to have idle taxis space themselves out from one another, rather than have all gather at the center? It should be of type String and initialized to the zero length string ("") in the constructor, as its initial value is not passed in a parameter to the constructor. You could copy some out of the solutions provided and add some yourself. There is a good example preceding the header of the class in Code 2.1. The definitions of the three fields are quite similar: ■ M02_BARN7367_06_SE_C02.indd 56 All definitions indicate that they are private fields of the object; we shall have more to say about what this means in Chapter 6, but for the time being we will simply say that we always define fields to be private. Between these symbols, a comment can have a main description followed by a tag section, although both are optional. Consider as many different sorts of applications as you can—for instance: those with a GUI; those with a textual interface and a human user; those with no sort of interactive user, such as software in a vehicle’s enginemanagement system; or software in embedded systems such as a cash machine. The string is also shown to the user if the exception is not handled and leads to the termination of the program. M13_BARN7367_06_SE_C13.indd 497 4/15/16 3:07 PM 498 | Chapter 13 ■ Building Graphical User Interfaces Exercise 13.49 Properly implement the makeSmaller and makeLarger methods. Two String objects, for example, could both contain the characters “bye”. Exercise 3.15 Write an expression using boolean variables a and b that evaluates to true when only one of a and b is true, and that is false if a and b are both false or both true. This display needs to store two values. In Chapter 12 we implement a predator/prey simulation. Exercise 13.17 Using the layouts project from this chapter, experiment with the examples illustrated in this section. For now, we shall ignore the user-interface design and use BlueJ method invocation to work with our program. Exercise 5.26 Write a method that takes an animal name as a parameter and returns the largest count for that animal in a single Sighting record. We often only create just a single object from each of the inner classes, because each is highly specialized for a particular component within a specific GUI. So let us start with a brief discussion of these two foundations. As an example, we can again use our foxes-and-rabbits simulation. On closer inspection, we see that we know some of these things not because they are poodles, but because they are dogs, mammals, or animals. It is useful to compare the syntax of a lambda with that of a method performing a similar task. This should be thrown by the addDetails method if either of the non-blank key fields of its actual parameter is already currently in use. This is why we rejected using reference equality for making string comparisons in Chapter 6. We can store the names of any number of music files and even play them. Exercise 2.52 After a ticket has been printed, could the value in the balance field ever be set to a negative value by subtracting price from it? Ideally, changing the implementation of one class should not make it necessary to change other classes as well. ■ Pay attention to the scope highlighting. The mail item contains information about the sender, the recipient, and the message itself. trim() Which version you prefer is mainly a matter of taste. The interface terminology is also used for individual methods. G.6 Fixtures The contents of the object bench may be captured as a fixture by selecting Object Bench to Test Fixture from the pop-up menu associated with the test class. Exercise 14.20 Using a copy of the address-book-v2t project, make changes to the AddressBook class to provide failure information to a client when a method has received incorrect parameter values, or is otherwise unable to complete its task. Exercise 13.78 The display of tracks is currently simply a JList of String objects. We have defined that we want to cut our string at every space character. Or perhaps we wish to look for a message by a particular author? In our world-of-zuul game, for instance, we want only a single parser. Open an inspector window for this object. There are many applications that run completely independently of a human user. Consider: ■ ■ ■ ■ We have to declare a variable for the first list index, and we have to initialize it ourselves to 0 for the first list element. There is no indication whether the company seeks to distinguish between taxis and shuttles when scheduling, so we do not need to take that aspect into account here. O X T M o; x; t; m; The following assignments are all legal (assume that they all compile): m = t; m = x; o = t; The following assignments are all illegal (they cause compiler errors): o = m; o = x; x = o; What can you say about the relationships of these classes? This is a very important difference between these two sorts of variables. Change your image viewer so that the two toolbar buttons are initially disabled. So far, a large part of these discussions has remained at the level of source code in single classes. use cases Use cases (also known as “scenarios”) can be used to get an understanding of the interactions in a system usually do something if we invoke a method. This ensures that all methods in concrete classes can always be executed. The method takes a lambda that receives an element and returns a boolean result. At each step, each fox and each rabbit is allowed to carry out the actions that characterize their behaviors. object creation Objects can create other objects, using the new operator. In fact, it is the fastest adoption of any new Java version ever released; so it is time also to change the way we teach novice students. This allows us to see the path the execution takes. ■ And contrary to the case of super calls in constructors, no automatic super call is generated and no super call is required; it is entirely optional. We have seen that constructors are distinguished from methods by having the same name as the class in which they are defined. Addison-Wesley. There are some sample images in the images folder inside the chapter13 folder (one level up from the project folder). Exercise 6.58 Find some uses of the color constants in the code of class DrawDemo. So in the timeTick method, the ClockDisplay object is asking the NumberDisplay objects to carry out part of the overall task. What happens if there is no CENTER component with BorderLayout, for instance? 0 "hello" 101 -1 true "33" 3.1415 M01B_BARN7367_06_SE_C01.indd 46 4/11/16 2:54 PM 1.15 Summary | 47 Exercise 1.32 What would you have to do to add a new field, for example one called name, to a circle object? The solution we use to deal with the complexity problem is abstraction. A particular collection (my music collection) would be an instance of the class. Class libraries One of the features of object-oriented languages that makes them powerful is that they are often accompanied by class libraries. is instance of... Unchecked exceptions are intended for cases that should never fail in normal operation—they usually indicate a program error. Classes represent the general concept of things, while objects represent concrete instances of a class. Using the unsophisticated matching technique described above, we will also find tracks by artists whose names happen to have that sequence of characters in them (e.g., Glover). Its purpose is to serve as a superclass for other classes. For instance: labels[6] machines[0] people[x + 10 − y] The valid values for an index expression depend upon the length of the array on which they are used. If value contains 3, for example, then the statement return "0" + value; will return the string "03". M02_BARN7367_06_SE_C02.indd 58 4/11/16 3:02 PM 2.4 Fields, constructors, and methods | 59 a particular machine will have until that machine is constructed. 6.4 Adding random behavior So far, we have made a small improvement to the TechSupport project, but overall it remains very basic. Code completion can also be used without a preceding object to call local methods. There is also the question of the most appropriate size of the time step. Here, we have presented only a brief idea of what design patterns are, and we have given an informal description of some of the more common patterns. M07_BARN7367_06_SE_C07.indd 255 4/15/16 3:35 PM 256 | Chapter 7 ■ Fixed-Size Collections—Arrays Figure 7.1 hourCounts An array of 24 integers : int[ ] 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 The general form of an array object’s construction is new type[integer-expression] The choice of type specifies what type of items are to be stored in the array. When creating a computer simulation, we try to model the behavior of a subset of the real world in a software model. Although we do not use everything from UML (by far), we attempt to use UML notation for those things that we show. While you might be responsible for implementing the SupportSystem class from our last example, someone else might implement the InputReader. These different views provide a useful base from which to discuss questions such as: ■ How much checking should a server’s methods perform on client requests? There are two main categories: selection statements and loops. It has no user interface yet (so it will not be usable outside BlueJ), and the data entered is not stored to the file system or in a database. The behavior we observe is a result of the general rules. This makes Java technically a hybrid language: a mostly imperative language with some functional elements. Its action would be to update its current count of animals. In addition, the AddressBookDemo class is provided as a convenient means of setting up an initial address book with some sample data. There is nothing to stop us doing this, because the body of a for-each loop is just an ordinary block, and we can use whatever Java statements we wish inside it. Includes the ability to play MP3 files. Figure 3.3 Object diagram and class diagram for the ClockDisplay ClockDisplay myDisplay: ClockDisplay : NumberDisplay hours 11 minutes : NumberDisplay NumberDisplay (b) 03 (a) M03_BARN7367_06_SE_C03.indd 99 4/11/16 3:06 PM 100 | Concept The object diagram shows the objects and their relationships at one moment in time during the execution of an application. It could return false, even if the value of the input variable is “bye”.2 The solution is to use the equals method, defined in the String class. However, it allows a class to implement any number of interfaces (in addition to possibly extending one class). On the positive side, by attempting to create a version that at least compiles, we certainly found that we were forced to think about the Vehicle inheritance hierarchy in some detail: in particular, which methods could be implemented in full in the superclass, and which were best left as abstract. Thus, looking at the explanations above, we can be more precise: the static type of v1 is Vehicle, the dynamic type of v1 is Car. 13.5.4 Nested containers All the layout strategies discussed above are fairly simple. As is our normal practice with instance fields, we will keep all of these private in the superclass. The condition is ultimately what controls how many times a particular loop will iterate. 6. } This class follows the same pattern as the MessagePost class. It can also apply three basic filters. In the list of methods for a circle, you will see one method with a different parameter type: the changeColor method has a parameter of type String. We shall discuss these in later chapters. However, too many predators could kill off all the prey and leave the hunters with nothing to eat. It assigns the value on the right-hand side (from) to the variable on the left (this.from). We could, for example, define the following two fields: private ArrayList members; private ArrayList machines; These definitions state that members refers to an ArrayList that can store Person objects, while machines can refer to an ArrayList to store TicketMachine objects. The new SimulatorView interface was constructed by searching through the Simulator class to find all methods that are actually called from outside, then defining an interface that specifies exactly those methods. After each step, the simulation pauses for a brief period so that the GUI does not change too quickly. The new functional style, which we cover in this chapter, is quickly becoming popular and will likely be the dominant style of writing new code in Java within a short space of time. BlueJ is particularly good at supporting interactive unit testing of both methods and classes. M10B_BARN7367_06_SE_C10.indd 389 4/11/16 3:32 PM This page intentionally left blank Chapter 11 More about Inheritance Main concepts discussed in this chapter: ■ method polymorphism ■ static and dynamic type ■ overriding ■ dynamic method lookup Java constructs discussed in this chapter: super (in method), toString, protected, instanceof The last chapter introduced the main concepts of inheritance by discussing the network example. Assignments and parameter passing have reference semantics (i.e., the reference is copied, not the object). } We can now use this method to add message posts and photo posts to the feed: NewsFeed feed = new NewsFeed(); MessagePost message = new MessagePost(. Note that the class diagram displays the inheritance relationship. In a programming context, the collection abstraction becomes a class of some sort, and the operations would be methods of that class. The subclass becomes a subtype of the superclass. | 37 Every one of those objects has its own position, color, and size. Looking at the documentation, we see that there are various methods called nextSomething for generating random values of various types. The basic idea is simple: the simulator holds collections of foxes and rabbits, and it repeatedly gives those animals an opportunity to live through one M12_BARN7367_06_SE_C12.indd 419 4/11/16 3:37 PM 420 | Chapter 12 ■ Further Abstraction Techniques Figure 12.1 SimulatorView Class diagram of the foxes-and-rabbits project FieldStats Simulator Counter Field Location Fox Rabbit Randomizer step2 of their life cycle. M12_BARN7367_06_SE_C12.indd 441 4/11/16 3:38 PM 442 | Chapter 12 ■ Further Abstraction Techniques Exercise 12.50 Was it possible to make these changes without having any impact on any other classes in the project? What other classes required changing as a result of introducing hunters? Exercise 6.9 Improve the code of the SupportSystem class in the tech-support1 project so that case in the input is ignored. For learners, it creates more work: we now have to study two different ways to achieve a similar goal. The collaborator may be shared in this way with several different objects. We do this on a new set of cards. To arrive at more formal descriptions, we can now play through the scenarios again, this time talking in terms of method calls, parameters, and return values. The new method should return the value of the total field. is an instance of... If execution is halted, the debugger will show the state of the program as if a breakpoint had been reached. Exercise 14.17 How many different ways can you think of to indicate that a method has received incorrect parameter values or is otherwise unable to complete its task? Documentation comments are always opened with the character triplet “/**” and closed by the character pair “*/”. For instance, the statement post.display(); could invoke the MessagePost’s display method at one time and the PhotoPost’s display method at another, depending on the dynamic type of the post variable. If, for example, someone asks us to give them a pen, we can Figure 10.9 Vehicle An inheritance hierarchy Car M10B_BARN7367_06_SE_C10.indd 382 Bicycle 4/11/16 3:32 PM 10.7 Subtyping Concept Substitution Subtype objects may be used wherever objects of a supertype are expected. The problem is a reflection of the fact that no instance of class Animal will ever exist. Code 10.1 Source code of the MessagePost class M10B_BARN7367_06_SE_C10.indd 363 4/11/16 3:32 PM 364 | Chapter 10 ■ Improving Structure with Inheritance Code 10.1 continued Source code of the MessagePost class M10B_BARN7367_06_SE_C10.indd 364 4/11/16 3:32 PM 10.1 The network example | 365 Code 10.1 continued Source code of the MessagePost class Some details are worth mentioning: ■ ■ Some simplifications have been made. In the loop body, we then use the loop variable to refer to each element. Objects have methods that we use to communicate with them. We cover the new, functional approach in addition to the existing material. At two points in the scenario, a vehicle is expected to notify the company of its arrival at either a pickup point or a destination. However, as writers of the ClockDisplay class, we have to make this happen. We shall now go one step further. } M14_BARN7367_06_SE_C14.indd 534 4/11/16 3:43 PM 14.5 Exception handling | 535 14.5.4 Propagating an exception So far, we have suggested that an exception must be caught and handled at the earliest possible opportunity. Values have now been assigned to the fields. The variable display areas reflect the details of the method or constructor currently highlighted in the call sequence. They might change the names of the rooms—“Transporter room” becomes “Transporterraum”—and suddenly the game does not work any more! This is a clear case of a maintainability problem. Exercise 12.44 Using your latest version of the project (or the foxes-andrabbits-v2 project in case you have not done all the exercises), record the number of foxes and rabbits over a small number of steps, to prepare for regression testing of the changes to follow. 12.2.4 The Simulator class: setup The Simulator class is the central part of the application that coordinates all the other pieces. Because of the lack of a name, lambdas are also known as anonymous functions. The need to model movement required the Location class to be implemented more fully than in the outline. 14.10 Summary When two objects interact, there is always the chance that something could go wrong, for a variety of reasons. class Scanner The Scanner class provides a way to read and parse input. 16.4.3 Testing the first stage As part of the implementation of the first stage, we have developed two test classes: LocationTest and TaxiTest. From the definitions of fields we have seen so far, we can begin to put a pattern together that will apply whenever we define a field variable in a class: ■ They usually start with the reserved word private. Finally, we add those extra details needed for a message post to the MessagePost class, and those for a photo post to the PhotoPost class. When the hierarchy does not seem to fit properly, we have to refactor the hierarchy. More recently, the JavaFX library has been added. Your class should create only a single instance of class Random (in its constructor) and store it in a field. When using collections, therefore, we always have to specify two types: the type of the collection itself (here: ArrayList) and the type of the elements that we plan to store in the collection (here: String). A bicycle is not a car (or, more formally, the type Bicycle is not a subtype of Car), and thus the assignment is not allowed. The lifetime of a parameter is limited to a single call of a constructor or method. 16.2.2 Using CRC cards Figure 16.1 contains a summary of the noun and verb associations we are left with once some simplification has been performed on the original description. 4.6 Generic classes The new notation using the angle brackets deserves a little more discussion. Probably more interesting as an interface, however, is the address-book-v1g version, which incorporates a simple GUI. As we further develop the application, resolutions of these issues and others will emerge. Local variables must be initialized before they are used in an expression—they are not given a default value. This one line, in fact, introduces two new keywords, which are used together: static and final. In the debugger display for the MailItem object, you can see the instance variables and local variables that have the same names, as discussed in Section 3.13.2. Step further to see the instance variables get initialized. To achieve what we want, we need to avoid hard-coding every filter-method name (lighter , threshold , etc.) into our ImageViewer class. This is a good stylistic validation habit to adopt, as it prevents failure of a library-class method call when passing on parameter values that could be invalid. (You can use network-v2 if you do not have your own version yet.) Remove the display method from class Post and move it into the MessagePost and PhotoPost classes. For integer fields, this default value is zero. This has allowed all types of posts to be stored in a single list. One problem with this policy is that it assumes that the server is aware enough of the context in which it is being used to be able to determine whether client recovery is likely or unlikely to be possible. But we are getting a little ahead of ourselves. These features will be sufficient for illustrating the basics of creating and using the ArrayList class, and later versions will then build further features incrementally until we have something more sophisticated. Most practical try statements have the general form shown in Code 14.8. This introduces two new Java keywords—try and catch—which mark a try block and a catch block, respectively. If all animals were to start with an age of zero, no new animals would be created until the initial population had reached their respective breeding ages. So the class Circle defines that each circle object will have five fields, named diameter, xPosition, yPosition, color, and isVisible. Before we continue this rather theoretical discussion, let us look at an example. The exact mechanism used to start an application depends on the operating system. 5.3.2 Basic syntax of a lambda A lambda is, in some ways, similar to a method: it is a segment of code that is defined to do something, but not immediately executed. We provide a partial implementation of such a system under the name animal-monitoring-v1 in the book projects. The recording symbol to the left of the class diagram will then be colored red, and the End and Cancel buttons become available. Exercise 2.50 In this version of printTicket, we also do something slightly different with the total and balance fields. */ public void printSightingsBy(int spotter) { sightings.stream() .filter(sighting -> sighting.getSpotter() == spotter) .map(sighting -> sighting.getDetails()) .forEach(details -> System.out.println(details)); } M05_BARN7367_06_SE_C05.indd 192 4/11/16 3:13 PM trea s | 193 This example is equivalent to the version we have seen before. H.2 Enabling teamwork functionality The teamwork tools are initially hidden in BlueJ. Exercise 6.47 When no word is recognized, use other words from the user’s input to pick a well-fitting default response: for example, words such as “why”, “how”, and “who”. Similarly modify cooler so that it will not allow temperature to be set to a value less than min. Concepts are usually introduced at a level of detail necessary for understanding and applying to the task at hand. Once again, test that the class works as you would expect it to by creating some Heater objects within BlueJ. Use the javadoc format for comments, with appropriate javadoc tags to document the details. ■ These fields will need accessors and mutators, so we can move the existing getLocation, setLocation, isAlive, and setDead from Fox and Rabbit. It turns out on closer inspection that building a 12-hour clock is slightly more difficult than a 24-hour clock; we shall leave this until the end of the chapter. We have also seen that the for-each loop does not provide us with an index value for the items in the collection. Can you have an abstract class without abstract methods? M12_BARN7367_06_SE_C12.indd 433 4/11/16 3:38 PM 434 | Chapter 12 ■ Further Abstraction Techniques 12.3.1 The Animal superclass For the first set of changes, we will move the identical elements of Fox and Rabbit to an Animal superclass. Exercise 3.49 Set up the same test situation as we did before. Could a passenger end up being driven back and forth while the shuttle responds to competing requests, the passenger never getting delivered? We might want them to appear next to each other, or one below the other, or in any other possible arrangement. In other words, when the constructor has finished executing, the whole constructor space is removed, along with the parameter variables held within it (see Figure 2.4). That way, they save a huge amount of effort that can be better used in working on other parts of the program. The Static variables area displays the values of the static variables defined in the class of that object. We make no judgments yet about which are “good ones” and which are not. The run method of the Demo class plays out this scenario. A version of the project that includes a GUI picks up on a running theme of the book—that we often provide additional code for the interested and able student to explore, without covering it in detail in the text. We can note for the Show class: Can reserve seats. So far, we have not met any features of Java that would allow us to group together arbitrary numbers of items. So far, our frame uses a BorderLayout, where the WEST area is empty. By setting a modest goal, the task seemed achievable within a reasonably short time. What does its header look like? With the inspector open, call the object’s increment method. You will find that the chapters in this book continually revisit and build on themes that have been introduced in previous chapters. This was just the first, simple scenario. The key point behind declaring them like this is that the way in which the variables are used in the rest of the code is independent of the exact, concrete type of the object to which they refer. J.2 Layout J.2.1 One level of indentation is four spaces J.2.2 All statements within a block are indented one level J.2.3 Braces for classes and methods are alone on one line The braces for classes and method blocks are on separate lines and are at the same indentation level. In the refundBalance method, amountToRefund is used briefly to hold the value of the balance immediately prior to the latter being set to zero. inheritance Inheritance allows us to define one class as an extension of another. Another advantage is that code that we write does not have to know the concrete type that might have been used in code written by someone else – we only need to know the abstract type: List, Map, Set, etc. By nesting multiple BoxLayouts inside each other, sophisticated twodimensionally aligned layouts may be built. If not, read Appendix A first. 5.1 An alternative look at themes from Chapter 4 In Chapter 4, we started to look at techniques to process collections of objects. Exercise 11.4 Look up toString in the library documentation. For instance, we might want to select only those Sighting objects that relate to elephants. We start with all sightings, apply a filter that only selects elephants, and we are left with a stream of all elephant sightings. Finally, we have the two lines frame.pack(); frame.setVisible(true); The first line causes the frame to arrange the components inside it properly, and to size itself appropriately. There are really two effects to consider: the effect in the method where the problem is discovered, and the effect in the caller of the method. Consider whether the current mouse operations used to chose a color or choose a i el are the ost a ro riate for a user han e them if you feel that they are not. In Java, javadoc comments are written with a special comment symbol at the beginning: /** This is a javadoc comment. A JComboBox may also be editable, in which case the values are not all predefined but can be typed by a user. Work out exactly how five adjoining seats are might be. new Date("March", 23, 1861) Try to give meaningful names to the parameters. Terms introduced in this chapter: functional programming, lambda, stream, pipeline, filter, map, reduce Exercise 5.29 Take a copy of music-organizer-v5 from Chapter 4. The class we shall use is called HashSet. Code 14.1 The AddressBook class M14_BARN7367_06_SE_C14.indd 512 4/11/16 3:43 PM 14.1 The address-book project | 513 Code 14.1 continued The AddressBook class M14_BARN7367_06_SE_C14.indd 513 4/11/16 3:43 PM 514 | Chapter 14 ■ Handling Errors Code 14.1 continued The AddressBook class New details can be stored in the address book via its addDetails method. For example, comments for a post are stored as strings. We will cover this topic in full in Chapters 10 and 11, but it may be instructive to touch briefly on it here to deepen your understanding of the different types of collection. We can then use this GridLayout for our JPanel by using the panel’s setLayout method immediately after creating it: JPanel toolbar = new JPanel(); toolbar.setLayout(new GridLayout(0, 1)); Alternatively, the layout manager can also be specified as a constructor parameter of the container: JPanel toolbar = new JPanel(new GridLayout(0, 1)); Exercise 13.46 Change your code so that your toolbar panel uses a GridLayout, as discussed above. Add a corresponding getRefNumber accessor to help you check that the mutator works correctly. We can, however, use a loop variable of type Post, because variables are polymorphic. Thus, each element in the list gets printed out. A complete list of simple types and their wrapper classes is given in Appendix B. BinaryOperator interfaces take two parameters and return a result of the same type. Select End to complete the recording and capture the test, or select Cancel to discard the recording, leaving the test class unchanged. He was one of the driving forces in the development of BlueJ and the ideas and pedagogy behind it from the very beginning, and we talked about the writing of this book for several years. We use two tools throughout the book to enable the concepts introduced to be put into practice: the Java programming language and the Java development environment BlueJ. Displaying static images We often want to display an image in a GUI. Seeing the interface provides all the information needed. Appendix E describes the details of this method and the commands needed to start the Java system without BlueJ. Exercise 10.3 Draw an inheritance hierarchy for the people in your place of study or work. No code is provided, as the example represents the development of an application from a blank sheet of paper. The programmer of both classes might even be the same person, but the classes should still be loosely coupled. static type The static type of a variable v is the type as declared in the source code in the variable declaration statement. However, the Room class has an extra field whose value is really needed only because of the nature of one or two of the instances. Key methods are close, read, and readLine. We shall now change this to a new version in which the InputReader returns the input as a set of words. This is where we make use of the equals method that every class inherits M11_BARN7367_06_SE_C11.indd 405 4/11/16 3:35 PM 406 | Chapter 11 ■ More about Inheritance from the Object superclass. String phone = details.getPhone(); We can say that, in all cases, the execution of these statements will be left incomplete; the exception thrown by getDetails will interrupt the execution of the first statement, and no assignment will be made to the details variable. For this particular case, the solution is found in object-oriented languages. We shall have to learn what the important components are, how to create them, and how to make them look the way we want them to look. Subtype objects may be substituted for supertype objects, and variables are allowed to hold objects that are instances of subtypes of their declared type. This means that any method to return the next complete line from a file must be able to read an arbitrary number of characters. The second variant, the for loop, is an alternative iterative control structure2 that is particularly appropriate when: 2 Sometimes, if people want to make clearer the distinction between the for loop and the for-each loop, they also talk about the former as the “old-style for loop,” because it has been in the Java language longer than the for-each loop. The return type is void, as this method does not return a value. The menu bar and the content pane are under the control of the application. This is a difference that applies in all cases. negative testing Negative testing is the testing of cases that are expected to fail. This static method then typically creates the first object. Investigate whether there are any Swing components available that would provide greater sophistication than this. String[] labels = new String[20]; Exercise 7.8 What is wrong with the following array creation? A further feature is that statements in methods of the inner class can see and access private fields and methods of the enclosing class—just as a lambda expression is able to do. We can achieve this by using another layout manager. This is not the case at all— we shall see how printing is done when we look at the printTicket method. The following sections discuss some new features that have been used in the setValue, getDisplayValue and increment methods. As we have done in previous chapters, we will start with a version of an application that works perfectly well from a user’s point of view, but whose internal view is not so good when judged by the principles of good object-oriented design and implementation. All future events are stored in an ordered queue, where the next event to take place is held at the head of the queue. Interfaces can have no direct instances, but they serve as supertypes for instances of other classes. Java refers to these object attributes as fields. What does it do? We use an example of an online shop and an implementation of an electronic calculator to discuss these topics. The Observable class provides methods for observers to attach themselves to the observed entity. The map function takes a stream and creates a new stream, where each element of the original stream is mapped to a new, different element in the new stream (Figure 5.2). In order to do this, we shall use a method called CRC cards.1 CRC stands for Class/Responsibilities/Collaborators. Although we were required only to handle a single taxi and a single passenger, we tried to bear in mind that ultimately there could be multiple pickup requests outstanding at any one time. M06_BARN7367_06_SE_C06.indd 217 4/11/16 3:17 PM 218 | Chapter 6 ■ More-Sophisticated Behavior The classes ArrayList and Random are both in the package java.util . The brightness of each pixel should remain unchanged. This publication is protected by Copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. People often call in advance to reserve seats. Here, the variable hour is able to store a single integer value, whereas hourCounts will be used to refer to an array object once that object has been created. Exercise 2.43 Modify the constructor of TicketMachine so that it no longer has a parameter. Now try this in the Code Pad: String swimmer = "cat" + "fish"; swimmer One again, we have given an appropriate type to the variable swimmer, allowing us to make an assignment to it and find out what it stores. Try it out within BlueJ. To enable us to do this easily, we have implemented the getDisplayValue method. .". The basic form of a call to println is System.out.println(something-we-want-to-print); where something-we-want-to-print can be replaced by any arbitrary string, enclosed between a pair of double-quote characters. Abstract classes are classes that are not intended to have any instances. The rule you will learn here is an important one, so be sure to remember it. ■ These views clearly represent opposite extremes. The ability to omit the public access modifier, for example, and the return type, are a start of this. Associated with the request will be a passenger and a pickup location. Instead, its header is terminated with a semicolon. If so, document some tests for each. } 2.9 Printing from methods Code 2.7 shows the most complex method of the class: printTicket. Exercise 3.59 Challenge exercise In the current design of ClockDisplay, a ClockDisplay object is responsible for detecting when a NumberDisplay object has rolled over to zero and then telling another NumberDisplay object to increment. However, one problem with this is evident from the single-list solution in Code 12.5. Although we know that each item in the list is an Animal, we still have to work out which type of animal it is in order to call the correct action method for its type—run or hunt. The advanced sections in this book (there will be some others later) can be skipped on first reading if you wish. In the remainder of this chapter, we shall not discuss the implementation phase of the cinema booking system in detail. The Object class All classes have a superclass. The constructors are responsible for ensuring that an object is set up properly when it is first created. Imagine that we have a class Vehicle with two subclasses, Car and Bicycle (Figure 10.9). These are the methods that return new collections as method results; we have not yet discussed how to create a new collection from a stream. Interfaces are not primarily used for the first benefit but for the second. Placing all participants in a single list keeps the basic simulation step simple. It follows that assert statements should never be used to provide normal functionality. Code 3.2 The ClockDisplay class containing two NumberDisplay fields When we discussed fields in Chapter 2, we said that the word “private” in the field declaration is followed by a type and a name for the field. This also looks good if you invert the image at the same time. You can find a working implementation of everything described so far in the imageviewer1-0 project. Key methods are add, getFirst, getLast, iterator, removeFirst, removeIf, removeLast, size, and stream. This fits the criteria, as the fixed number of times corresponds to the length of the array and the variable is needed to provide an incrementing index into the array. Which methods are truly identical in the Fox and Rabbit classes? Make any changes necessary to make it runnable again. subclass A subclass is a class that extends (inherits from) another class. It takes care that the value resets to 0 when the limit is reached: public void increment() { value = (value + 1) % limit; } This method uses the modulo operator (%). 4/11/16 3:02 PM 80 | Chapter 2 ■ ■ ■ ■ ■ ■ ■ Understanding Class Definitions As long as they are defined as private, fields cannot be accessed from anywhere outside their defining class. The TaxiCompany must Receive notification of passenger arrival. However, this will not be the case with all listener interfaces. You will notice several other operations in the circle’s menu. Example: A PassengerSource object receives the TaxiCompany object through its constructor. You may need to consult more resources online a a lan ua e resources other a a ooks etc to find out the details. The main concepts we shall use to design better program structures are inheritance and polymorphism. We do not have to change the hours in that case. The result is a stream with fewer elements (a subset of the original). It involves tracking populations of foxes and rabbits within an enclosed area. Exercise 12.19 Repeat the investigations of the previous exercise, but vary the proportions of the two smaller fields. ■ All Java statements end with a semicolon. We can make this decision only much later. Create some event-post objects and test that all methods work as expected. ake sure that ou choose an artist ith ore than one file se the playSample method of the MusicPlayer (provided in music-organizer-v3). This is abstraction in action again. Exercise 11.7 Having to use a superclass call in display is somewhat restrictive in the ways in which we can format the output, because it is dependent on the way the superclass formats its fields. Exercise 2.33 Complete the body of the following method, whose purpose is to add the value of its parameter to a field named score. More often, we want random numbers within a given limited range. For this reason, object-oriented languages often define a level of access that lies between the complete restriction of private access and the full availability of public access. A further reason for keeping fields private is that it allows an object to maintain greater control over its state. In // this case, we pick one of our default responses. Take some time to read the two versions carefully to be sure you understand how each works. Using any text editor, change the content of this file so that it contains an empty line between any two responses. Our simplified machines print tickets of only a single price. Code 2.8 A more sophisticated TicketMachine M02_BARN7367_06_SE_C02.indd 71 4/11/16 3:02 PM 72 | Chapter 2 ■ Understanding Class Definitions Code 2.8 continued A more sophisticated TicketMachine M02_BARN7367_06_SE_C02.indd 72 4/11/16 3:02 PM 2.13 Making choices: the conditional statement | 73 Code 2.8 continued A more sophisticated TicketMachine 2.13 Making choices: the conditional statement Code 2.8 shows the internal details of the better ticket machine’s class definition. When implementing overriding methods, the super keyword can be used to invoke the superclass version of the method. Centralized control of random aspects of the simulation is provided through a single, shared Random object supplied by the Randomizer class. Methods appear in the format Class.method in the sequence, irrespective of whether they are static methods or instance methods. Exercise 14.19 Do you think the different interface styles of the v2t and v2g address-book projects mean that there should be a difference in the way errors are reported to users? However, if we execute these statements in sequence, we know that we could actually allow this assignment. From each LogEntry, the analyzeHourlyData method of the analyzer obtains the value of the hour field: int hour = entry.getHour(); We know that the value stored in the local variable hour will always be in the range 0 to 23, which exactly matches the valid range of indices for the hourCounts array. nd.setValue(int 5); The error message is not actually very helpful at all. In more modern GUI systems, this is too simplistic. 10.5 Network: adding other post types Now that we have our inheritance hierarchy set up for the network project so that the common elements of the items are in the Post class, it becomes a lot easier to add other types of posts. In the next chapter, we shall discuss exactly what the source code of a class contains, and how it is structured. The imperative style covered in the previous chapter, however, is still the way most code is written today, and is still considered the “standard” Java way to do things. 3.4 Modularization in the clock example Let us have a closer look at the clock-display example. John contributed significantly to the original version of this text and helped improve it in many ways. This information can be found in the class documentation. The solution is shown in a new version of the InputReader’s getInput method (Code 6.5). When no or only partial implementation of a type is inherited, the subclass must provide the implementation before it can be instantiated. This time we chose to set it to the value we wanted at the same time as declaring it. 4/11/16 3:35 PM 11.5 super call in methods | 401 This explains the behavior that we observe in our network project. Do you notice anything about their headers that might suggest why they do not require return statements? So the following attempt to create an invalid ContactDetails object will completely fail; it will not result in a null value being stored in the variable: ContactDetails badDetails = new ContactDetails("", "", ""); Code 14.7 The constructor of the ContactDetails class 14.5 Exception handling The principles of exception throwing apply equally to unchecked and checked exceptions, but the rules of Java mean that exception handling is a requirement only with checked exceptions. Back to our code in the getDisplayValue method. We will continue with our original version in the rest of this chapter. responsibility-driven design Responsibility-driven design is the process of designing classes by assigning well-defined responsibilities to each class. Using the same approach, we can move the remaining methods, incrementAge and breed, to the superclass. They receive their values from outside, being initialized by the actual parameter values that form part of the constructor or method call. What would you expect to see after the following? Protected access allows access to the fields or methods within a class itself and from all its subclasses, but not from other classes.5 The getTimeStamp method shown in Code 11.5 can be called from class Post or any subclasses, but not from other classes. If it has not been set, then print the string "ZZZ" instead. 11.12 Summary When we deal with classes with subclasses and polymorphic variables, we have to distinguish between the static and dynamic type of a variable. ! (4 < 5) ! false (2 > 2) || ((4 == 4) && (1 < 0)) (2 > 2) || (4 == 4) && (1 < 0) (34 != 33) && ! false fter ritin our ans ers on a er o en the ode Pad in Blue and tr it out Check your answers. If, instead of using ArrayList or LinkedList as variable and parameter types, we always use List, our application will work independently of the specific type of list we are currently using. You should plan to spend at least as much time working on the design as on the implementation. 4.9.2 Selective processing of a collection The listAllFiles method illustrates the fundamental usefulness of a for-each loop: it provides access to every element of a collection, in order, via the variable declared in the loop’s header. Key methods of the String class are charAt, equals, indexOf, length, split, and substring. The seventh statement adds the balance inserted by the customer (through previous calls to insertMoney) to the running total of all money collected so far by the machine. This is one of the great advantages of using library classes: someone has invested time and effort to implement something useful, and we are getting access to this functionality almost for free by using this class. Pitfall Two very common errors are to think that the valid indices of an array start at 1, and to use the value of the length of the array as an index. We will improve it throughout the chapter. M16_BARN7367_06_SE_C16.indd 591 4/11/16 3:47 PM 592 | Chapter 16 ■ A Case Study Code 16.2 The Taxi class as an actor M16_BARN7367_06_SE_C16.indd 592 4/11/16 3:47 PM 16.4 Iterative development | 593 Code 16.2 continued The Taxi class as an actor One of the major issues that had to be addressed was how to manage the association between a passenger and a vehicle, between the request for a pickup and the point of the vehicle’s arrival. It is particularly useful in applications with persistent data, such as address books or media databases, because it allows all entries created in one session to be saved and then read back in at a later session. 15.6 Software growth Several models exist for how software should be built. Explain how the Adapter pattern might help in this situation by avoiding the need to rewrite any of the existing classes. Experiment with what happens if a negative amount is entered, for instance. These problems are not the result of logical programming errors, but they could easily cause a program to fail if the possibility of their arising has not been taken into account. For tasks where you might want to stop partway through, there are more appropriate loops to use—for instance, the while loop, which we will introduce next. subtype As an analog to the class hierarchy, types form a type hierarchy. The second assert statement in Code 14.16 illustrates the alternative form of assert statement. Use the polymorphic-variable technique described above to write the class so that it only knows it is performing its tests on objects of the interface type List rather than on the concrete types ArrayList and LinkedList. It is repeatedly asked whether it is going to breed, even though it takes several time steps before this is possible. As with the ArrayList, a map can store a flexible number of entries. 7.4 The for loop Java defines two variations of for loops, both of which are indicated by the keyword for in source code. The address-book-junit project contains a test class to illustrate this combination. The initial values of the first two are set from parameter values passed into the constructor. The reason is that a container in a BorderLayout (our toolbar JPanel in this case) always covers its whole area (the WEST area in our frame). How do you explain this effect? Now that we know about message dialogs, this is easy to do. 2.15 Scope highlighting You will have noticed by now that the BlueJ editor displays source code with some additional decoration: colored boxes around some elements, such as methods and if-statements (see, for example, Code 2.8). Code 11.2 Redefining method with a super call When display is now called on a PhotoPost object, initially the display method in the PhotoPost class will be invoked. The element type is automatically inferred from the variable type. Swing uses layout managers to arrange the layout of components in a GUI. In order to avoid an inappropriate call, the client could make use of the address book’s keyInUse method, as follows: // Add what should be a new set of details to the address book. In our example, the view consists of a single GUI class. For instance, the comma-separated values (CSV) format is a commonly used way to store text files whose lines consist of multiple values, each of which is separated from its neighbors by a comma character.8 In effect, such lines of text have an implicit structure. charset package. A pattern description is not only information about a structure of some classes, but also includes a description of the problem(s) this pattern addresses and competing forces for or against use of the pattern. They may think about the parts of the car, such as the shape of the outer body, the size and location of the engine, the number and size of the seats in the passenger area, the exact spacing of the wheels, and so on. Note carefully that the trim method, for example, returns a new string; it does not modify the original string. They are things such as buttons, menus, menu items, checkboxes, sliders, text fields, and so on. Instead, we apply a pipeline of operations to a stream derived from a collection, in order to transform the sequence into the form we want. In addition, some future events will be rendered obsolete by events that occur before them—an obvious example is that the natural-death event for a rabbit will not take place if the rabbit is eaten beforehand! M12_BARN7367_06_SE_C12.indd 456 4/11/16 3:38 PM 12.11 Summary of inheritance | 457 Event-driven simulations lend themselves particularly well to the techniques we have described in this chapter. Because we do not wish to break encapsulation and make these fields public, as was suggested above, the easiest way to solve this is to define public accessor methods for them. Inexperienced programmers often view the writing of the code as the “real programming.” Doing the initial design is seen as, if not superfluous, at least annoying, and people cannot wait to get it over with so that the “real work” can start. You should familiarize yourself with these. This allows other objects to read the current value of the display. The name “main” is arbitrarily chosen by the Java developers, but it is fixed—the method must have this name. Type checking is done by the compiler using the static type, whereas at runtime method lookup uses the dynamic type. The computer that executes this .jar file must have the JDK or JRE (Java Runtime Environment) installed and associated with .jar files. This same rule also applies between formal parameters and actual parameters: the type of an actual-parameter expression must match the type of the formal-parameter variable. Both the movement and the breeding behaviors have random components. Z08_BARN7367_06_SE_APPH.indd 628 4/11/16 3:56 PM AppendIx I Javadoc Writing good documentation for class and interface definitions is an important complement to writing good-quality source code. Reinforcing the constructs used in the ticket-machine example. 4/11/16 3:47 PM 16.3 Class design | 585 A collaborator is received as an argument to a method. Exercise 16.23 If you see any problems with the current way in which vehicle:passenger associations are stored, would creating a unique identification for each association help—say a “booking number”? The Pen class provides a pen object that can be used to produce drawings on the canvas by moving the pen across the screen. How should it be written properly? ■ In the next section, we show how Java 8’s lambda expressions can significantly simplify the code for event handling. Exercise 16.1 Is there any additional data that you feel it would be useful to gather from the model? 6.8 Dividing strings Now that we have seen how to use a set, we can investigate how we can cut the input string into separate words to be stored in a set of words. Consider this segment of code (a part of the BouncingBall class): public class BouncingBall { // Effect of gravity. Why is the TaxiCompany object unable to grant a pickup request at this stage? The website also provides links to download BlueJ, and other resources. We have noticed above that the MessagePost and PhotoPost classes are very similar. This is not going to change much: the opportunity (and challenge) of parallel hardware will remain, and programming these devices with traditional imperative languages will not get any easier. As a result, there is always exactly one copy of this variable, independent of the number of created instances. Using this form does not change the fact that the object being created will only be able to store String objects; it is just a convenience that saves us some typing and makes our code shorter. A FlowLayout does not do this; it is quite happy to leave some empty space around the components. Each can hold a reference to an object of type NumberDisplay. Check that you thoroughly understand how the Field and the animal lists are kept consistent between the simulateOneStep method in Simulator, hunt in Fox, and run in Rabbit. Write them down, and then play them out. We shall now improve this by defining a set of plausible phrases with which to respond. Such a collaborator will usually be stored in one of the new object’s fields so that it is available through the new object’s life. If this exception were to be caught by an exception handler in the caller, the key would be available to the statements that attempt to recover from the error. interface A Java interface is a specification of a type (in the form of a type name and a set of methods). This reuse has the effect that a lot less new code is needed when we now introduce additional post types. Those strings will probably be created in another part of the class to which names belongs. The Stream class, for example, has methods called count, findFirst, and max—these are all variants of a reduce operation—and methods called limit and skip, which are examples of a filter. Any attempt to write could fail, even if the file has been opened successfully. Reasons for failure might be that file system permissions prevent a user from writing to certain files, or that the given file name does not match a valid location in the file system. Lists The program also includes an example of a list (class JList) for the list of tracks. Now draw a yellow rectangle. } Using this approach, it is clearly possible to completely avoid a DuplicateKeyException being thrown from addDetails, which suggests that it could be downgraded from a checked to an unchecked exception. M13_BARN7367_06_SE_C13.indd 478 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 479 Exercise 13.16 Continuing from your last version of the project, use the code fragment shown above to add the two labels. One solution might be that the CinemaBookingSystem stores a collection of shows. Fields are defined outside constructors and methods. Instead, passengers were created directly in the Demo and Test classes. The Java language has two variations of the for loop: one is the for-each loop, which we are discussing here; the other one is simply called a for loop and will be discussed in Chapter 7. The highest number possibly returned by this call is n–1. First, the keyword extends defines the inheritance relationship. The folder for this chapter’s projects also includes a folder called images. This is a fairly important statement. Each student has an address that is held in an Address object (i.e., each Student object holds a reference to an Address object). The code structure is always similar to the following pseudo-code: loop (for each element in the collection): get one element; do something with the element; end loop It does not matter whether we use a for loop, a for-each loop, or a while loop, or whether we use an iterator or an index to access the elements—the principle is the same. In practice, the best way to find out is often to try it out: implement the application with both alternatives and measure the performance. Exercise 2.54 Write an assignment statement that will store the result of multiplying two variables, price and discount, into a third variable, saving. Figure 2.5 The BlueJ Code Pad M02_BARN7367_06_SE_C02.indd 87 4/11/16 3:02 PM 88 | Chapter 2 ■ Understanding Class Definitions When the result of an expression in the Code Pad is an object (such as a String), it will be marked with a small red object symbol next to the line showing the result. Exercise 3.36 Does the Picture class contain any internal method calls? Some additional details are stored with each post. Where these are checked exceptions, they must all be listed in the throws clause of the method, separated by commas. That will give us the M02_BARN7367_06_SE_C02.indd 49 4/11/16 3:02 PM 50 | Chapter 2 ■ Understanding Class Definitions opportunity to ask some questions about how these models differ from the real-world versions, and how we might change our classes to make the objects they create more like the real thing. Can a concrete class have abstract methods? coupling The term coupling describes the interconnectedness of classes. } M10B_BARN7367_06_SE_C10.indd 386 4/11/16 3:32 PM 10.9 The collection hierarchy Figure 10.10 | 387 Object All classes inherit from Object String Person Vehicle Car Bicycle The Java compiler automatically inserts the Object superclass for all classes without an explicit extends declaration, so it is never necessary to do this for yourself. Try removing a curly bracket in the editor or adding one at an arbitrary location, and observe how the coloring changes. We have to implement a method with the signature public void actionPerformed(ActionEvent e) This is the only method declared in the ActionListener interface. Early chapters provide at least two discussion examples. Indeed, the computer running the application might not have any visual-display device connected to it at all. This is legal, because all objects in the collection are foxes or rabbits and are all subtypes of Animal. In a software development team, the implementation of classes is typically shared between multiple programmers. In this chapter, we will discuss some alternative techniques to achieve the same tasks as discussed in the previous chapters. Add a comment to the MessagePost object on the object bench (the one you entered into the news feed). It is deficient in several ways: ■ It contains no check that the customer has entered enough money to pay for a ticket. What happens now if you try to print a ticket without inserting any money? And a GridLayout always resizes its components to fill the whole container. There are, however, occasional valid cases where direct access by subclasses is desirable. Exercise 13.35 Open the imageviewer2-0 project. You will likely need longer to study it than was the case for previous chapters. We did not check how it was implemented. Which of these alternatives is better? Exercise 12.45 Move the age field from Fox and Rabbit to Animal. This means that the application functionality (the model) is separated cleanly from the application’s user interface (the GUI). Most client interactions will be reasonable, with the occasional attempt to use the server incorrectly—either as the result of a logical programming error or of misconception on the part of the client programmer. The weblog-analyzer project contains an application that performs an analysis of data from such a web server. The collect method takes a Collector as a parameter. Thus, "answer: " + 42 results in the string "answer: 42" This works for all types. The first item added to a collection is given index number 0, the second is given index number 1, and so on. Make any further necessary changes to AddressBook to ensure that all of the assertions are now successful. 2.23 Summary In this chapter, we have covered the basics of how to create a class definition. 5.5.6 Removing from a collection We have noted that the filter method does not actually change the underlying collection from which a stream was obtained. The obvious ones to mention at this point are “= 0) Check your predictions by running some tests. Thus, after this line of code, input refers to a string without spaces at either end. Use the String class s toLowerCase method to do this. The structure of the application would change, of course: the program would not control and move the taxis, but rather record their positions, which it might receive from GPS (global positioning system) receivers in each vehicle. class Random The Random class supports generation of pseudo-random values—typically, random numbers. Then we have to work through the NewsFeed class and add another list variable, another list object, another add method, and another loop in the show method. M15_BARN7367_06_SE_C15.indd 559 4/11/16 3:45 PM 560 | Chapter 15 ■ Designing Applications 15.1.4 Using CRC cards The next step in our design process is to work out interactions between our classes. Customers can communicate with the technical-support system online. Add similar tests to those Hacker used (and any others you find useful), and include correct assertions. The standard library documentation that we have used, for example, was created from the classes’ source files by javadoc. For instance, suppose the Actor and Drawable interfaces both define a default method called, reset, that has a void return type and takes no parameters. The class describes the kind of object; the objects represent individual instances of the class. These issues raise questions about how a shuttle organizes its priorities. 16.4.4 A later stage of development It is not our intention to discuss in full the completion of the development of the taxi company application, as there would be little for you to gain from that. Figure 1.6 An object inspector, showing details of an object M01B_BARN7367_06_SE_C01.indd 37 4/11/16 2:54 PM 38 | Chapter 1 1.8 ■ Objects and Classes What is in an object? We can already put some tests in place that will gradually evolve as the implementation is evolved. Does your method still work when you check an index if the collection is empty? Do not create a new Random instance every time you want a new number. The following statement explicitly wraps the value of the primitive int variable ix in an Integer object: Integer iwrap = new Integer(ix); Concept autoboxing is performed automatically when a primitive-type value is used in a context requiring a wrapper type. Exercise 2.11 What are the two features of the constructor that make it look significantly different from the methods of the class? We shall start our look at the source code of methods by considering getPrice (Code 2.5). Exercise 6.6 If you found methods for the two tasks above, how did you find them? A third possibility, of course, is an intentionally hostile client who is trying to break or find a weakness in the server. Similarly, unboxing is applied when a wrapper-type value is passed as a parameter to a method that expects a primitive-type value, and when stored in a primitivetype variable. You will see a red rectangle toward the bottom of the screen labeled “circle1” (Figure 1.2). Imagine a user at an automatic 4/11/16 3:43 PM 520 | Chapter 14 ■ Handling Errors teller machine being confronted with a NullPointerException! Only in those cases where the user’s direct action has led to the problem—such as supplying invalid input to the application—is the user likely to be able take some appropriate corrective or avoiding action the next time. interface Predicate The Predicate interface takes a single parameter of its parameterized type and returns a boolean result. For this project, SimulatorView was changed from a class to an interface, and the implementation of this view was moved into a class named GridView. collection.doThisForEachElement(some code); We can see that the code looks much simpler. In particular, programmers with experience in a non-object-oriented language who wish to migrate their skills into object orientation should also be able to benefit from the book. There is no class definition for arrays. Next, we examine the source code of the MessagePost class: public class MessagePost extends Post { private String message; // Constructors and methods omitted. Selecting Test All from the test class's pop-up menu runs all tests from a single test class. In reality, the program does a lot. Exercise 1.5 This is a very simple example, and not many colors are supported. It can be placed at the top of the screen with Java applications by using a Mac OS–specific property. M03_BARN7367_06_SE_C03.indd 98 4/11/16 3:06 PM 3.6 Class diagrams versus object diagrams | 99 The type of a field specifies what kind of values can be stored in the field. In BlueJ, we typically create an object and invoke one of its methods, but without BlueJ, an application starts without any object in existence. The getTime method is trivial—it just returns the current display string. An increment statement is executed after each execution of the loop body. The implementation for all our projects is written very carefully, so that many peripheral issues may be studied by reading the projects' source code. It does not maintain any specific order. Try doing this and seeing if the code still compiles. 6.10 Autoboxing and wrapper classes We have seen that, with suitable parameterization, the collection classes can store objects of any object type. Do the errors need reporting in some way? Mutators often take parameters whose values are used in the modification, although it is still possible to write a mutating method that does not take parameters. To find out more about the background of this topic, and perhaps gain an understanding of population dynamics, do a web search for the Lotka-Volterra model. 13.5.2 Adding the image Now that we have prepared the classes for dealing with images, adding the image to the user interface is easy. The method invocation then starts in a similar way: steps 1 through 3 from the previous scenario are executed again, but then it continues differently: 4. So we should raise it to protected visibility, to indicate that it is for subclasses to call. For now, we can say that the types of both must be the same, although we shall see in later chapters that this is not the whole truth. However, ideally we should like to avoid such error situations from arising in the first place. The Actor class would include the common part of all actors. This process of discovery, when combined with an iterative development approach, means that we obtain valuable feedback on our design and on the decisions we make, at an early enough stage for us to be able to incorporate it back into a flexible and evolving process. We want to use it for the parameter, where it serves as a hint to the caller, indicating what needs to be passed. functional style In the functional style of collection processing, we do not retrieve each element to operate on it. Now create a MailClient object for one of the users. You will find this code: private Square wall; private Square window; private Triangle roof; private Circle sun; You need to add a line here for the second sun. Functional constructs in Java are most prominent when working with collections of objects, and the mastering traditional approach—using loops and explicit iteration—is still essential for any programmer. The position of an object in a collection is more commonly known as its index. The application makes use of several new library classes and techniques—each requiring study individually—such as hash maps, sets, string tokenization, and further use of random numbers. J.1.5 Constants are written in UPPERCASE Constants occasionally use underscores to indicate compound identifiers: MAXIMUM_SIZE. 4/11/16 3:02 PM 2.4 Fields, constructors, and methods | 55 In BlueJ, fields are shown as text on a white background, while constructors and methods are displayed as yellow boxes. 4.2 The collection abstraction One of the abstractions we will explore in this chapter is the idea of a collection—the notion of grouping things so that we can refer to them and manage them all together. We can then concentrate on adding attributes that are specific to event posts, such as the event type. Each group member is assigned one class (or a small number of classes), and that person plays their role by saying out loud what the class is currently doing. 14.4.1 Throwing an exception Code 14.5 shows how an exception is thrown using a throw statement. The taxi-company-stage-one project contains an implementation of the requirements of this first stage. We will be building on these in future chapters, so it is important that you are comfortable with them. Once again, on rare occasions, the attempt to close the file could fail. total = total + price; // Reduce the balance by the price. The user interface (often a graphical user interface) is sometimes referred to as just the interface, but Java also has a language construct called interface (discussed in Chapter 12) that is related but distinct from our meaning here. All are very common and useful. An example is PrintJobListener and PrintJobAdapter. } Perform any actions here common to whether or not an exception is thrown. */ public void increase(int points) { ... Some other object-oriented languages do not allow public fields at all. We execute the same statement. 3.9 The ClockDisplay class Now that we have seen how we can build a class that defines a two-digit number display, we shall look in more detail at the ClockDisplay class—the class that will create two number displays to create a full time display. And again, as before, the objects have methods that you can call from their pop-up menu(s). Exercise 3.9 What error message do you see in the Code Pad if you type the following? The equality operator (==) checks whether each side of the operator refers to the same object, not whether they have the same value! That is an important difference. A FlowLayout (Figure 13.5) arranges all components sequentially from left to right. "Jar" files can be opened with zip programs and vice versa.) To make a .jar file executable, it is necessary to specify the main class somewhere. Exercise 14.27 If you have not already done so, add javadoc documentation to describe any exceptions thrown by methods in the AddressBook class. 2.20 Reviewing a familiar example By this point in the chapter, you have met a lot of new concepts. Code 6.9 shows a method from the national-park project we looked at in Chapter 5. 14.4 Exception-throwing principles Throwing an exception is the most effective way a server object has of indicating that it is unable to fulfill a call on one of its methods. Similarly, when a passenger is dropped off at their destination, the driver notifies the company. Exercise 13.1 Open the imageviewer0-1 project. It provides us with a way to access every item in the collection in sequence, one by one, and process those items in whatever way we want. The Simulator class is responsible for creating the initial state of the simulation, then controlling and executing it. For instance, discussion of the scenarios suggested that PassengerSource should have the responsibility 4/11/16 3:47 PM 588 | Chapter 16 ■ A Case Study Generate pickup and destination locations for a passenger, and Passenger should have the responsibility Receive pickup and destination locations. [experiment.jpg] I think I might call this thing 'telephone'. In order to write a text file, it is usual to create a FileWriter object, whose constructor takes the name of the file to be written. There are only two things that can happen to a software system: either it is continuously improved and adapted, or it will disappear. The initial values are set in the constructor of Animal, with alive set to true, and field and location passed via super calls from the constructors of Fox and Rabbit. Layout deals with the issue of how to arrange the components on screen. Now that we know about subtyping, we need to be more precise. Creating a File object within a program does not create a file in the file system. Defining formal parameters in an exception's constructor will help to ensure that diagnostic information is available. We add to the responsibilities of the CinemaBookingSystem card: Stores collection of shows. If we want one, then we have to declare and maintain our own local variable. In such a case, the finally clause would still be executed. These key symbols start with the @ symbol and include @version @author @param @return M06_BARN7367_06_SE_C06.indd 231 4/11/16 3:17 PM 232 | Chapter 6 ■ More-Sophisticated Behavior Exercise 6.52 Find examples of javadoc key symbols in the source code of the TechSupport project. (You may like to read the "About compilation" note for more information on what is happening when you compile a class.) Once a class has been compiled, objects can be created again and you can try out your change. It gives information about objects at runtime and presents the dynamic view of a program. This ensures that the classes will be found. "Instance" is roughly synonymous with "object"; we refer to objects as instances when we want to emphasize that they are of a particular class (such as "this object is an instance of the class car"). We might have preferred to show the population as a graph of population numbers along a timeline, or as an animated bar chart (Figure 15.3). Thus, the qualified names of the two classes we used here are java.util.ArrayList and java.util.Random. Hint: The principles of using reduce with String elements and a String result are er si ilar to those hen usin inte ers Decide on the correct identity and formulate a two-parameter lambda that combines the running "sum" with the next element of the stream. These include values for the maximum age to which a rabbit can live (defined as a number of simulation steps) and the maximum number of offspring M12_BARN7367_06_SE_C12.indd 422 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 423 Code 12.1 The Rabbit class M12_BARN7367_06_SE_C12.indd 423 4/11/16 3:38 PM 424 | Chapter 12 ■ Further Abstraction Techniques Code 12.1 continued The Rabbit class M12_BARN7367_06_SE_C12.indd 424 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 425 Code 12.1 continued The Rabbit class it can produce at any one step. If a method fails for any reason, the object on which it was called should ideally be left in the state it was before the operation was attempted. Benefit of lambdas In practice, when we use lambdas, the lambda code is often short and simple, and the shortcut notation just discussed here can be used. Serializable objects may be written and read as a whole to and from sources of output and input. (Hint: Look at the setText method in the JLabel class.) Exercise 13.26 What happens if the Darker menu item is selected when no image has been opened? It defines signatures for the add, clear, iterator, remove, and size methods. Let us now take a closer look at the makeFrame method. Exercise 13.30 Again add a menu named Help. When an array object is assigned to an array variable, the type of the array object must match the declared type of the variable. These numbers are typically not really random, but follow complicated rules. Is it a class or an object? Exercise 16.6 Do the same for any of your own extensions you wish to follow through in the next stage. 10.7.1 Subclasses and subtypes We have discussed earlier that classes define types. Note that this is a method of the collection (not of a stream) and it does modify the original collection. From a programming-language design point of view, it would have been nicer to use two different keywords for these two loops, maybe for and foreach. An ArrayList is not, itself, a stream, but we can ask it to provide the source of a stream by calling its stream method. You will need to decide what sort of impact its existence will have on the existing animal types. Pay attention to the Graph View output. We have tried to create great examples. We have chosen a three-level threshold. } writer.close(); The main issue that arises is how to deal with any exceptions that are thrown during the three stages. You can access objects on the object bench from the ode Pad usin their na es or e a le if ou ha e an ArrayList named al1 on the object bench, in the Code Pad you can type: al1.size() Exercise 4.23 If you wish, you could use the debugger to help you understand how the statements in the body of the loop in listAllFiles are repeated. Exercise 6.72 Give the balls in boxBounce random colors. The inner class is considered to be a part of the enclosing class just as are any of the enclosing class's methods. Here we use the class NumberDisplay as the type for the fields named hours and minutes. If you don't remember this project well, have a quick read through Chapter 8 again, or look at your own zuul project. Figure 3.4 shows an object diagram of this application when the current time is 15:23. If we simply add the following statement to the addDetails method book.put(details.getAddress(), details); do you anticipate that any assertions will now fail? The second example illustrates that it might be useful to provide a method specifically for the purpose of performing an assertion test (consistentSize in this example). Exercise 7.3 Write a declaration for an array variable vacant that could be used to refer to an array of boolean values. We do not rely on a reader of the class knowing what the default value is, and we document that we really want this value to be zero and have not just forgotten to initialize it. This is an example of how inheritance enables us to reuse existing work. Would this make a significant difference to the average waiting time of passengers? The terminal operation can then just print those details: /** * Print all the sightings by the given spotter. The important thing is that a reader must be able to recognize whether two versions are different, and to determine which one is newer. Then there was a call to the print method of the mail item. They can also be parameterized with any other type: private ArrayList notes; private ArrayList students; Because we can parameterize an ArrayList with any other class type that we choose, this is reflected in the API documentation. Each programmer should concentrate on her own area and need not understand the details of all the other parts (we discussed this in Section 3.2 where we talked about abstraction and modularization). Exercise 2.90 Modify your setRefNumber mutator so that it sets the refNumber field only if the parameter is a string of at least three characters. All classes in Java are arranged in an inheritance hierarchy. Completion should be marked by the passing of a set of tests and a review of the step's achievements, so as to be able to incorporate any lessons learned into the steps that follow. When a mouse is clicked or moved, a MouseEvent is raised. Many of the constructs and techniques discussed in earlier chapters are influenced by aspects of inheritance and polymorphism, and we shall revisit some issues introduced earlier and gain a fuller understanding of the interconnections between different parts of the Java language. File opening, writing, and closing will all be separated in time from one another (or would it make sense to open, write, and then close the file for every line that is written?). Then execute another single step and check your prediction. The finally clause provides for statements that should be executed whether an exception arises in the protected statements or not. } is equivalent to writing public class Person extends Object { . For instance, LongSupplier. 4 Joshua Bloch: Effective Java, 2nd edition. (Note this on the card: Stores theater. Given all of these characteristics, it must remain as a class rather than becoming an interface. What does it mean for a shuttle not to be free? Try the same with our prototype version of the project, tech-support1. The reason is that inexperienced programmers usually work on projects that only have a handful of classes and are written in the span of a few weeks or months. Exercise 2.41 Add a showPrice method to the TicketMachine class. If an attempt to write to the file fails, then it is unlikely that repeating the attempt will succeed. Recovery from an error will usually involve taking some form of corrective action within the catch block, and then trying again. If we are, then we find the next room by getting a random room (of course, we have to implement the getRandomRoom method somehow); otherwise, we just do the same as before. Having a common superclass for all objects serves two purposes: First, we can declare polymorphic variables of type Object to hold any object. That means we will just be asking the ArrayList to store String objects representing the file names. public TicketMachine(int cost) { int price = cost; balance = 0; total = 0; } Try out this version in the better-ticket-machine project. Could it be done in different ways? This can be found in the separate number-display project. Give examples of what a tabbed pane might be used for. What significant differences exist between the systems? Subclasses usually represent specializations of superclasses. In the line of code above, we see the new keyword being used to create the new object, and we see the parameters being passed to the constructor. public ClockDisplay() { hours = new NumberDisplay(24); minutes = new NumberDisplay(60); updateDisplay(); } Methods omitted. We have already met three different, commonly used types: int, String, and (very briefly) boolean. If you don't, then don't worry. This ensures loose coupling, and makes an application more modular and easier to maintain. The content pane of this frame uses a BorderLayout, where the EAST position M13_BARN7367_06_SE_C13.indd 481 4/15/16 3:07 PM 482 | Chapter 13 Figure 13.9 ■ Building Graphical User Interfaces JPanel with GridLayout JPanel with FlowLayout Building an interface using nested containers JPanel with vertical FlowLayout JPanel with FlowLayout content pane with BorderLayout (EAST area empty) is unused. 6.4.2 Random numbers with limited range The random numbers we have seen so far were generated from the whole range of Java integers (−2147483648 to 2147483647). Iterators of collections are an example of this technique. ■ In many cases, an unsuccessful request will not represent a logical programming error, whereas an incorrect request almost certainly does. Type "bye" when you are done. In this style, we do not M05_BARN7367_06_SE_C05.indd 196 4/11/16 3:13 PM u ar | 197 write loops to process the elements in a collection. One of these collections can then hold all message posts, the other all photo posts. Using code completion should not be a replacement for reading the documentation of a class, because it does not include all information (such as the introductory class comment). methodName (parameter-list) This syntax is known as dot notation. In Java, this problem is solved using a convention. We now have to add code to react to menu selections. Recall that we might wish to create multiple machine objects to sell tickets with different prices, so no one initial price will always be right. To understand it better, we look in more detail at how methods are invoked. If the file name does not match, then we just ignore it—no else part is needed. This is the Picture class. Which of the following assignments are legal, and why or why not? And how do we find out? We can simply use the super construct, which we have already encountered in the context of constructors in Chapter 10. The Code Pad, which we briefly used in Chapter 1, can help us experiment with Java expressions (Figure 2.5). This ensures that all the data really has been written to the external file system, and it often has the effect of freeing some internal or external resources. Mastering both is the goal. We can have many objects of any class. documentation The documentation of a class should be detailed enough for other programmers to use the class without the need to read the implementation. M06_BARN7367_06_SE_C06.indd 240 4/11/16 3:17 PM | 6.14 Class variables and constants 241 Figure 6.8 Instance variables and a class variable BouncingBall GRAVITY 3 is an instance of... for(Actor actor : actors) { actor.act(...); } // Draw all drawables. We do not need to specify the type of the lambda's parameter, because the compiler knows that an ArrayList will deliver a stream of Sighting objects, so the parameter to the predicate will have the type Sighting. What actually happens next depends upon whether or not the exception is caught. We will discuss this method in some more detail. superclass method calls Calls to non-private instance methods from within a superclass are always evaluated in the wider context of the object's dynamic type. // implementation omitted } } 7 We might also think of using instanceof, but the point here is that none of these ideas is the best. An accessor usually contains a return statement in order to pass back that information. The reason for the second sort of error requires a more detailed explanation, and this is explored in the next section. If a value is intended not to change, it is a good idea to declare it final. Some of the information about a lambda is provided by default or inferred from the context—its visibility and return type—and we have no choice over this. We can, however, see them by opening an inspector window (Section 1.7). As with other collections, array indices always start at zero and go up to one less than the length of the array. This project is identical to foxes-and-rabbits-v2 in its model (i.e., the animal/fox/rabbit/ simulator implementations), but it adds a second view to the project: a graph showing population numbers over time. ■ Using the value returned as a result as part of an expression. M11_BARN7367_06_SE_C11.indd 401 4/11/16 3:35 PM 402 | Chapter 11 ■ More about Inheritance It is worth reiterating what was illustrated in Exercise 10.6: that in the absence of method overriding, the non-private methods of a superclass are directly accessible from its subclasses without any special syntax. M13_BARN7367_06_SE_C13.indd 489 4/15/16 3:07 PM 490 | Chapter 13 ■ Building Graphical User Interfaces Code 13.10 Two of the filter-handling methods from ImageViewer Figure 13.10 ImageViewer Class structure for filters as objects ImageFileManager Filter ImagePanel DarkerFilter LighterFilter ThresholdFilter OFimage M13_BARN7367_06_SE_C13.indd 490 4/15/16 3:07 PM 13.6 ImageViewer 2.0: improving program structure | 491 Every filter will have an individual name, and its apply method will apply that particular sort of filter to an image. This class definition contains many of the features of Java that we will see over and over again, so it will pay greatly to study it carefully. You will probably find that you need to experiment quite a lot with the configuration settings you use for it. Exercise 2.1 Create a TicketMachine object on the object bench and take a look at its methods. Thus, the use of inheritance in this example has removed the need for two separate loops in the show method. The lambda used here itself has two parameters, called total and count. Study the code for the new method to create and apply filters in class ImageViewer. Twelve months of prepaid access are included with the purchase of a new textbook. Ticket-machine (Chapter 2) A simulation of a ticket vending machine for train tickets; introduces more about fields, constructors, accessor and mutator methods, parameters, and some simple statements. Finally, the updateDisplay method is responsible for updating the display string so that the string correctly reflects the time as represented by the two number display objects. Test your method by creating a machine, inserting some money, printing some tickets, checking the total, and then emptying the machine. AWT and Swing Java has three GUI libraries. Use code completion in the process of entering your code. Z07_BARN7367_06_SE_APPG.indd 626 4/11/16 3:55 PM Appendix H Teamwork Tools In this appendix, we briefly describe the tools available to support teamwork. If we have a variable of type Collection, we can ask it for an Iterator object (using the iterator method) and then work with that iterator (Code 15.3). It was designed by instructors who have been in the classroom facing this problem every day. 6.4.4 Reading documentation for parameterized classes So far, we have asked you to look at the documentation for the String class from the java.lang package, and the Random class from the java.util package. A BorderLayout (Figure 13.6) places up to five components in an arranged pattern: one in the center and one each at the top, bottom, right, and left. There are two stages to throwing an exception. The download for Windows and Mac OS includes a copy of the JDK (the Java system)—this does not need to be installed separately. In this chapter, we shall define a class that models something like these ticket machines. When this function is used, a copy of the project is placed into the central repository. An array-variable declaration does not itself create the array object. Arrays processing and the associated types of loops are discussed in detail. The problems with this duplication become clear when we analyze what we would have to do to add another type of post to this program. This makes it clear to a reader that the correct initialization of all fields has been considered. The server writes a line to a log file each time an access is made. signature The method name and the parameter types of a method are called its signature. Air traffic controllers coordinate the traffic and give planes permission to take off or land. * This might form part of a larger application such * as a library system, for instance. The current situation in both the ContactDetails and AddressBook classes is that there is no checking at all on parameter values. } It does not require any additional code, because it already implements the interface's methods. What changes do you observe in the class diagram? // Make the computed value depend on the order in which // the fields are processed. Compare this with the second network version (with inheritance), which prints only Leonardo da Vinci 40 seconds ago - 2 people like this. Were this software to run in a real clock, we would present the output on the real clock display instead. 15.6.1 Waterfall model In the waterfall model, several phases of software development are done in a fixed sequence: ■ analysis of the problem ■ design of the software ■ implementation of the software components ■ unit testing ■ integration testing ■ delivery of the system to the client If any phase fails, we might have to step back to the previous phase to fix it (for example, if testing shows failure, we go back to implementation), but there is never a plan to revisit earlier phases. More importantly, we will show you how you can explore and understand the library on your own. What are the arguments? This displays the class's interface with the javadoc documentation. swing.border—we have to add an import statement for this package.) All the improvements discussed in the section have been implemented in the next version of this application in the book projects: imageviewer3-0. } The problem here is that it is possible for several independent String objects to exist that all represent the same text. How might you break up a string in which the words are separated by colon characters (:)? The static getLogger method of the Logger class returns a Logger object. In both versions, note in particular the condition hour < hourCounts.length This illustrates two important points: ■ ■ All arrays contain a field length that contains the value of the fixed size of that array. It expresses explicitly what we assume to be true at a given point in the execution, and therefore increases readability both for the current developer and for a future maintenance programmer. Then, when you call the draw method, it moves them around and changes their color and size, until the canvas looks like the picture we see in Figure 1.8. The important points here are that: objects can create other objects; and they can call each other's methods. A separate check is made at runtime to ensure that the object referred to by veh really is a Car and not an instance of a different subtype. Exercise 4.11 Write a method call to add the object held in the variable favoriteTrack to a collection called files. Simply the fact that there are only twenty-four hours in a day, too many of which were already taken up with too much other work, prevented him from actually writing this book. M05_BARN7367_06_SE_C05.indd 186 4/11/16 3:13 PM trea s | 187 Streams add one further significant new feature over previous facilities in Java for the processing of collections: the potential for safe parallel processing. In this book we cover Java constructs in as much detail as is necessary to illustrate the concepts at hand and implement the practical work. Code 13.5 shows the source code to implement this. In the next few sections, we shall examine the implementation of an improved ticket machine class that attempts to deal with some of the inadequacies of the naïve implementation. Then one person can concentrate on implementing the methods, while the other person can just use them. Streams are a little like collections, but with some important differences: ■ Concept Streams unify the processing of elements of a collection and other sets of data strea ro ides useful methods to manipulate these data sets. If this statement is a method call, then execution will "step into" that method and be paused at the first statement inside it. We create three menu items (class JMenuItem) named Darker, Lighter, and Threshold, and add them to our filter menu. It makes no difference that all known subtypes of Post do have a display method. Exercise 6.67 Add a method to your DrawDemo class that produces a picture on the canvas directly (without using a pen object). In the simulation, we presented the animal populations on screen in a two-dimensional animated grid. Edit the TicketMachine class to try different orderings. Later, a much-improved GUI library, called Swing, was added to Java. (Either the isAlive method could be renamed to isActive, or a separate isActive method in Animal could simply call the existing isAlive method.) Figure 12.3 Simulation structure with Actor Simulator Actor Animal Rabbit M12_BARN7367_06_SE_C12.indd 443 Hunter Fox 4/11/16 3:38 PM 444 | Chapter 12 ■ Further Abstraction Techniques Exercise 12.53 Introduce the Actor class into your simulation. 7.1 Fixed-size collections In Chapter 4, we looked at the way in which library classes, such as ArrayList, allow us to maintain collections of objects. The symbol "&&" is a logical "and" operator. (We are talking about computer input devices here, not a small furry mammal.) Exercise 10.11 Sometimes things are more difficult than they first seem. Call its showInterface method to display the GUI and inter- act with the sample address book. We have tended not to provide javadoc-style commenting for fields, because we regard these as private implementation-level details, and not something to be relied upon by users. Is it an object or a class? Compile your project. Check that the class works properly. Here, we also introduce the first types of statement. When we enlarge the window, we would like the labels to maintain their height and the image to receive all the extra space. Could this class be used instead of the Random class? Exercise 6.79 Write a test class that has a method to test how long it takes to count from 1 to 10000 in a loop. We hope, however, that this discussion serves to show where to go from here. Don't be put off by the fact that we suggest that you do these on paper rather than within BlueJ. At that point, the data gathering will be terminated. However, it could also be a checked exception that is not handled by a catch block but propagated from the method, to be handled at a higher level in the call sequence. M11_BARN7367_06_SE_C11.indd 395 4/11/16 3:34 PM 396 | Chapter 11 ■ More about Inheritance Exercise 11.2 In your network project, add a display method in class Post again. Instead, we pass a code segment to the collection to be applied to each element. For instance, the concept of an event is likely to be implemented as an Event abstract class containing concrete details of when the event will occur, but only abstract details of what the event involves. Being able to do this well is essential. In this section, there are many interesting subsections. Constants are similar to variables, but they cannot change their value during the execution of an application. GUI objects of any type can be placed into a scroll pane, and the scroll pane will, provide the necessary scrollbars if the held object is too big to be displayed in the available space. The effect of creating a fixture is that a field definition for each object is added to the test class, and statements are added to its setUp method that re-create the exact state of the objects as they were on the bench. Code 6.4 shows an example in which a HashMap named responseMap is created and three entries are made. However, sometimes it is beneficial to use additional tools in order to help us gain a deeper understanding about how a program executes. This is implemented as imageviewer4-0. Java allows multiple inheritance of interfaces (which it calls "implements" relationships) but only single inheritance for classes ("extends" relationships). */ public Book(String bookAuthor, String bookTitle) { author = bookAuthor; title = bookTitle; } // Add the methods here... The tutorial is accessible via the BlueJ Tutorial item in BlueJ's Help menu. Now, any client (e.g., the NewsFeed class) is free to do whatever it chooses with this text. This is a very simple situation—there is no inheritance or polymorphism involved here. checked exception A checked exception is a type of exception whose use will require extra checks from the compiler. And remember: a steep learning curve is not a problem as long as you ensure that your students can climb it! No complete language coverage Related to our iterative approach is the decision not to try to provide complete coverage of the Java language within the book. As a general principle, you should, in parallel with studying the examples in this book, look at the class documentation for all classes we encounter. M13_BARN7367_06_SE_C13.indd 472 4/15/16 3:07 PM 13.4 The ImageViewer example | 473 Depending on the item label string for performing the function is not a good idea. The printList method from our AnimalMonitor class looks like this: /** * Print details of all the sightings. Method polymorphism What we have just discussed in the previous sections (Sections 11.2–11.5) is yet another form of polymorphism. Try the next two exercises first, before you write your implementation. One good description is at Oracle's web site at index.html. Concept A GUI is built by arranging components on screen. This style is often called indefinite iteration, and we explore it next. Now create a second MailClient in a similar way, with a different username. In such cases, it will usually be necessary to resort to the alternative technique of throwing an exception (see Section 14.4), which does, in fact, offer some significant advantages. A peek operation can also be a convenient way to create a position in the middle of a pipeline sequence for setting a breakpoint for a debugger. Try out the getPrice method. Rather than mapping these responsibilities to individual method calls, the more natural implementation in Java is to write something like new Passenger(new Location(. . .), new Location(. . .)) ■ ■ ■ ■ ■ We have ensured that our outline project is complete enough to compile successfully. Exercise 16.3 Is it possible to eliminate any of the following as synonyms in this context: "location," "destination," and "pickup location"? Open the naíve-ticket-machine project in BlueJ. Exercise 13.67 Implement a slide show function that lets you choose a directory and then displays each image in that directory for a specified length of time (say, 5 seconds). Exercise 14.46 Change your code so that several lines of text found in the file not separated by an empty line are read as one single response. Simple mutator methods should be named setSomething(. . .). In our example, we have placed our track list into a scroll pane. Do you see any problems with this solution? One way this could be done is by using inheritance. The original version always printed the text to the output terminal. On the other hand, with object-oriented programming it is very easy to create multiple instances of the class, each with its own price setting, to fulfill a need for different types of tickets. However, using lambdas can make code quite hard to read if the lambda expression is long. Usually a programmer works on the implementation of one class at a time, while making use of several other classes via their interfaces. When you create a TicketMachine instance, you will be asked to supply a number that corresponds to the price of tickets that will be issued by that particular machine. Figure 4.3 illustrates the same situation as above, with index numbers shown in the ArrayList object. Explain what happened and why. The analyzer delegates the task of reading its log file to a LogfileReader. We know that it is not a field, because fields are defined outside methods. The associated object will have to be created explicitly, and we shall see how this is done when we look at the constructor of the ClockDisplay class. 16.4.1 Development steps Planning some development steps helps us to consider how we might break up a single large problem into several smaller problems. If an exception can be avoided in this way, then the exception being thrown really represents a logical programming error in the client. Experiment with the MailClient objects. The differences are: ■ ■ ■ ■ There is no public or private keyword—the visibility is assumed to be public. ■ Making these changes is a first step toward eliminating code duplication through the use of inheritance, in much the same way as we did in Chapter 10. Extendibility Using inheritance, it becomes much easier to extend an existing application in certain ways. Instead, we just trust that it does its job—another example of the way abstraction is used to hide detail that we do not need to be aware of. As a result of this approach, it is less straightforward to use the book as a reference book. Most of the Java library classes override toString (all collections, for instance, can be printed out like this), and often it is a good idea to override this method for our classes as well. Isn't there a way to avoid asking this unnecessary question until the rabbit is actually ready? The company might decide to analyze the words being used in questions and add further specific responses for those being used most frequently that it does not have ready responses for. There are ho e er other enefits in addition to this ne is that this allo s the use of strea s discussed in the ne t section nother enefit is the use of concurrenc also called arallel ro ra in ost co uters toda ha e ulti le cores and are ca a le of arallel rocessin o e er writing code that makes good use of these multiple cores is extremely difficult. The action listeners should call the methods makeDarker, makeLighter, and threshold, respectively. Interfaces define types that can be used for variables. The header of all the display methods is exactly the same. class Paths The Paths class provides get methods to return concrete instances of the Path interface. Largebrain @version 2012.12.03 Z09_BARN7367_06_SE_APPI.indd 630 4/11/16 3:57 PM I: Javadoc | 631 The @param and @throws tags are used with methods and constructors, whereas @return is just used with methods. Select it. MessagePost objects inherit everything from both superclasses and have the same fields and methods as before. This is a standard refactoring technique in situations like this, where we have subtype-specific behavior invoked from a context that only deals with the supertype. This ensures that it always conforms to the official and most up-to-date Java specification. Now all we need is a mechanism to access a field when there is a more closely defined variable with the same name. This is because execution stops before the line with the breakpoint is executed. Would it be possible to have one NumberDisplay object tell another that it has rolled over, and that the other NumberDisplay object should then increment? This discussion is central to this book, because it strongly influences how we view the tasks and skills required of a programmer or software engineer. Casting is permitted in Java between the numeric types, but it is not possible to convert a boolean value to any other type with a cast, or vice versa. There is often confusion about what "returning a value" actually means in practice. Exercise 16.27 Report on the statistical information that is being gathered by taxis and the passenger source; also on taxi idle time and missed pickups. We both have experienced how the use of BlueJ has increased the involvement, understanding, and activity of students in our courses. We have seen that the printNextMailItem method picks up this mail item and prints it to the terminal. From the default implementation in Object, distinct objects have distinct hashCode values. Except for the for-each loop, repetition is controlled in each with a boolean expression. 14.7.4 Assertions and the BlueJ unit-testing framework In Chapter 9, we introduced the support that BlueJ provides for the JUnit unit-testing framework. Event handling refers to the technique we shall use to deal with user input. This program introduces a few additional GUI components. They completely determine the simulation behavior. As testimony to the value of developing tests alongside implementation, it is worth recording that the existing test classes enabled us to identify and correct two serious errors in our code. 6.13.2 Code completion Often, we are reasonably familiar with a library class that we are using, but we still cannot remember the exact names of all methods or the exact parameters. This indicates that the hourCounts variable is of type integer array. Check your spelling. From then on, instruction can concentrate on the important concepts at hand—object orientation and Java—and no time needs to be wasted talking about environments, file systems, class paths, or DLL conflicts. The exact details of how documentation is produced and formatted are different in different programming languages and environments. Used to demonstrate object creation and interaction. We are very grateful for this crucial contribution. We can try to identify subcomponents in those objects that we want to model, and we can implement subcomponents as independent classes. Initially, put just a single println statement into these method bodies to see when they have been called. The correct code reads: if(input.equals("bye")) { ... (You are welcome, of course, to study this class as well if you like, but it uses some concepts that we shall not discuss in this book.) Following are some noteworthy observations about the musicplayer project. // Update the total collected with the price. An arrow (->) separates the parameter list from the lambda's body—this is the distinctive notation for a lambda. Deciding on the interface of each class (that is, the set of public methods that a class should have) is a bit harder, but we have made an important step toward that as well. (The teacher, here, represents the collection.) In fact, an interesting side-effect of this approach is that we don't even need to know how the teacher will complete the task. M16_BARN7367_06_SE_C16.indd 596 4/11/16 3:48 PM 16.4 Iterative development | 597 Exercise 16.26 Add assertion and exception-throwing consistency checks within each class, to guard against inappropriate use. That means that we typically have two finishing possibilities to consider when writing a searching loop: ■ The search succeeds after an indefinite number of iterations. We use the standard class Color (from package java.awt) to represent each pixel's color. With so much Java material already available, is there still room for more to be said about it? M07_BARN7367_06_SE_C07.indd 256 4/15/16 3:35 PM 7.3 A log-file analyzer | 257 Exercise 7.7 How many String objects are created by the following declaration? Planes must keep a certain distance from one another. Java also has an add method for adding components directly in the JFrame class, which will also add the component to the content pane. The variable v1 is accessed. However, we will often want to use stream operations to create a fresh version of an original collection that is a modified copy—typically by filtering the original contents to either select desired objects or reject those that are not required. Our solution is therefore to use both: the GridLayout to arrange the buttons in a column, and a FlowLayout around it to allow some space. If you are curious, read about class methods in Section 6.15, and try to use this version. The removeIf method passes each element of the list, in turn, to the predicate lambda, then removes all those for which the lambda returns true. 40 seconds ago - 2 people like this. The for loop has two forms. ■ ■ Elements in a stream are not accessed via an index, but usually sequentially. We can illustrate the way that a for loop executes by rewriting its general form as an equivalent while loop: M07_BARN7367_06_SE_C07.indd 259 4/15/16 3:35 PM 260 | Chapter 7 ■ Fixed-Size Collections—Arrays initialization; while(condition) { statements to be repeated post-body action } So the alternative form for the body of printHourlyCounts would be int hour = 0; while(hour < hourCounts.length) { System.out.println(hour + ": " + hourCounts[hour]); hour++; } From this rewritten version, we can see that the post-body action is not actually executed until after the statements in the loop's body, despite the action's position in the for loop's header. The condition uses the less-than operator, animal == record.getAnimal() && area == record.getArea() && spotter == record.getSpotter()) .collect(Collectors.toList()); M09_BARN7367_06_SE_C09.indd 353 4/11/16 3:28 PM 354 | Chapter 9 ■ Well-Behaved Objects Imagine that the list produced by this code is always empty, even though you are using test data with sighting records that should definitely match. As we gradually develop more-complex classes, we shall inevitably encounter more-complex questions that require more work to supply their answers. You can declare a literal as long by putting an L after the number. MailServer is quite complex at this stage; it makes use of concepts discussed only much later in this book. A large part of learning the art of programming is learning how to write these class definitions. In this chapter, we aim only to give an introduction to the problems encountered in the process. class HashSet HashSet is a hash-based implementation of the Set interface. ■ the name of the class; ■ a general description of the purpose of the class; ■ a list of the class's constructors and methods; ■ the parameters and return types for each constructor and method; ■ a description of the purpose of each constructor and method. Do you notice anything strange about the machine's behavior? Because this method is in the same class as the call of the method, we also call it an internal method call. The former is typified by the for-each loop and for loop, while the latter is typified by the while loop and do loop. (Remember: In our version, Simulator was coupled to classes Fox and Rabbit, because it creates the initial instances.) Instead, we can introduce an interface ActorFactory and classes implementing this interface for each actor (for example, FoxFactory and RabbitFactory). F.2.4 Continue The Continue button resumes execution until the next breakpoint is reached, execution is interrupted via the Halt button, or the execution completes normally. Thus, EventPost objects already have a username, a time stamp, a likes counter, and comments. You can use the Project Documentation function from the main window's Tools menu to generate documentation for all classes in the project. It will be useful to have a record of these when we come to make changes later on and perform regression testing. Consider the case of a national park containing endangered species and a proposal to build a freeway through the middle of it, completely separating the two halves. 4 Don't confuse this case with the regular situation where a single class might have several superclasses in its inheritance hierarchy, such as Fox, Animal, Actor, and Object. It is part of the Java Development Kit (JDK), which must be installed on your system. for(Drawable item : drawables) { item.draw(...); } M12_BARN7367_06_SE_C12.indd 444 4/11/16 3:38 PM 12.6 Interfaces Figure 12.4 Drawable Actor hierarchy with Drawable class 445 Actor Animal Rabbit | Fox Hunter Ant All of the actors would be in the actors collection, and those actors we want to show on screen would also be in the drawables collection. For instance, a problem involving generating some statistics on data values might have been programmed to find the mean value rather than the median value (the "middle" value). More importantly, we explain how to read and understand the library documentation. 15.7 Using design patterns In earlier chapters, we have discussed in detail some techniques for reusing some of our work and making our code more understandable to others. Wherever there are equivalent classes in AWT and Swing, the Swing versions have been identified by adding the letter J to the start of the class name. The effect of an exception on the point in the program that called the problem method is a little more complex. Create method stubs for all methods. In the address-book-io project, both AddressBook and ContactDetails implement this interface so that they can be saved to a file. The reason it is safer is that it is always guaranteed to come to an end. There is still a case for further improvement, though. If we do not recognize any of the words, as before, we pick one of our default responses. The attempt to assign c to b (even with the cast) will be a compile-time error. Is it the fault of the client object for calling the method with a bad parameter value, or is it the fault of the server object for failing to handle this situation properly? Fill them in before clicking OK. In doing so, we have introduced two new language constructs: the conditional statement and local variables. private int count; private Student representative; private Server host; Exercise 2.13 What are the names of the following fields? The idea is to take cardboard cards (normal index cards do a good job) and use one card for each class. Once an object has been created, the constructor plays no further role in that object's life and cannot be called again. * * @author (Insert your name here.) * @version (Insert today's date here.) */ public class Book { // The fields. For instance, can you think of any circumstances in which the following calculation would not produce the same value? So, strictly speaking, we could have done without setting balance and total to zero, relying on the default value to give us the same result. Thus, the pattern language introduced by commonly known design patterns introduces another level of abstraction, one that allows us to cope with complexity in ever-more-complex systems. Similarly, failure to close a file is not usually worth a further attempt. Java classes that are stored in the class library are not automatically available for use, like the other classes in the current project. Learning to work with layout managers takes some experience and often some trialand-error experimentation. This is abstraction. Because the dynamic type of the variable determines which method is actually executed (as discussed in Chapter 11), the fox's action method will be executed for foxes, and the rabbit's method for rabbits. 6.16.1 The main method If we want to start a Java application without BlueJ, we need to use a class method. An important point to bear in mind throughout the following discussion is that, where exceptions are involved, the place where an error is discovered will be distinct from where recovery (if any) is attempted. The header above states that the method requires one parameter of type int named distance . The display shows an image of the field and counters for each species (the current number of rabbits and foxes). You can associate individual sounds with rooms, items, or characters. It consists of an object name, a dot, the method name, and parameters for the call. A designer at the highest level will regard a wheel as a single part. Without the valuable assistance of knowledgeable and supportive postgraduate supervisors, running classes would be impossible. All methods in an interface—whether abstract, concrete or static—have public visibility, so the public keyword may be omitted in their definition. In addition, we shall have to arrange for simulated time to pass as the taxi moves within the city. Details of other Java operators can be found in Appendix C. Menus are often held in a menu bar. Which one should we use for the "About" box? This section does not introduce any new concepts, so it consists in large part of exercises, with some commentary sprinkled in. Assume that we have an object of a class PhotoPost stored in a variable v1 declared of type PhotoPost (Figure 11.5). Test strategies are introduced, including formalized regression testing using JUnit, and a number of debugging methods are discussed in detail. Exercise 16.10 Do you think that a need for further classes will emerge as the application is developed—classes that have no immediate reference in the problem description? F.1 Breakpoints A breakpoint is a flag attached to a line of code (Figure F.2). Hunters have no maximum age and neither feed nor breed. Could it e ritten ith a for each loo ould the other ethods e ritten usin a while loop? The two calls to getBalance should show different outputs, because the call to insertMoney had the effect of changing the machine's state via its balance field. The filter turns the image into a black-and-white image in shades of gray. Is anything at all printed in this case Exercise 4.26 Challenge exercise In listMatching, can you find a way to print a message, once the for-each loop has finished, if no file names matched the search string? private int price; Concept Comments are inserted into the source code of a class to provide explanations to human readers. All rights reserved. If so, can you pinpoint any reasons why that might be occurring? Code 14.23 contains the source of saveToFile to illustrate how little code is actually required to save the whole address book, in a single write statement. This should display a new pane next to the object bench in your main BlueJ window. We shall investigate this now. Note When doing the exercises, you may have noticed that the show method has a problem: not all details are printed out. It should allow us to display lists of posts, such as a list of the most recent posts, or a list of all posts by a given user. 1.2 Creating objects Start BlueJ and open the example named figures.1 You should see a window similar to that shown in Figure 1.1. In this window, a diagram should become visible. Its task is to print just the phrase "Message post from NAME", where NAME should show the name of the author. Web pages, written in HTML, are a particular example. Instead, we suggest some, in the form of exercises, to the reader. Here it is in outline: if(balance >= price) { Printing details omitted. Fix any errors you discover in the process of doing this. Similar to this: if(currentRoom == transporterRoom) { nextRoom = getRandomRoom(); } else { nextRoom = currentRoom.getExit(direction); } This time, we assume that we have an instance variable transporterRoom of class Room, where we store the reference to our transporter room.6 Now the check is independent of the room's name. As we can see, the code has become significantly shorter and simpler since our change to use inheritance. 13.5.1 Image-processing classes On the way to the solution, we shall investigate one more interim version: imageviewer0-4. The shared and distinct elements of the Vehicle, Taxi, and Shuttle classes only really begin to take shape as we move towards their implementation. Making progressive improvements through the introduction of new programming features will be the focus of subsequent sections. In addition to aging and possibly breeding at each step, a fox searches for food (using findFood). Detailed instructions can be found in the document, BlueJ Teamwork Repository Configuration, which is accessible via the BlueJ Tutorial item in BlueJ's Help menu. On the other hand, even though taxis and shuttles have different ways of deciding where they are heading, they can share the concept of having a single target location. In this section, we have done pure refactoring. It is what is known as polymorphic method dispatch (or method polymorphism for short). We have seen how containers and layout managers work together to achieve the exact arrangement we need on screen. A.2 Opening a project You can download all of the example projects from the companion website for this book at Download the zip file and uncompress it to give you a folder called projects. Software development is usually done in teams. 16.2 Analysis and design As suggested in Chapter 15, we will start by seeking to identify the classes and interactions in the system's description, using the verb/noun method. The oval areas in the diagram show the group of classes that are able to access members in class SomeClass. If so, what is it called, and what are its parameters? Instance-specific constants are much less frequently used. Appendix C shows a complete table of logic operators in Java. The scope coloring in BlueJ's editor gives us some hints that may help in understanding this structure (Figure 13.12). Exercise 14.18 The Java API includes a sophisticated collection of errorlogging classes in the java.util.logging package. 12.2.6 Taking steps to improve the simulation Now that we have examined how the simulation operates, we are in a position to make improvements to its internal design and implementation. 7.3.1 Declaring array variables The LogAnalyzer class contains a field that is of an array type: private int[] hourCounts; The distinctive feature of an array variable's declaration is a pair of square brackets as part of the type name: int[]. Special-case code such as this is a typical indicator of a weakness in class design. Instead of iterating over the whole field every time and drawing actors in every position, we could iterate over a separate collection of drawable actors. Polymorphism can be used to avoid writing multiple catch blocks, if desired. Then all the details would be printed out. Indeed, they are so common that most programming languages provide at least one—and commonly more than one—loop construct to express them. However, the type of the collection must still be declared using the wrapper type (e.g., ArrayList, not ArrayList). 4.4 Using a library class Code 4.1 shows the full definition of our MusicOrganizer class, which makes use of the library class ArrayList. 4/11/16 3:06 PM 118 | Chapter 3 ■ Object Interaction One mail-server object must be created that is used by all mail clients. The type of an object that was created from class MessagePost is MessagePost. We can tell that getPrice is a method and not a field because method headers always include a pair of parentheses–"(" and ")"–and no semicolon at the end of the header. In general, therefore, when writing our own interfaces we will tend to limit ourselves to purely abstract methods. Exercise 16.15 The taxi-company-outline-testing project includes some simple initial JUnit tests. Multiple TaxiCompany objects could be created and the passenger source allocate passengers to them competitively on the basis of how quickly they could be picked up. They are: view.setColor(classObject, color); view.isViable(field); view.showStatus(step, field); view.reset(); We can now easily define the complete SimulatorView interface: import java.awt.Color; public interface SimulatorView { void setColor(Class animalClass, Color color); boolean isViable(Field field); void showStatus(int step, Field field); void reset(); } Figure 12.6 SimulatorView The SimulatorView interface and implementing classes M12_BARN7367_06_SE_C12.indd 453 implements implements GraphView GridView 4/11/16 3:38 PM 454 | Chapter 12 ■ Further Abstraction Techniques The one slightly tricky detail in the definition above is the use of the type Class as the first parameter of the setColor method. Its role is to handle the task of breaking up each log line into separate data values, but we can abstract from the implementation details by considering just the headers of two of its methods: public boolean hasNext() public LogEntry next() These exactly match the methods we have seen with the Iterator type, and a LogfileReader can be used in exactly the same way, except that we do not permit the remove method to be used. The type int signifies whole numbers (also called "integer" numbers, hence the abbreviation "int"). Together, the name of a method and the parameter types found in its header are called the method's signature. In a highly cohesive system, each unit of code (method, class, or module) is responsible for a well-defined task or entity. However, by using the highest-level abstract type (be it abstract class or interface) for our variables, wherever possible, our code will remain flexible in light of future library changes—such as the addition of a new Map or Set implementation, for instance. It is important to know how to use the library. As a result of this reasoning, we create two methods, one in ImageViewer and one in OFImage, to share the work (Code 13.7 and Code 13.8). These are typically omitted from production code. Are there any cases of a class name being a plural name? In contrast, the lifetime of a field is the same as the lifetime of the object to which it belongs. Clearly, the only mouse event we are interested in is a mouse click, but implementing the MouseListener requires that we implement five separate methods. The constructor receives the roll-over limit as a parameter. Exercise 14.11 Save a copy, to work on, of one of the address-book-v1 projects under another name. Values can be looked up by providing the ke A map is a collection of key/value pairs of objects. In practice, both assumptions are typically not true. public int refundBalance() { return balance; balance = 0; } What do you know about return statements that helps to explain why this version does not compile? These influences are not found in the basic description of how the taxi company normally operates, but they do represent scenarios that will have to be played through when we draw up the design. Each machine keeps a running total of the amount of money it has collected throughout its operation. Our buttons now are much larger than we intended. Exercise 13.56 What is a slider? A top-level window is one that is under the control of the operating system's window management and which typically can be moved, resized, minimized, and maximized independently. We will look at correct Java code below. The inheriting classes (MessagePost and PhotoPost in this example) are referred to as child classes or subclasses. There is clearly a problem here, but whose fault is it? ■ ■ ■ We want to add two labels: one to display the image filename at the top and a status text at the bottom. When you write your own code, you can choose your style: the functional and imperative styles are two different ways to solve the same problem, and one can replace the other. BlueJ includes numerous other tools and characteristics that are specifically designed for students of software development. This structure is cohesive and extendable. Exercise 12.63 Implement a new class TextView that implements SimulatorView. Subclasses also form subtypes, which leads to polymorphic variables. Exercise 3.46 Step one line forward in the execution of the printNext MailItem method by clicking the Step button. We will also need to add a getField method in Animal so that direct access to field from the subclass methods run, hunt, giveBirth, and findFood can be replaced. The file is closed. In addition, its reset method resets the starting point for the shared Random object. This is because the ClockDisplay class contains two constructors. It receives the key in its constructor and then makes it available through both the diagnostic string and a dedicated accessor method. The programming language does not allow access to the private section of one class by statements in another class. The Java system will then look for a method in class Game with exactly the following signature: public static void main(String[] args) Z05_BARN7367_06_SE_APPE.indd 617 4/11/16 3:53 PM 618 | Appendices The method has to be public so that it can be invoked from the outside. M15_BARN7367_06_SE_C15.indd 577 4/11/16 3:45 PM This page intentionally left blank ChApter 16 A Case Study Main concepts discussed in this chapter: ■ whole-application development Java constructs discussed in this chapter: (No new Java constructs are introduced in this chapter.) In this chapter, we draw together many of the object-oriented principles that we have introduced in this book by presenting an extended case study. The code for class Game, for example, is stored in a file named Game.class. The "like" count is stored as a simple integer. Writing a class declaration such as public class Person { . In order to do this, filters must themselves become objects, rather than just method names. M06_BARN7367_06_SE_C06.indd 232 4/11/16 3:17 PM 6.12 Public versus private | 233 The implementation is the section of a class that defines precisely how the class works. The controllers sometimes give permission right away, but sometimes they tell planes to wait. Concept A design pattern is a description of a common computing problem and a description of a small set of classes and their interaction structure that help to solve that problem. It is called javac. Second, the MessagePost class defines only those fields that are unique to MessagePost objects (only message in this case). How can you ensure that the script file is always closed when the end of the game is reached? A way to do this would be to artificially arrange for the value of index to be too large if we find what we are looking for. The two variables are said to be aliases for the same object. The following code shows the full syntax for a lambda expression used as the event handler for the Open menu item: openItem.addActionListener((ActionEvent e) -> { openFile(); }); When a menu item is selected, the associated listener lambda expression will receive an ActionEvent object—with which it does nothing—and the body of the listener calls the openFile method defined in the enclosing ImageViewer class. The other example we have mentioned above—mapping to the number of animals spotted in each sighting—would look like this: sightings.stream() .filter(sighting -> sighting.getSpotter() == spotter) .map(sighting -> sighting.getCount()) . Exercise 13.12 Open the imageviewer0-3 project and examine it; that is, test it and read its source code. The compiler, however, allows us to go further: Several other elements can be omitted where the compiler can work them out by itself. This often happens when a class is reused in a setting that is different from its original one, perhaps through inheritance. They can be recognized by the presence of an assignment operator, such as "=" in the example above. For the next version of our project, we have made use of a set of classes from javazoom. One of the most important strengths of the BlueJ environment is the user's ability to directly create objects of any class, and then to interact with their methods. We can reflect this requirement by preventing construction of a ContactDetails object with no valid key details. However, it is important to choose one style and then use it consistently, because then your classes will be easier to read and understand. Try invoking moveRight and moveDown a few times to move the circle closer to the corner of the screen. Imagine that we create a LabClass object and three Student objects. Any attempt to change a constant field will result in a compile-time error message. The start should be zero, and the end should be the length of the music file. The classes then form an inheritance hierarchy. Of course, you can also use your own images. M10B_BARN7367_06_SE_C10.indd 359 4/11/16 3:32 PM 360 | Chapter 10 ■ Improving Structure with Inheritance Here, we will start small and simple, with a view to extending and growing the application later. M12_BARN7367_06_SE_C12.indd 428 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 429 Exercise 12.22 Challenge exercise Given the random elements in the simulation, argue why the population numbers in an apparently stable simulation could ultimately collapse. 1.3 Calling methods Right-click on one of the circle objects (not the class!), and you will see a pop-up menu with several operations (Figure 1.3). Z05_BARN7367_06_SE_APPE.indd 618 4/11/16 3:53 PM E: Running Java without BlueJ E.2 | 619 Creating executable .jar files Java projects are typically stored as a collection of files in a directory (or "folder"). Exercise 5.22 Rewrite the removeZeroCounts method using the removeIf ethod as sho n a o e Exercise 5.23 Write a method removeSpotter that re o es all records re orted a i en s otter 5.5.7 Other stream methods We have said that many common tasks can be achieved with these three kinds of operations: filter, map, and reduce. A pipeline is the chaining of two or more of these kinds of function, so that they are applied one after the other. Figure 12.2 The graphical display of the foxes-andrabbits simulation Exercise 12.2 Does the number of foxes change on every step? You can look at the complete task and devise a solution using a single class. or its affiliates. The principle is simple: inheritance is an abstraction technique that lets us categorize classes of objects under certain criteria and helps us specify the characteristics of these classes. Word processors typically do not save text in plain text format, and the Java system will not be able to read it. Now modify the warmer method so that it will not allow the temperature to be set to a value greater than max. This class should have a method named generateStarWarsName that generates a Star Wars name, following the method described above. Objects can create other objects, using the new operator. Java lies somewhere in the middle. See what happens when you specify a color that is not known. As opposed to other fields (about which we commented earlier that they should never be declared public), declaring constants public is generally unproblematic and sometimes useful. Uncomment this call and run the simulation. Does it run? For instance, DoubleConsumer takes a single double parameter and returns no result. A01_BARN7367_06_SE_FM.indd 24 4/15/16 6:10 PM List of Projects Discussed in Detail in This Book Figures (Chapter 1) Simple drawing with some geometrical shapes; illustrates creation of objects, method calling, and parameters. The animal-monitoring-v2 project is written using the functional style as discussed here and can be used in case you want to check your solutions to some of these exercises. The documentation for the stream methods always tells you whether an operation is intermediate or terminal. Instead, objects must be combined so that they cooperate to perform a common task. Give a short example in Java code about creating and using a slider. Z11_BARN7367_06_SE_APPK.indd 641 4/11/16 3:59 PM This page intentionally left blank Appendix L Concept Glossary abstract class An abstract class is a class that is not intended for creating instances. Having a proper initial state will enable an object to respond appropriately to method calls immediately following its creation. Now add a method, setIncrement, that takes a single parameter of the appropriate type and uses it to set the value of increment. Remember that this method will not actually change the String it is called on, but result in the creation of a new one being created with slightly different contents. This method takes care of constructing the GUI. The loop's body is then skipped over and execution continues with whatever follows immediately after the loop. This issue is known as coupling. Code 11.3 toString method for Post and MessagePost 2 The magic number is in fact the memory address where the object is stored. This is something we shall improve later. The same is true for many other parts. Answer these questions on paper, then create a test project to check your answers and try it. 6.11 Writing class documentation When working on your projects, it is important to write documentation for your classes as you develop the source code. A user uses a mail client to send mail items to a server, for delivery to another user's mail client. One possibility is to just store hour values from 1 to 12. Exercise 4.20 Implement the listAllFiles method in your version of the music-organizer project. 3.14 Using a debugger The most interesting class in the mail-system example is the mail client. We can use assertions to state our assumptions explicitly and to detect programming errors more easily. One difference between the ArrayList and a Map is that with a Map each entry is not an object, but a pair of objects. Exercise 1.16 In the source code of class

Picture, find the part that actually draws the picture. Since arbitrary additional functionality can be included in an enum definition in the same way as in a class, this approach, rather than a hand-crafted approach, is well worth considering in Java. The key point that is relevant to writing a stream-based version of this process is to recognize that the variable total acts as a form of "accumulator": each time a relevant count is identified, it is added into the value accumulated so far in total to give a new value that will be used the next time around the loop. Then add a popup menu (using class JComboBox) to select the image to display. Figure 13.7 As the name suggests, a GridLayout (Figure 13.7) is useful for laying out components in an evenly spaced grid. For the tire engineer, the tire is a complex thing. Here is an outline of some of the major developments in this version from the previous one. If we were careful, and it is truly is a Car, everything is fine. Interfaces are relatively lightweight types that minimize constraints on implementing classes. Whenever you encounter new operators and method calls, it is a good idea to try them out here to get a feel for their behavior. That is exactly the situation that is covered in the listAllFiles method in Code 4.5, where the condition is: while(index < files.size()) The condition expresses that we want to continue as long as the index is within the valid index range of the collection; as soon as it has been incremented out of range, then we want the loop to stop. Also, it actually performs the check at runtime so that we get notified if our assumption turns out to be incorrect. It is good practice to commit and update frequently so that the changes at any step do not become too substantial. The problem we do have, though, is how to reference the six variables so as to be able to distinguish between the two sets. This makes it easy to understand, but also allows migration to full UML in later courses. What happens if you insert too much money into the machine—do you receive any refund? The frame on the right then displays the documentation of the String class (Figure 6.3). Their purpose is to serve as superclasses to other classes. In particular, it lets us execute individual methods of classes and objects easily; this is very useful if we want to quickly test a segment of new code. Other objects can become event listeners and be notified of such events by implementing standard interfaces. If not, what changes are required? From this diagram, we can tell that the ticket machine was created by passing in 500 as the value for the ticket price. 1.6 Multiple instances Once you have a class, you can create as many objects (or instances) of that class as you like. M09_BARN7367_06_SE_C09.indd 354 4/11/16 3:28 PM 9.14 Summary | 355 So Hacker's way of testing—writing his own test class—was one step in the right direction, but was, flawed. You should still get used to reading it in the same way: as "array of int." Exercise 7.2 Write a declaration for an array variable people that could be used to refer to an array of Person objects. M11_BARN7367_06_SE_C11.indd 409 4/11/16 3:35 PM 410 | Chapter 11 ■ More about Inheritance However, suppose that we wish to retrieve just the message posts or just the photo posts from the list; how would we do that? Consider the following code fragment: import java.util.HashSet; ... As every listener has its own implementation of the actionPerformed method, we can now write specific handling code in these methods. The Observer pattern can also be used for problems other than a model/view separation. Over time, however, you will get to know the layout managers well. Change their positions, sizes, and colors. Exercise 6.86 Rewrite the getSightingsInArea method from the original animal-monitoring project in the functional style. We can use it to stop our program, step through it one line of code at a time, and examine the values of our variables. Without wishing to de-emphasize the importance of that step, we shall leave it for you to do and move directly to a BlueJ project outline containing stub classes and methods. Programs can potentially make use of multiple cores without much effort on the side of the programmer. What is needed to do this? It also provides details of how much time vehicles spend in each of the following activities: carrying passengers, going to pickup locations, and being idle. M04_BARN7367_06_SE_C04.indd 132 4/11/16 3:10 PM 4.4 Using a library class | 133 Code 4.1 The MusicOrganizer class M04_BARN7367_06_SE_C04.indd 133 4/11/16 3:10 PM 134 | Chapter 4 ■ Grouping Objects Code 4.1 continued The MusicOrganizer class 4.4.1 Importing a library class The very first line of the class file illustrates the way in which we gain access to a library class in Java, via an import statement: import java.util.ArrayList; This makes the ArrayList class from the java.util package available to our class definition. M04_BARN7367_06_SE_C04.indd 150 4/11/16 3:10 PM 4.10 Indefinite iteration | 151 Try to express the second version by completing the following outline: boolean found = false; while(. This is the last change to the application discussed here in this chapter. This paper is worth reading as information supplemental to this chapter. Do things still work as expected if a negative value is passed to the setIncrement method? 10.1 The network example The network project implements a prototype of a small part of a social-network application. You might want to study this example to deepen your understanding. M12_BARN7367_06_SE_C12.indd 455 4/11/16 3:38 PM 456 | Chapter 12 ■ Further Abstraction Techniques If we have a choice, interfaces are usually preferable. When rooms are created, they could receive a boolean flag indicating whether a given room is a transporter room. For example: private Circle sun2; Then write the appropriate code in two different places for creating the second sun and making it visible when the picture is drawn. 14.5.5 The finally clause A try statement can include a third component that is optional. After each change, close the editor. This class is programmed to do exactly what we have done by hand in Exercise 1.9. In reality, if we want a sequence of tasks done in Java, we would not normally do it by hand. It does not print anything, but returns true if the parameter's value is a valid index for the current state of the collection, and false otherwise. CRC cards can be used to refine the design down to the definition of method names and their parameters. ISBN: 0-321-35668-3. If so, are those situations justified for a particular reason? ■ Exercise 16.11 As the next section discusses the taxi-company-outline project, pay particular attention to where objects are created and how collaborating objects get to know about each other. 12.3.2 Abstract methods So far, use of the Animal superclass has helped to avoid a lot of the code duplication in the Rabbit and Fox classes, and has potentially made it easier to add new animal types in the future. Change the size of the triangle so that it looks more like the leaves of a fir tree growing from the trunk. It is purely a way of gaining access to type information that is already true of the object—that is, part of its full dynamic type. The length is equal to the number of Unicode code units in the string. In the one at the top left, you see a list of packages. In Java, fields can also be declared private or public. For example, the word "slow" is associated with the text "I think this has to do with your hardware. However, many of the classes developed for the simulation could be reused with little or no change. Try other colors. These classes have been placed in the package java.lang, and this package is automatically imported into every class. } } Instances of the inner class are attached to instances of the enclosing class; they can only exist together with an enclosing instance, and they exist conceptually inside the enclosing instance. 1 This is exactly what you will have experienced whenever your programs inadvertently died because of a NullPointerException or IndexOutOfBoundsException. public interface Quiz { int CORRECT = 1; int INCORRECT = 0; ... Do you think this message clearly explains what is wrong? Execution will continue with whatever follows the complete try/ catch statement. The exception class should store details of the offending key(s). 14.1 The address-book project We shall use the address-book family of projects to illustrate some of the principles of error reporting and error handling that arise in many applications. This can be observed by using the Step Into command at the line where the object is being constructed. They present alternative approaches to other constructs and can be covered independently. This introduces a new feature of Java that is also found in some other programming languages. It is the value to which our running total is initialized. Each operation creates a fresh stream, based on its input and the operation, to pass on to the next operation in the sequence. File-based input/output An important programming area in which error recovery cannot be ignored is input/output. These hooks ensure that a relevant topic is brought up at an appropriate time, and leave it up to the reader or the teacher to decide to what level of detail that topic should be covered. Exercise 6.70 Change the bounce method to place the balls randomly anywhere in the top half of the screen. Complete the scenario analysis if you feel there is more to be done. This will place a copy of the shared project from the central server into your local file system. We have included it here because classes from the java.io and javax.swing packages often use URL objects. Thus, this construct gives us a means to refer to the field instead of the parameter with the same name. This particular example illustrates some important general principles: ■ ■ ■ If a server's validity-check and state-test methods are visible to a client, the client will often be able to avoid causing the server to throw an exception. Each sighting report consists of the name of the animal that has been seen, how many have been seen, who is sending the report (an integer ID), which area the sighting was made in (an integer), and an indication of M05_BARN7367_06_SE_C05.indd 178 4/11/16 3:13 PM 5.2 Monitoring animal populations | 179 when the sighting was made (a simple numerical value which might be the number of days since the experiment started). Discussing it in detail is far outside the scope of this book. As we saw in the previous chapters, BlueJ gives us the means of interacting with our application before a final user interface is available, so we can choose to work on the internal structure first. M02_BARN7367_06_SE_C02.indd 92 4/11/16 3:02 PM 2.23 Summary | 93 Exercise 2.93 Challenge exercise Create a new project, heater-exercise, within BlueJ. Exercise 6.38 What happens if there is more than one space between two words (e.g., two or three spaces)? If we know that the supertype variable holds a subtype object, the assignment could actually be allowed. Exercise 6.29 What happens when you add two entries to a map with the same value and two different keys? System.out.println(index + ": " + filename); index++; } Having a local index variable can be particularly important when searching a list, because it can provide a record of where the item was located, which is still available once the loop has finished. They could also appear as pop-up menus, but we shall not do that now. Exercise 4.2 What happens if you create a new MusicOrganizer object and then call removeFile(0) before you have added any files to it? We can make that decision later; for now, we just note this as a ShowCollection.) This is an example of how we might introduce additional classes during the playing of scenarios. Above the class header is a comment (shown as blue text) that tells us something about the class. In addition to a Path parameter corresponding to the file to be opened, one complication is that a Charset parameter is also required. Many of the cases where an AddressBook object is forced to throw an exception involve null parameter values passed to its methods. Why are they particularly significant in our attempts to introduce inheritance into this application? The previous versions of the foxes-and-rabbits project contained only one SimulatorView class. It provides a way to cross-reference a comment to another class, method, or other form of documentation. Add and remove components from the existing classes to get a proper feel for the key characteristics of the different layout styles. A drop-down menu contains a set of possible assertions for the result value. Exercise 12.48 Can the breed method be moved to Animal? For instance, if we know for certain that every Student is assigned a unique id, then we need not test the name and credits fields as well. Code 6.3 The Responder source code with random responses M06_BARN7367_06_SE_C06.indd 214 4/11/16 3:17 PM 6.4 Adding random behavior | 215 Code 6.3 continued The Responder source code with random responses In this version, we have put the code that fills the response list into its own method, named fillResponses, which is called from the constructor. The Simulator class, however, is still coupled to Fox and Rabbit, because these classes are referenced in the populate method. The comment of the changeColor method describes what color names the system knows about. We now want to improve the processing of input a little. 12.6.5 Interfaces as specifications In this chapter, we have introduced interfaces as a means to implement multiple inheritance in Java. Add to that the first two letters of your first name. The second feature—the ArrayList object keeping its own count of inserted objects— has important consequences for the way in which we implement the MusicOrganizer class. Any animal in one of the target locations is killed. A description of a pattern includes at least: a name that can be used to conveniently talk about the pattern ■ a description of the problem that the pattern addresses (often split into sections such as intent, motivation, and applicability) ■ ■ a description of the solution (often listing structure, participants, and collaborations) ■ the consequences of using the pattern, including results and trade-offs In the following section, we shall briefly discuss some commonly used patterns. The other is the current value. It is followed by a pair of parentheses, within which the loop details are defined. Once we understand how to create good implementations of single classes with well-defined functionality, we can concentrate on deciding what kinds of classes we should have in our application and how they should cooperate. Thus, in our system, the CinemaBookingSystem must be able to retrieve and display the show's details. The core package for input/output-related classes has always been java.io. Instead, we shall use a collection of filters and then write a single filter-invocation method that finds and invokes the right filter. This is the usual pattern, and it would almost certainly be a programming error to enclose a throw statement directly within a try statement. A label is a component that can display text and/or an image. We present the new functional-construct-oriented material in the book where we discuss the problems that these constructs address. Observe the instance fields and their initialization. So the body of the TicketMachine class, the bodies of the constructor, and all of the methods within the class are blocks. Design patterns are used to document generally good structures that have proven useful in the implementation of different classes of problems. Even the most basic usage involves multiple concepts that are already advanced for this relatively early stage of this book: streams, static methods, and polymorphism. For instance, have we included too little or too much detail in the discussion of the differences between taxis and shuttles? Try to explain your observations. The class contains three fields: name, id, and credits. You are encouraged to browse through the source code and associate the concrete classes with the corresponding descriptions of Section 16.2.3. Code 16.1 shows an outline of the Vehicle class from the project. Exercise 1.26 Call the printList method of the LabClass object. Then use Sophie's sendMailItem method to send a messa e to uan Do not read the essa e et After the setup in Exercise 3.44, we have a situation where one mail item is stored on the server for Juan, waiting to be picked up. We do this by providing two functions: larger, which doubles the image size, and smaller, which halves the size. It was public in Rabbit because a fox needs to be able to call a rabbit's setDead method when it eats its prey. 11.1 The problem: network's display method When you experimented with the network examples in Chapter 10, you probably noticed that the second version—the one using inheritance—has a problem: the display method does not show all of a post's data. 14.4.5 Preventing object creation An important use for exceptions is to prevent objects from being created if they cannot be placed in a valid initial state. The most interesting detail in this class is the line private static final int GRAVITY = 3; This is a construct we have not seen yet. Imagine engineers in a car company designing a new car. The break instruction after the default (or the last case, if there is no default) is not needed but is considered good style. So even though the call to getBreedingAge originates in the code of the superclass, the method called is defined in the subclass. Our task would have been much harder had we been required to read the classes' implementation before using them. A GridLayout does what we want. asList method. Buy a ticket from that machine. pitfall A local variable of the same name as a field will prevent the field being accessed from within a constructor or method. Many of the input/output classes in java.io are distinguished by whether they are stream-based (operating on binary data) or readers and writers(operating on characters). These methods return the values of each separate number display. We will provide this in the next chapter. Because we always keep the display string up to date, this is all there is to do. Thus, the object diagram shows the situation at runtime (when the application is running). Write some code fragments that illustrate what needs to be done. Inheritance relationships can be used to avoid code duplication, to reuse existing code, and to make an application more maintainable and extendable. The first is of type String and is called myName. The user is requested in some way for the name of a file (perhaps via a GUI dialog window), and the address book's saveToFile method is then called to write out the list to the file. Throughout this chapter, we will work on the construction of a single application (the TechSupport system), which makes use of various different library classes. Includes a version with an animated GUI. If we have a collection called myList, we can write myList.forEach(. As a second major example, we examine a simulation of an email system in which messages can be sent between mail clients. This file contains the code that can be executed by the Java virtual machine. Learning to work with library classes is the main topic of this chapter. In our example, the value of the args parameter will be an array of length zero. fixture A fixture is a set of objects in a defined state that serves as a basis for unit tests. The second test makes sure that we are comparing two students. As part of this, we shall use our own image class to represent an image while it is in memory, implement various filters to change the image's appearance, and use Swing components to build a user interface. } Exercise 2.84 Add two methods, printAuthor and printTitle, to the outline Book class. Inheritance represents a much closer form of coupling than does a normal client relationship. If the left operand of && is false, then the value of the right operand is irrelevant and will not be evaluated. Instead, the diagram focuses on user-defined classes. We will not discuss this further, and it is more general to consider protected access as intended for the special relationship between superclass and subclass. Which type of collection should you choose? In our example, we are interested in the question of whether the input variable and the string constant "bye" represent the same value, not whether they refer to the same object. We start with a stream of sighting objects, and we end with a stream of integers. The project foxes-and-rabbits-v2 provides an implementation of our simulation with the improvements discussed here. This ensures that the responses list will be filled as soon as a Responder object is created, but the source code for filling the list is kept separate to make the class easier to read and understand. It would also be worth remembering this error message because it results from an easy error to make in the early stages of learning. It has constructors that can take String, File, or Path arguments. As a consequence, their index numbers will be decreased by 1. In Java, using javadoc, several special key symbols are available for formatting the documentation. The object stored in that variable is found (following the reference). Exercise 13.7 Implement the menu-handling code, discussed above, in your own imageviewer project. Exercise 13.54 Find the online Java Tutorial section Creating a GUI with JFC/ Swing (the sections are called trails on the web site). If something does go wrong, a program is likely either to terminate prematurely (i.e., crash!) or to produce incorrect and undesirable effects. Or it may be a HashSet, and iterator returns a HashSetIterator. One difference is how values are stored. 2 If you wish, you can include trivial return statements in the bodies of methods with non-void return types. The changes are, however, more than merely the addition of a few new language constructs. A class describes,—in an abstract way,—all objects of a particular kind. The idea is that a try block represents a sequence of actions we wish to treat as a logical whole but recognize that they might fail at some point.5 The catch block will then attempt to deal with the situation or report the problem if an exception arises from any statement within the associated try block. As a result, every time we change the source code, we must first run the compiler before we can use the class again to create an object. The declaration int[] would in more conventional syntax appear, maybe, as Array. And now iwrap could obviously easily be stored in an ArrayList collection, for instance. Exercise 6.80 Can a static method be called from an instance method? It will create a file called Game.class. It is important to understand that the fields and the parameters are separate variables that exist independently of each other, even though they share similar names. Example: try (FileWriter writer = new FileWriter(filename)){ ... Use the writer . . . ... } catch(IOException e) { ... } Z04_BARN7367_06_SE_APPD.indd 614 4/11/16 3:52 PM D: Java Control Structures D.5 | 615 Assertions Assertion statements are primarily used as a testing tool during program development rather than in production code. Methods from the framework, such as assertEquals, are built around an assertion statement that contains a boolean expression made up from their parameters. A popular alternative is the issue of how to schedule elevators in a large building. If we look at these methods in the ImageViewer class (Code 13.10 shows two of them as an example), this looks a lot like code duplication. This method should create a pen (as in the drawSquare method) and then draw a green triangle. This does not necessarily imply that there are weaknesses in our techniques or abilities. As such, they maintain the current state of an object. For instance, the normal rules of polymorphism allow us to handle foxes and rabbits as instances of the Animal type. However, learning about collections in programming has become more complicated in recent years through the introduction of new programming techniques into mainstream programming languages. 14.9.7 Object serialization Concept Serialization allows whole objects, and object hierarchies, to be read and written in a single operation. Binary files are more varied: image files are one common example, M14_BARN7367_06_SE_C14.indd 545 4/11/16 3:43 PM 546 | Chapter 14 ■ Handling Errors as are executable programs such as word processors and media players. This makes it less likely that a method will get partway through its actions before having to throw an exception because of bad parameter values. Both Fox and Rabbit define age, alive, field, and location attributes. These techniques introduce an improved method of representation of abstractions in object-oriented programs. In its body, you will see a call to a delay method that is commented out. A subclass may override the implementation of methods and add additional methods. The Blueroom Perhaps more important than the static web site resources is a very active community forum that exists for instructors who teach with BlueJ and this book. Some of the most important parts of the library are the collections, of which the ArrayList class is one. Use the insertMoney method to simulate inserting an amount of money into the machine. The TaxiCompany class is responsible for creating the taxis to be used in the simulation. There are two forms of assert statement: assert boolean-expression ; assert boolean-expression : expression; Examples: assert getDetails(key) != null; assert expected == actual: "Actual value: " + actual + "does not match expected value: " + expected; If the assertion expression evaluates to false, then an AssertionError will be thrown. Do the numbers of foxes and rabbits increase or decrease at similar rates? Then call its clear method if (and only if) its number of pixels is greater than two million. size()–1] before passing the index on to the ArrayList methods. Key methods are close, flush, and write. ■ Choosing which pixel to replace. Packages can be nested (that is, packages can contain other packages). Thinking ahead about other possible scenarios, we might decide to go with the idea of storing rows. For example, the String documentation shows us the interface of the length method: public int length() Returns the length of this string. The first version, using the diamond notation (thus leaving out the mention of the String type) is merely a shortcut notation for convenience. Look at the class definition in Code 2.1 and use this knowledge, along with the additional information about ordering we have given you, to make a list of the names of the fields, constructors, and methods in the TicketMachine class. Exercise 1.28 Use the inspector on a LabClass object to discover what fields it has. Examples are @author Hacker T. Exercise 7.6 Given the following variable declarations, double[] readings; String[] urls; TicketMachine[] machines; write assignments that accomplish the following tasks: (a) Make the readings variable refer to an array that is able to hold 60 double values; (b) Make the urls variable refer to an array that is able to hold 90 String objects; (c) Make the machines variable refer to an array that is able to hold 5 TicketMachine objects. An interface defines a type just as a class does. Once we understand the principles, we can find out all the necessary details by working with the standard library documentation. In our diagrams, all variables are represented by white boxes. The actors are the vehicles, the passenger source, and a GUI provided by the CityGUI class. That way, because the method would now belong to the MessagePost and PhotoPost classes, it could access the specific fields of MessagePost and PhotoPost. The second is of type int and is called myAge. What we really need is a separate class, such as Track, say—that stores the details of artist and title independently from the file name. This will be completely empty of contact details. We shall discuss those in a separate section later. Open the source code of the MessagePost class and remove the "extends Post" phrase. The solution will be a scheme where we can specify the layout in more general terms. However, the present availability of default methods in interfaces should not really change the answer to this question in most cases. set A set is a collection that stores each individual element at most once. What fields would a NumberDisplay object have? We can go a long way toward avoiding many of these problems by using exception throwing. For instance, mathematical models were used in the early twentieth century to explain variations in the level of fish stocks in the Adriatic Sea as a side effect of World War I. 6.14 Class variables and constants So far, we have not looked at the BouncingBall class. Note that, as well as improving the source code in the method, we have updated the method's comment, to document the fact that unknown keys are ignored. If it is simply desired to interrupt the execution in order to examine the current program state, then the Halt operation is preferred. If the creation of the collection object is combined with an assignment, then the compiler can work out the type of the collection elements from the type of the variable on the left hand side of the assignment, and Java allows us to skip defining it again. If so, how would you report it? This method must have a specific signature: public static void main(String[] args) If such a method does not exist in that class, an error is reported. .); Exercise 5.7 Write pseudo-code to determine how many elephants a particular s otter spotterID sa on a articular da dayID Exercise 5.8 Write pseudo-code to create a stream containing only those si htin s that ha e a count reater than Exercise 5.9 Consider the music-organizer project from Chapter 4 and assume that each Track object in the collection contains a count of how many times it has been played. Exercise 2.8 Check whether or not it is possible to leave out the word public from the outer wrapper of the TicketMachine class. The interface defines some method headers, and the adapter class defines the same methods, each with an empty method body. This example is used in a discussion of class discovery and application design. The modulo operator calculates the remainder of an integer division. Z09_BARN7367_06_SE_APPI.indd 629 4/11/16 3:57 PM | 630 Code I.1 The main description of a class comment Appendices /** * This class is the main class of the "World of Zuul". What do you think has happened in the assignment? While it is worth being familiar with both styles, neither is obviously superior to the other. Enter a message post and a photo post into the news feed and call the news feed's show method. This reduces coupling between Simulator and the individual animal subclasses. The process of throwing an exception from a constructor is exactly the same as throwing one from a method. Now we have a first approximation of the classes needed in our system, and a physical representation of them on CRC cards. One of the questions we have not asked is whether a for-each loop can be used if we want to stop partway through processing the collection. Constructors appear as Class. If the return type is void, they do not return anything. Rather, it creates a fixed-size collection that is able to have 10 strings stored within it. Exercise 12.23 Modify the populate method of Simulator to determine whether setting an initial age of zero for foxes and rabbits is always catastrophic. There is a special relationship between functional interfaces and lambda expressions. The company is considering whether to expand its operations into a new part of a city. It operates taxis and shuttles. This should be taken into consideration when designing classes and their relationships. If you are curious to see what we will build, you can open and try out the imageviewer1-0 project—that is the version displayed in Figure 13.2; just create an ImageViewer object. If the body of the lambda contains only a single statement, then the curly brackets may be omitted. As it was, I wasn't able to talk to the instructor about the problem until it was too late. Note that it should not be necessary to use a loop in this method. On the one hand, this seems logical; Post does not have a display method any more (see Figure 11.2). A01_BARN7367_06_SE_FM.indd 23 4/15/16 6:10 PM 24 | Preface Supplements VideoNotes: VideoNotes are Pearson's visual tool designed to teach students key programming concepts and techniques. Flexible-size collections can store only objects.1 ■ Another distinctive feature of arrays is that they have special syntactic support in Java; they can be accessed using a custom syntax different from the usual method calls. Direct coupling between Vehicle and TaxiCompany is reduced, but implicit coupling is still involved, and the notification process is a little more complex to program. Exercise 13.34 The showInputDialog methods of JOptionPane allow a user to be prompted for input via a dialog when required. Catch and report exceptions in AddressBookTextInterface that arise from use of a key that does not match any existing entry. 6.5 Packages and import There are still two lines at the top of the source file that we need to discuss: import java.util.ArrayList; import java.util.Random; We encountered the import statement for the first time in Chapter 4. What techniques did you use to find the errors? You will find that you can go much further if you develop your own ideas for projects and implement them in your own way. This suggests a BorderLayout: the labels can be in the NORTH and SOUTH areas, and the image in the CENTER. A canvas can be used by creating an instance interactively or from another object. (Don't worry about things being logical here; the goal is only to write something that is syntactically correct—i.e., that would compile if we typed it in.) Exercise 3.56 Describe the changes that would be required to the ClockDisplay class in order to be able to display hours, minutes, and seconds. Java's mechanism for doing this is the Java Archive (.jar) format. Note what is shown in the Terminal window. In this example, we first filter all sightings to select only elephant sightings, then we map each sighting object to the number of elephants spotted in this sighting, and finally we add them all up with a reduce function. In all development projects, we need phases like this. We will discuss some aspects of its implementation a little later in this chapter; for now, just experiment with this project. Exercise 2.38 What do you think would be printed if you altered the fourth statement of printTicket so that price also has quotes around it, as follows? Make sure that you reinstate the original version after your experiments! M02_BARN7367_06_SE_C02.indd 57 4/11/16 3:02 PM 58 | Chapter 2 ■ Understanding Class Definitions Exercise 2.16 Is it always necessary to have a semicolon at the end of a field declaration? We will assume that each music file represents a single music track. Reference equality is tested for using the == operator. Create the necessary classes. Exercise 12.51 Challenge exercise Define a completely new type of animal for the simulation, as a subclass of Animal. It does this by counting how many accesses were made in each one-hour period over the duration covered by the log. Exercise 2.25 If the name of getBalance is changed to getAmount, does the return statement in the body of the method also need to be changed for the code to compile? For us, implementing event listeners is the only example in this book where we use this construct.6 Exercise 13.51 Review the implementation of the pixel editor in imageviewer4-0. In the world-of-zuul game, we used a set of Room objects to create a scene for a simple game. ■ Successful recovery cannot be guaranteed. Objects can communicate by calling each other's methods. Some classes are defined by the standard Java system (such as String); others are those classes we write ourselves. In that way, as much information as possible will be available to someone wishing to use a method that throws an exception. They help us in creating good class structures. Code 12.6 shows the code implementing this solution. M01B_BARN7367_06_SE_C01.indd 42 4/11/16 2:54 PM 1.13 Return values | 43 Exercise 1.20 Challenge exercise Make a person walk up to the house after the sunset. Its purpose is to define what the class does. Only the component to which they are attached has a reference to their specific listener object, so that they can call the listener's event-handling methods. This is what makes possible the repeatability seen in Exercise 12.9. In addition, each individual rabbit has four instance variables that describe its state: its age as a number of steps, whether it is still alive, and its location in a particular field. Comments are included to provide information to the (human) reader and are described in Chapter 2. The second solution, which is slightly better, would be to use an instance variable instead of the room's name to identify the transporter room. Exercise 2.76 Create a Student with name "djb" and id "859012". It's been refreshing to talk to the folks who developed BlueJ: they have a very clear idea of what their target is. In getPrice, the method body contains a single statement, but we shall soon see examples where the method body consists of many lines of both declarations and statements. Make sure you can see the text terminal window as you step forward. 14.4.3 The effect of an exception What happens when an exception is thrown? We have discussed how to design them, how to make them maintainable and robust, and how to make them interact. On the other hand, adding objects or removing them from within the list requires no shifting of existing objects. As a problem grows larger, it becomes increasingly difficult to keep track of all details at the same time. Use the listAllFiles method to print them out; check that the method works as it should. For example: Vehicle v; Car c = new Car(); v = c; // correct c = v; // error The above statements would not compile: we get a compiler error in the last line, because assigning a Vehicle variable to a Car variable (supertype to subtype) is not allowed. Next, we shall do the filters. 3.11 Multiple constructors You might have noticed when you created a ClockDisplay object that the pop-up menu offered you two ways to do that: new ClockDisplay() new ClockDisplay(int hour, int minute) Concept Overloading. Also try calling the same methods from the Code Pad. That should enable it to display a complete set of information again. Before we rush in and do it, however, let us think about what this involves. We can summarize the Java syntax and actions of a for-each loop in the following pseudo-code: for(ElementType element : collection) { loop body } The main new piece of Java is the word for. Classes contain fields, constructors, and methods that define the state and behavior of objects. Wherever possible, mutable fields in superclasses should remain private. In general, we can distinguish two main purposes of using inheritance: we can use it to inherit code (code inheritance), and we can use it to inherit the type (subtyping). A for-each loop is one way to perform a set of actions repeatedly on the items in a collection, but without having to write out those actions more than once, as we saw was a problem in Exercise 4.19. The price, balance, and total fields are all the data items that a ticket-machine object needs to fulfill its role of receiving money from a customer, printing tickets, and keeping a running total of all the money that has been put into it. Constructors have a special role to fulfill. We can think about it like this: Imagine you need to give every child in a school class a haircut. A point worth remembering is that Java keywords never contain uppercase letters, whereas the words we get to choose (like "TicketMachine") are often a mix of upper- and lowercase letters. There is another spot where we have code duplication: in the NewsFeed class. Try out this approach by completing Exercise 11.1. Figure 11.2 Display, version 2: display method in subclasses NewsFeed Post MessagePost ... For example: // field declaration private int numberOfSeats; // methods public void setAge(int replacementAge) { ... Deciding which details to leave out and which to include is often a challenging task. Key methods are binarySearch, fill, and sort. Package java.util.function —Summary of some of the typical interfaces K.5 interface BiFunction The BiFunction interface takes two parameters and returns a result. Do not be too ambitious to start with, and expect to have to rework your ideas as you go; that is all part of the natural learning process. 12.9 Abstract class or interface? An (incorrect!) attempt to write this code could look as follows: if(input == "bye") { // does not always work! ... Although an organizer has a getNumberOfFiles method, we have not actually defined a specific field for recording this information. M03_BARN7367_06_SE_C03.indd 116 4/11/16 3:06 PM 3.13 Another example of object interaction | 117 The name "debugger" Errors in computer programs are commonly known as "bugs." Thus programs that help in the removal of errors are known as "debuggers." It is not entirely clear where the term "bug" comes from. Objects are added and retrieved via its put and get methods. Discuss this issue. It is called the Blueroom and can be found at The Blueroom contains a resource collection with many teaching resources shared by other teachers, as well as a discussion forum where instructors can ask questions, discuss issues, and stay up-to-date with the latest developments. The class defines two list variables, then creates two list objects, defines two add methods, and has two almost-identical blocks of code in the show method to print out the lists. It is this area that we now want to improve. ■ ■ Several mail-client objects can be created. The solution in Java is to declare the method abstract. When we create a message post, the MessagePost constructor is called, which, in turn, as its first statement, calls the Post constructor. It is not usually applied to fields, because that would be a weakening of encapsulation. New checked exception classes can be defined as subclasses of any existing checked exception class (such as Exception), and new unchecked exceptions would be subclasses of the RuntimeException hierarchy. Only one of the two blocks of statements following the test will ever be performed following the evaluation of the test. It is important to know about some essential classes from the standard Java class library and to be able to find out more when necessary. We then enroll all three students in that lab. Often, the interface name ends with Listener and the class name with Adapter. This documentation should include good comments for every project, class, and method. null The Java reserved word null is used to mean "no object" when an object variable is not currently referring to a particular object. I.1.1 The main description The main description for a class should be a general description of the purpose of the class. In this section, we introduce some further advanced material and the same advice applies. Thus we do not need to write the call explicitly and could instead write System.out.println(post); Now consider the modified version of the show method of class NewsFeed shown in Code 11.4. In this version, we have removed the toString call. M07_BARN7367_06_SE_C07.indd 252 4/15/16 3:35 PM 7.3 A log-file analyzer | 253 sample log file called weblog.txt is provided in the project folder. At most, one animal may occupy a single location within the field. Sometimes students have fewer problems dealing with it than some long-time teachers. Give reasons for your answer. In particular, casting between object types involves no change of the object involved. ■ Supplier interfaces return a result of the indicated type. } It is common for methods that return object references to use the null value as an indication of failure or error. We have discussed before that we can often abstract from the implementation; i.e., we do not need to think about it in much detail. Does it support more than one passenger being picked up from the same location? Exercise 6.76 In a program that uses the constant value 73.28166 in ten different places, give reasons why it makes sense to associate this value with a variable name. F.3 The variable displays Figure F.4 shows all three variable display areas active at a breakpoint, in an example taken from the predator–prey simulation discussed in Chapter 12. Imagine that we want to store not only text messages and photo posts, but also activity posts. We have appreciated his friendship and collaboration immensely. We will ignore the static-variable area for now. M10B_BARN7367_06_SE_C10.indd 360 4/11/16 3:32 PM 10.1 The network example | 361 Figure 10.1 : MessagePost Fields in MessagePost and PhotoPost objects : PhotoPost username username message filename timestamp caption likes timestamp comments likes comments Figure 10.2 MessagePost Details of the MessagePost and PhotoPost classes username message timestamp likes comments like unlike addComment getText getTimeStamp display PhotoPost username filename caption timestamp likes comments like unlike addComment getImageFile getCaption getTimeStamp display top half shows fields bottom half shows methods Objects of these classes should then encapsulate all the data we want to store about these objects (Figure 10.1). (The term "icon" seems to suggest that we are dealing only with small images here, but the image can in fact be of any size.) This method works for JPEG, GIF, and PNG images. Concept The class diagram shows the classes of an application and the relationships between them. Starting with the situation depicted in Figure 4.3, the object with index 1 has been removed. M13_BARN7367_06_SE_C13.indd 466 4/15/16 3:07 PM 13.4 The ImageViewer example Figure 13.3 | 467 Title bar Different parts of a frame Menu bar Content pane Frame The content pane itself is of type Container. When experienced designers discuss the structure of an application, one might say, "I think we should use a Singleton here." Singleton is the name of a widely known design pattern, so if both designers are familiar with the pattern, being able to talk about it at this level saves explanation of a lot of detail. Exercise 4.6 Write a declaration of a private field called tracks for storing a collection of MusicTrack objects. The body of this method is for(Post post : posts) { post.display(); System.out.println(); // empty line between posts } Here, we iterate through the list of posts (held in an ArrayList in the posts variable). Classes that are not abstract (all classes we have seen previously) are called concrete classes. */ private Room findRandomRoom() { ... For more complex code, it may be best for the lambda to call a separate method defined in the enclosing class—as we have done here—or to consider the use of an inner class. More uses of inheritance and their benefits will be discussed in the following chapters. Number 3 then registers our own object as a listener for the menu items. If the keys are still missing, then we go back into the loop body and look in the next place. Exercise 6.15 Find the nextInt method in class Random that allows the target range of random numbers to be specified. They differ only in their details, such as some of their fields and corresponding accessors and the bodies of the display method. The idea for this construct is based on the observation that we only use each inner class exactly once to create a single, unnamed instance. Exercise 6.71 Write a new method named boxBounce. The outer JPanel is then inserted into the WEST area of the frame. Which display methods were executed? Note that it is important to distinguish between this usage, which involves an instance method, and both usage b), which involve a specific instance, and usage c), which involves a static method. The values of the fields are stored in the object. ball1: BouncingBall xPosition 10 yPosition 233 ball3: BouncingBall xPosition 782 yPosition 33 ball2: BouncingBall xPosition 76 yPosition 155 6.14.2 Constants One frequent use for the static keyword is to define constants. This project makes extensive use of exceptions. Come back to this exercise later.) Add a sunset to the single-sun version of Picture. The default implementation of toString in class Object cannot supply a great amount of detail. 16.3.4 Testing Having made a start on implementation, we should not go too much further before we start to consider how we shall test the application. Therefore, we shall tend to use the style of the first example, listing all imported classes separately. It contains a document called javadoc—The Java API Documentation Generator (for example, at technotes/tools/windows/javadoc.html). abstract method An abstract method definition consists of a method header without a method body. As the signature indicates, you need to specify the maximum number of students in that class (an integer). You should be able to check this by having the old and new versions of the project open side by side, for instance, and making identical calls on Simulator objects in both, expecting identical outcomes. do { statements } while(expression); Example: do { System.out.print("Please enter a filename: "); input = readInput(); } while(input == null); Z04_BARN7367_06_SE_APPD.indd 612 4/11/16 3:52 PM D: Java Control Structures | 613 D.3.3 for The for loop has two different forms. This provides a clearly defined way for an M14_BARN7367_06_SE_C14.indd 555 4/11/16 3:43 PM 556 | Chapter 14 ■ Handling Errors object to report to a client that something has gone wrong. ■ Exercise 3.43 Draw an object diagram of the situation you have after creating a mail server and three mail clients. This string is later available to the receiver of the exception via the exception object's getMessage and toString methods. H.6 More information More detailed information is available in the Team Work Tutorial, which is accessible via the BlueJ Tutorial item in BlueJ's Help menu. A return type is written just before the method name. The plus operator, therefore, represents string concatenation again, as seen in Section 2.9. Before continuing, we will now look at string concatenation a little more closely. Exercise 4.18 What might the header of a listAllFiles method in the MusicOrganizer class look like? Chapter 3 ■ Object Interaction It is very important to understand these two different diagrams and different views. Don't worry about the loop's body. It also includes methods for opening files, such as newBufferedReader. In this method, we used the following statement as the central section of code: nextRoom = currentRoom.getExit(direction); This statement retrieves from the current room the neighboring room in the direction we want to go. Exercise 12.31 What sort of regression-testing strategy could you establish before undertaking the process of refactoring on the simulation? When you now list the news feed again, will the post listed there have a comment attached? This is exactly what happens when an object variable is passed as a parameter to a method: there is only one object, but both the original variable and the parameter variable refer to it. There are some types of collections that do not naturally associate integer indices with the items they store. Exercise 4.13 Suppose that an object is stored at index 6 in a collection. These are particularly useful when a listener interface is not a functional interface (it has more than one abstract method) and cannot be implemented via a lambda expression. Change the actionPerformed method so that it calls the corresponding method when a menu item is activated. The operations are of two different kinds: intermediate operations and terminal operations. This involves writing a class comment and method comments for each class in the project. .); } catch(Exception e) { System.out.println("Error: " + e); } String phone = details.getPhone(); The exception has been caught and reported, but no account has been taken of the fact that it is probably incorrect, just to carry on regardless. Now we seem to have reached an appropriate level of abstraction that we can represent as a class: a two-digit display class. 4.3 An organizer for music files We are going to write a class that can help us organize our music files stored on a computer. This is where streams and lambdas meet: the parameter to each of the methods is a lambda. Figure 2.2 shows a diagrammatic representation of a ticket-machine object with its three fields. Operations in a pipeline often take lambdas as parameters in order to specify what is to be done with each element of the sequence. It is often used to read input from the keyboard. You should see the following: getBalance, getPrice, insertMoney, and printTicket. It has not changed very much. In it, add a menu item labeled About ImageViewer Exercise 13.31 Add a method stub (a method with an empty body) named showAbout, and add an event handler that calls showAbout to the About ImageViewer enu ite One of the main characteristics of a dialog is whether or not it is modal. M02_BARN7367_06_SE_C02.indd 90 4/11/16 3:02 PM 2.23 Summary | 91 Add two accessor methods to the class—getAuthor and getTitle—that return the author and title fields as their respective results. Strings are immutable objects, so methods such as trim that appear to be mutators actually return a new String object representing the result of the operation. Exercise 12.67 Challenge exercise Rewrite the foxes-and-rabbits simulation in the event-based style. See Section B.4 for more details. First, a programmer making use of a class should not need to know the internals; second, a user should not be allowed to know the internals. 2.14 A further conditional-statement example The printTicket method contains a further example of a conditional statement. Type in 50 and click OK. Our concern in this chapter is not to resolve such disputes, but to try to prevent them from arising in the first place. A design pattern describes a common problem that occurs regularly in software development and then describes a general solution to that problem that can be used in many different contexts. We shall come back to this below. 10.7.4 Polymorphic variables Variables holding object types in Java are polymorphic variables. And we add ShowCollection to the collaborators. Examine the InputReader further by creating an object of this class and then looking at the object's methods. Assume that we create a MessagePost and a PhotoPost object with the following data: The message post: Leonardo da Vinci Had a great idea this morning. public void storeMarkInList(int mark) { markList.add(mark); } 4/11/16 3:17 PM | 228 Chapter 6 ■ More-Sophisticated Behavior The reverse operation—unboxing—is also performed automatically, so retrieval from a collection might look like this: int firstMark = markList.remove(0); Autoboxing is also applied whenever a primitive-type value is passed as a parameter to a method that expects a wrapper type, and when a primitive-type value is stored in a wrappertype variable. Is it easy or hard to find methods you are looking for? So this string serves as our software simulation for the clock's output device.1 In addition to the display string, the ClockDisplay class has two more fields: hours and minutes. These characteristics will lead us to explore a further feature of Java in the next section. Exercise 12.10 Check to see that setting the useShared field in Randomizer to false breaks the repeatability of the simulations seen in Exercise 12.9. Be sure to restore it to true afterwards, because repeatability will be an important element in later testing. 12.1 Simulations Computers are frequently used to simulate real systems. M14_BARN7367_06_SE_C14.indd 523 4/11/16 3:43 PM 524 | Chapter 14 ■ Handling Errors Code 14.5 Throwing an exception Concept An exception is an object representing details of a program failure. The forEach method is a terminal operation because it does not return another stream as a result—it is a void method. Invoking this method is valid only because the class Post (the static type!) has a toString method. In those cases, it can be beneficial to write a class prototype. It is also not a parameter, as those are always defined in the method header. If we don't find an entry for that word, we call a method called pickDefaultResponse. So what are the benefits of a while loop over a for-each loop? For example, the result of the expression "Java" + "with BlueJ" is the single string "Javawith BlueJ" Note that the system does not automatically add a space between the strings. The nature of file output means that any of these steps could fail, for a range of reasons, many completely beyond the application programmer's control. 3.12.3 Summary of the clock display It is worth looking for a minute at the way this example uses abstraction to divide the problem into smaller parts. (MessagePost inherits the fields from Post.) Instances of PhotoPost will have all fields defined in PhotoPost and in Post. For instance, here is some code to identify all of the message posts in a list of posts and to store them in a separate list. Fields are used to store data that persist throughout the life of an object. Apart from the major changes described so far, this edition also presents numerous minor improvements. We shall briefly discuss the different files below. We can store whatever type we choose, but we have to designate that type when declaring an ArrayList variable. System.out.println("You must insert at least: " + (price – balance) + " more cents."); The single actual parameter to the println method consists of a concatenation of three elements: two string literals on either side of a numeric value. For this, we use another example. They all have a void return type and take no parameters. 6.6.1 The concept of a map Concept A map is a collection that stores key/ value pairs as entries. map We can map a stream to a new stream, where each element of the original stream is replaced with a new element derived from the original. Add an Adjust menu to the menu bar. Exercise 10.5 Create a MessagePost object. For example: private final int SIZE = 10; Here, we define a constant named SIZE with the value 10. The compiler notices that Car and Bicycle do not form a subtype/supertype relationship, so c can never hold a Bicycle object—the assignment could never work. Older, more primitive GUI systems handled this with two-dimensional coordinates: the programmer specified x- and y-coordinates (in pixels) for the position and the size of each component. Thus, for our purposes, a HashSet and a TreeSet are very similar. We have to keep this in mind so that later, when we play through the scenario of Scheduling a new show, we remember to create a theater instance for each show.) The way a show deals with reserving a seat is probably by passing this reservation request on to the theater. The testAddDetailsError method of AddressBookTest will trigger an assertion error, because addDetails should not be used to change existing details (see Exercise 14.34). In the remainder of this book, we shall encounter many more such operations, sometimes written with operator symbols (such as "+") and sometimes written as method calls (such as substring). When we do this exercise with students, some students immediately leave out some nouns. There are also many GUI/Swing tutorials available, both in print and on the web. Of particular value is documentation for the public elements of a class or interface, so that programmers can make use of it without having to know the details of its implementation. Declaring fields public breaks the information-hiding principle. Our GUI class does not instantiate a JFrame M13_BARN7367_06_SE_C13.indd 506 4/15/16 3:07 PM 13.10 Another example: MusicPlayer | 507 object; instead, it extends the JFrame class. Exercise 14.12 Is it necessary to report the detection of an invalid key in a call to removeDetails? ■ How should a server report errors to its clients? Every simulation is necessarily a simplification of the real thing. 14.9.2 The File class and Path interface A file is much more than just a name and some contents. Casting should be avoided wherever possible, because it can lead to runtime errors, and that is clearly something we do not want. 16.3.1 Designing class interfaces In Chapter 15, we suggested that the next step was to create a fresh set of CRC cards from the first, turning the responsibilities of each class into a set of method signatures. Here is what might happen next: The user (the cinema employee) wants to find all showings of The Shawshank Redemption that are on tonight. 15.1.5 Scenarios Concept Scenarios (also known as "use cases") can be used to get an understanding of the interactions in a system. Use an if-statement. Objects of class MessagePost will nonetheless have fields for username, timestamp, and so on. Once found, you want to stop looking rather than complete the list (which would be pointless). /** * Increase score by the given number of points. As the loop's condition should evaluate to true if we want to iterate one more time, each of the finishing criteria should, on their own, make the condition evaluate to false to stop the loop. The functional constructs present an alternative to the imperative collection processing discussed in Chapter 4. M16_BARN7367_06_SE_C16.indd 597 4/11/16 3:48 PM 598 | Chapter 16 ■ A Case Study 16.4.6 Reuse Currently, our goal has been to simulate the operation of vehicles in order to assess the commercial viability of expanding a business into a new area of the city. As a general rule, strings should almost always be compared with equals, rather than with the == operator. Teacher and Student are both subclasses of Person. You could place all of the file handling in the Parser class so that, as each line is read, it is written out immediately in exactly the same form as it was read. Swing uses a very flexible model to deal with GUI input: an event-handling model with event listeners. To do this, we shall learn to use the Java language (although there are many other programming languages that could be used to write code). Many of the Swing components are containers. The reason is not that text-based interfaces have any great advantage in principle; they just have the one advantage that they are easier to create. Theater A has 26 rows with 18 seats each. Exercise 14.40 ContactDetails are immutable objects—that is, they have no mutator methods. In fact, it can also be used to describe the location of something on a local file system. This suggests that we might be able to reuse some of the ideas involving actors that we saw in Chapter 12. The Color class defines some color constants, which we can refer to as follows: Color.RED Using these constants requires the Color class to be imported in the using class. This is called an internal method call. We have now seen how we can use a for-each loop to perform some operation (the loop body) on every element of a collection. Every window has at most one JMenuBar.3 ■ JMenu—Objects of this class represent a single menu (such as the common File, Edit, or Help menus). Exercise 15.14 Are there any other organizations that might use booking systems similar to the one we have discussed? They are not intended to be used in released code. Examine its methods and try calling some (such as add, remove, size, isEmpty). The whole body of a class is a scope, as is the body of each method and the if and else parts of an if-statement. Here is one way to express the search: while(the keys are missing) { look in the next place } When we arrive at the loop for the first time, the condition is evaluated: the keys are missing. What error message do you see now when you try compiling the class? For example, when calling a method to find a free seat in the cinema system, a method could always return seat 3, row 15 instead of actually implementing the search. The supporters of the freeway proposal claim that splitting the park in half will lead to little actual land loss and make no difference to the animals in it, but environmentalists claim otherwise. Many more configuration options can be found by reading the bluej.defs file. This appendix is only a summary, and it should be read in conjunction with the full API documentation. So far, we have not seen examples of public fields, and there is a good reason for this. Exercise 2.85 Add a field, pages, to the Book class to store the number of pages. dynamic type The dynamic type of a variable v is the type of the object that is currently stored in v. That is okay as an experiment, but seldom useful. Exercise 2.28 Compare the method headers of getPrice and printTicket in Code 2.1. Apart from their names, what is the main difference between them? exception handler Program code that protects statements in which an exception might be thrown is called an exception handler. Recognizing these patterns means that we can often reuse part or all of a method or class we have previously written in a new situation. The constructor space is used to provide space to store the values for the constructor's parameters. ■ How should a client deal with failure of a request? They are commonly found controlling the choice between the two paths through a conditional statement. The most important methods of the HashMap class are put and get. Doesn't the following example illustrate the same flow of control as Code 14.14? However, although the FileReader class contains a method to read a single character,7 it does not contain a method to read a line. That was not necessary for utilizing its functionality. The simple data requirements make it easy for spotters in remote locations to send back relatively small amounts of valuable information—perhaps in the form of a text message— to a base that is then able to aggregate the data and create reports or direct the field workers to different areas. Exercise 4.25 Add the listMatching method in Code 4.4 to your version of the roject se music-organizer-v3 if you do not already have your own version.) Check that the method only lists matching files. Graphical user interfaces (GUIs) are also constructed from interacting objects, but they have a very specialized structure, and we avoided introducing them before discussing object structures in more general terms. Make the changes discussed above. class StringBuilder The StringBuilder class offers an efficient alternative to String when it is required to build up a string from a number of components: e.g., via concatenation. If no method is found in the superclass, the next superclass (if it exists) is searched. Concept The scope of a variable defines the section of source code from which the variable can be accessed. 2.4 Fields, constructors, and methods The inner part of the class is where we define the fields, constructors, and methods that give the objects of that class their own particular characteristics and behavior. Assume that you want a static method called numberOfInstances that returns the number of instances created. The BlueJ tutorial provides more detail if you are interested. More than two subclasses can inherit from the same superclass, and a subclass can, in turn, be a superclass to other subclasses. Can you understand why this happens? The class JFrame has a method called setJMenuBar. Exercise 1.15 Look at the pop-up menu of class Picture again. The return type of a method is not part of its signature. Conduct tests that cause both branches of the if-statement to be executed. Call the getName method on each object. This was just a single example of a useful class from the Java library. If a method has no parameter, the method name is followed by an empty set of parentheses. remaining MouseListener methods omitted ... You have five types—classes or interfaces—(U, G, B, Z, and X) and a variable of each of these types. 14.5.3 Throwing and catching multiple exceptions Sometimes a method throws more than one type of exception in order to indicate different sorts of problems. Code 2.2 Our ordering of fields constructors, and ethods Exercise 2.10 From your earlier experimentation with the ticket machine objects within BlueJ, you can probably remember the names of some of the methods— printTicket, for instance. These include class and interface types from the Java library (such as String) and user-defined types. The two boolean literals are true and false. If both operands are numbers, it represents addition, as we would expect. Finally, we make use of the fact that the private elements of an object are directly accessible to an instance of the same class; this is essential in situations such as this one, because there will not necessarily be accessor methods defined for every private field in a class. positive testing Positive testing is the testing of cases that are expected to succeed. A very good starting point for this, as so often is the case, is the Java Tutorial, available publicly on Oracle's web site. 1.1 Concept Java objects model objects from a problem domain. Exercise 14.37 The AddressBookDemo class contains several test methods that call methods of AddressBook that contain assert statements. If we add all the rabbit's food values, the fox will have a very high food level, making it unlikely to die of hunger for a very long time. M02_BARN7367_06_SE_C02.indd 69 4/11/16 3:02 PM 70 | 2.10 Chapter 2 ■ Understanding Class Definitions Method summary It is worth summarizing a few features of methods at this point, because methods are fundamental to the programs we will be writing and exploring in this book. Having variables that can hold any object type is not often useful, but there are some situations where this can help. For instance, a collection object's get method might be called with an index value outside the valid range. The addition of default methods to interfaces in Java 8 muddied the waters in the distinction between abstract classes and interfaces, since it is no longer true that interfaces never contain method bodies. There are many situations in which the order elements in a collection are processed does not matter, or when the processing of an element in the collection is largely independent of the other elements. Write down the arguments for and against including it. While ignoring errors is harder to do when exceptions are used, we have often seen the equivalent of the following approach to exception handling: AddressDetails details = null; try { details = contacts.getDetails(. The for-each loop is intended for definite iteration over a collection, and the for loop falls somewhere between the two. Key methods are add, get, iterator, remove, removeIf, size, and stream. 2.21 Calling methods The getLoginName method illustrates a new feature that is worth exploring: public String getLoginName() { return name.substring(0,4) + id.substring(0,3); } We are seeing two things in action here: ■ Calling a method on another object, where the method returns a result. The interfaces we are talking about now are neither interfaces of classes nor the Java interface construct. We store them in instance fields so that we can access them later to change their displayed text. We can see that the variable v actually contains an object of type Car, so the assignment to c would be okay. Which containers/layout managers might have been used to create it? Is there a way to decide on a time-step size that is not so small that most of the time nothing will be happening, or too long that different types of actions are not distinguished clearly enough between time steps? Anywhere that an object of a functional interface type is required, a lambda expression may be used instead. For example, it is common, when introducing types, to give a full list of built-in data types, or to discuss all available kinds of loop when introducing the concept of a loop. But in practice, this is a surprisingly useful layout that is used in many applications. The first is that it is a bad idea to use text strings, such as the room's name, to identify the room. Assess the impact of this change on the results of the simulation. To get the brightness of a pixel, you can get its red, green, and blue values and add them up. Do you think it would be more appropriate to calculate this value directly, from the number of unique entries in the TreeMap? Now create a few objects, call some of their methods, and observe the output in the terminal window. Fortunately, the implementors of the Java API have recognized this problem and provided no-op implementations of these interfaces in the form of abstract Adapter classes; for instance, MouseAdapter and MouseMotionAdapter. 6.17.2 The collect method of streams (Advanced) In this section, we continue the discussion of Java 8 streams and lambdas that we started in the previous (Advanced) chapter. David would like to add his personal thanks to both staff and students of the School of Computing at the University of Kent. Only this class is coupled to the concrete animal classes, making it easier for a maintenance programmer to find places where change is necessary when the application is extended. 15.7.6 Pattern summary Discussing design patterns and their applications in detail is beyond the scope of this book. The NumberDisplay class Before we start to analyze the source code of the full clock-display project, it will help if you gain an understanding of the NumberDisplay class, and how its features support the building of the ClockDisplay class. object All classes with no explicit superclass have Object as their superclass. A.4 Configuring BlueJ Many of the settings of BlueJ can be configured to better suit your personal situation. The last line in the method reads return responses.get(index); This line does two things: ■ It retrieves the response at position index using the get method. It makes a class that is dependent upon that information vulnerable to incorrect operation if the implementation changes. This is done by ensuring that ■ no instance of class Animal can be created directly, and ■ all concrete subclasses must implement the act method. We can add a method isTransporterRoom in the Room class. Within the body of getPrice there is a single statement: return price; This is called a return statement. Coordination between elevators becomes particularly significant here. That is why we also define content equality, as distinct from reference equality. class FileReader The FileReader class is used to open an external file ready for reading its contents as characters. (We can also note in the back of our heads, or on a separate piece of paper, that each show must have its own instance of the Theater object, because several shows can be scheduled for the same Theater and reserving a seat in one does not reserve the same seat for another show. Execution will pause again when the statement is completed. A first attempt to solve the display problem might be to move the display method to the subclasses (Figure 11.2). Exercise 13.42 Add a solarize filter. Playing through scenarios takes some patience and some practice. Selecting this menu item should display a dialog with the application's name, version number, and author information. 13.8.2 Anonymous inner classes The solution to implementing multi-method interfaces using inner classes is fairly good, but we want to take it one step further: we can use anonymous inner classes. Our focus here will be on Java's while loop, which is similar to loops found in other programming languages. Given a reasonably clear description such as this, we can make a first attempt at discovering classes and methods by identifying the nouns and verbs in the text. Code 6.10 shows how this might be done. 3. Exercise 6.74 Write constant declarations for the following: ■ ■ ■ A public variable that is used to measure tolerance, with the value 0.001. Code 12.5 An unsatisfactory single-list solution to making ani als act The fact that in Code 12.5 each type of animal must be tested for and cast separately, and that special code exists for each animal class, is a good sign that we have not taken full advantage of what inheritance has to offer. Expressions that select an element from an array can be used anywhere that a variable of the base type of the array could be used. ■ It stores that random number in the local variable index. The notation is similar to that used in BlueJ to show objects on the object bench, except that we show a bit more detail here. Public elements are accessible from inside the same class and from other classes; private elements are accessible only from within the same class. Is this something you could conveniently automate? Exercise 5.19 Rewrite your getCount method using streams, as shown here. From it, all objects inherit default implementations for important methods such as equals and toString. Thus, the result of the expression (27 % 4) would be 3. Their main disadvantage is that the activities are not easily repeatable. It could even be covered first. Does the printed ticket look any different from those printed by the first machine? For instance, can you find a way to provide a header line and align the artist, title, and other parts of the track information? There are many ways in which an input or output operation could fail at any stage. The easiest way to obtain a Collector is use one of the static methods defined in the Collectors class of the java.util.stream package: toList, toMap, and toSet. One of the authors is also the development lead of the BlueJ system. This uses the Arrays class from the standard library and a static method (also known as class method) that we do not really want to discuss just yet. 15.5 Prototyping Instead of designing and then building the complete application in one giant leap, prototyping can be used to investigate parts of a system. Classes such as ArrayList, which get parameterized with a second type, are called generic classes (we will discuss them in more detail later). So the only definitions in class Actor are those of abstract act and isActive methods: // all comments omitted public abstract class Actor { abstract public void act(List newActors); abstract public boolean isActive(); } This should be enough to rewrite the actor loop in the Simulator (Code 12.6), using class Actor instead of class Animal. But because a car is a vehicle, it is perfectly legal to store a car in a variable that is intended for vehicles. These methods are essentially the same (except for some small details), and for each new filter we have to add another one of these methods. Location is added as a collaborator of Vehicle. We know some things about poodles—for example, that they are alive, they can bark, they eat meat, and they give birth to live young. Our book is clearly designed as a textbook, and wherever a conflict occurred, the textbook style took precedence over its use as a reference book. Streams, and the stream functions, become even more useful when several functions are combined into a pipeline. The value for the second parameter is one of the public constants NORTH, SOUTH, EAST, WEST, and CENTER, which are defined in class BorderLayout. This design should work.) Before executing, predict which of the display methods will get called if you execute the news feed's show method. A GUI is added in Chapter 11. They can try out a method immediately after it has been written, without the need to write test drivers. We will come back to this in Chapter 6, where we shall see how to create a new collection out of the transformed sequence. ■ Exercise 13.14 Open and test the imageviewer0-4 project. The Random class also offers a method to support this. Using two very different examples supports the iterative approach: each concept is revisited in a different context after it is introduced. These colored annotations are known as scope highlighting, and they help clarify logical units of your program. M15_BARN7367_06_SE_C15.indd 564 4/11/16 3:45 PM 15.2 Class design | 565 15.2.1 Designing class interfaces Before starting to code our application in Java, we can once more use the cards to make another step toward the final design by translating the informal descriptions into method calls and adding parameters. verb/noun Classes in a system roughly correspond to nouns in the system's description. In TechSupport's complete version, the system manages to produce reasonably varied responses—sometimes they even seem to make sense! In the prototype version we are using as a starting point, the responses are much more restricted (Figure 6.1). The huge amount of high quality support material makes Java an excellent choice as an introduction to object-oriented programming. (boolean is a type that can represent two values: true and false. Code 14.11 Multiple catch blocks in a try statement When an exception is thrown by a method call in a try block, the catch blocks are checked in the order in which they are written until a match is found for the exception type. Exercise 1.34 Write the header for a method named average that has two parameters, both of type int, and returns an int value. There remains one problem: Java has some types that are not object types. We shall call it the constructor space of the object (or method space when we talk about methods instead of constructors, as the situation there is the same). Create an instance of class Picture and invoke its draw method. The main classes we shall be discussing are AddressBook (Code 14.1) and ContactDetails. Exercise 6.32 How do you print out all keys currently stored in a map? Exercise 6.57 Interactively create an instance of class Canvas and try some of its methods. We might ask you to "invoke the moveRight method of circle1." 1.4 Concept Methods can have parameters to provide additional information for a task. Create a NewsFeed object. Each operation creates a fresh stream, based on its input and the operation, to pass on the next operation in the sequence. The syntax of an external method call is object . Hint: You could add protected accessors to do this. Exercise 12.43 Repeat some of your experiments with different sizes of fields (especially smaller fields). You can think of an OFImage as a two-dimensional array of pixels. Do the same with the Responder class. Then modify the display methods in MessagePost and PhotoPost so that the MessagePost version prints out only the message and the PhotoPost version prints only the caption. Exercise 6.41 Challenge exercise Create a class called SortingTest. In short, for a learner to become a good programmer, it is necessary to become familiar with both styles of processing collections. Does it behave as expected? On the other hand, many Java details are essential to actually doing practical programming work. One of the main problems is that it always gives the same response, regardless of the user's input. Exercise 15.10 Document all classes and methods. Vehicle responsibility: Request destination location; Passenger responsibility: Provide destination location. This is because they return information to the caller about the state of an object; they provide access to information about the object's state. Exercise 5.13 Does the order of the two filter calls matter in your solution to the re ious e ercise ustif our ans er 5.5.4 The map method The map method is an intermediate operation that creates a stream with different objects, possibly of a different type, by mapping each of the original elements to a new element in the new stream. Identify and explain the differences between them. Hint: Use a boolean local variable. Is the level of complexity of each too high, too low, or just right? The following lines add two items, labeled Open and Quit, to the File menu: JMenuItem openItem = new JMenuItem("Open"); fileMenu.add(openItem); JMenuItem quitItem = new JMenuItem("Quit"); fileMenu.add(quitItem); Exercise 13.5 Add the menu and menu items discussed here to your imageviewer project. A combo box is a set of values, one of which is selected at any time. New programmers often find it difficult to work out whether a variable should be defined as a field or as a local variable. We note TaxiCompany as a collaborator of PassengerSource and add Request a pickup as a responsibility. For instance, the Fox and Rabbit classes share many similar characteristics that suggest they should be subclasses of a common superclass, such as Animal. 6.12 Concept access modifiers define the visibility of a field, constructor, or method. That phase largely involves the sorts of task we have been doing throughout this book in previous chapters, and we hope that by now readers can determine for themselves how to continue from here. The expression used to switch on and the case labels may be strings. Functional programming could be covered as an advanced topic at the end of the traditional corpus of this book, or it could be addressed when we first encounter the topics where it is applicable, as an alternative to the imperative techniques. Exercise 6.27 Create a class MapTester (either in your current project or in a new project). Add an assert statement (and any other statements you might need) to check this. Note, however, that typing "Bye" or " bye"—starting with a capital letter or with a space in front of the word—is not recognized as starting with "bye". Formal parameters have a scope that is limited to their defining constructor or method. Resize the resulting frame (make it larger). Exercise 1.18 Challenge exercise (This means that this exercise might not be solved quickly. This style is often called definite iteration. The sophistication of the tool added significant complexity to the task of learning. 1.5 Concept Parameters have types. As we have seen with the removeDetails method, this can lead to a fatal runtime error. The ActionListener interface contains a single abstract method, which means that it fits the definition of a functional interface, as discussed in Chapter 12. u x b z g = = = = = b; g; u; u; x; What can you say about the types and their relationships? Strings are always enclosed within double quotes. The same argument discussed for library classes holds true for classes that you write: if we can use the classes without having to read and understand the complete implementation, our task becomes easier. These should print the author and title fields, respectively, to the terminal window. We will follow this convention in future versions of the imageviewer project. display 11.3 PhotoPost ... JOptionPane has, among other things, static methods to show three types of standard dialog. This illustrates the power of reuse that we gain from good class structure and class design. M10B_BARN7367_06_SE_C10.indd 387 4/11/16 3:32 PM 388 | 10.10 Chapter 10 ■ Improving Structure with Inheritance Summary This chapter has presented a first view of inheritance. For instance, try three-quarters and one quarter, or two-thirds and one-third. We shall follow the convention of defining and using exception classes that are subclasses of the Exception class, also defined in java. Compare Figure 4.1 with Figure 4.2, where a third file name has been stored. Even more, the notion of a complete software system does not exist at all! The traditional waterfall model has as its goal the delivery of a complete system. After we have added the menus and created the (initially empty) methods to handle the filter functions, we need to implement each filter. Each of the number displays would be a field in the clock display (Code 3.2). 13.6 ImageViewer 2.0: improving program structure Version 1.0 of our application has a useable GUI and can display images. M10B_BARN7367_06_SE_C10.indd 365 4/11/16 3:32 PM 366 | Chapter 10 ■ Improving Structure with Inheritance Now let us compare the MessagePost source code with the source code of class PhotoPost, shown in Code 10.2. Looking at both classes, we quickly notice that they are very similar. In order to develop the second set of tests, the Location class was enhanced with the distance method, to provide the number of steps required to move between two locations.1 In normal operation, the application runs silently, and without a GUI there is no visual way to monitor the progress of a taxi. Exercise 12.25 Each animal is always held in two different data structures: the Field and the Simulator's rabbits and foxes lists. Exercise 6.63 Write a method drawPentagon that draws a pentagon. If you have worked in a group, assign responsibilities for classes to different group members. We assume that we want an object that responds to the same method calls (has the same interface) as the existing object, but has added or altered behavior. As a consequence, a client could easily carry on as if nothing has happened, and could then end up terminating with a NullPointerException. This means that the serialization process is managed automatically by the runtime system and requires little user-defined code to be written. It causes the condition in the if-statement to be true if both the conditions on either side of the "&&" symbol are true. The for-each loop gets its name from the way we can read this loop: if we read the keyword for as "for each" and the colon in the loop header as "in," then the code structure shown above starts to make more sense, as in this pseudo-code: for each element in collection do: { loop body } When you compare this version to the original pseudo-code in the first version, you notice that element was written in the form of a variable declaration as ElementType element. The final statement in the body of the while loop illustrates a special operator for incrementing a numerical variable by 1: index++; M04_BARN7367_06_SE_C04.indd 151 4/11/16 3:10 PM 152 | Chapter 4 ■ Grouping Objects This is equivalent to index = index + 1; So far, the for-each loop is clearly nicer for our purpose. Pick a topic that interests you, and work through the stages we have outlined: analyze the problem, work out some scenarios, sketch out a design, plan some implementation stages, and then make a start. Inserting buttons into a GridLayout will result in all buttons being resized to the width of the widest button. Exercise 14.39 Suppose that we decide to allow the address book to be indexed by address as well as name and phone number. What difference does having a scroll pane make? When trying to understand how the various collection classes are used, and the relationships between them, it helps to pay close attention to their names. This repetitive process continues until the keys are no longer missing.1 Note that we could equally well express the loop's condition the other way around, as follows: while(not (the keys have been found)) { look in the next place } The distinction is subtle—one expressed as a status to be changed, and the other as a goal that has not yet been achieved. There are around 50 of these in Java, and you will soon be able to recognize most of them. At the top, it shows the class Post, which defines all fields and methods that are common to all posts (messages and photos). Instead, we might think of them as being objects that can display values from zero up to a given limit. Create the Animal superclass in your version of the project. * @param direction Ignored. Had a great idea this morning. Change the default.txt file so that it contains some responses spanning multiple lines. The closing brace is on a separate line, aligned under the keyword that defines the block. However, there are various reasons why this solution is not perfect, and we shall explore this issue further in the exercises below. Premium Website for students: The following resources are available to all readers of this book at its Premium Website, located at www.pearsonhighered.com/cs-resources: ■ Program style guide for all examples in the book ■ Links to further material of interest ■ Complete source code for all projects Instructor resources: The following supplements are available to qualified instructors only: ■ Solutions to end-of-chapter exercises ■ PowerPoint slides Visit the Pearson Instructor Resource Center at www.pearsonhighered.com/irc to register for access or contact your local Pearson representative. A method call to a method of another object is referred to as an external method call. To illustrate this feature we will develop another version of the image viewer project; one that allows simple editing of individual pixels. The source code is text written in the Java programming language. Methods can have parameters, and parameters have types. How might data be gathered on how long passengers wait to be picked up? 40 seconds ago. Convention We start names of classes with capital letters (such as Circle) and names of objects with lowercase letters (such as circle1). (For a more detailed explanation of the debugger controls, see Appendix F.) On the right-hand side of the debugger window are three areas for variable display, titled static variables, instance variables, and local variables. Playing through scenarios is best done in a group. Class PhotoPost also inherits from Post. There were good reasons for this. Typically that subset will be those elements that fulfill some condition; i.e., there is something about those particular elements that means we want to retain and act on them rather than the others. Because type checking is done using the static type, this code will compile only if class Animal has an act method with the right header. For instance, suppose we wanted to find all tracks with the word "love" in the title. Key methods are close and read. Exactly one copy exists of a class variable at all times, independent of the number of created instances. 14.7.2 The assert statement In order to deal with the need to perform efficient internal consistency checks, which can be turned on in development code but off in released code, an assertion facility is available in Java. Code 13.5 Using a Border Layout to arrange components 4 Strictly speaking, the setLayout call is not needed here, as the default layout manager of the content pane is already a BorderLayout. The File class from java.io allows a program to enquire about details of an external file in a way that is independent of the particular file system on which the program is running. (Borders are defined in the package javax. Even where there is a human user to see the error message, it will be rare for that user to be in a position to do something about the problem. So even if two or more methods in the same class use local variables for a similar purpose, it is not appropriate to define them as fields if their values don't need to persist beyond the end of the methods. Looking at the method body, we can see that it does so by calling the setValue methods of both number displays (the one for the hours and the one for the minutes). Here, we make no use of inheritance, and the situation is reminiscent of the first version of the network project introduced in Chapter 10. lang package, is Runnable. Resize the dialog and observe the resize behavior to get additional information. Exercise 6.65 Write a method called spiral that draws a spiral (see Figure 6.6). If we, for example, wanted to know how many reports a given spotter has made on a given day, we can do the following: sightings.filter(spotter == spotterID) .filter(period == dayID) .reduce(count elements); Pipelines always start with a source (a stream), followed by a sequence of operations. The java.nio package supplies several classes that support convenient access to the file system. Also, BlueJ does not show field and method names in the diagram. Figure 3.3b shows the class diagram for the same situation. This will create a folder named docs. event listener An object can listen to component events by implementing an eventlistener interface. Implement an improved version that supports the requirements of all existing scenarios. If the key is already in use in the map then this method returns its associated value, but if the key is not in use then it will return the default value rather than null. Becoming familiar with the whole Swing library takes time, and is not something done in a few weeks. Make sure that you call the method more than once, when the machine is in different states, so that both parts of the conditional statement will be executed on separate occasions. We then shift the likes and comments fields from the Post class to this new class. In this case, the toString method would not print out the details, but just create a string with the text. The data entry field shown in Figure 1.5 then lets you enter that number. They are used to provide operations to users of a class (public methods), and they are used to break up a larger task into several smaller ones to make the large task easier to handle. Abstract classes and interfaces are then introduced to deal with these problems. M13_BARN7367_06_SE_C13.indd 505 4/15/16 3:07 PM 506 | 13.10 Chapter 13 ■ Building Graphical User Interfaces Another example: MusicPlayer So far in this chapter, we have discussed one example of a GUI application in detail. Drag this icon onto the object bench. Explain, in writing, the meaning of the graph you see, and try to explain why it looks the way it looks. ■ A variable called found, initially set to false and used in the condition as !found, could keep the search going until set to true when the item is found. The concrete class names have been chosen to communicate information about both what kind of interface they conform to and some of the underlying implementation detail. The main focus of this book is to convey object-oriented programming principles in general, not Java language details in particular. The type of the object in v is actually Car, but the compiler does not know this. We do not want to make the mistake of devising tests only when the full implementation is complete. Let us look at some concrete code. Write an assignment statement in the body of the following constructor so that the name field will be initialized with the value of the constructor's parameter. Experiment with different numbers of taxis to see how the balance between these two sets of data varies. We also discuss how one object can create other objects. Using our image-processing classes, this also is easy now. So we do not need to write import statements for classes in java.lang. Exercise 14.4 The AddressBook class uses quite a lot of classes from the java.util package; if you are not familiar with any of these, check the API documentation to fill in the gaps. That is one reason why studying source code in detail is so useful at this stage. Interfaces Up to this point in the book, we have used the term "interface" in an informal sense, to represent that part of a class that couples it to other classes. Which version you prefer, again, depends on which one you find easier to read. The students who have taken his introductory OO course have always been a privilege to teach. } Fields, constructors, and methods can all be either public or private, although so far we have seen mostly private fields and public constructors and methods. The idea behind this is to design a small and clean system initially and get it into a working state in which it can be used by end users. How do they influence the formatting of the documentation? Exercise 13.39 Add a mirror filter that flips the image horizontally. Exercise 12.62 Review the source code of the Simulator class. reuse Inheritance allows us to reuse previously written classes in a new context. The body of a lambda expression is able to access any of the members of the enclosing class, including those that are private. The lambda we have written in our code is: (total, count) –> return total + count The body of the lambda should return the result of combining the running total and the element. Concept Method calling. Classes that look like this are called parameterized classes or generic classes. A shuttle will Add location to collection of target locations and choose the next one. We determine the type using the instanceof operator. This means that we shall use some AWT classes that are still used with Swing programs, but use the Swing versions of all classes that exist in both libraries. In object-oriented programming, relationships between classes are expressed via inheritance. The interface includes constructor and method signatures and comments. When a method call is encountered, the matching method is executed, and the execution returns to the method call and continues at the next statement after the call. This chapter is about collections that are not flexible but fixed in their capacity—at the point the collection object is created, we have to specify the maximum number of items it can store, and this cannot be changed. result Methods may return information about an object via a return value. This project is discussed and then extended in great detail to introduce the foundations of inheritance and polymorphism. Can you devise some tests to illustrate the problems this could cause? in the sequence. We have defined the core of the application—the data structure that stores the essential information. Have a look at the changeSize method of the triangle. It has operations for drawing lines, shapes, and text. The catalog changes as new books are bought and old ones are put into storage or discarded. It is not very useful except to establish identity. The attempt to assign v to b (with the cast) will be accepted at compile time, but will fail at runtime. 2.11 Summary of the naíve ticket machine We have now examined the internal structure of the naíve TicketMachine class in some detail. Every room should have an associated image that is displayed when the player enters the room. Exercise 6.33 Implement the changes discussed here in your own version of the TechSupport system. try { Protect one or more statements here. Explain in detail how the creation of the filter menu items and their activation works. 6 In the Java java.util package, Observer is actually an interface with a single method, update. This is a very common situation in designing class hierarchies. How many methods with this name are there? A variable is not needed because, with an internal method call, an object calls the method on itself. This process can be used to determine which class should implement which part of an application function. If we are interested in more detail, we can look further into the process and see the print method itself execute step by step. In Java, a Singleton can be defined by making the constructor private. double[] prices = new double(50); 7.3.3 Using array objects The individual elements of an array are accessed by indexing the array. In a more complete version, we would probably use a custom class for comments, as comments also have additional detail such as an author and a time. K.1 The java.lang package Classes and interfaces in the java.lang package are fundamental to the Java language, as this package is automatically imported implicitly into any class definition. 6 If you'd like to find out more about inner classes, have a look at these two sections of the online Java tutorial: and . Thus, they are known as short-circuit operators. Is that what you expected? Exercise 2.94 Challenge exercise Modify your Heater class to define three new double-precision floating point fields: min, max, and increment. (Remember that parameters of type String must be written within double quotes.) 1.13 Return values As before, you can create multiple objects. It is also referred to as the public part of a class. One rule about assignment statements is that the type of the expression on the right-hand side must match the type of the variable to which its value is assigned. Generic classes, in contrast to other classes we have seen so far, do not define a single type in Java, but potentially many types. If the exception being propagated is unchecked, then the throws clause is optional, and we prefer to omit it. You will quickly get used to the way well-structured code looks. M03_BARN7367_06_SE_C03.indd 115 4/11/16 3:06 PM 116 | Chapter 3 ■ Object Interaction Exercise 3.38 Challenge exercise Change the clock from a 24-hour clock to a hour clock Be careful This is not as eas as it i ht at first see na hour clock the hours after idni ht and after noon are not sho n as ut as Thus the inute dis la sho s alues fro to hile the hour display shows values from 1 to 12! Exercise 3.39 There are (at least) two ways in which you can make a 12-hour clock. It inherits all fields and methods from its superclass. Part of the process of learning to program involves looking out for such patterns and then using them in your own programs. In other words, within a single step of the program, one vehicle could still be heading to a pickup location while another could be arriving at a passenger's destination, and a new passenger might be requesting a pickup. The projects represent an application that stores personal-contact details—name, address, and phone number— for an arbitrary number of people. We may also want to add to the existing interface. B.4 Wrapper classes Every primitive type in Java has a corresponding wrapper class that represents the same type but is a real-object type. You do not write a toString method. 13.4.1 First experiments: creating a frame Almost everything you see in a GUI is contained in a top-level window. Exercise 13.61 Disable all menu items that cannot be used when no image is being displayed. Later in the chapter, we will add further sophistication to make a more viable music organizer and player. The LogReader and LogLineTokenizer classes use features of the Java language that we have not yet covered, so we shall not explore those in detail. For less-experienced designers, it helps to play through scenarios in a group. An if-else statement involves a decision between two different sets of statements, whereas a switch statement allows the selection of a single option from among several. The "new" techniques are not really new—they are only new in this particular kind of language. A great benefit of defining just a toString method is that we do not mandate in the Post classes what exactly is done with the description text. It ensures better modularization of an application. M14_BARN7367_06_SE_C14.indd 543 4/11/16 3:43 PM 544 | Chapter 14 ■ Handling Errors Exercise 14.34 established the principle that the addDetails method should not accept a new set of details if one of the key values is already in use for another set. 10.7.5 Casting Sometimes the rule that we cannot assign from a supertype to a subtype is more restrictive than necessary. M16_BARN7367_06_SE_C16.indd 583 4/11/16 3:47 PM 584 | Chapter 16 ■ A Case Study Exercise 16.8 Do you feel that we have described the scenario at the correct level of detail? ■ A customer calls who already has a reservation. method polymorphism Method calls in Java are polymorphic. The reason behind this requirement is that items stored in ArrayList collections have an implicit numbering, or positioning, that starts from 0. Within the body of a constructor or method, a sequence of statements implements that part of its behavior. In our first version, we had two methods to add posts to the news feed. For the balls, do not use BouncingBall, but create a new class BoxBall that moves around inside the box, bouncing off the walls of the box so that the ball always stays inside. This is interesting, because the two implementations differ greatly in the efficiency of some of their functions. If you have sound files of the right format of your own, you should be able to play them by dropping them into the audio folder. We can do this by applying a filter, map, and reduce function one after the other (Figure 5.4). A lambda taking two String parameters and returning a String result is compatible with the BinaryOperator interface, and we might give a type and name to a lambda as follows: BinaryOperator aka = (name, alias) –> return name + " (AKA " + alias + ")"; This lambda would be used by calling its apply method with appropriate parameters, for instance: System.out.println(aka.apply("Michelangelo Merisi", "Caravaggio")); M12_BARN7367_06_SE_C12.indd 452 4/11/16 3:38 PM 12.7 A further example of interfaces 12.7 | 453 A further example of interfaces In the previous section, we have discussed how interfaces can be used to separate the specification of a component from its implementation so that different implementations can be "plugged in," thus making it easy to replace components of a system. 6.1 Concept The Java standard class library contains many classes that are very useful. We shall start by examining a new project in a fair amount of detail. The expression is tested before execution of the loop body, so the body may be executed zero times (i.e., not at all). Figure 3.7 Stopped again after a single step M03_BARN7367_06_SE_C03.indd 122 4/11/16 3:06 PM sin a de u er | 123 We can now use the Step button repeatedly to step to the end of the method. However, we continuously re-evaluate and seek to improve where we see opportunities. It follows that checked exceptions should be used for failure situations that are beyond the control of the programmer, such as a disk becoming full when trying to write to a file or a network operation failing because a wireless network connection has dropped out. This way, we should arrive at a better understanding of the whole system than we would by just reading the complete solution. Your method should use the map operation as part of the pipeline. Table C.1 shows everything that is classified as an operator, including things such as type casting and parameter passing. The instanceof operator tests whether a given object is, directly or indirectly, an instance of a given class. So the method answers by just returning the value of that variable. (You may have noticed that the response does not depend on the input at all! This is certainly something we shall have to improve later.) The last part to examine is the check of the exit condition. The header of the try statement is amended to include the opening of the resource—often a file—and the resource will be closed automatically at the end of the try statement. M14_BARN7367_06_SE_C14.indd 528 4/11/16 3:43 PM 14.5 Exception handling | 529 An exception thrown from a constructor has the same effect on the client as an exception thrown from a method. We will now go on to discuss the Java syntax for the methods that implement these functions. class LinkedList LinkedList is an implementation of the List interface that uses an internal linked struc- ture to store objects. Do you notice something wrong about the value of the price field in the inspector with this version? 10.1.3 Discussion of the network application Even though our application is not yet complete, we have done the most important part. An instance of class Poodle (an actual poodle) has all the characteristics of a poodle, a dog, a mammal, and an animal, because a poodle is a dog, which is a mammal, and so on. In light of this, now try the following in the Code Pad: int sum = 0; sum = 99 + 3; This time there is no complaint, because sum has been introduced with a type and can be used without repeating the type thereafter. Propagation is common where the calling method is either unable to, or does not need to, undertake any recovery action itself, but this might be possible or necessary from within higher-level calls. It is represented in the BlueJ editor as a small stop sign (Figure 3.5). (You can do this by using the second constructor of Simulator.) Does the size of the field affect the likelihood of species surviving? Explain your answer. The two types of functionality that we need are the ability to enter elements into the set, and retrieve the elements later. It uses a Java constructor that we have not encountered before. M06_BARN7367_06_SE_C06.indd 223 4/11/16 3:17 PM 224 | Chapter 6 ■ More-Sophisticated Behavior Code 6.5 The getInput method returning a set of words Here, in addition to using a HashSet, we also use the split method, which is a standard method of the String class. In addition, associated with maintenance of code duplication is always the danger of introducing errors, because the maintenance programmer might not realize that an identical change is needed at a second (or third) location. Static variables are displayed in the upper area, instance variables in the middle area, and local variables in the lower area. Here is the method header for getPrice, preceded by a descriptive comment: /** * Return the price of a ticket. How is further development of this class likely to affect existing test classes? How do you construct an instance? For non-functional interfaces—i.e., those containing more than one abstract method—a different syntax is required, and we cover this in Section 13.8, Inner classes. Exercise 1.4 Invoke the changeColor method on one of your circle objects and enter the string "red". (The body of simulateOneStep is shown in Code 12.4.) When a Simulator object is created, all other parts of the simulation are constructed by it (the field, the lists to hold the different types of animals, and the graphical interface). This is also called the dynamic view. For the contacts list, we will use strings for both the keys and the values, but the two types will sometimes be different. We do not use an index—the position of the entry in the contacts list—to find it. Class Post (the class that the others inherit from) is called the parent class or superclass. In reality, this is probably better done in a separate class (say RoomRandomizer) than in the TransporterRoom class itself. Overall, when you finally reach the end and have managed to undertake the implementation suggested in the exercises, you will have learned about a good variety of important topics. However, we will not discuss this any further here. If the definition of the class interfaces and the documentation was done well, it should be possible to implement the classes independently. For example, moveLeft changes the xPosition attribute. M13_BARN7367_06_SE_C13.indd 464 4/15/16 3:06 PM 13.4 The ImageViewer example | 465 Code 13.1 A first version of an ImageViewer class To get a GUI on screen, the first thing we have to do is create and display a frame. You will easily see the blank line if you print a second ticket. This will enable you to write much more interesting programs. Exercise 13.70 Change the music player so that it displays a different image in its center. Java interfaces are similar to completely abstract classes: they define method headers, but generally provide no implementation. Remember to include the curly brackets that mark the start and end of the class body, but otherwise leave the body empty. } finally { Perform any actions here common to whether or not an exception is thrown. Code 14.16 shows the removeDetails method, which now contains two forms of the assert statement. The items in the library are not just a set of unrelated, arbitrary classes that we all have to learn individually, but are often arranged in relationships, exploiting common characteristics. Use the Commit function to copy your changes into the repository, and use the Update function to copy changes from the repository (which other team members have committed) into your own local copy. Some of them have Abstract in the class name, but is there any other way to tell from the documentation? We shall not discuss it in any great amount of detail. Here are some further collection examples that are more obviously related to a programming context: ■ ■ M04_BARN7367_06_SE_C04.indd 130 Electronic calendars store event notes about appointments, meetings, birthdays, and so on. When a vehicle arrives at a pickup location, the driver notifies the company. Exercise 15.13 In which ways might the cinema booking system be adapted or extended in the future? Multiple inheritance is quite easy to understand in principle but can lead to significant complications in the implementation of a programming language. Concept The method name and the parameter types of a method are called its signature. This pair consists of a key object and a value object. Z06_BARN7367_06_SE_APPF.indd 622 4/11/16 3:54 PM F: Using the Debugger | 623 F.2.2 Step The Step button resumes execution at the current statement. These will predominantly be classes associated with input/output. Java has two more access levels. After installing and starting BlueJ by double-clicking its icon, select Open . . . from the Project menu. Call its increment method and note how the method calls are represented in the Terminal window. Choose makeVisible from the menu—this will draw a representation of this circle in a separate window (Figure 1.4). Objects usually do something if we invoke a method. The constructor should take two parameters. 15.1.2 The cinema booking example This time, we will not start by extending an existing project. When it calls the company with the request, the passenger source could pass the passenger and pickup location as separate objects. You may also like to try makeInvisible and makeVisible to hide and show the circle. These libraries typically contain many hundreds or thousands of different classes that have proved useful to developers on a wide range of different projects. We actually have to be careful when using phrases such as "the same"; this is because it can mean two quite different things when talking about objects. Without their work, BlueJ would never have reached the quality and popularity it has today, and this book might never have been written. Primitive types have no methods. */ public void printList() { for(Sighting record : sightings) { System.out.println(record.getDetails()); } } We can now write the following lambda-based version of this method: /** * Print details of all the sightings. 3.14.1 Setting breakpoints To start our investigation, we set a breakpoint (Exercise 3.45). Define a constructor that takes no parameters. reduce We can reduce a stream; reducing means to apply a function that takes a whole stream and delivers a single result. We can summarize the essential features of those three components of a class as follows: ■ ■ ■ M02_BARN7367_06_SE_C02.indd 54 The fields store data persistently within an object. Exercise 1.33 Write the header for a method named send that has one parameter of type String, and does not return a value. The LogfileCreator class allows you to create your own log files containing random data. The most significant new aspects in Java 8 center around new constructs to support a (partial) functional programming style. The assignment to hourCounts is allowed because the array object is an integer array, and hourCounts is an integer-array variable. This approach fits well with both highly managed projects—such as might be undertaken by a National Park and involve motion triggered cameras and people evaluating the camera footage—and with loosely organized crowd-sourcing activities—such as national birdcounting days, where a large group of volunteers uses phone apps to send data. The Java specification answers this question. A problem with that is that a computer cannot execute Java source code directly. This is for a number of reasons. Also, try out the setBlackAndWhite and setColor methods. interface Set Set extends the Collection interface with the intention of mandating that a collection contain no duplicate elements. This exercise is harder than it looks and more important than you realize. In reality, growing software is, of course, not a contradiction to designing software. ■ A customer calls and says he forgot the seat numbers he was given for the reservation he made yesterday. If the value is greater than zero, then it is added to the balance. Chapter 9 deals with a whole group of issues connected to producing correct, understandable, and maintainable classes. Because it buffers input, it is able to offer a readLine method that is not available in most other input classes. Which implementation is better in any given application can be hard to judge in advance. Discussions tended to focus more on what to leave out, than what to throw in. M04_BARN7367_06_SE_C04.indd 140 4/11/16 3:10 PM 4.8 Playing the music files | 141 Exercise 4.16 Rewrite both the listFile and removeFile methods in MusicOrganizer so that they use your validIndex method to check their parameter, instead of the current boolean expression. This would mean that there would be an explicit association between the two classes on the class diagram. It also implements a first, simple version of the display method to show the post in the text terminal. 16.1.1 The problem description The following paragraph presents an informal description of the taxi company's operating procedures, arrived at following several meetings with them. It reads: public void setValue(int replacementValue) { if((replacementValue >= 0) && (replacementValue < limit)) { value = replacementValue; } } Here, we pass the new value for the display as a parameter into the method. Try implementing this refactoring step. Exercise 6.49 Add a method to the WordCounter class in tech-support-analysis to print the usage count of each word after the "goodbye" message has been printed. The need for this was alluded to in Section 4.3, where we noted that ArrayList is a general-purpose collection class—i.e., not restricted in what it can store. This will be a thread that runs through many chapters. Remember: The circle has a method slowMoveVertical that you can use to do this. Because all objects in our animal collections are a subtype of Animal, we can merge them into a single collection and hence iterate just once using the Animal type. Exercise 1.27 Create three students with the following details: Snow White, student ID: A00234, credits: 24 Lisa Simpson, student ID: C22044, credits: 56 Charlie Brown, student ID: A12003, credits: 6 Then enter all three into a lab and print a list to the screen. We say that int is the base type of this particular array, which means that the array object will store values of type int. Define an accessor method to return the value of temperature. The definition is: public void timeTick() { minutes.increment(); if(minutes.getValue() == 0) { // it just rolled over! hours.increment(); } updateDisplay(); } Were this display connected to a real clock, this method would be called once every 60 seconds by the electronic timer of the clock. If we have found the keys, the loop is finished and we can skip over the loop and leave the house. loop A loop can be used to execute a block of statements repeatedly without having to write them multiple times. So discovering omissions actually says something positive about the process we are using! 16.3.2 Collaborators Having identified collaborations between classes, one issue that will often need to be addressed is how a particular object obtains references to its collaborators. Import statements must always be placed before class definitions in a file. More details can be found in the testing tutorial that is available from the BlueJ web site. Fields store data persistently within an object. It serves to provide an understanding early in the development process of how the system will work. Z06_BARN7367_06_SE_APPF.indd 624 4/11/16 3:54 PM Appendix G JUnit Unit-Testing Tools In this appendix, we give a brief outline of the main features of BlueJ's support for JUnitstyle unit testing. Exercise 12.61 Challenge exercise Investigate the Comparable interface. Given that we have a large degree of freedom in our choice of variable names, it is worth following this principle of choosing names that communicate a sense of purpose rather than arbitrary and meaningless combinations of letters and numbers. Call some of its methods. Each container has its own layout manager attached. Exercise 2.61 Add a new method, emptyMachine, that is designed to simulate emptying the machine of money. M15_BARN7367_06_SE_C15.indd 560 4/11/16 3:45 PM 15.1 Analysis and design | 561 We start with a simple example scenario: A customer calls the cinema and wants to make a reservation for a seats tonight to watch the classic movie The Shawshank Redemption. ■ ■ Only fields that are constant class fields (static and final) with public visibility are allowed in an interface. For each parameter, it defines a type and a name. See how it behaves. To do this, you have to create a new OFImage with a different size, copy the pixels from the current image across (while scaling it up or down), and then set the new image as the current image. (The nouns are shown in the order in which they appear in the text; verbs are shown attached to the nouns they refer to.) M15_BARN7367_06_SE_C15.indd 558 4/11/16 3:45 PM 15.1 Analysis and design Nouns cinema booking system seat booking theater seat row customer row number seat number show movie date time telephone number | 559 Verbs stores (seat bookings) stores (telephone number) has (seats) reserves (seats) is given (row number, seat number) requests (seat booking) is scheduled (in theater) The nouns we identified here give us a first approximation for classes in our system. Consider each of these possible solutions in terms of responsibility-driven design and the handling of exceptions, along with the likely implications for playing the game if it proves impossible to write the script. Add the "extends Post" phrase again. So far, we have concentrated on two of these areas. PhotoPost filename caption * EventPost eventType * also works for the EventPost class. Unless otherwise indicated herein, any third-party trademarks that may appear in this work are the property of their respective owners and any references to third-party trademarks, logos or other trade dress are for demonstrative or descriptive purposes only. Exercise 13.68 Once you have the slide show, add a slider (class JSlider) that lets you select an image in the slide show by moving the slider. Then we can declare that a MessagePost is a Post and a PhotoPost is a Post. ■ The imageviewer2-0 project includes a complete implementation of these changes. For the process to work, total obviously has to be given an initial value of 0 for the first count to be added to. In this chapter, we have presented some of the most important classes, and have discussed how to browse the library documentation. Later exercises will encourage you to examine and modify LogEntry, because it also uses an array. Exercise 6.81 The Collections class in the java.util packages contains a large number of static methods that can be used with collections such as ArrayList, LinkedList, HashMap and HashSet. Once all output has been written, it is important for the file to be closed. Direct access to the ends of the list is efficient, but access to individual objects via an index is less efficient than with an ArrayList. Students are not expected to understand everything about these concepts immediately. That is, after all, what we have seen so far: how to build classes to do a job. This is called casting. We have seen in the discussion above that our system is not very tolerant: if we type "Bye" or " bye" instead of "bye", for instance, the word is not recognized. ■ Exercise 11.3 Modify your latest version of the network project to include the super call in the display method. Exercise 7.4 Read through the LogAnalyzer class and identify all the places where the hourCounts variable is used. A FileWriter object is often passed to the constructor of another Writer class (such as a BufferedWriter) rather than being used directly. Remember that no special syntax is required when a subclass calls a superclass method. String inputLine = reader.nextLine(); M14_BARN7367_06_SE_C14.indd 553 4/11/16 3:43 PM 554 | Chapter 14 ■ Handling Errors The nextLine method of Scanner returns the next complete line of input from standard input (without including the final newline character). ■ Ensure that taxis and shuttles are able to operate concurrently. Before doing that, though, we will discuss the quality of the solution so far. This is the case in the revised removeDetails (Code 14.3) and getDetails (Code 14.4). We implement an organizer for music files and an auction system to introduce collections. Exercise 6.20 Add a method to your RandomTester class that takes two parameters, min and max, and generates a random number in the range min to max (inclusive). We can illustrate this with the following exercise. Exercise 6.8 Implement this improvement in your version of the tech-support1 project. M14_BARN7367_06_SE_C14.indd 554 4/11/16 3:43 PM u ar | 555 Code 14.23 Serialization of a complete Address Book with all Contact Details Exercise 14.52 Modify the network project from Chapter 11 so that the data can be stored to a file. For instance: int index = 0; while(index < files.size()) { String filename = files.get(index); // Prefix the file name with the track's index. components A GUI is built by arranging components on screen. M10B_BARN7367_06_SE_C10.indd 370 4/11/16 3:32 PM 10.2 Using inheritance | 371 There are several fundamental problems with our current solution. The reason is that a subclass is a specialization of a superclass. We do this by using an example of graphical shapes that can be interactively drawn, and a second example of a simple laboratory class enrollment system. add an implementation of the filter in OFImage Numbers 1 and 3 are unavoidable—we need a menu item and a filter implementation. Non-modal dialogs allow interaction in other frames while the dialogs are visible. In practice, we would use different strategies at different times. We have used as a starting point a method of identifying nouns and verbs in a textual description of the problem. Exercise 1.10 Select Show Terminal from the View menu. Exercise 14.1 Open the address-book-v1g project and create an AddressBookDemo object. Can an instance method be called from a static method? Refer to the class's documentation to find out what they are. The publisher does not offer any warranties or representations, nor does it accept any liabilities with respect to the programs or applications. We discuss how to define fields and implement methods, and point out the crucial role of the constructor in setting up an object's state as embodied in its fields. Sometimes we make the complete state of an object immutable once it has been constructed; the String class is an important example of this. Add any other information you feel was left out in this description. To make this method more useful, we would typically override it in our own classes. Package java.net —Summary of the most important classes class URL Z11_BARN7367_06_SE_APPK.indd 640 The URL class represents a Uniform Resource Locator. It is impossible to memorize them all and all of the details that go with them. Exercise 1.29 Set the instructor, room, and time for a lab, and print the list to the terminal window to check that these new details appear. However, this does not matter in our context. For instance, a defined type of int allows a variable to store an integer value. Only when we create a new list do we really have to use the name of the specific implementation. Modularization and abstraction thus complement each other. Where is it right now? Rather, it returns a Collector that ultimately leads to the creation of a suitable concrete List object. One of these contains a value for a field defined in class Post, and the other a value for a field defined in class MessagePost. Both of them contain only the definition of methods, without method implementations. The put method inserts an entry into the map, and get retrieves the value for a given key. Exercise 1.13 Open the house project. Exercise 14.42 What methods of the Files class tell you whether a Path represents an ordinary file or a directory (folder)? The data is written. } There is nothing special about this class so far. We can see what those commands look like in text form by using the BlueJ Terminal. Suppose the ContactDetails class had a setPhone method, for instance? The most interesting of these methods is toString, which we introduce here (if you are interested in more detail, you can look up the interface for Object in the standard library documentation). In it, use a HashMap to implement a contacts list similar to the one in the example above. These should be described in sufficient detail to identify the overall purpose of each class and method. ■ These changes have all been implemented in the version of the application to be found in the address-book-v2g and address-book-v2t projects. Some methods, when called, change the state of an object. While the first chapters are written for students with no programming experience, later chapters are suitable for more advanced or professional programmers as well. Code 14.20 shows its use with in the LogfileCreator class in the weblog-analyzer project. Pitfall A common error in Java is to try to modify a string—for example by writing input.toUpperCase(); This is incorrect (strings cannot be modified), but this unfortunately does not produce an error. Second, the MessagePost constructor receives parameters needed to initialize both Post and MessagePost fields. In the following sections, we will introduce this feature, which is called inheritance. Project-driven approach The introduction of material in the book is project driven. The body of the method should print: The price of a ticket is xyz cents. Once we solve one of the subproblems, we do not think about the details of that part any more, but treat the solution as a single building block for our next problem. Furthermore, it is often the case that incorrect parameter values are the result of some form of programming error in the client that supplied them. M14_BARN7367_06_SE_C14.indd 551 4/11/16 3:43 PM 552 | Chapter 14 ■ Handling Errors Exercise 14.45 The file default.txt in the project folder of the techsupport-io project contains the default responses read in by the fillDefaultResponses method. The ImagePanel class implements a custom-made Swing component to display our image. If the statement involves a method call, the complete method call is completed before the execution pauses again (unless the call leads to another explicit breakpoint). (This is also called an exclusive or.) Exercise 3.16 Consider the expression (a && b). What can we do about this? This usually means writing an exception handler in the form of a try statement. A list does not automatically have a scrollbar. Initially, we have only two types of posts appearing in our news feed: text posts (which we call messages), and photo posts consisting of a photo and a caption. Think carefully about this before you try it, and be sure to use the t2 variable this time. If you close the editor, the source code will automatically be saved. For this project, we can treat OFImage like a library class; you will not need to modify this class. We can now insert this line into our source code so that it reads String input = reader.getInput(); input = input.trim(); if(input.startsWith("bye")) { finished = true; } else { Code omitted. In contrast, fields are used to store data that persists through the life of a whole object. It should provide a search function that allows us to find, for example, all posts by a certain user, or all photos within a given date range. Exercise 1.22 Create some Student objects. We can see in the first line of the printNextMail Item method that item is declared to be of class MailItem. Notice the use of the getOrDefault method of the HashMap, which takes two parameters: a key and a default value. If it is an int array, then all elements will be set to zero. Solarization is an effect one can create manually on photo negatives by re-exposing a developed negative. BlueJ automatically displays a UML-like diagram representing the classes and relationships in a project. This construction process is also called initialization. We call this variable the loop variable. Along with analysis and design, documentation is a further area that is often neglected by beginners. Can you find a connection between the variables t1 and t2 that would explain what is happening? 10.8 Concept All classes with no explicit superclass have Object as their superclass. This is okay for debugging, but for testing we need something better: we need a mechanism that allows easy repetition for regression testing. M06_BARN7367_06_SE_C06.indd 241 4/11/16 3:17 PM 242 | Chapter 6 ■ More-Sophisticated Behavior We have encountered two more examples of constants in the scribble project. The reduce method takes two parameters: a starting value and a lambda. For this situation, development environments commonly offer some help: code completion. ImageFileManager is a helper class that provides static methods to read an image file (in JPEG or PNG format) from disk and return it in OFImage format, then save the OFImage back to disk. Reverse lookup (finding the key for a value—i.e., finding the name for a given phone number) is not so easy with a map. Earlier versions of JUnit, up to version 3, required the method names to start with the prefix "test". That, of itself, is not an error; but the error arises from the following statement, where we assume that details refers to a valid object: book.remove(details.getName()); It is an error to call a method on a variable containing null, and the result will be a runtime error. Instead of telling each animal exactly what to do, we are just telling it to "act," and we leave it up to the animal itself to decide what exactly it wants to do. The object reference is what we have drawn as an arrow in the object diagrams. Exercise 2.86 Are the Book objects you have implemented immutable? The phrase "extends Post" specifies that this class is a subclass of the Post class. Use object serialization for this. anonymous inner classes Anonymous inner classes are a useful construct for implementing event listeners that are not functional interfaces. Because this object is being printed to System.out and it is not a String, its toString method is automatically invoked. It is intended as a basis for studying the source code largely on your own and as a source of code fragments for you to copy and modify. You can find a list of predefined color names on the API page documenting the Color class in the java.awt package. It is about programming. Code 5.1 The Sighting class M05_BARN7367_06_SE_C05.indd 179 4/11/16 3:13 PM 180 | Chapter 5 ■ unctional Processin of ollections d anced Code 5.1 continued The Sighting class Code 5.2 shows part of the AnimalMonitor class that is used to aggregate the individual sightings into a list. Using indices outside the bounds of an array will lead to a runtime error called an ArrayIndexOutOfBoundsException. To do this, create a new class called RandomTester. Now make a call to its removeDetails method with any string value for the key. Then, when the frame is built, we can show it in a completed state. The classes starting with a J are the Swing versions; these are the ones we shall use, and the two should not be mixed in an application. Code 15.2 A Singleton definition using a Java enum The singleton instance would then be accessed as Parser.INSTANCE. A super call in a method always has the form ■ super.method-name(parameters) The parameter list can, of course, be empty. Local variables are primarily used as temporary storage, to help a single method complete its task; we think of them as data storage for a single method. One potentially useful functional interface type, defined in the java. Don't actually try it, at this stage. Exercise 10.7 Set a breakpoint in the first line of the MessagePost class's constructor. Many of them are online and many are available free of charge. We use it to discuss inheritance again and see that we run into some new problems. Exercise 6.46 Identify multiple matching words in the user's input, and respond with a more appropriate answer in that case. Through the study of design patterns, a software engineer can learn a lot about good application structures and improve application design skills. The problem with reading lines from a file is that there is no predefined limit to the length of a line. Code 6.2 shows the source code of class Responder as it is in our first version. In Java, you will see a message about an IndexOutOfBoundsException. A successful test will be indicated by a message in the main window's status line. Java code Object interaction Source code Another example Return values Objects as parameters Summary 31 32 33 34 35 36 37 38 39 40 41 43 43 44 45 Understanding Class Definitions 49 Ticket machines Examining a class definition The class header Fields, constructors, and methods Parameters: receiving data Assignment 49 51 53 54 60 62 4/15/16 6:10 PM 6 | Contents 2.7 2.8 2.9 2.10 2.11 2.12 2.13 2.14 2.15 2.16 2.17 2.18 2.19 2.20 2.21 2.22 2.23 Chapter 3 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 3.10 3.11 3.12 3.13 3.14 3.15 3.16 Chapter 4 4.1 4.2 A01_BARN7367_06_SE_FM.indd 6 Methods Accessor and mutator methods Printing from methods Method summary Summary of the naíve ticket machine Reflecting on the design of the ticket machine Making choices: the conditional statement A further conditional-statement example Scope highlighting Local variables Fields, parameters, and local variables Summary of the better ticket machine Self-review exercises Reviewing a familiar example Calling methods Experimenting with expressions: the Code Pad Summary 63 64 67 70 70 71 73 75 76 77 79 81 81 83 85 87 89 Object Interaction 95 The clock example Abstraction and modularization Abstraction in software Modularization in the clock example Implementing the clock display Class diagrams versus object diagrams Primitive types and object types The NumberDisplay class The ClockDisplay class Objects creating objects Multiple constructors Method calls Another example of object interaction Using a debugger Method calling revisited Summary 95 96 97 97 98 99 100 100 108 111 112 112 116 120 124 125 Grouping Objects 129 Building on themes from Chapter 3 The collection abstraction 129 130 4/15/16 6:10 PM Contents 4.3 4.4 4.5 4.6 4.7 4.8 4.9 4.10 4.11 4.12 4.13 4.14 4.15 Chapter 5 5.1 5.2 5.3 5.4 5.5 5.6 Chapter 6 6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13 6.14 6.15 6.16 A01_BARN7367_06_SE_FM.indd 7 | 7 An organizer for music files Using a library class Object structures with collections Generic classes Numbering within collections Playing the music files Processing a whole collection Indefinite iteration Improving structure—the Track class The Iterator type Summary of the music-organizer project Another example: an auction system Summary 131 132 135 137 138 141 143 148 156 159 163 165 175 Functional Processing of Collections (Advanced) 177 An alternative look at themes from Chapter 4 Monitoring animal populations A first look at lambdas The forEach method of collections Streams Summary 177 178 182 184 186 196 More-Sophisticated Behavior 199 Documentation for library classes The TechSupport system Reading class documentation Adding random behavior Packages and import Using maps for associations Using sets Dividing strings Finishing the TechSupport system Autoboxing and wrapper classes Writing class documentation Public versus private Learning about classes from their interfaces Class variables and constants Class methods Executing without BlueJ 200 201 206 211 217 218 223 223 225 227 229 232 234 239 242 244 4/15/16 6:10 PM 8 | Contents 6.17 6.18 Chapter 7 7.1 7.2 7.3 7.4 7.5 7.6 7.7 7.8 Chapter 8 8.1 8.2 8.3 8.4 8.5 8.6 8.7 8.8 8.9 8.10 8.11 8.12 8.13 8.14 8.15 Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 A01_BARN7367_06_SE_FM.indd 8 Further advanced material Summary 244 248 Fixed-Size Collections—Arrays 251 Fixed-size collections Arrays A log-file analyzer The for loop The automaton project Arrays of more than one dimension (advanced) Arrays and streams (advanced) Summary 251 252 258 264 272 279 280 Designing Classes 283 Introduction The world-of-zuul game example Introduction to coupling and cohesion Code duplication Making extensions Coupling Responsibility-driven design Localizing change Implicit coupling Thinking ahead Cohesion Refactoring Refactoring for language independence Design guidelines Summary 284 285 287 288 291 294 298 301 302 305 306 310 314 319 320 Well-Behaved Objects 323 Introduction Testing and debugging Unit testing within BlueJ Test automation Refactoring to use streams (advanced) Debugging Commenting and style Manual walkthroughs 323 324 325 332 339 340 342 343 4/15/16 6:10 PM Contents 9.9 9.10 9.11 9.12 9.13 9.14 Part 2 Chapter 10 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 10.10 Chapter 11 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 11.10 11.11 11.12 Chapter 12 12.1 12.2 12.3 A01_BARN7367_06_SE_FM.indd 9 | 9 Print statements Debuggers Debugging streams (advanced) Choosing a debugging strategy Putting the techniques into practice Summary 348 352 353 354 355 355 Application Structures 357 Improving Structure with Inheritance 359 The network example Using inheritance Inheritance hierarchies Inheritance in Java Network: adding other post types Advantages of inheritance (so far) Subtyping The Object class The collection hierarchy Summary 359 371 373 374 377 379 380 386 387 388 More about Inheritance 391 The problem: network's display method Static type and dynamic type Overriding Dynamic method lookup super call in methods Method polymorphism Object methods: toString Object equality: equals and hashCode Protected access The instanceof operator Another example of inheritance with overriding Summary 391 393 396 398 401 402 402 405 407 409 410 413 Further Abstraction Techniques 417 Simulations The foxes-and-rabbits simulation Abstract classes 417 418 433 4/15/16 6:10 PM 10 | Contents 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 Chapter 13 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 13.10 13.11 Chapter 14 14.1 14.2 14.3 14.4 14.5 14.6 14.7 14.8 14.9 14.10 Chapter 15 15.1 15.2 15.3 A01_BARN7367_06_SE_FM.indd 10 More abstract methods Multiple inheritance Interfaces A further example of interfaces The Class class Abstract class or interface? Code 13.12 Implementation of a specific filter class M13_BARN7367_06_SE_C13.indd 491 4/15/16 3:07 PM 492 | Chapter 13 ■ Building Graphical User Interfaces Code 13.12 continued Implementation of a specific filter class As a side effect of this, the OFImage class becomes much simpler, as all of the filter methods can be removed from it. 3 Note that it is not essential that unequal objects always return distinct hash codes. The expression a || b is true if either a or b or both are true, and false if they are both false. Unlike previous chapters, it is not our intention here to introduce any major new topics. In this case, such methods should be private. You may have come across cases where you had to introduce additional classes (this is often the case with classes that represent internal data structures), and you may have noticed that you have a card for a class that was never used. You have just created your first object! "Circle," the rectangular icon in Figure 1.1, represents the class Circle; circle1 is an object created from this class. code duplication Code duplication (having the same segment of code in an application more than once) is a sign of bad design. ■ They include a type name (such as int, String, Person, etc.) ■ They include a user-chosen name for the field variable. Over the course of the next few sections, we shall examine how this class uses an array to accomplish this task. Figure I.1 The Source Code and Documentation view option More details are available at: index-137868.html Z09_BARN7367_06_SE_APPI.indd 631 4/11/16 3:57 PM This page intentionally left blank APPendix J J.1 Program Style Guide Naming J.1.1 Use meaningful names Use descriptive names for all identifiers (names of classes, variables, and methods). Pitfall A common error for beginners is to forget the double quotes when typing in a data value of type String. Applying both of these simplifications the code now becomes short enough to fit in a single line, and we can write the forEach call as: sightings.forEach(record –> System.out.println(record.getDetails())); This is the version we shall prefer in our own code. Terms introduced in this chapter: exception, unchecked exception, checked exception, exception handler, assertion, serialization Exercise 14.54 Add to the address-book project the ability to store multiple e-mail addresses in a

ContactDetails object. The loop variable is assigned the value of successive elements of the collection on each iteration of the loop. This seemingly obvious assertion is more important than might at first appear; notice that the removal process does not actually involve use of the key with the address book. And now your task: Create a new BlueJ project named star-wars. Do not comment obvious statements—assume that your reader understands Java! J.4 Language-use restrictions J.4.1 Order of declarations: fields, constructors, methods The elements of a class definition appear (if present) in the following order: package statement; import statements; class comment; class header; field definitions; constructors; methods; inner classes. Instead of introducing a new construct and then providing an exercise to apply this construct to solve a task, we first provide a goal and a problem. M13_BARN7367_06_SE_C13.indd 494 4/15/16 3:07 PM 13.7 ImageViewer 3.0: more interface components | 495 Exercise 13.44 Experiment with your filters on different pictures. Code 13.9 Displaying a modal dialog This was the last task to be done to complete "version 1.0" of our image-viewer application. What is a car in our context? You may, for example, implement a prototype to test a graphical user interface. We have two classes, and the arrow indicates that the class ClockDisplay makes use of the class NumberDisplay (NumberDisplay is mentioned in the source code of ClockDisplay). The reason for using this construct is that we have a situation known as name overloading—the same name being used for two different entities. For this purpose, we introduce two new control structures: the for-each loop and the while loop. It is only by coincidence of circumstance that John is not one of the authors of this book. u x g x = = = = z; b; u; u; The following assignments are all illegal (they cause compiler errors). The following table lists the primitive types and their corresponding wrapper type from the java.lang package. A single-line comment is introduced by the two characters "//", which are written with no spaces between them. If we could remedy these problems, then we would have a much more functional piece of software that might serve as the basis for operating a real-world ticket machine. Parameters Now invoke the moveHorizontal method. At this stage, do not worry about what all the uses mean, as they will be explained in the following sections. We have discussed most of the important concepts, but there is still a large amount of functionality to be discovered, most of which is beyond the scope of this book. If so, add these requirements to the descriptions given above and use them in your own extensions to the project. Both fountain pen and ballpoint pen are subclasses of pen, so supplying either where an object of class Pen was expected is fine. We have, however, provided support for use as a reference book by listing the Java constructs introduced in each chapter in the chapter introduction. Exercise 1.6 Invoke the changeColor method, and write the color into the parameter field without the quotes. We want to store this information in fields, therefore, to represent each student's state. The value of this field will always match the value of the integer expression used to create the array object. This means that the value of an id field remains fixed once the object has been constructed. In the same way as we think of a call to an accessor as a request for information (a question), we can think of a call to a mutator as a request for an object to change its state. You will see a list of all the students in that class printed to the BlueJ terminal window (Figure 1.10). So TaxiCompany has Passenger and Location as collaborators. Their values are not instances of classes, and it would not normally be possible to add them into a collection. Do you have any specific criticisms of it? The class diagram is shown in Figure 12.1. The main classes we will focus on in our discussion are Simulator, Fox, and Rabbit. Two issues we ought to consider, therefore, are: how often potential customers are lost because no vehicle is available to collect them, and, at the opposite extreme, how much time taxis remain idle for lack of passengers. The line MailItem item = server.getNextMailItem(user); includes a call to the getNextMailItem method of the server object. */ public void removeZeroCounts() { sightings.removeIf(sighting -> sighting.getCount() == 0); } M05_BARN7367_06_SE_C05.indd 195 4/11/16 3:13 PM 196 | Chapter 5 ■ unctional Processin of ollections d anced Once again, the iteration is implicit. If a class similar to the one we need already exists, we can sometimes subclass the existing class and reuse some of the existing code, rather than having to implement everything again. The variable is declared to be able to store cars. Every time a new scope starts (after an open curly bracket), indent the following code one level more. Exercise 16.16 The Location class currently contains no fields or methods. As part of the condition in the if-statement, it calls another method of the minutes object: getValue. interface List List is an extension of the Collection interface and provides a means to impose a sequence on the selection. Considering what steps to break the overall problem into has the added advantage of helping to identify some of the ways in which the various parts of the application are interconnected. ■ Exercise 15.5 Play through these scenarios. As a consequence, language constructs are introduced as they are needed to solve the problems before us. Which package is it in? Example: TaxiCompany receives a Passenger collaborator through its method to handle a pickup request. abstract subclass For a subclass of an abstract class to become concrete, it must provide implementations for all inherited abstract methods. This is used to describe the character set to which the characters in the file belong. Exercise 12.49 In light of all the changes you have made to these three classes, reconsider the visibility of each method and make any changes you feel are appropriate. To do this, download the Java documentation file from java/javase/downloads/ (a zip file) and unzip it at a location where you want to store the Java documentation. Make sure the program compiles and runs as before. The following code makes use of the removeIf method of the collection: /** * Remove from the sightings list all of those records with * a count of zero. This has been done so that we can read the system's default responses from a file, rather than hardwiring them into the code of the Responder class (project: techsupport-io in this chapter's folder). The company could use the distance method of the Location class to work out which is the nearest free vehicle to a pickup. Once we have created our components and positioned them on screen, we also have to make sure that M13_BARN7367_06_SE_C13.indd 462 4/15/16 3:06 PM 13.4 The ImageViewer example Concept The term event handling refers to the task of reacting to user events, such as mouse-button clicks or keyboard input. You might be able to tell that the authors of this book strongly favor the iterative development model over the waterfall model.4 As a consequence, certain tasks and skills become much more important than they would be in the waterfall model. Exercise 3.19 In Exercise 2.79 you were asked to investigate (among other things) the expressions 9 + 3 + "cat" and "cat" + 3 + 9 Predict, and then test, the result of these two expressions again. We shall see that this is done using layout managers. interface Consumer The Consumer interface takes a single parameter of its parameterized type and has a void result. Are any assertion errors generated? We will program the clock display so that it automatically creates two NumberDisplay objects for itself. Rewrite the test in the conditional statement to check the value of amountLeftToPay. Will this code compile and run? Below that is a list of all classes in the Java library. These issues are discussed in the next two sections. M06_BARN7367_06_SE_C06.indd 222 4/11/16 3:17 PM 6.8 Dividing strings 6.7 Concept A set is a collection that stores each individual element at most once. There we noted that a lambda expression may be used wherever an object of a functional interface type is required. Code 11.5 shows an example of a protected accessor method, which we could add to class Post. Often, it is very convenient if objects can easily be printed out in a sensible format. We now have almost 15 years of continuous experience teaching with this book, and this is reflected in the many minor improvements throughout. The amountToRefund variable is what is known as a local variable, because it is defined inside a method body. The width of JButton instances is initially determined by the text on the button—each button is made just wide enough to GridLayout (a) (b) M13_BARN7367_06_SE_C13.indd 480 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 481 Figure 13.8 BoxLayout (a) (b) display its text. Any of our objects can become an event listener for any of these events. Exercise 13.65 Change your application so that it can open multiple images at the same time (but only one image is displayed at any time). The entries in the circle's menu represent operations that you can use to manipulate the circle. If the user chooses a directory, the player should open all sound files in that directory (as it does now with the audio directory). This will work, because you have not made any references to the implementation of ArrayList in your own code. Maybe the system runs over a network, and the user interface is presented in a web browser on a different machine. You may also notice an additional detail about parameters. State The set of values of all attributes defining an object (such as x-position, y-position, color, diameter, and visibility status for a circle) is also referred to as the object's state. Follow that with a call to its printHourlyCounts method, which will print the results of the analysis. inheritance hierarchy Classes that are linked through inheritance relationships form an inheritance hierarchy. When a method is overridden, only the last version (the one lowest in the inheritance hierarchy) is executed. Try it. Having reached a reasonable level of confidence in the current state of the implementation, we have simply left print statements in the notification methods of TaxiCompany to provide a minimum of user feedback. Terms introduced in this chapter: abstract method, abstract class, concrete class, abstract subclass, multiple inheritance, interface (Java construct), implements M12_BARN7367_06_SE_C12.indd 458 4/11/16 3:38 PM 12.12 Summary | 459 Exercise 12.68 Can an abstract class have concrete (non-abstract) methods? The easiest way to do this is to include in the interface a JLabel that has a graphic as its label (a JLabel can display either text or a graphic or both). As a result, the objects share this variable. Examples: switch(day) { case 1: dayString = "Monday"; break; case 2: dayString = "Tuesday"; break; case 3: dayString = "Wednesday"; break; case 4: dayString = "Thursday"; break; case 5: dayString = "Friday"; break; case 6: dayString = "Saturday"; break; case 7: dayString = "Sunday"; break; default: dayString = "invalid day"; break; } switch(dow.toLowerCase()) { case "mon": case "tue": case "wed": case "thu": case "fri": goToWork(); break; case "sat": case "sun": stayInBed(); break; } D.3 Loops Java has three loops: while, do-while, and for. Before we explore other aspects of inheritance, we shall summarize the general advantages we have encountered so far: ■ ■ Avoiding code duplication The use of inheritance avoids the need to write identical or very similar copies of code twice (or even more often). Objects are created from class definitions that have been written in a particular programming language. Just as we expect to see a close link between a constructor and the fields of its class, we expect to see a close link between the constructor's parameters and the fields, because external values will often be needed to set the initial values of one or more of those fields. Each has a number of distinctive features that make it appropriate for particular situations. This method returns the current value as a string, and it adds a leading 0 if the value is less than 10. By storing the entries in the alphabetical order of their keys, finding the key and looking up the value is easy. It consists of thousands of classes, each of which has many methods, both with and without parameters, and with and without return types. } }); This code fragment looks quite mysterious when you encounter it for the first time, and you will probably have trouble interpreting it, even if you have understood everything we have discussed in this book so far. It is important to spend enough time doing this. We recognized that the main problem with the naïve ticket machine was its failure to check certain conditions. The example files we have provided with the project have both the artist's name and the track's title embedded in the file name, and we will use this feature later. This book is unique in its completely integrated use of the BlueJ environment. 8 In practice, any character can be used in place of a comma; for instance, a tab character is frequently used. Types such as int, boolean, char, double, and long are the most common primitive types. M13_BARN7367_06_SE_C13.indd 496 4/15/16 3:07 PM 13.7 ImageViewer 3.0: more interface components | 497 If we try this out, we can see that we are getting closer, but we still do not have what we want. We shall use this to find out about the library classes. With the current structure of filters, we have to do three things for each filter: 1. This would not be possible for an external class without the addition of accessor and mutator methods in the GUI class, likely provided solely for the listener's benefit. These methods can initially have empty bodies, or they could simply print out that they have been called. Exercise 12.11 Do you feel that omitting gender as an attribute in the Rabbit class is likely to lead to an inaccurate simulation? For instance, if name is the string "Leonardo da Vinci" and id is the string "468366", then the string "Leon468" would be returned by this method. We never looked at the implementation of those classes. All of the examples we have used so far to illustrate exception throwing have involved unchecked exceptions. Users should be able to enter text, edit, scroll, etc. Such an interface is called a functional interface. The numbers of rows and columns can be specified, and the GridLayout manager will always keep all components at the same size. However, it is worth noting that this interface defines no methods. Exercise 6.83 Execute the program without BlueJ. M14_BARN7367_06_SE_C14.indd 539 4/11/16 3:43 PM 540 | Chapter 14 ■ Handling Errors The first assert statement shows that an assertion will often make use of an existing method within the class (e.g., keyInUse). As long as it is used consistently, this convention allows class names to be easily distinguished from other sorts of names, such as variable names and method names, which will be described shortly. While you might not fully understand the explanations or the notation used, being aware that these methods exist will be useful to you. This example reinforces concepts introduced earlier, and is used to discuss testing and debugging. Exercise 6.18 Extend your getResponse method so that it uses an ArrayList to store an ar itrar nu er of res onses and rando l returns one of the When using a method that generates random numbers from a specified range, care must be taken to check whether the boundaries are inclusive or exclusive. Here is how that might be done: sightings.stream() .filter(s -> "Elephant".equals(s.getAnimal())) . We will see whether we can identify subcomponents in the problem that we can turn into separate classes. You can try this by either adding more tracks until they do not fit into the available space, or by resizing the window to make it too small to display the current list. 14.2.2 Parameter checking A server object is most vulnerable when its constructor and methods receive external values through their parameters. Luckily, BlueJ takes care of this for you. Bouncing-balls (Chapter 6) A graphical animation of bouncing balls; demonstrates interface/implementation separation and simple graphics. In other words, the fact that the declared type of the variable v1 is now Post does not have any effect. This is used to introduce functional processing of collections. This method has two, and a comma separates them in the header. The best starting point for understanding and experimenting with this project is the DrawDemo class. This is not always possible, and sometimes the client must enlist the help of the server. 15.1 Analysis and design Analysis and design of software systems is a large and complex problem area. For menu items, this is by default the label text of the item. Look through the AddressBook class and identify all of the assert statements to be sure that you understand what is being checked and why. However, even experienced programmers often wonder how it is possible to write the documentation before the implementation. Exercise 4.29 Suppose we express the first version of the key search in pseudo-code as follows: boolean missing = true; while(missing) { if(the keys are in the next place) { missing = false; } } 1 At this stage, we will ignore the possibility that the keys are not found, but taking this kind of possibility into account will actually become very important when we look at real Java examples. We now want the sunset in a separate method, so that we can call draw and see the picture with the sun up, and then call sunset (a separate method!) to make the sun go down. We have seen earlier that the new statement has the following form: new type-name(parameters) and we have also seen that the full type name for our collection is ArrayList Therefore, with an empty parameter list, the statement to create the new collection object should look as follows: files = new ArrayList(); Indeed, writing this statement would work as well. Furthermore, if we provide a type as an abstract class, then subclasses cannot extend any other classes. A 1 Although the autoboxing feature described in Chapter 6 provides a mechanism that also lets us store primitive values in flexible-size collections, it is nonetheless true that only arrays can directly store them. But don't worry—we shall investigate this slowly. To be able to store seat reservations, it must have a representation of the seats in the theater. Just try to find out what you need to know. Can you assume anything about the names of its fields? (You must still write a main method exactly as discussed above.) For details with this function, read the BlueJ tutorial, which you can get through the BlueJ menu Help—Tutorial or from the BlueJ web site. Because interfaces allow multiple inheritance, the use of an interface does not create such a restriction. The operators are: && and || or ^ exclusive or In addition, ! not takes a single boolean expression and changes it from true to false and vice versa. Here, we could now add code to properly handle the menu invocation. What does this suggest about the relative sizes of the initial populations and their impact on the outcome of the simulation? A good example of how this can be used in practice can be found in the Java collection hierarchy. This means that it is the classes that we write for using the library classes that provide the scenario-specific operations, such as the fact that we are dealing with music files, or playing a file that is stored in the collection. Instead, these fundamental concepts will be revisited again and again throughout the book, allowing students to get a deeper understanding over time. We revisit this exercise here, because its solution can greatly benefit from inheritance. Each particular ArrayList is a separate type that can be used in declarations of fields, parameters, and return values. However, the constructor should still use those parameters to set the name and id fields, even if the error message is printed. For instance, "individual" and "fare" are both synonyms for "passenger." A further refinement is to eliminate those entities that do not really need to be modeled in the system. static variable, class variable Classes can have fields. You have four classes (O, X, T, and M) and a variable of each of these. One thing to note is that we need to call frame.pack() at the end of the openFile method, as the size of our image component has changed. However, not all methods take parameters; many simply use the data stored in the object's fields to carry out their task. 1 CRC cards were first described in a paper by Kent Beck and Ward Cunningham, titled A Laboratory For Teaching Object-Oriented Thinking. While you are doing this, write down what you have to do to achieve this. When we think about what our program will do, we think about the object structures it creates and how these objects interact. An example can be seen in Figure 12.2. ■ FieldStats provides to the visualization counts of the numbers of foxes and rabbits ■ in the field. As a consequence, members defined as public in either the superclass or subclass portions will be accessible to objects of other classes, but members defined as private will be inaccessible. Then open a web browser, and, using the Open File . . . . These are projects that are discussed in detail to illustrate the important concepts of each chapter. display PhotoPost v1; instance of : PhotoPost M11_BARN7367_06_SE_C11.indd 398 4/11/16 3:35 PM 11.4 Dynamic method lookup | 399 The PhotoPost class has a display method and no declared superclass. We get out each post and then invoke its display method. Some are better than others—more elegant, easier to read, and easier to maintain and to extend. You see the class diagram in its main window. To both, we can add some components to create a GUI. Who does it ask? Exercise 1.36 Can an object have several different classes? M05_BARN7367_06_SE_C05.indd 194 4/11/16 3:13 PM trea s | 195 The second parameter is a lambda with two parameters: one for the running total, and one for the current element of the stream. You will see that it has only a single method available, called getInput, which returns a string. For information regarding permissions, request forms and the appropriate contacts within the Pearson Education Global Rights & Permissions department, please visit www.pearsoned.com/permissions/. If this seems a lot of code for one line, you could also write int listSize = responses.size(); int index = randomGenerator.nextInt(listSize); This code is equivalent to the first line above. The first one in our example is 0, and the second is a lambda. ■ The MailItem class is never explicitly instantiated by the user. class InnerClass { . (Figure 12.4 shows an example where we assume that we have ants, which act but are too numerous to visualize.) 12.5.4 Drawable actors: multiple inheritance Concept Multiple inheritance. .); PhotoPost photo = new PhotoPost(. Another construct for defining types in Java is the interface. For instance, the getDetails method returns a ContactDetails object corresponding to a given key, and the example below assumes that a particular key will locate a valid set of contact details: // Send David a text message. This is usually symptomatic of viewing the implementation as being more important than the design. M10B_BARN7367_06_SE_C10.indd 384 4/11/16 3:32 PM 10.7 Subtyping | 385 The post variable is able to hold MessagePost and PhotoPost objects, because these are subtypes of Post. M15_BARN7367_06_SE_C15.indd 563 4/11/16 3:45 PM 564 | Chapter 15 ■ Designing Applications It is very common for beginners to take shortcuts and not question and record every detail about the execution of a scenario. If its value is less than or equal to zero, a ticket should be printed; otherwise, an error message should be printed stating the amount left to pay. The nouns in a human language describe "things," such as people, buildings, and so on. This makes our code short and clear and eas to rite lso ecause e do not rite the loo oursel es an ore we are less likely to make errors—if we don't write the loop, it cannot be wrong. 10.4.1 Inheritance and access rights To objects of other classes, MessagePost or PhotoPost objects appear just like all other types of objects. You will find that lambdas are often used for relatively simple, one-off tasks that do not require the complexity of a full class. 4.9.1 The for-each loop Concept A loop can be used to execute a block of statements repeatedly without having to write them multiple times. layout Arranging the layout of components is achieved by using layout managers. The new stream will have the same number of elements, but the type and content of each element can be different; it is derived in some way from the original element. Which changes are more likely than others? An important point to bear in mind when dealing with library classes is that they have not been written for any particular application scenario—they are general-purpose classes. The basic pattern that emerges from the above discussion looks like this: FileWriter writer = new FileWriter(" ... The elements of the ArrayList are of type Book. Classes can now be assigned to programmers, who can work on them alone or in pairs. Exercise 13.11 Implement menu-item handling with lambda expressions, as discussed here, in your own version of the image viewer. Code 11.1 shows the relevant details of the source code of all three classes. The java.util package defines several important collection abstractions in the form of interfaces, such as List, Map, and Set. So the value of length here will be 24. A server object may be unable to fulfill a client's request because of a particular set of external circumstances. It follows that if a subclass method needed M10B_BARN7367_06_SE_C10.indd 374 4/11/16 3:32 PM 10.4 Inheritance in Java | 375 to access or change private fields in its superclass, then the superclass would need to provide appropriate accessor and/or mutator methods. However, more important at this stage are really the test classes—LocationTest, PassengerTest, PassengerSourceTest, and TaxiTest—which we discuss in Section 16.4.3. Rather than discuss this project in detail, we shall simply describe here some of the issues that arose from its development out of the previous outline version. Chapter 15 ■ Designing Applications quickly develop an executable (but not fully functional) system so that we can investigate parts of the application in practice. Thereafter, they are stored in a collection holding elements of the SimulatorView supertype, and only the interface type is used to communicate with them. Describe in writing and in detail the sequence of events that results from activating the Quit menu item. What is their purpose? Buffered input is often more efficient than unbuffered, particularly if the source of input is in the external file system. There it can later be picked up by the mail client of the recipient. Exactly when functional techniques should be introduced is an interesting question. Swing provides several different layout managers to support different layout preferences. An alternative is to use the Observer pattern introduced in Chapter 15, with Vehicle extending the Observable class and TaxiCompany implementing the Observer interface. In a language such as Java, the pseudo-random number generation has fortunately been implemented in a library class, so all we have to do to receive a pseudo-random number is to make some calls to the library. That doesn't need a class." It is really important at this stage not to do this. We have covered assignment statements and conditional statements, and will be adding further types of statements in later chapters. (A different solution will be discussed later in this chapter.) This is, in fact, quite easy to achieve. It is also possible to omit the catch blocks in a try statement that has both a try block and a finally clause if the method is propagating all exceptions: try { Protect one or more statements here. In some situations, a choice has to be made between whether to use an abstract class or an interface, while in other cases, either abstract classes or interfaces can do the job. Each theater has seats arranged in rows. Exercise 2.91 Add a further integer field, borrowed, to the Book class. Local variables are defined inside the body of a constructor or method. One indicator of this is the chapter headings. The ad hoc solution of just "having the documentation in your head" does not work anymore. However, do the exercises yourself, and use this project only if you really get stuck. You can essentially copy the code pattern from there. Revise the list as you see fit, to suit your own view of the project. Exercise 15.6 What other scenarios can you think of? Viewing a piece of software as a continuously growing, changing, adapting entity, rather than a static piece of text that is written and preserved like a novel, determines our views about how good code should be written. Chapter 7 concentrates on one specific—but very special—type of collection: arrays. Initially, we have only classes, so static methods are all we can call. One is that Java has many characteristics that make it easy to teach: it has a relatively clean definition; extensive static analysis by the compiler informs students of problems early on; and it has a very robust memory model that eliminates most "mysterious" errors that arise when object boundaries or the type system are compromised. Hint: There is only one constructor in the class. The difference is much deeper, and much more fundamental, than just adding new syntax. An implementation of this design is provided in the project network-v3. The practice of checking parameters, which we have introduced in this chapter, slightly shifts the emphasis from wholly external checking to a combination of external and internal checking. Instead of looking up entries in this collection using an integer index (as we did with the ArrayList), we use the key object to look up the value object. Objects and classes If you write a computer program in an object-oriented language, you are creating, in your computer, a model of some part of the world. Only the first is intended to be studied here. Now we want to investigate exactly how this works. The simulation loop still works unchanged. Description: Sixth edition. What should a constructor do if it receives inappropriate parameter values? M13_BARN7367_06_SE_C13.indd 477 4/15/16 3:07 PM 478 | Chapter 13 ■ Building Graphical User Interfaces Exercise 13.15 What happens when you open an image and then resize the frame? Javadoc also supports the use of HTML markup within these comments. println prints its parameter to the text terminal. The most basic form of mutator is one that takes a single parameter whose value is used to directly overwrite what is stored in one of an object's fields. The areas and buttons become active only when a program reaches a breakpoint or halts for some other reason. Because no matching method was found, the superclass is searched for a matching method. Does it behave as you expected? We start with a simple method-lookup scenario. Formally, the starting value is called an identity. Informal descriptions are rarely written in a way that suits that sort of direct mapping. For instance, all three items could be printed on a single line, or each could be printed on a separate line. Exercise 12.35 Is it necessary for a class with one or more abstract methods to be defined as abstract? 11.4 Dynamic method lookup One surprising detail is what exactly is printed once we execute the news feed's show method. The class may override either by calling the preferred version in the overriding method, or by defining a completely different implementation. Repeatedly call the increment method until the value in the inspector rolls over to zero. We can use a method to make a change to the object or to get information from the object. Elements in this set are kept in order. The file name can be either in the form of a String or a File object. Separating the application's functionality from the interface is an example of good cohesion; it makes the program easier to understand, easier to maintain, and easier to adapt to different requirements (especially different user interfaces). (Give a Java code example.) M06_BARN7367_06_SE_C06.indd 220 4/11/16 3:17 PM 6.6 Using maps for associations | 221 Exercise 6.31 What happens when you try to look up a value and the key does not exist in the map? If you do not write a call to a superclass constructor, the Java compiler will insert a superclass call automatically, to ensure that the superclass fields are properly initialized. Before we look at a proper Java example, let us look at a pseudo-code version of the key hunt described earlier, to try to develop a feel for how a while loop works. The ImagePanel object is stored in an instance field so that we can access it again later. For this to work, those parameters needed for the initialization of the post fields are passed on to the superclass constructor as parameters to the super call. M14_BARN7367_06_SE_C14.indd 533 4/11/16 3:43 PM 534 | Chapter 14 ■ Handling Errors Code 14.12 Catching all exceptions in a single catch block A better way to handle multiple exceptions with the same recovery or reporting action is to list the exception types together, separated by the "|" symbol, in front of the exception variable name. 13.4.2 Adding simple components Immediately following creation of the JFrame, the frame will be invisible and its content pane will be empty. 12 minutes ago - 4 people like this. This type is defined in class Color in the java.awt package (thus, its fully qualified name is java.awt.Color). The main difference is in their implementation, which is important only when we start thinking about efficiency: one implementation will perform some operations much faster than another. 6.11.1 Using javadoc in BlueJ The BlueJ environment uses javadoc to let you create documentation for your class in two ways: ■ ■ You can view the documentation for a single class by switching the pop-up selector at the top right of the editor window from Source Code to Documentation (or by using Toggle Documentation View from the editor's Tools menu). It represents more accurately a mixed-age population that should be the normal state of the simulation. Typically, these are conditions we wish to establish while developing a class, before it is released. It is not a cut-down, simplified version of Java for teaching. Now create a NumberDisplay object and give it the name hours, rather than usin the default na e offered Blue se a rollo er li it of 24. In this document, the key symbols are called javadoc tags. House (Chapter 1) An example using shape objects to draw a picture; introduces source code, Java syntax, and compilation. The presence of default methods in interfaces can lead to complications in the implementation of multiple interfaces by a class. If we are using an index variable to work our way through successive elements of a collection, then a failed search is easy to identify: the index variable will have been incremented beyond the final item in the list. private static final int GRAVITY = 3; private int xPosition; private int yPosition; Other fields and method omitted. The latter always move the circle a fixed distance, whereas moveHorizontal lets you specify how far you want to move the circle. M12_BARN7367_06_SE_C12.indd 421 4/11/16 3:38 PM 422 | Chapter 12 ■ Further Abstraction Techniques Exercise 12.4 What changes do you notice if you run the simulation for a much longer time, say for 4,000 steps? Lookup is flexible: entries can be searched by partial definition of name or phone number. We call the type of the object stored in a variable the dynamic type, because it depends on assignments at runtime—the dynamic behavior of the program. Figure 3.4 myDisplay: ClockDisplay Object diagram of the clock display : NumberDisplay hours minutes limit 24 value 15 : NumberDisplay 1 limit 60 value 23 The book projects folder also includes a version of this project with a simple graphical user interface (GUI), named clock-display-with-GUI. As a result, the designers of the Java language decided at some point to add some elements of functional programming to the Java language. M14_BARN7367_06_SE_C14.indd 549 4/11/16 3:43 PM 550 | Chapter 14 ■ Handling Errors 14.9.5 Text input The complement to the output of text with a FileWriter is the input with a FileReader. If they do disappear, why might that be, and does that represent realistic behavior? The first point to note is that it would be a mistake to move straight from this list of nouns to a set of classes. Now call getBalance again. The compiler translates the Java code into machine code. This does not feel right. Most importantly: the loop has disappeared completely. Conversely, if an exception is thrown from the try block, the appropriate catch block is executed, and this is then followed by execution of the finally clause. Code 14.5 also illustrates that the javadoc documentation for a method can be expanded to include details of any exceptions it throws, using the @throws tag. 15.1.3 Discovering classes The first step in identifying the classes is to go through the description and mark all the nouns and verbs in the text. Similarly, the top-level section Laying Out Components within a Container also has a How To . . . section that tells you about all available layout managers. Don't worry about understanding everything, because some new features are the subject of this section. This is called type loss. Sometimes it is tempting to leave structures as they are, even though we recognize that they are not good. implementation The complete source code that defines a class is called the implementation of that class. p = database.lookup(details); } catch(Exception e) { } System.out.println("The details belong to: " + p); Note that in all the examples of try statements you have seen, the exception is not thrown directly by the statements in the try block, which is in the client object. A.5 Changing the interface language You can change the interface language to one of several available languages. 2.8 Accessor and mutator methods We often describe methods such as the two "get" methods of TicketMachine (getPrice and getBalance) as accessor methods (or just accessors). If we allowed an abstract method in a concrete class, we would be able to create an instance of a class that lacked an implementation for a method. There are two versions. Mistakes in the overall design can, at best, be expensive to put right and, at worst, be fatal to the whole application. The first three lines in that class are import statements of all classes in the packages java. You will be prompted for the name of the new method. ■ We see that, to call a method on an object, we write the name of the object, followed by a dot, followed by the name of the method. Java uses the same syntax established in other programming languages to keep things simple for programmers who are used to arrays already, even though it is not consistent with the rest of the language syntax. How many println statements would be required to complete the method? What next methods does it have in addition to those we have discussed in this section? Because method lookup starts in the dynamic class of the instance (at the bottom of the inheritance hierarchy), the last redefinition of a method is found first, and this is the one that is executed. A programmer can get away with bad documentation when working on these mini-projects. You may recall that we briefly encountered parameters in Chapter 1 (Section 1.4). If the source code does not include such a call, Java will attempt to insert a call automatically. All shows run in theater A. */ public int length() so the following is an example of its use with the String variable fullName: fullName.length() Add conditional statements to the constructor of Student to print an error message if either the length of the fullName parameter is less than four characters, or the length of the studentId parameter is less than three characters. Exercise 12.52 Challenge exercise The text of the giveBirth methods in Fox and Rabbit is very similar. We are using the plus operator for the sole purpose of forcing a conversion of the integer value to a value of type String. They should only call get or remove on the ArrayList if validIndex returns true. Class variables are frequently used if a value should always be the same for all instances of a class. 6.17.1 Polymorphic collection types (Advanced) By now we have introduced several different collection classes from the java.util package, such as ArrayList, HashMap and HashSet. Exercise 13.13 You will notice that activating the Quit menu item now quits the program. Is it possible to use the technique illustrated with canBreed to move the common code into a shared giveBirth method in Animal? This structure is nicely cohesive and extendable. Enable a single shuttle to pick up multiple passengers and carry them concurrently to their destinations. Most applications available today do not exploit current hardware to a degree approaching anything that is theoretically possible. Technically, this will be a set of strings, where each string in the set represents a single word that was entered by the user. A competent Java programmer should be familiar with most of these. This means that all data entered will be lost each time the application ends. We can use that method to handle the second problem case. Code 14.4 Returning an out-of-bounds error diagnostic value M14_BARN7367_06_SE_C14.indd 521 4/11/16 3:43 PM 522 | Chapter 14 ■ Handling Errors Code 14.4 continued Returning an out-of-bounds error diagnostic value This would allow a client to examine the result of the call, then either continue with the normal flow of control or attempt to recover from the error: ContactDetails details = contacts.getDetails("David"); if(details != null) { // Send a text message to David. Programs that print inappropriate error messages are more likely to annoy their users rather than achieve a useful outcome. The basic structure is there, and it works. In simplified terms, the rules ensure that a client object calling a method that could throw a checked exception will contain code M14_BARN7367_06_SE_C14.indd 525 4/11/16 3:43 PM 526 | Chapter 14 ■ Handling Errors that anticipates the possibility of a problem arising and that attempts to handle the problem whenever it occurs.3 Exercise 14.24 List three exception types from the java.io package. When it receives a pickup location, it may have to choose between several possible alternative locations to head to next. Exercise 12.3 Call the simulate method with a parameter to run the simulation continuously for a significant number of steps, such as 50 or 100. To help reinforce them, we shall now revisit a few in a different but familiar context. Objects of subclasses have all fields and methods declared in their own classes, as well as those from all superclasses. There is a good reason for this: BlueJ gives us tools to make some development tasks very easy. It is not easy for inexperienced programmers to see why documentation is so important. Consider functions for formatting (font faces, style, and size) and a character/word-count function. Can you see any weaknesses in this approach? Which of the classes should be implemented first, and which should remain in rotot e sta e Exercise 15.12 Implement your cinema-system prototype. Create some MessagePost objects and some PhotoPost objects. If it is a class, name some objects. However, unlike a method, it does not belong to a class, and we will not give it a name. This call would not be allowed if class Post had no toString method. We start with an exercise. The BlueJ interface then contains three extra buttons (Update, Commit, Status) and an additional submenu titled Team in the Tools menu. Since the type of the lambda parameter must always match the type of the collection elements, the compiler can work this out, and we are allowed to omit it. Code 4.6 indin the first matching item in a list M04_BARN7367_06_SE_C04.indd 154 4/11/16 3:10 PM 4.10 Indefinite iteration | 155 It might be tempting to try to have just one condition in the loop, even though there are two distinct reasons for ending the search. We shall use the term "instance" quite regularly from now on. M15_BARN7367_06_SE_C15.indd 573 4/11/16 3:45 PM 574 | Chapter 15 ■ Designing Applications We can make good use of this pattern in our foxes-and-rabbits simulation from Chapter 12, to decouple the Simulator class from the specific animal classes. M16_BARN7367_06_SE_C16.indd 595 4/11/16 3:48 PM 596 | Chapter 16 ■ A Case Study Figure 16.2 A visualization of the city ■ ■ ■ ■ Items in the city may optionally implement the DrawableItem interface, which allows the GUI to display them. In this chapter we shall concentrate on using Swing, but many of the principles we cover will apply equally well to GUI libraries in general. | 61 A concept related to variable scope is variable lifetime. Typically, several people work together on a project by working on different parts. Objects can create other objects, and they can invoke each other's methods. Exercise 13.36 What needs to be changed to add a new filter to your image viewer? The condition is evaluated before every execution of the loop body (so the statements in the loop's body may execute zero times). Within the BlueJ editor, the source-code view of a class can be switched to the documentation view by changing the Source Code option to Documentation at the right of the window (Figure I.1), or by using Toggle Documentation View from the editor's Tools menu. 4.4.2 Diamond notation Note that when creating the ArrayList instance, we have written the following statement: files = new ArrayList(); M04_BARN7367_06_SE_C04.indd 134 4/11/16 3:10 PM 4.5 Object structures with collections | 135 This is the so-called diamond notation (because the two angle brackets create a diamond shape) and it looks unusual. Methods may return information about an object via a return value. circle_2: Circle circle_1: Circle diameter 30 diameter 50 xPosition 230 xPosition 80 yPosition 75 yPosition 30 color "red" isVisible true color isVisible M01B_BARN7367_06_SE_C01.indd 38 "blue" true 4/11/16 2:54 PM 1.9 Java code | 39 Figure 1.8 Two images created from a set of shape objects The story is similar for methods. The application we shall build in this chapter is an image viewer (Figure 13.2). Code 14.3 A boolean return type to indicate success or failure M14_BARN7367_06_SE_C14.indd 520 4/11/16 3:43 PM 14.3 Server error reporting | 521 Code 14.3 continued A boolean return type to indicate success or failure This allows a client to use an if-statement to guard statements that depend on the successful removal of an entry: if(contacts.removeDetails(". The container holds the components, but the layout manager decides their exact arrangement on screen. interface Map The Map interface offers an alternative to list-based collections by supporting the idea of associating each object in a collection with a key value. Example: TaxiCompany creates a collection to store its vehicles. Exercise 1.24 Call the numberOfStudents method of that class. ■ These scenarios should give you a good understanding of the seat lookup and reservation part of the system. When the listener object is notified, it can take appropriate action to deal with the user event. We assume that the specific action methods (run for Rabbit, hunt for Fox) have been renamed act. Figure 11.9 Possible output from display: superclass call at the beginning of display (shaded areas printed by superclass method). In Section 16.2.3, we decided that a vehicle should receive its passenger M16_BARN7367_06_SE_C16.indd 593 4/11/16 3:48 PM 594 | Chapter 16 ■ A Case Study when it notifies the company that it has arrived at the pickup point. Figure 11.3 Post post Variable of type Post containing an object of type PhotoPost : PhotoPost The compiler reports an error because, for type checking, the static type is used. if(contacts.keyInUse(details.getName()) { contacts.changeDetails(details.getName(), details); } else if(contacts.keyInUse(details.getPhone()) { contacts.changeDetails(details.getPhone(), details); } else { Add the details . In the Simulator class, the concrete subclasses GridView and GraphView are only mentioned once when each view was constructed. When a BorderLayout is resized, the middle component is the one that gets stretched in both dimensions. All projects are designed as open-ended problems. Make sure your makeSmaller and makeLarger methods get called by activating the buttons. If JUnit test classes are used to test classes containing their own assertion statements, then assertion errors from these statements will be reported in the test-results window along with test-class assertion failures. The remaining methods—insertMoney and printTicket—have a M02_BARN7367_06_SE_C02.indd 64 4/11/16 3:02 PM 2.8 Accessor and mutator methods | 65 Exercise 2.23 Compare the header and body of the getBalance method with the header and body of the getPrice method. ■ Interfaces do not contain any constructors. Something to do with flying... So the following test will return true if both var1 and var2 are referring to the same object (or are both null), and false if they are referring to anything else: var1 == var2 Reference equality takes no account at all of the contents of the objects referred to, just whether there is one object referred to by two different variables or two distinct objects. Set breakpoints in the ClockDisplay constructor and each of the methods, and then single-step through them. Although they do not provide an implementation, they nonetheless ensure that all concrete subclasses have an implementation of this method. Note that the slider is not currently functional. While the scenario is played through, the person records on the CRC card everything that is found out about the class in action: what its responsibilities should be and which other classes it collaborates with. We can use pen-and-paper diagrams, code reading, and debuggers to investigate how an application executes or to track down bugs. So far, we have seen an ArrayList, a HashMap, and a HashSet. The editor window for the MailClient class and a debugger window will pop up (Figure 3.6). result = 37 * result + count; result = 37 * result + name.hashCode(); return result; } 11.9 Protected access In Chapter 10, we noted that the rules on public and private visibility of class members apply between a subclass and its superclass, as well as between classes in different inheritance hierarchies. Now it is time to discuss how we can get started from a clean slate. Can you work out why it starts at that particular time? In many object-oriented programming languages, the internals of a class—its implementation—are hidden from other classes. What about NoSuchMethodException? Fields, therefore, provide a place to store long-lasting (i.e., persistent) data. This process is called casting (or downcasting). The Java programming language itself provides a clean implementation of most of the important object-oriented concepts, and serves well as an introductory teaching language. Test your implementation by creating machines via the two different constructors. We can verify this by experiment. We end up with a GridLayout panel inside a FlowLayout panel inside a BorderLayout. First, we have to find out how to generate a random integer number. Exercise 14.14 Why do you think we have felt it unnecessary to make similar changes to the getDetails and keyInUse methods? Figure 15.3 Observers Multiple views of one subject Rabbits Foxes Empty Model M15_BARN7367_06_SE_C15.indd 574 4/11/16 3:45 PM 15.7 Using design patterns Figure 15.4 Observable attach(Observer) detach(Observer) notify( ) Structure of the Observer pattern Field getState( ) | 575 Observer update( ) observers observed SimView update( ) For the Observer pattern, we use two types: Observable and Observer.6 The observable entity (the Field in our simulation) extends the Observable class, and the observer (SimulatorView) implements the Observer interface (Figure 15.4). The declaration introduces a new kind of variable: public int refundBalance() { int amountToRefund; amountToRefund = balance; balance = 0; return amountToRefund; } M02_BARN7367_06_SE_C02.indd 77 4/11/16 3:02 PM 78 | Chapter 2 ■ Understanding Class Definitions What sort of variable is amountToRefund? The source files can then be compiled from a command line with the Java compiler that is included with the JDK. Note that the class diagram shows only two classes, whereas the object diagram shows three objects. Figure 7.1 illustrates the result of this assignment. ■ The vehicle now requests the passenger's intended destination. Experiment with adding some files to it and playing them. The main distinction between a taxi and a shuttle is that a taxi is only ever concerned with picking up and transporting a single passenger or coherent group, but a shuttle deals with multiple independent passengers concurrently. For instance, we might want to add event posts, which consist of a description of a standard event (e.g., "Fred has joined the 'Neal Stephenson fans' group."). M06_BARN7367_06_SE_C06.indd 210 4/11/16 3:17 PM 6.4 Adding random behavior | 211 6.3.3 Checking string equality An alternative solution would have been to check whether the input string is the string "bye" instead of whether it starts with the string "bye". Does this method need to take any parameters? Initialize it to zero in the constructor. There are actually two versions of the collect method, but we will concentrate on just the simplest. Exercise 16.2 Consider simplifying the number of nouns associated with the vehicles. However, BlueJ does offer the alternative of setting a breakpoint within the act method of, say, the Taxi class. At the end of your method, you should call the frame's pack method to rearrange the components with the changed size. access modifier Access modifiers define the visibility of a field, constructor, or method. Using the abstraction concepts we have just described, we want to try to find the best way to view this example so that we can write some classes to implement it. Code 4.2 shows the new elements of the MusicOrganizer class that access some of this playing functionality. It can be used to find bugs. M06_BARN7367_06_SE_C06.indd 233 4/11/16 3:17 PM 234 | Chapter 6 ■ More-Sophisticated Behavior For now, it is important to understand that the private keyword enforces information hiding by not allowing other classes access to this part of the class. For instance: public void process() throws EOFException, FileNotFoundException An exception handler must cater for all checked exceptions thrown from its protected statements, so a try statement may contain multiple catch blocks, as shown in Code 14.11. It is a logical step that we should try to achieve the same goals for class structures that we attempted for source code. Note that you will find it hard to understand everything, as the documentation for these classes is not very good. We prefer to write Java. The first two take the name of the audio file to play. Buffered output is often more efficient than unbuffered, particularly if the destination of the output is in the external file system. Note too that, because we are writing objects in binary form, a Stream object has been used rather than a Writer. Typically, the main method should do exactly what you did interactively to start the same application in BlueJ. Terms introduced in this chapter: field, instance variable, constructor, method, method header, method body, actual parameter, formal parameter, accessor, mutator, declaration, initialization, block, statement, assignment statement, conditional statement, return statement, return type, comment, expression, operator, variable, local variable, scope, lifetime M02_BARN7367_06_SE_C02.indd 89 4/11/16 3:02 PM 90 | Chapter 2 ■ Understanding Class Definitions The following exercises are designed to help you experiment with the concepts of Java that we have discussed in this chapter. As a result, most textbooks typically either ■ ■ have to work their way through this forbidding list, and only reach objects somewhere around the fourth chapter; or use a "Hello, world"-style program with a single static main method as the first example, thus not creating any objects at all. Concept Object references. New collection classes, as well as some other useful classes, will be introduced and discussed. refactoring Refactoring is the activity of restructuring an existing design to maintain a good class design when the application is modified or extended. Z10_BARN7367_06_SE_APPJ.indd 636 4/11/16 3:58 PM Appendix K Important Library Classes The Java platform includes a rich set of libraries that support a wide variety of programming tasks. What are the possible random numbers that are enerated hen ou call this ethod ith as its ara eter Exercise 6.16 Write a method in your RandomTester class called throwDie that returns a random number between 1 and 6 (inclusive). The following code fragment creates a HashMap and inserts three entries into it. Exercise 2.67 Write out definitions for the following fields: ■ a field called name of type String ■ a field of type int called age ■ a field of type String called code ■ a field called credits of type int Exercise 2.68 Write out a constructor for a class called Module. More recent versions of Java introduced the java.nio packages, which supersede some of the older java.io classes. Then you give the child a haircut. Once we have defined our filters like this, we can create filter objects and store them in a collection (Code 13.13). Test your method on the object bench with both valid and invalid parameters. } The first two lines can also be merged into a single line: String input = reader.getInput().trim(); The effect of this line of code is identical to that of the first two lines above. Should the seat also store information about who has reserved it? | Boston : Pearson Education Inc., [2017] Identifiers: LCCN 2016009911| ISBN 9780134477367 | ISBN 0134477367 Subjects: LCSH: Object-oriented programming (Computer science) | Java (Computer program language) | Computer science—Study and teaching. The first checks basic functionality of the Location class that is crucial to correct movement of vehicles. Make sure that both words are put back as they were originally before continuing. In this appendix, we give a brief summary of the main elements of the documentation comments that you should get into the habit of using in your own source code. Pitfall If you are not careful, you may try to access a collection element that is outside the valid indices of the ArrayList. TextView provides a textual view of the simulation. In previous chapters we have assumed that large parts of the application structure already exist, and we have made improvements. Notice that we have to first create a stream from the sightings list, in order to be able to apply the filter function. int[] hourCounts; // An int-array variable. From its name, it is tempting to assume that a HashSet must be very similar to a HashMap. ■ The changeDetails method should check both that the old key is one that is in use and that the new details are not null. The Scanner class, in the java.util package, is specifically designed to scan text and convert composite sequences of characters to typed values, such as integers (nextInt) and floating-point numbers (nextDouble). Figure 13.9, for example, shows an interface arrangement similar to that of the BlueJ main window. This allows reuse of existing code and avoids code duplication. Classes that require such a type parameter are called generic classes. It achieves this with a very low degree of coupling between the observers and the observed object. Now that we know about inheritance, we must state the typing rule more completely: a variable can hold objects of its declared type, or of any subtype of its declared type. ■ We have to ask ourselves: How does the system find the show? Exercise 12.8 Make a note of the numbers of foxes and rabbits at each of the first few steps, and at the end of a long run. Immediately following its creation, an array object can be thought of as empty. 13.4.7 Lambda expressions as event handlers The material in this section makes extensive use of the lambda expression feature that was introduced in Java 8, and which was covered in detail in Chapter 5 of this book. When a breakpoint is reached during program execution, the debugger's displays and controls become active, allowing you to inspect the state of the program and control further execution. Exercise 3.29 How many times would you need to call the timeTick method on a newly created ClockDisplay o ject to ake its ti e reach o else could you make it display that time? Exercise 3.50 Set a breakpoint in the first line of the sendMailItem method in the MailClient class Then in oke this ethod se the Step Into function to step into the constructor of the mail item. M13_BARN7367_06_SE_C13.indd 501 4/15/16 3:07 PM 502 | Chapter 13 ■ Building Graphical User Interfaces We are now in a position to illustrate anonymous inner classes. Here, to simplify things for the moment, we assume that only a single word (for example, "slow") is entered by the user. M12_BARN7367_06_SE_C12.indd 427 4/11/16 3:38 PM 428 | Chapter 12 ■ Further Abstraction Techniques Exercise 12.14 As you did for rabbits, assess the degree to which we have simplified the model of foxes and evaluate whether you feel the simplifications are likely to lead to an inaccurate simulation. In fact, many of the most powerful computers in the world are used for running some sort of simulation. However, before we do this, we shall explore further what we have so far. Class ArrayList, for example, inherits from a class called AbstractList, which, in turn, inherits from AbstractCollection. This way, we can change the whole application to use a linked list by just changing ArrayList to LinkedList in a single location when the list is being created. They view that module as a single component that is used to build more-complex components. For a subclass of an abstract class to become concrete, it must provide implementations for all inherited abstract methods. intervening code omitted . Now we have to implement the showAbout method so that it displays an "About" dialog. 16.4.5 Further ideas for development The version of the application provided in the taxi-company-later-stage project represents a significant point in the development toward full implementation. In the SupportSystem class of the TechSupport system, for instance, we saw the methods printWelcome and printGoodbye declared as private methods. They are not visible to other classes. However, predicate lambdas make it relatively easy to remove all the items from a collection that match a particular condition. We will see other differences between primitive types and object types later. In general, the interface names indicate the return type and the parameter types of their single method, and hence a lambda of that type. This is used to hold the frame that the image viewer wants to show on screen. For this to be the case, we need one more thing: a specific class method known as the main method. We separate the discussion of working without BlueJ into two categories: executing an application without BlueJ, and developing without BlueJ. Now that we know how to change the color for pens and canvases, we can do some more exercises. Could you please look up the seat numbers again? Use CRC cards and scenarios. It is largely a matter of personal preference, but you should be aware that both styles are widely used. Here, you can find some test images you can use. If the user chooses a file that is not a valid image file, we now show a proper error message. B.1 Primitive types The following table lists all the primitive types of the Java language: Type name Description Example literals Integer numbers byte short int long byte-sized integer (8 bit) short integer (16 bit) integer (32 bit) long integer (64 bit) 24 137 5409 423266353L −2 −119 −2003 55L Real numbers float double single-precision floating point double-precision floating point 43.889F 45.63 2.4e5 Other types char boolean a single character (16 bit) a boolean value (true or false) 'm' true '?' false '\u00F6' Notes: ■ ■ ■ ■ A number without a decimal point is generally interpreted as an int but automatically converted to byte, short, or long types when assigned (if the value fits). Second, when we add a component to a container with a BorderLayout, we use a different add method that has a second parameter. Exercise 12.6 If you run a simulation for long enough, do all of the foxes or all of the rabbits ever die off completely? That is, an exception thrown in a method process would have to be caught and handled in the method that called process. Their advantage is that they are quick and easy to use, they work in any programming language, and they are (except for the interactive testing) independent of the environment. In fact, the opposite approach is a much better rule to adopt: define variables local to a method unless they are clearly a genuine part of an object's persistent state. The compiler will report this as an error. The particular actions depend on the specific subtype. Here is how we might think of writing the method in the Student class of the lab-classes project from Chapter 1: public boolean equals(Object obj) { if(this == obj) { return true; // Reference equality. Ensure that details are recorded of passengers for whom there is no free vehicle. For example, the type of String.class is Class. This is a commonly used technique in search situations: the return of an out-of-bounds value to indicate failure. If the input from the user contains one of our known words, we can generate a related response. The parameter we have used introduces a new notation which is called a method reference, whose distinctive syntax is a pair of adjacent colon characters. Figure 2.4 ticketMa1: TicketMachine Parameter passing (A) and assi n ent B price (A) 500 balance 0 total 0 (B) TicketMachine (constructor) cost 500 Exercise 2.18 To what class does the following constructor belong? Source code Each class has some source code associated with it. Exercise 11.8 Implement a transporter room with inheritance in your version of the zuul project. This leads to a more circular process than the waterfall model. We use an if-statement to check that the value is legal before we assign it. Save the better-ticket-machine project under a new name, and implement your changes in the new project. M03_BARN7367_06_SE_C03.indd 106 4/11/16 3:06 PM 3.8 The NumberDisplay class | 107 Exercise 3.18 Is there any difference in the result of writing return value + ""; rather than return "" + value; in the getDisplayValue method? This is very important for maintenance work. Each line records the date and time of the access in the following format: year month day hour minute For instance, the line below records an access at 03:45am on 7 June 2015: 2015 06 07 03 45 The project consists of five classes: LogAnalyzer , LogfileReader , LogEntry , LoglineTokenizer, and LogfileCreator. We divide the problem into sub-problems, then again into sub-sub-problems, and so on, until the individual problems are small enough to be easy to deal with. The Singleton pattern ensures that only one instance will be created from a class, and it provides unified access to it. It is important for this activity to do this using real, physical cards, not just a computer or a single sheet of paper. Exercise 13.59 Find the demo application ProgressBarDemo. There is no leftover space with a BorderLayout when the window is resized; it is all distributed (unevenly) between the components. (If there are errors, remove them. ■ It will list all the tracks. So, for our example, we will create an inner class that is a subclass of MouseAdapter, and just override the mousePressed method. If you want to read more about this, do a web search for "pseudo-random numbers." 6.4.1 The Random class The Java class library contains a class named Random that will be helpful for our project. Before we encountered inheritance, there was no need to distinguish whether by "type of c1" we meant "the type of the variable c1" or "the type of the object stored in c1." It did not matter, because the type of the variable and the type of the object were always the same. The designer designing the body shape of the car abstracts from the technical details of the wheels and the engine to concentrate on the design of the body (he will just be interested in the size of the engine and the wheels). Define a simple class that implements Comparable. All the difficult work is done in the ArrayList object. Because the human user interacts with the booking system (represented by the Cinema BookingSystem class), this is where the scenario starts. In addition, within an enclosed building, it may be possible to estimate numbers of people on each floor and hence to anticipate demand. Different objectoriented languages vary in their treatment of multiple inheritance: some languages allow the inheritance of multiple superclasses; others do not. Explain in detail what happens. While the slide show runs, the slider should move to indicate progress. This is illustrated with the arrow labeled (A). In the following sections, we shall explore a range of options for error reporting by a server. A conditional statement has the general form described in the following pseudo-code: if(perform some test that gives a true or false result) { Do the statements here if the test gave a true result } else { Do the statements here if the test gave a false result } Certain parts of this pseudo-code are proper bits of Java, and those will appear in almost all conditional statements–the keywords if and else, the round brackets around the test, and the curly brackets marking the two blocks–while the other three italicized parts will be fleshed out differently for each particular situation being coded. It gives a solid, hands-on introduction to these concepts without going into the details of Java syntax. It could also access the inherited fields by calling accessor methods defined in the Post class. (You can have multiple projects open at the same time.) Each project folder contains a bluej.project file that, when associated with BlueJ, can be double-clicked to open a project directly. An object might be asked to do something it is unable to. M13_BARN7367_06_SE_C13.indd 500 4/15/16 3:07 PM 13.8 Inner classes | 501 Once we have defined an inner class we can create instances of it in exactly the same way as for those of any other class: // Detect mouse clicks on the image when the user // wishes to edit it. There, a BufferedReader is used as a Decorator for a Reader (Figure 15.2). In Table C.1, those operators having the highest precedence appear at the top, so we can see that multiplication, division, and modulus all take precedence over addition and subtraction, for instance. The relevant code is shown in Code 12.4. Now that we have the Animal class, we can improve this. ContactDetails details = contacts.getDetails("David"); String phone = details.getPhone(); . The java.util.function package defines a large number of interfaces that provide convenience names for the most commonly occurring types of lambda expression. M06_BARN7367_06_SE_C06.indd 248 4/11/16 3:17 PM 6.18 Summary | 249 It is also important to be able to document any class that is written, in the same style as the library classes, so that other programmers can easily use the class without the need to understand the implementation. Suppose at least one of those pickups will reach their destination before the final pickup is reached: Does that mean it could accept more pickup requests than its capacity?! Another area for further development is vehicle scheduling. 1 The notation style for class diagrams that is used in this book and in BlueJ is a subset of a widely used notation called UML. There is an important link between the equals and hashCode methods in that two objects that are the same as determined by a call to equals must return identical values from hashCode. So by simply creating a clock display, we expect that we have implicitly created two number displays for the hours and minutes. Not only are there millions of lines of code out there that are written in this style—and will be continued to be written in this style—but there are also specific cases where it is necessary to use these techniques even if one generally favors the new functional constructs. If constructed in a method, the collaboration will usually be short term, for the duration of the block in which it is constructed. Exercise 14.6 The AddressBook class defines a field to record the number of entries. Note on a separate piece of paper all the questions you have left unanswered. Exercise 3.51 se a co ination of code readin e ecution of ethods breakpoints, and single stepping to familiarize yourself with the MailItem and MailClient classes. Breakpoints can be set only within classes that have been compiled. 12.8 | 455 The Class class In Chapter 10, we described the paradoxically named Object class. If a method has a non-void return type, it will return some data to the place it was called from—and that data will almost certainly be used in the caller for further calculations or program manipulations. The relationship between these two vehicles is suggestive of an inheritance hierarchy, where "taxi" and "shuttle" represent subtypes of vehicle. An unsuccessful test will cause the Test Results window to appear. To understand in detail why it does not work, we need to look more closely at types. This suggests that they might be related in some way. The second form above makes use of this. Adding more menus and other components to the frame will now be quite easy—just more of the same. Sometimes, however, we need an operation that will “collapse” its input stream to just a single object or value, and this is the function of the reduce method, which is a terminal operation. M15_BARN7367_06_SE_C15.indd 570 4/11/16 3:45 PM 15.7 Using design patterns | 571 Second, design patterns have names and thus establish a vocabulary that helps software designers talk about their designs. If we need to define what it means for two objects to be equal according to their internal states, then we must override the equals method, which then allows us to write tests such as var1.equals(var2) This is because the equals method inherited from the Object class actually makes a test for reference equality. J.2.6 Use a space before the opening brace of a control structure’s block J.2.7 Use a space around operators J.2.8 Use a blank line between methods (and constructors) Use blank lines to separate logical blocks of code; this means at least between methods, but also between logical parts within a method. Code 11.4 New version of NewsFeed show method M11_BARN7367_06_SE_C11.indd 404 4/11/16 3:35 PM 11.8 Object equality: equals and hashCode | 405 In fact, the method does work as expected. Exercise 2.69 Write out a constructor for a class called Person. These initial steps of developing a software system are generally referred to as analysis and design. This distinction between the interface and the implementation is a very important concept, and it will surface repeatedly in this and later chapters of this book. Hint: Use a conditional statement whose test calls the length method on the refNumber string. It is an absolute rule in Java that a constructor may not have a return type. This project contains a version of the network application, rewritten to use inheritance, as described above. The details we want to store for each message post are: ■ the username of the author ■ the text of the message ■ a time stamp (time of posting) ■ how many people like this post ■ a list of comments on this post by other users The details we want to store for each photo post are: ■ the username of the author ■ the filename of the image to display ■ the caption for the photo (one line of text) ■ a time stamp (time of posting) ■ how many people like this post ■ a list of comments on this post by other users 10.1.1 The network project: classes and objects To implement the application, we first have to decide what classes to use to model this problem. Student other = (Student) obj; return name.equals(other.name) && id.equals(other.id) && credits == other.credits; } The first test is just an efficiency improvement; if the object has been passed a reference to itself to compare against, then we know that content equality must be true. The one that generates a random integer number is called nextInt. In order to be eligible to participate in serialization, a class must implement the Serializable interface that is defined in the java.io package. Why do you think that these methods are not included in List? The iterator method in this example is the Factory method. It should be avoided. In the following sections, we shall show how arrays can be used to maintain collections of fixed size. If time is short, these advanced sections can be skipped, and emphasis can be placed on a thorough grounding in imperative, object-oriented programming. Figure 5.3 l in a reduction to a stream 3 1 4 reduce 14 1 2 3 M05_BARN7367_06_SE_C05.indd 189 4/11/16 3:13 PM 190 | Chapter 5 ■ unctional Processin of ollections d anced Figure 5.4 i eline of strea functions "Elephant" 3 "Tiger" 1 "Snake" 3 "Elephant" 1 filter "Elephant" 3 map 3 "Elephant" 1 1 "Elephant" 4 4 reduce 8 "Elephant" 4 "Parrot" 5 We can write this, using pseudo-code, as follows: sightings.filter(name == elephant).map(count).reduce(add up); This is not correct Java syntax, but you get the idea. The solution is simple. M05_BARN7367_06_SE_C05.indd 197 4/11/16 3:13 PM This page intentionally left blank Chapter 6 More-Sophisticated Behavior Main concepts discussed in this chapter: ■ using library classes ■ reading documentation ■ writing documentation Java constructs discussed in this chapter: String, Random, HashMap, HashSet, Iterator, static, final, autoboxing, wrapper classes In Chapter 4, we introduced the class ArrayList from the Java class library. When you work with existing code written by other programmers (as you will most of the time), it is essential that you understand and can work with the imperative style. Exercise 2.26 Write an accessor method getTotal in the TicketMachine class. To understand how this works, it might be useful to look at the code for adding all counts as if we were writing it in the traditional way. Include an accessor, getBorrowed, that returns the value of this new field as its result. For instance, a required data file may have been accidentally M14_BARN7367_06_SE_C14.indd 544 4/11/16 3:43 PM ile ased in ut out ut | 545 deleted or have become corrupted in some way, before the application is run; or an attempt to store results to the file system may be thwarted by lack of appropriate permissions or exceeding a file-system quota. All pixels that are in the upper-third value range for brightness will be turned white, all that are in the lower third will be turned black, and the middle third will be gray. Exercise 12.12 Are there other simplifications that you feel are present in our implementation of the Rabbit class, compared with real life? It is a good idea to always include a final else part. menu bar, content pane Components are placed in a frame by adding them to the frame’s menu bar or content pane. However, it is important to exercise caution when considering defining a default method in an interface. However, before we assign the value, we have to check whether the value is legal. We have also added a method called display that will show details of a MessagePost or PhotoPost object. Exercise 5.5: Open the animal-monitoring-v1 project and rewrite the printList ethod in our ersion of the AnimalMonitor class to use a lambda, as sho n a o e Test that it still orks and error s the sa e as efore 5.4.1 Variations of lambda syntax One goal of the lambda syntax in Java is to allow us to write code clearly and concisely. This uses two different write methods: one to write a string, and one to write a character. The exact type rarely matters in any given situation. Add a class for event posts to the project. Exercise 5.27 Write a method that takes an animal name and spotter ID and returns the first Sighting object stored in the sightings collection for that combination. Inner classes are discussed in Section 13.8. 13.4.8 Summary of key GUI elements At the beginning of this chapter, we listed the three areas of GUI construction: components, layout, and event handling. Do the hunters remain in the simulation throughout, or do they ever disappear? 2.6 Assignment In the previous section, we noted the need to copy the short-lived value stored in a parameter variable into somewhere more permanent—a field variable. In this figure, we have defined accessor and mutator methods for those fields that may change over time (“liking” or “unliking” a post and adding a comment) and assume for now that the other fields are set in the constructor. M04_BARN7367_06_SE_C04.indd 142 4/11/16 3:10 PM 4.9 Processing a whole collection | 143 4.8.1 Summary of the music organizer We have made good progress with the basics of organizing our music collection. When the company receives a call from an individual, hotel, entertainment venue, or tourist organization, it tries to schedule a vehicle to pick up the fare. Which of these objects would the timeTick method interact with? This second example is a music-player application. A01_BARN7367_06_SE_FM.indd 15 4/15/16 6:10 PM 16 | Preface With functional language constructs, it is possible to automate some concurrency very efficiently. Replace the label in the example above with a button. However, storing of primitive values into an object collection is made even easier through a compiler feature known as autoboxing. For example, a student leaves out the noun row from the previous description. No comments. Explain in detail your answers and observations. This will not work if your machine does not have network access. Flexible, extensible class structures are not always easy to design. In Java applications, the default behavior is to attach the menu bar to the window. All buttons that have no function at any point in time should be grayed out at that time, and should be enabled only when they can reasonably be used. A facsimile ticket should be printed in the BlueJ terminal window. Make one big and yellow; make another one small and green. If we now abstract away from that very low-level view, we can see that it could also be viewed as two separate two-digit displays (one pair for the hours and one pair for the minutes). Each location in the array is used to represent an access count for the corresponding hour. 6.6.2 Using a HashMap HashMap is a particular implementation of Map . In contrast, the scope of a field is the whole of the class definition–it can be accessed from anywhere in the same class. We shall see this in the next section. Z03_BARN7367_06_SE_APPC.indd 607 4/11/16 3:51 PM This page intentionally left blank AppenDix D D.1 Java Control Structures Control structures Control structures affect the order in which statements are executed. If we need an additional menu item, we just add code to create the item and the lambda that handles its function. Get used to recognizing when scopes look wrong. Objects of class EventPost will inherit the username and timestamp, but not the comments. Between two integer values, division yields an integer result and discards any remainder, but between floating-point values, a floating-point value is the result: 5 / 3 gives a result of 1 5.0 / 3 gives a result of 1.6666666666666667 (Note that only one of the operands needs to be of a floating-point type to produce a floating-point result.) When more than one operator appears in an expression, then rules of precedence have to be used to work out the order of application. When activated, it presents a file-selection dialog that lets the user choose a sound file to open. Reading and understanding the documentation is the first part of our introduction to library classes. 2.19 Self-review exercises This chapter has covered a lot of new ground, and we have introduced a lot of new concepts. By using a conditional statement, we have, in effect, protected the change to balance in the case where the parameter does not represent a valid amount. Thus, using the == operator is wrong. Because of this, the inheritance relationship is also referred to as an is-a relationship (a car is-a vehicle). Can you work out what is incorrect about this call to setValue, and correct it? Figure F.1 shows the debugger window. Their lifetime is only as long as a single call, so their values are lost between calls. The Java code we need to write is exactly like that shown above. It returns alternative images to the GUI, depending on whether it is occupied or empty. In fact, there are good reasons why a user should be prevented from knowing about the implementation (or at least from making use of this knowledge). To show the tools, open the Preferences dialog and, in the Miscellaneous tab, tick the Show teamwork controls box. An iterative approach Another important aspect of this book is that it follows an iterative style. .).inter2(. When you then try to use it as an index to access a list element, you will get an IndexOutOfBoundsException. Exercise 14.50 Review the Parser class of zuul-better to also see how it uses the Scanner class. M06_BARN7367_06_SE_C06.indd 224 4/11/16 3:17 PM 6.9 Finishing the TechSupport system | 225 Exercise 6.37 What is the difference in the result of returning the words in a HashSet compared with returning them in an ArrayList? Methods have return types, which specify what type of data they return. Code 14.13 Catching multiple exceptions Exercise 14.32 Enhance the try statements you wrote as solutions to ercises and so that the handle checked and unchecked e ce tions in different catch locks Exercise 14.33 What is wrong with the following try statement? (This is a very simple solarization algorithm—you can find more-sophisticated ones described in the literature.) Exercise 13.43 Implement an edge detection filter. 14.3 Server error reporting Having protected a server object from performing an illegal operation through bad parameter values, we could take the view that this is all that the server writer needs to do. The final improvement to complete the application is to let the user enter complete questions again, and then pick matching responses if we recognize any of the words in the questions. Fields are used to store data that enable objects to maintain a state that persists between method calls. This should update the field by 1 each time it is called. M15_BARN7367_06_SE_C15.indd 571 4/11/16 3:45 PM 572 | Chapter 15 ■ Designing Applications Figure 15.2 Structure of the decorator pattern : BufferedReader : Reader the same interface). Exercise 10.18 Look at the code below. There are several more rules to follow when using checked exceptions, because the compiler enforces checks both in a method that throws a checked exception and in any caller of that method. We would like them arranged vertically. The contact details are indexed in the address book by both name and phone number. Both Fox and Rabbit will define their own versions of getBreedingAge to return their particular values of BREEDING_AGE: /** * @return The age at which a rabbit starts to breed. M14_BARN7367_06_SE_C14.indd 537 4/11/16 3:43 PM 538 | Chapter 14 ■ Handling Errors Exercise 14.35 Do you feel that DuplicateKeyException should be a checked or unchecked exception? In Java, there are very few rules about the order in which you choose to define the fields, constructors, and methods within a class. The theater could have a collection of seats in it. The employee makes that reservation. Try to draw a class diagram and an object diagram for that situation. How many methods are shown? Exercise 12.46 Move the canBreed method from Fox and Rabbit to Animal, and rewrite it as shown in Code 12.8. Provide appropriate versions of getBreedingAge in Fox and Rabbit that return the distinctive breeding age values. pipeline A pipeline is the combination of two or more stream functions in a chain, where each function is applied in turns. If the index is valid, then it prints nothing. Multiple exceptions may be handled in the same catch clause by writing the list of exception types separated by the “|” symbol. This is a difference that applies in this particular case. As well as the exception type name, this also includes a variable name (traditionally, simply e or ex) that can be used to refer to the exception object that was thrown. Z01_BARN7367_06_SE_APPA.indd 599 4/11/16 3:48 PM 600 | Appendices Configuration details are explained in the “Tips archive” on the BlueJ web site. Still, it can be surprisingly effective, and it is a good next step. We would introduce another class, ActivityPost, and essentially write a third version of the source code that we already have in the MessagePost and PhotoPost classes. However, instead of trying to cover every possible topic ourselves (and thus blowing the size of this book out to 1500 pages), we deal with it using hooks. Path is, in effect, a replacement for the older File class of the java.io package. It will use a default layout manager if we do not explicitly set one. In other words, we recommend using a for-each loop only if you definitely want to process the whole collection. Exercise 3.25 Explain in detail how the increment method works. The server needs to be set up by an administrator. This version was released in 2014 and is now very widely used in practice. Here are some of them: ■ M16_BARN7367_06_SE_C16.indd 587 You should expect to find some differences between the design and the implementation, owing to the different natures of design and implementation languages. Notice that we have consistently used content-equality tests rather than reference-equality tests on the object fields name and id. } else { // The removal failed. Figure 10.6 Animal An example of an inheritance hierarchy Mammal Dog Poodle M10B_BARN7367_06_SE_C10.indd 373 Bird Cat Chicken Sparrow Dalmatian 4/11/16 3:32 PM 374 | 10.4 Chapter 10 ■ Improving Structure with Inheritance Inheritance in Java Before discussing more details of inheritance, we will have a look at how inheritance is expressed in the Java language. The second expression does not have to be an explicit string; any value-giving expression is acceptable, and will be turned into a String before being passed to the constructor. The benefit of simulations is that we can undertake experiments that we could not do with the real system, either because we have no control over the real thing (for instance, the weather) or because it is too costly, too dangerous, or irreversible in case of disaster. Clients of the Singleton can now use that static method to gain access to the parser object: Parser parser = Parser.getInstance(); In fact, Java offers an even easier way to obtain the fundamental features of a singleton—an enum with a single value (Code 15.2). We shall discuss containers in more detail later. It executes the loop over and over, but we cannot see any effect of this, and the program seems to have died. Code 6.8 The WordCounter class, used to count word frequencies M06_BARN7367_06_SE_C06.indd 228 4/11/16 3:17 PM 6.11 Writing class documentation | 229 Code 6.8 continued The WordCounter class, used to count word frequencies The addWords method receives the same set of words that are passed to the Responder, so that each word can be associated with a count. They will think of the engine not as a single entity, but as a complex work of many parts. And because a photo post is also a post, it has everything that a post has, and more. Note how the container and the layout manager cooperate in the layout of the components. Logic operators Logic operators operate on boolean values (true or false) and produce a new boolean value as a result. primitive type The primitive types in Java are the non-object types. VideoNotes are located at www.pearsonhighered.com/cs-resources. That is a bit better. Test it to get a feel for how well it works. Writing this.from refers to the from field in the current object. If it is an object, name its class. To do this, the subclass declares a method with the same signature as the superclass, but with a different method body. Further details about in-line tags and the remaining available tags can be found in the javadoc section of the Tools and Utilities documentation that is part of the JDK. You might already have noticed that all these two people have to agree on is what method signatures the class should have and what they should do. The command string is a string that somehow identifies the component that caused the event. Creating a FileWriter has the effect of opening the external file and preparing it to receive some output. If the value of the minutes is not zero, then we’re done. Programmers can adopt at least two possible views when designing and implementing a server class: They can assume that client objects will know what they are doing and will request services only in a sensible and well-defined way. We have to take into account different screen resolutions, different fonts, users resizing windows, and many other aspects that make layout more difficult. Code 4.3 shows an implementation of a listAllFiles method that lists all file names currently in the organizer’s ArrayList that use such a for-each loop. If you think it is, try it out. In this model, a repository server is set up that is accessible over the Internet from the machines the users work on. 4.10 Indefinite iteration Using a for-each loop has given us our first experience with the principle of carrying out some actions repeatedly. M02_BARN7367_06_SE_C02.indd 60 4/11/16 3:02 PM 2.5 Parameters: receiving data Concept The lifetime of a variable describes how long the variable continues to exist before it is destroyed. Doing this, we find the following nouns and verbs. Analyzing the problem at hand determines what kinds of solutions we need. This code segment would result in a stream of integers, which we could then process further. Exercise 13.81 Add sounds to the word-of-zuul game. This could be slightly annoying for a user, but it turns out that we can solve these problems if we know a bit more about the String class. Constructors are used to set up an initial state when an object is created. One thing you may have noted about the ArrayList class is that we used it without ever looking at the source code. In fact, the rule on privacy also applies between a subclass and its superclass: a subclass cannot access private members of its superclass. Correspondingly, we add to TaxiCompany a responsibility to Receive a pickup request. method cohesion A cohesive method is responsible for one, and only one, well-defined task. Looking at the rest of the class shows very quickly that all the interesting stuff is in the makeFrame method. The application should, then, be able to find empty seats for a requested screening and reserve them for the customer. 16.3.3 The outline implementation The project taxi-company-outline contains an outline implementation of the classes, responsibilities, and collaborations that we have described as part of the design process. And finally, we have given a pointer to an online reference and tutorial site that may be used to learn about details not covered in the chapter. We can implement a class TransporterRoom as a subclass of class Room. For the Animal class, we wish to state that each animal has an act method, but we cannot give a reasonable implementation in class Animal. Being able to visualize the object structures is essential. Z10_BARN7367_06_SE_APPJ.indd 634 4/11/16 3:58 PM J: Program Style Guide | 635 J.3.2 Every method has a method comment J.3.3 Comments are Javadoc-readable Class and method comments must be recognized by Javadoc. This looks unusual, although there are some similarities to the syntax for lambda expressions. There won’t always be a human user around to prompt for alternative input, so it might be the client object’s responsibility to log the error, via something like a logging API, so that it will be noticed and can be investigated later. Before adding the finishing polish, we can first focus on making the buttons work. Use assertions and JUnit testing through all stages of this process to provide maximum confidence in the final version. They make applications look much more like the “typical” applications people are used to. Exercise 6.77 Read the class documentation for class Math in the package java.lang. The seat itself can remember whether it has been reserved. Implement this functionality. It is immediately clear from this construct that the tight coupling between inner listener class and the enclosing GUI class is explicit. These are often called “third-party libraries,” and they are imported and used in the same way as are standard Java library classes. 2.4.1 Fields Concept Fields store data for an object to use. 4.10.1 The while loop A while loop consists of a header and a body; the body is intended to be executed repeatedly. In the second case, the subtasks are not intended to be invoked directly from outside the class, but are placed in separate methods purely to make the implementation of a class easier to read. If this is the case, you can purchase a subscription by going to www.pearsonhighered.com/cs-resources and following the on-screen instructions. Code 6.10 Another version of the getSightingsOf method This time we have called the static toCollection method of Collectors, which requires a single parameter whose type is Supplier. How do you generate a random number? You can also explore the use of variables in the Code Pad. When our method is called, the menu item will pass along a parameter of type ActionEvent that provides some details about the event that has occurred. For this to work, each team member must write documentation about his class similar to the documentation for the Java standard library, which enables other people to use the class without the need to read the code. The first two are illustrated in the relatively straightforward addFile and getNumberOfFiles methods, respectively. Exercise 14.31 Why is the following not a sensible way to use an exception handler? That is, the number, type, and names of the fields are the same, while the actual value of a particular field in each object may be different. The type defines what kinds of values a parameter can take. Here are some reasons why this approach is not always practical: ■ ■ 14.9 Making a server class’s validity-check and state-test methods publicly visible to its clients might represent a significant loss of encapsulation, and result in a higher degree of coupling between server and client than is desirable. Were you right or wrong? Only abstract classes can have abstract methods. 6.17 Further advanced material In the previous chapter, we introduced material that we described as “advanced” and suggested that this material could be skipped on first reading, if desired. These advanced sections can be skipped (you can now skip ahead to Chapter 6 if you want), and you will still learn how to program, and will still be able to solve the problems we present. This shows another window that BlueJ uses for text output. Typically, to make it useful, an object should override this method. Exercise 6.68 Change the method bounce in class BallDemo to let the user choose how many balls should be bouncing. So, if we consider the example in Code 14.9, the effect of an IOException being thrown from the call to saveToFile will be that control will transfer from the try block to the catch block, as shown in Code 14.10. boolean expression Boolean expressions have only two possible values: true and false. In such circumstances, we have the option of choosing to use a specialized fixed-size collection object to store the items. A better solution is placing a method in the superclass (Animal), letting an animal act, and then overriding it in each subclass so that we have a polymorphic method call to let each animal act appropriately, without the need to test for the specific animal types. We could even imagine working our way through the entire collection by having an integer index variable whose value is initially set to zero and is then successively increased by 1, passing its value to the get method to access each item in the list in order (stopping when it goes beyond the final index value of the list). This serves to discuss additional abstraction mechanisms based on inheritance, namely interfaces and abstract classes. For example, in a list of 20 items, the last one will be at index 19. ArrayList messages = new ArrayList(); for(Post post : posts) { if(post instanceof MessagePost) { messages.add((MessagePost) post); } } It should be clear that the cast here does not alter the post object in any way, because we have just established that it already is a MessagePost object. (Remember: each sighting instance can be of multiple animals.) 5.5.2 Pipelines Concept pipeline is the combination of two or more stream functions in a chain, where each function is applied in turn. The cinema has two theaters, each of a different size. As we shall be looking inside our first Java example classes, we shall keep our simulation fairly simple to start with. 4/11/16 3:47 PM 16.2 Analysis and design | 583 However, a vehicle can be scheduled only if it is free. 13.8.1 Named inner classes The obvious approach, in such cases, is to define a separate class to implement the required interface, and then create an instance to act as the listening object. Furthermore, we shall see later that it is possible to insert items into an ArrayList at a position other than the end of it. Z04_BARN7367_06_SE_APPD.indd 615 4/11/16 3:52 PM This page intentionally left blank AppEndix E Running Java without BlueJ Throughout this book, we have used BlueJ to develop and execute our Java applications. The project diagram shows us three classes: SupportSystem , InputReader , and Responder (Figure 6.2). 4.10.4 Some non-collection examples Loops are not only used with collections. Exercise 2.81 Now add the following in the Code Pad: TicketMachine t2 = t1; What would you expect a call to t2.getBalance() to return? It is called every time the time of the clock changes. ■ Abstract classes with abstract methods force subclasses to override and implement those methods declared abstract. Gaining trust in it through controlled experiments will be essential. lambda A lambda is a segment of code that can be stored and executed later. Its class structure is shown in Figure 13.4. As you can see, we have added three new classes: OFImage, ImagePanel, and ImageFileManager. If a field’s value cannot be changed once initialized, we say that it is immutable. The structure looks like this: public class ImageViewer { . Create a Demo object and try its pickupTest method. In this chapter, we also extend our understanding of abstraction to see that it does not just mean hiding detail, but also means seeing the common features and patterns that recur again and again in programs. Once the foxes do become old enough to breed, does the simulation tend to behave again like the original version? All of the files of an application can be bundled into a single file, and they can still be executed. Exercise 6.34 What are the similarities and differences between a HashSet and an ArrayList? This explains what we saw in the dialog earlier. Do this for each color component (red, green, blue). Similarly, there is a corresponding standard input source available as System.in, which is of type java.io.InputStream. Exercise 4.9 Write a method call using get to return the fifth object stored in a collection called items. The system asks you for a “name of the instance”; click OK—the default name supplied is good enough for now. Fortunately, these tasks contain hardly anything new for us. variables and subtypes Variables may hold objects of their declared type or of any subtype of their declared type. Use the brush size to edit multiple adjacent pixels on each mouse press. This approach of associating keywords with responses works quite well as long as the user does not enter complete questions, but only single words. They provide the information needed to invoke that method. As its first statement, this method will in turn invoke the display method of the superclass, which prints out the general post information. (Why is this?) You can easily obtain a copy of the image by creating a new OFImage with the original as the parameter to its constructor. In these cases, the number of times the loop’s body will be executed is less certain; it typically depends on what happens during the iteration. In this project, we have classes named Circle, Square, Triangle, Person, and Canvas. Finally, we have to extend the generateResponse method in the Responder class to accept a set of words as a parameter. In this case, a BlueJ user enters the external value into the dialog box when creating a new ticket machine (shown on the left), and that value is then copied into the cost parameter of the new machine’s constructor. Our style is not necessarily better than all others. String phone = details.getPhone(); . Exercise 2.29 Do the insertMoney and printTicket methods have return statements? ■ It will tell us how many tracks are in the collection. However, as we develop our model, we shall focus on just the original description of the company’s operating procedures, and leave the additional features as exercises. For instance, some methods in the address-book application, such as changeDetails, take a key parameter that should match an existing entry. You don’t have to include the definition for code, just the text of the constructor. Which one to choose becomes clearer when we think about resizing behavior. What is its purpose and how do you use it? It now only defines the setPixel and getPixel methods. This suggests the following basic pattern for reading the contents of a text file: Charset charset = Charset.forName("US-ASCII"); Path path = Paths.get(filename); BufferedReader reader = Files.newBufferedReader(path, charset); String line = reader.readLine(); while(line != null) { do something with line line = reader.readLine(); } reader.close(); Code 14.21 illustrates the practical use of a BufferedReader in the tech-support project from Chapter 6. Methods are defined in the class of the object. The key characteristic of a search is that it involves indefinite iteration; this is necessarily so, because if we knew exactly where to look, we would not need a search at all! Instead, we have to initiate a search, and it will take an unknown number of iterations before we M04_BARN7367_06_SE_C04.indd 152 4/11/16 3:10 PM 4.10 Indefinite iteration | 153 succeed. Our “About” box is a simple message dialog. Instead of storing one copy of the same value in each object, which would be a waste of space and might be hard to coordinate, a single value can be shared among all instances. Our experience with textbooks is that much of the detail is initially distracting, and has the effect of drowning the important points, thus making them harder to grasp. Once that call has completed its task, the formal parameters disappear and the values they held are lost. Because predators in one context are often prey for other species (think of cats, birds, and worms, for instance), loss of one part of the food chain can have dramatic effects on the survival of other parts. Then we note on the card for CinemaBookingSystem: Retrieves and displays show details, and on the Show card you write: Provides details about theater and number of free seats. The subclass inherits the code (method implementations and fields) from the superclass. After studying the documentation, we can now implement our “About” box by making a call to the showMessageDialog method. The new logic, then, is that we pick an appropriate response if we recognize a word, or a random response out of our list of default responses if we don’t. M13_BARN7367_06_SE_C13.indd 484 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 485 The simplest kinds of filters involve iterating over the image and making a change of some sort to the color of each pixel. Exercise 13.74 Add an Open item to the file menu. In BlueJ, this can often be detected by the fact that the red-andwhite-striped “running” indicator remains on while the program appears to be doing nothing. M13_BARN7367_06_SE_C13.indd 488 4/15/16 3:07 PM 13.6 ImageViewer 2.0: improving program structure | 489 13.5.7 Summary of layout management In this section, we have added some custom classes to deal with images, but more importantly for our GUI, we have looked at the layout of components. Let us discuss this with an example. To deal with more general actors, it seems like a good idea to introduce an Actor superclass. Solving this problem requires some more explanation. Most of these are outside the scope of this book. In BlueJ, for space reasons, the fields are not displayed on the object icon. When using a lambda, we approach the problem differently. You can make a pixel any shade of gray by giving all three color components (red, green, blue) the same value. Exercise 6.89 Assume that we want to swap the values of two integer variables, a and b. You might have noticed when doing this that some class names in the documentation list look slightly different, such as ArrayList or HashMap. The balls should initially be placed in a row along the top of the canvas. There is no name given to the lambda; it starts with the parameter list. We also need to add a second part to the condition that indicates whether we have found the search item yet and stops the search when we have. For instance, it might be useful to simulate other predator–prey scenarios such as a marine simulation involving fish and sharks, or fish and fishing fleets. Run the TechSupport system again and type “bye bye” or “bye everyone”. You should be aware that this is not a chapter to be read and understood in a single day, but that it contains several sections that deserve a few days of study each. Will it really be necessary to maintain these distinctions? Indeed, we will choose to focus on just its role in enabling us to create a new collection object as the final operation of a pipeline, and leave further exploration to the interested reader. The button group in the WEST area was first placed into a JPanel with a one-column GridLayout to give all buttons the same width. There is one small problem, though. Objects, on the other hand, are not stored directly in the variable, but instead a reference to the object is stored (drawn as an arrow in our diagrams, as in Figure 3.3a). These include code inheritance and subtyping as well as inheriting from interfaces, abstract classes, and concrete classes. However, the methods are invoked on objects. The software growth model assumes that complete systems that are used indefinitely in an unchanged state do not exist. A.7 Changing the new class templates When you create a new class, the class’s source is set to a default source text. The green shading indicates a class, the yellowish color shows a method definition, and the white background identifies a method body. M06_BARN7367_06_SE_C06.indd 204 4/11/16 3:17 PM 6.2 The TechSupport system | 205 Code 6.2 The Responder source code Toward the top of the method is a call to printWelcome, and at the end is a call to printGoodbye. Make sure you have two or three students and a LabClass object on the object bench, then call the enrollStudent method of the LabClass object. However, if the operands are strings, then the meaning of the plus sign is string concatenation, and the result is a single string that consists of both operands stuck together. The constructor stores the roll-over limit in a field and sets the current value of the display to 0. In the new style, you do the following: You write down instructions for how to give a haircut, and then you give this to the teacher and say: Do this to every child in your class. Typically, all classes should be created and method stubs for all public methods should be written. The first plays some seconds of the beginning of the file and returns when it has finished playing, while the second starts its playing in the background and then immediately returns control back to the organizer—hence the need for the stop method, in case you want to cancel playing. It should allow us to remove information. When using an anonymous inner class, we create an inner class without naming it and immediately create a single instance of the class. Exercise 14.3 Examine the implementation of the AddressBook class and assess whether you think it has been well-written or not. Code 14.10 1. TaxiCompany has the responsibility Direct vehicle to pickup, with the corresponding responsibility in Vehicle being Receive pickup location. A student can create an object and call its methods as the very first activity! Because users can create and interact with objects directly, concepts such as classes, objects, methods, and parameters can easily be discussed in a concrete manner before looking at the first line of Java syntax. A01_BARN7367_06_SE_FM.indd 27 4/15/16 6:10 PM Acknowledgments Many people have contributed in many different ways to this book and made its creation possible. Looking at the class diagram for this project, we can see that the addition also makes use of a Java interface (Fig 12.6). Use the descriptions of Set, HashSet, List, and ArrayList in the library documentation to find out, because HashSet is a special case of a Set, and ArrayList is a special case of a List. This means that variables can be declared to be of interface types, even though no objects of that type can exist (only subtypes). Manufactured in the United States of America. So when calling the addActionListener method of a JMenuItem, we can use a lambda expression to specify the actions to be taken when the associated ActionEvent occurs. In addition, it maintains a count of missed pickups for statistical analysis. Is that unavoidable? This should provide a good feel for the complexity of the project and whether we have missed anything crucial in the steps taken so far. We do not know which one of these it is, assuming that we have entered both MessagePost and PhotoPost objects into the feed. For instance, what effect does it have on the populations if the breeding probability of rabbits is much higher or much lower than it currently is? This deals effectively with the second problem we described above. Accessor methods provide information about an object’s state, and mutator methods change an object’s state. The while-loop version is shown in Code 4.5. A key feature is the way that an integer variable (index) is used both to access the list’s elements and to control the length of the iteration. Exercise 16.7 Review the problem description and the scenario we have worked through. Java projects are usually stored each in a separate directory. As with the project in Chapter 10, using a common superclass should avoid code duplication in the subclasses and simplify the code in the client class (here, Simulator). You can continue the exercises from here on with either version of these projects. The fact that we end up searching the whole list when the search fails does not turn a failed search into an example of definite iteration. Music-player (Chapter 13) A GUI is added to the music-organizer project of Chapter 4 as another example of building GUIs. Address-book (Chapter 14) An implementation of an address book with an optional GUI interface. In the next section, we look at the printHourlyCounts method, as it introduces a new control structure that is well suited to iterating over an array. It is used internally in the mail clients and server to create, store, and exchange messages. Exercise 12.13 Experiment with the effects of altering some or all of the values of the class variables in the Rabbit class. M12_BARN7367_06_SE_C12.indd 431 4/11/16 3:38 PM 432 | Chapter 12 ■ Further Abstraction Techniques Code 12.4 Inside the Simulator class: simulating one step In order to let each animal act, the simulator holds separate lists of the different types of animals. Exercise 2.62 Rewrite the printTicket method so that it declares a local variable, amountLeftToPay. Try to identify at least one further example of each of the patterns we have described. As a consequence, it will be necessary to anticipate exceptions being thrown at every stage. Class variables are fields that are stored in a class itself, not in an object. It is common for programmers not to take documentation seriously enough, and this frequently creates serious problems later. Once again, we can use abstraction to help us here. Terms introduced in this chapter: inheritance, superclass (parent), subclass (child), is-a, inheritance hierarchy, abstract class, subtype substitution, polymorphic variable, type loss, cast M10B_BARN7367_06_SE_C10.indd 388 4/11/16 3:32 PM 10.10 Summary | 389 Exercise 10.16 Go back to the lab-classes project from Chapter 1. In the example above, the signature of the moveHorizontal method states that, before the method can execute, we need to supply a whole number specifying the distance to move. Two of our abstract classes in the example above, Actor and Drawable, are good candidates for being written as interfaces. A large population of prey will potentially provide plenty of food for a small population of predators. In some cases, a missing class can hold up continuation of development and testing of other classes. Exercise 5.3 Read through the full source code of the AnimalMonitor class to understand ho the ethods ork The class onl uses techni ues e ha e co ered in re ious cha ters so ou should e a le to ork out the details M05_BARN7367_06_SE_C05.indd 181 4/11/16 3:13 PM 182 | Chapter 5 ■ unctional Processin of ollections d anced Exercise 5.4 Why does the removeZeroCounts method use a while loop with an iterator, instead of a for-each loop as used in the other methods? We know that every Post object in the collection is in fact a MessagePost or a PhotoPost object, and both have display methods. This is often done to separate parts of a system that are logically only loosely coupled. M02_BARN7367_06_SE_C02.indd 80 4/11/16 3:02 PM 2.19 Self-review exercises | 81 Exercise 2.63 Challenge exercise Suppose we wished a single TicketMachine object to be able to issue tickets of different prices. Exercise 3.31 Look at the second constructor in ClockDisplay’s source code. The method signatures are written on the CRC card instead of the responsibilities. Another way to get the Class object for a type is to write “.class” after the type name: for instance, Fox.class or int.class—notice that even the primitive types have Class objects associated with them. All of these methods have been implemented using the techniques described in Chapter 4 for basic list manipulation: iteration over the full list; processing selected elements of the list based on some condition (filtering); and removal of elements. If you do not supply sufficient documentation, it may be very hard for another programmer (or yourself some time later!) to understand your classes. 3.3 | 97 The point is, if viewed in enough detail, a car consists of so many parts that it is practically impossible for a single person to know every detail about every part at the same time. 4/11/16 3:10 PM 4.3 An organizer for music files ■ | 131 Universities maintain records of students. This time, note exact method names for each method you call from another class, and specify in detail (with type and name) all parameters that are passed and the methods’ return values. substring(0,4) expression in the Student class. It takes an integer parameter and returns a boolean result. You can see them in the class’s source code (Code 2.1) as yellow boxes. Almost all programming platforms now are concurrent. Many possible changes would have to be done twice. Set a breakpoint just before the loop, and step through the method until the loop has processed all elements and exits. This means that you will sometimes see a method that has a throws clause, but with no throw statement in the method body. If so, why is this the case? Declaring a class abstract serves several purposes: ■ M12_BARN7367_06_SE_C12.indd 437 No instances can be created of abstract classes. Code 13.13 Adding a collection of filters M13_BARN7367_06_SE_C13.indd 492 4/15/16 3:07 PM 13.6 ImageViewer 2.0: improving program structure | 493 Code 13.13 continued Adding a collection of filters Once we have this structure in place, we can make the last two necessary changes: We change the code that creates the filter menu items so that it iterates over the filter collection. The syntax of an operation to create a new object is new ClassName (parameter-list) The new operation does two things: 1 It creates a new object of the named class (here, NumberDisplay). We can then write code in the Singleton class itself to create a single instance and provide access to it (Code 15.1 illustrates this for a Parser class). Exercise 10.8 Open the network-v2 project. So each time an hour value is read, we wish to update the count for that hour by 1. Why is it not possible for it to treat each object in the collection simply using the Object type? To test your understanding of how this loop operates, try the following exercises. Thus, we have written the string 0, not the integer number 0. From the class Circle, you can create many circles. So there is little further to add here about how to throw an unchecked exception—simply use a throw statement. If no default is given, it may happen that no case is executed. The filter method of a stream is an intermediate operation that passes on to its output stream only those elements from the input stream that fulfill a given condition. Otherwise, it will itself be abstract. By setting a relevant goal, the task was clearly taking us closer toward completing the overall project. If, for instance, you created an object of class Game and invoked a method named start to start an application, you should add the following main method to the Game class: public static void main(String[] args) { Game game = new Game(); game.start(); } Now, executing the main method will mimic your interactive invocation of the game. There are also time-related behaviors to take account of: morning arrivals, evening departures, and local peaks of activity around lunchtimes. Just return a null value for object-returning methods and a zero, or false, value for primitive types. Before looking at the internal details of the class, experiment with it by creating some instances and see whether you notice any differences in behavior between this version and the previous naive version. They are for information only. We call words like “public” and “class” keywords or reserved words – the terms are used frequently and interchangeably. Private methods, on the other hand, can be invoked only from within the class in which they are declared. M13_BARN7367_06_SE_C13.indd 482 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 483 Exercise 13.19 What kind of layout managers might have been used to create the layout of BlueJ’s editor window? We introduce the Java library and discuss some important library classes. The source code behind the scene, which makes the class work, is called the implementation of the class. Constants are, by convention, often written in capital letters. Most books silently skip over the issue, or touch it lightly, leaving the instructor with the burden of figuring out how to relate the book’s material to the actual steps that students have to go through to solve the exercises. It could store the name of the customer or the telephone number. After writing out the text of the entry as a string, we write a newline character so that each entry appears on a separate line. A scenario is an example of an activity that the system has to carry out or support. There is one exception to these rules: some classes are used so frequently that almost every class would import them. The address-book-assert project is a development version of the address-book projects that illustrates how assertions are used. Exercise 13.29 Implement the threshold filter. Use these features as you work on the following exercise, to check that you do not change anything fundamental about the overall simulation as you introduce an Animal class. Java captures this concept more formally by allowing interface types to be defined. One particular problem that we wish to address in the base version is that it does not make good use of the inheritance techniques that were introduced in Chapter 10. This is very helpful for trying out new operators and methods. A list of projects discussed in this book is provided on page xxv. An exception is thrown to indicate that a failure has occurred. So do not become discouraged if your early efforts seem to take forever or are full of errors. Figure 6.5 A method call with a fully qualified class name M06_BARN7367_06_SE_C06.indd 236 4/11/16 3:17 PM 6.13 Learning about classes from their interfaces | 237 As you have seen, we can either draw directly on to the canvas or we can use a pen object to draw. When you make a change to the source code and close the editor, the icon for that class appears striped in the diagram.3 The stripes indicate that the source has been changed. Some of these data items should probably also have accessor and mutator methods (Figure 10.2).1 For our purpose, it is not important to decide on the exact details of all the methods right now, but just to get a first impression of the design of this application. The best-known example of an inheritance hierarchy is probably the classification of species used by biologists. Using the Java Class Libraries item from the Help menu should now open your local copy. The listener will often need to access and modify private elements of the GUI object’s state. 6.17.3 Method references (Advanced) Suppose that we wish to collect the objects from a filtered stream into a particular concrete type of collection, such as an ArrayList, rather than a polymorphic type. If you want to find out about them now, see at Appendix B. This suggests use of an unchecked exception for such situations. This new feature of object-oriented programming requires some new terminology. (Remember: The executed method is always main, but we need to specify the class this method is in.) This is done by including a text file in the .jar file (the manifest file) with this information. Terms introduced in this chapter: interface, implementation, map, set, autoboxing, wrapper classes, javadoc, access modifier, information hiding, class variable, class method, main method, static, constant, final, polymorphic variable, method reference M06_BARN7367_06_SE_C06.indd 249 4/11/16 3:17 PM 250 | Chapter 6 ■ More-Sophisticated Behavior Exercise 6.87 There is a rumor circulating on the Internet that George Lucas (the creator of the Star Wars movies) uses a formula to create the names for the characters in his stories (Jar Jar Binks, ObiWan Kenobi, etc.). In some respects, a constructor can be likened to a midwife: it is responsible for ensuring that the new object comes into existence properly. Online-shop (Chapter 9) The early stages of an implementation of a part of an online shopping website, dealing with user comments; used to discuss testing and debugging strategies. Chapter 6 deals with libraries and interfaces. M04_BARN7367_06_SE_C04.indd 145 4/11/16 3:10 PM | 146 Chapter 4 ■ Grouping Objects Exercise 4.24 Challenge exercise The for-each loop does not use an explicit integer variable to access successive elements of the list. The question, then, is: What do we actually gain by implementing interfaces? If the condition evaluates to true, then the body is executed; and once it evaluates to false, the iteration is finished. This should print details of the author, title, and pages to the terminal window. We do not need to know the details of how it manages that. We shall represent both of these as integer fields in our class (Code 3.1). M06_BARN7367_06_SE_C06.indd 229 4/11/16 3:17 PM 230 | Concept The documentation of a class should be detailed enough for other programmers to use the class without the need to read the implementation. If no exception arises during execution of protected statements, then the catch block will be skipped over when the end of the try block is reached. Exercise 2.79 Consider the following expressions. B.5 Primitive type Wrapper type byte Byte short Short int Integer long Long float Float double Double char Character boolean Boolean Casting of object types Because an object may belong to an inheritance hierarchy of types, it is sometimes necessary to convert an object reference of one type to a reference of a subtype lower down the inheritance hierarchy. Person p = null; try { // The lookup could fail. We might even like to see all representations at the same time. M03_BARN7367_06_SE_C03.indd 120 4/11/16 3:06 PM sin a de u er | 121 Figure 3.5 A breakpoint in the Blue editor Figure 3.6 The debugger window, execution stopped at a breakpoint Along the bottom of the debugger window are some control buttons. These two stages are almost invariably combined in a single statement: throw new ExceptionType("optional-diagnostic-string"); When an exception object is created, a diagnostic string may be passed to its constructor. 6.11.2 Elements of class documentation The documentation of a class should include at least: ■ the class name ■ a comment describing the overall purpose and characteristics of the class ■ a version number M06_BARN7367_06_SE_C06.indd 230 4/11/16 3:17 PM 6.11 Writing class documentation ■ the author’s name (or authors’ names) ■ documentation for each constructor and each method | 231 The documentation for each constructor and method should include: ■ the name of the method ■ the return type ■ the parameter names and types ■ a description of the purpose and function of the method ■ a description of each parameter ■ a description of the value returned In addition, each complete project should have an overall project comment, often contained in a “ReadMe” file. The solution is a program called the compiler. Code 2.4 shows the constructor of the TicketMachine class. The fact that the value of price doesn’t vary once set does not alter the fact that it is still called a variable. The type defined by a subclass definition is a subtype of the type of its superclass. The body comprises eight statements plus associated comments. The methods can be private. Make any further changes to the user interface class that are necessary to catch and report the exception. Thus, if we define both Actor and Drawable as interfaces instead of abstract classes, we can define class Hunter (Figure 12.4) to implement both of them: public class Hunter implements Actor, Drawable { // Body of class omitted. The values of min and max should be set by parameters passed to the constructor. See, for instance, its saveSearchResults and showSearchResults methods. Furthermore, since a lambda has no associated class, there are also no instance fields and no constructor. They may request bookings of several adjoining seats. MessagePost and PhotoPost are now subclasses of our new CommentedPost class, while EventPost inherits from Posts directly. If an item with a low index number is removed, then the collection moves all subsequent items along by one position to fill in the gap. Also try it with a search string that matches none of the file names. The NORTH area of this BorderLayout contains a JPanel with a horizontal FlowLayout that arranges its components (say toolbar buttons) in a row. Methods implement the defined behavior of the class’s objects. If so, would any of the existing method signatures in the Vehicle hierarchy need to be changed? More information about the use of BlueJ is included in the BlueJ Tutorial. This is a parameterized interface. Start recording by selecting Create Test Method from the pop-up menu associated with a test class. See the “Tips archive” for instructions how to find it. All have in common that they store data, but each sort of variable has a particular role to play. However, an object of a subclass may call any public methods defined in its superclass as if they were defined locally in the subclass—no variable is needed, because the methods are all part of the same object. This is illustrated in Figure 2.4 by the arrow labeled (B). It would then be possible to reduce the final statement above to return id.equals(other.id); Whenever the equals method is overridden, the hashCode method should also be overridden. In the next few sections, we shall use the example of keeping track of a personal music collection to illustrate how we can group together an arbitrary number of objects in a single container object. The constructor has three parameters, also named from, to, and message! So while we are executing the constructor, how many variables exist? All of these variables are associated with monetary items that a ticket-machine object has to deal with: ■ ■ ■ M02_BARN7367_06_SE_C02.indd 55 price stores the fixed price of a ticket; balance stores the amount of money inserted into the machine by a user prior to asking for a ticket to be printed; total stores the total amount of money inserted into the machine by all users since the machine object was constructed (excluding any current balance). immutable An object is said to be immutable if its contents or state cannot be changed once it has been created. M13_BARN7367_06_SE_C13.indd 469 4/15/16 3:07 PM 470 | Chapter 13 ■ Building Graphical User Interfaces So far, we have achieved half of our task; we can create and display menus. Our problem is to decide how we should define Animal’s act method. Imagine that the hours and minutes objects on the object bench represent the two NumberDisplay objects managed by a ClockDisplay object. BlueJ is an interactive development environment with a mission: it is designed to be used by students who are learning how to program. They may be words and paragraphs if you are programming a word processor, users and messages if you are working on a social-network system, or monsters if you are writing a computer game. We still need to pass a Collector to the collect operation, but we must obtain it in a different way. (A solution with this method implemented is provided in the music-organizer-v3 version of this project, but to improve your understanding of the subject, we recommend that you write this method yourself.) Exercise 4.21 Create a MusicOrganizer and store a few file names in it. Modify the mail client accordingly. A class name can be used as the type for a variable. balance = balance – price; } else { System.out.println("You must insert at least: " + (price – balance) + " more cents."); } With this if-statement, we fix the problem that the naíve version makes no check that a customer has inserted enough money for a ticket before printing. The listFile and removeFile methods both illustrate the way in which an index number is used to gain access to an item in an ArrayList: one via its get method, and the other via its remove method. } else { // Failed to find the entry. I.1.2 The tag section Following the main description comes the tag section. Exercise 4.5 Write a declaration of a local variable called cs101 that can hold an ArrayList of Student. Each of these is initialized in the single constructor. The rest of this book deals with these issues. The Scanner’s hasNextInt method that controls the loop will return false if it encounters text in the file that does not appear to be part of an integer. If changes in one part of a program do not make it necessary to also make changes in another part of the program, this is known as weak coupling or loose coupling. Here, we create two NumberDisplay objects from the NumberDisplay class. 4.4.3 Key methods of ArrayList The ArrayList class defines quite a lot of methods, but we shall make use of only four at this stage, to support the functionality we require: add, size, get, and remove. It also has to do with modularization, but in a different context. Among the components we have encountered are menus, menu items, buttons, labels, borders, and others. In Chapter 13, where we introduce the Java GUI libraries, we will be making enormous use of abstract classes and interfaces as we see how to create quite sophisticated functionality with very little additional code. The lambda itself has a parameter, named record. We did not really care how the work was done. However, fields are handled differently from methods in Java: they cannot be overridden by subclass versions.3 This means that a canBreed method in Animal would use a meaningless value defined in that class, rather than one that is specific to a particular subclass. 3.1 The clock example The project we shall use to discuss interaction of objects is a display for a digital clock. Concept Components are placed in a frame by adding them to the frame’s menu bar or content pane. Because there is no explicit loop in our code anymore, it might be a little tricky to understand at first, but the overall process contains all of the same elements as the version using the for-each loop. Again, refer to the class’s documentation while you do this. M12_BARN7367_06_SE_C12.indd 459 4/11/16 3:38 PM 460 | Chapter 12 ■ Further Abstraction Techniques Exercise 12.72 The collection library has a class named TreeSet, which is an example of a sorted set. While doing this, we shall concentrate our discussion on the GUI aspects of the program. Below the Post class, it shows the MessagePost and PhotoPost classes, which hold only those fields and methods that are unique to each particular class. More generally, the Observer pattern defines a one-to-many relationship so that when one object changes its state, many others can be notified. While these simplifications make our prototype incomplete, they are not relevant for our main discussion here, and we shall leave them as they are for now. M06_BARN7367_06_SE_C06.indd 247 4/11/16 3:17 PM 248 | Chapter 6 ■ More-Sophisticated Behavior Method references are a convenient shorthand for some lambdas. To start the program, we will create an object of class ClockDisplay. When a frame is closed or iconified, a WindowEvent is generated. Commands are currently available to list the address book’s contents, search it, and add a new entry. Java divides exception classes into two categories: checked exceptions and unchecked exceptions. TableI.1 Common javadoc tags Tag Associated text @author @param @return @see @throws @version author name(s) parameter name and description description of the return value cross-reference exception type thrown and the circumstances version description The @author and @version tags are regularly found in class and interface comments and cannot be used in constructor, method, or field comments. 13.7.2 Borders The last polish we want to add to our interface is some internal borders. In other words, there is potential to turn the simulation of the taxi company into a taxi management system used to help the real company in its operations. M01B_BARN7367_06_SE_C01.indd 36 4/11/16 2:54 PM 1.7 State Concept Multiple instances. These short step-by-step videos demonstrate how to solve problems from design through coding. The debugger window can be accessed by selecting the Show Debugger item from the View menu or by pressing the right mouse button over the work indicator and selecting Show Debugger from the pop-up menu. Key methods are nextBoolean, nextDouble, nextInt, and setSeed. We always have to do this; GUI components are added to a frame by adding them to the frame’s content pane.2 1 2 The swing package is really in a package called javax (ending with an x), not java. Class methods are conceptually related and use a related syntax (the keyword static in Java). Entering an element a second time simply has no effect. What do you observe? Trying to use the new keyword with an abstract class is an error and will not be permitted by the compiler. The LogfileCreator class in the weblog-analyzer project includes a method to write a number of random log entries to a file M14_BARN7367_06_SE_C14.indd 547 4/11/16 3:43 PM 548 | Chapter 14 ■ Handling Errors whose name is passed as a parameter to the createFile method. Method bodies contain the declarations and statements that define what an object does when that method is called. ■ It generates a random number between 0 (inclusive) and the size (exclusive). In other words, there is no direct link between NumberDisplay objects. Note that some details of this hierarchy require an understanding of Java interfaces. A call to add, clear, get, remove, or size on tracks would all have the same syntax, and all have the same effect on the associated collection. Each of the fields has an associated get accessor method, but only name and credits have associated mutator methods. The stream returned will contain all the elements of the ArrayList in index order. Conditional statements are also known as if-statements, from the keyword used in most programming languages to introduce them. Change it so that the sun will be blue rather than yellow. Code 12.7 Animal as an abstract class Concept An abstract class is a class that is not intended for creating instances. Methods correspond to verbs. Z05_BARN7367_06_SE_APPE.indd 619 4/11/16 3:53 PM This page intentionally left blank AppenDix F Using the Debugger The BlueJ debugger provides a set of basic debugging features that are intentionally simplified yet genuinely useful, both for debugging programs and for gaining an understanding of the runtime behavior of programs. Or, if we are interested in more detail, we can go to a lower level of abstraction and look inside the print method. ■ There should be some escape route from endlessly attempting hopeless recovery. We note that this approach works. M06_BARN7367_06_SE_C06.indd 215 4/11/16 3:17 PM 216 | Chapter 6 ■ More-Sophisticated Behavior The most interesting code segment in this class is in the generateResponse method. How fast can it go? This is a program that can open and display image files in JPEG and PNG formats, perform some image transformations, and save the images back to disk. While this solution works, it has several drawbacks. 2.4.2 Constructors Concept Constructors allow each object to be set up properly when it is first created. One advantage of using polymorphic variables in this way is that if we ever wished to change from one concrete type to another, the only place in the code requiring a change is the place where the object M06_BARN7367_06_SE_C06.indd 245 4/11/16 3:17 PM 246 | Chapter 6 ■ More-Sophisticated Behavior is created. Parameters are variables that are defined in the header of a constructor or method: public TicketMachine(int cost) This constructor has a single parameter, cost, which is of type int—the same type as the price field it will be used to set. The Address class has accessor methods for these. It should be possible to isolate this duplication in much the same way as we did in creating the Filter class. This records whether or not a book is being used as a text book on a course. This is better than our first version, but is still not very convincing. ■ JMenuItem—Objects of this class represent a single menu item inside a menu (such as Open or Save). This is a significant gain, because having to write try statements for “cannot happen” situations is annoying for a programmer and makes it less likely that providing proper recovery for genuine error situations will be taken seriously. We explained there that it is important to know that each operation of the stream leaves its input stream unmodified. At first, this might seem like an unnecessary restriction, however, in some applications we know in advance exactly how many items we wish to store in a collection, and that number typically remains fixed for the life of the collection. You don’t have to include the definitions for the fields, just the text of the constructor. Java also allows us to import complete packages with statements of the form import package-name.*; So the following statement would import all class names from the java.util package: import java.util.*; Listing all used classes separately, as in our first version, is a little more work in terms of typing but serves well as a piece of documentation. Exercise 1.7 Create several circle objects on the object bench. An exception thrown when attempting to open a file is really the only one it is likely to be possible to do anything about, and only then if there is some way to generate an alternative name to try instead. In fact, while we can declare an explicit superclass for a class, all classes that have no superclass declaration implicitly inherit from a class called Object. These simply print out some text—a welcome message and a good-bye message, respectively. The exception type we have used here, IllegalArgumentException, is defined in the java.lang package and is regularly used to indicate that an inappropriate actual parameter value has been passed to a method or constructor. M01B_BARN7367_06_SE_C01.indd 40 4/11/16 2:54 PM 1.11 Source code | 41 Five of the classes in the house project are identical to the classes in the figures project. A pattern for this process is shown in Code 13.6. Morecomplicated filters might use the values of neighboring pixels to adjust a pixel’s value. Discuss in writing, and justify your choice. M04_BARN7367_06_SE_C04.indd 131 4/11/16 3:10 PM 132 | Chapter 4 ■ Grouping Objects We shall find that the ArrayList class makes it very easy to provide this functionality from our own class. Exercise 14.2 Repeat your experimentation with the text interface of the address-book-v1t project. Where these conditions apply, parallelization of collection processing can offer significant acceleration when dealing with large amounts of data. Exercise 2.21 Suppose that the class Pet has a field called name that is of the t e String. Handling collections is one of the fundamental techniques in programming; almost all computer programs process collections of some sort, and we will see much more of this throughout this book. Figure 2.2 An object of class TicketMachine ticketMa1: TicketMachine price balance total Each field has its own declaration in the source code. Correct them. Rewrite the simulateOneStep method in Simulator to use Actor instead of Animal. The book discusses numerous programming projects and provides many exercises. A for-each loop does not help us in those cases. When you create the client, you will need to supply a MailServer instance as a ara eter se the one you just created. Many other teachers, as well as developers of BlueJ and the authors of this book, can be contacted in the Blueroom. More complex cases involving multiple parameters will also be encountered in the more general examples. M13_BARN7367_06_SE_C13.indd 510 4/15/16 3:07 PM CHaptEr 14 Handling Errors Main concepts discussed in this chapter: ■ defensive programming ■ error reporting ■ exception throwing and handling ■ basic file processing Java constructs discussed in this chapter: TreeMap, TreeSet, SortedMap, assert, exception, throw, throws, try, catch, File, FileReader, FileWriter, Path, Scanner, Stream In Chapter 9, we saw that logical errors in programs are harder to spot than syntactical errors, because a compiler cannot give any help with logical errors. M06_BARN7367_06_SE_C06.indd 201 4/11/16 3:17 PM 202 | Chapter 6 ■ More-Sophisticated Behavior Figure 6.1 A first TechSupport dialog In Exercise 6.1, you have seen that the program essentially holds a dialog with the user. M15_BARN7367_06_SE_C15.indd 557 4/11/16 3:45 PM 558 | Chapter 15 ■ Designing Applications We will use a fairly simple method to address these tasks, which serves well for relatively small problems. For instance, have the minutes object tell the hour object that another hour has passed, or have the seconds object tell the minutes object that another sixty seconds have elapsed. Trivial tasks such as the ticket machine can be solved as a single problem. We shall not investigate that class in detail here. Activity posts can be automatically generated and inform us about an activity of one of our contacts, such as "Fred has changed his profile picture" or "Jacob is now friends with Feena." Activity posts seem similar enough that it should be easy to modify our application to do this. As a general rule: Take the time; keep your code clean! Now that we have done this, we are ready to add some more filters. We can choose the name of this variable just as we can that of any other variable; it does not have to be called "filename." The type of the loop variable must be the same as the declared element type of the collection we are going to use—String in our case. The first step of design will be at a higher level than the class design discussed in Chapter 8. This is commonly used in reduce operations. M06_BARN7367_06_SE_C06.indd 202 4/11/16 3:17 PM 6.2 The TechSupport system | 203 Figure 6.2 TechSupport class diagram SupportSystem InputReader Responder 6.2.2 Reading the code The complete source code of the SupportSystem class is shown in Code 6.1. Code 6.2 shows the source code of class Responder. With its essential simplicity necessarily comes some limitations. ■ In a similar vein, notice that setDead was public in Rabbit, but private in Fox. We shall also introduce a new loop structure that is often closely associated with arrays—the for loop. The debugger not only allows us to interrupt the execution of the program so we can inspect the variables, it also lets us step forward slowly. This has been possible because the listener interfaces have been functional interfaces—i.e., they have consisted of a single abstract method. Which classes do you have to declare to be serializable? Duplication can represent wasted effort, and can lead to inconsistencies where two things that should be identical turn out not to be, through error. To do this, the simulateOneStep method is called repeatedly in a simple loop. Exercise 14.5 Modify the CommandWords and AddressBookTextInterface classes of the address-book-v1t project to provide interactive access to the getDetails and removeDetails methods of AddressBook. The code in the simulator class would look similar to this: // Let all actors act. The reason for this has to do with abstraction, again. Input dialog: This dialog includes a prompt and a text field for the user to enter some text. Because we cannot specify a breeding age for animals in general, we can again use an abstract method in the Animal class and concrete redefinitions in the subclasses. Having established that we have another student, we use a cast and another variable of the right type so that we can access its details properly. Local variables can be used as temporary data storage to assist with that. 12.5.2 Flexibility through abstraction By moving towards the notion of the simulation being responsible for managing actor objects, we have succeeded in abstracting quite a long way away from our original very specific scenario of foxes and rabbits in a rectangular field. object diagram The object diagram shows the objects and their relationships at one moment in time during the execution of an application. The project is named scribble, and you can find it in the Chapter 6 folder of the book projects. Exercise 13.4 What happens when you add two labels (or two buttons) to the content pane? You might also choose to include some explanatory text to help a user work out which is the author and which is the title, for example Title: Robinson Crusoe, Author: Daniel Defoe, Pages: 232 Exercise 2.88 Add a further field, refNumber, to the Book class. M12_BARN7367_06_SE_C12.indd 435 4/11/16 3:38 PM 436 | Chapter 12 ■ Further Abstraction Techniques Let us assume that we create such a method, called act, and investigate the resulting source code. For this book, we recognize that different teachers will have different constraints and preferences. The price is taken to be a number of cents, so a positive whole number such as 500 would be appropriate as a value to work with. The printTicket method reduces the value of balance by the value of price. println The method System.out.println prints its parameter to the text terminal. Rather than building the freeway first and then observing what happens, we will try to simulate the effect in order to make a well-informed decision.1 Our simulation will necessarily be simpler than the scenario we have described, because we are using it mainly to illustrate new features of object-oriented design and implementation. It will be possible with some fields, such as balance and total, to set sensible initial values by assigning a constant number—zero in this case. Figure 11.8 illustrates this. A complete M06_BARN7367_06_SE_C06.indd 199 4/11/16 3:17 PM 200 | Chapter 6 ■ More-Sophisticated Behavior implementation containing all the ideas and source code discussed here, as well as several intermediate versions, is included in the book projects. A benefit of having an explicit index variable is that we can use its value both inside and outside the loop, which was not available to us in the for-each examples. It looks something like this: public boolean equals(Object obj) { return this == obj; } Because the Object class has no fields, there is no state to compare, and this method obviously cannot anticipate fields that might be present in subclasses. This fills a gap in the list of Consumer interfaces in that it takes no parameters and has a void return type. This package contains numerous classes to support input/output operations in a platform-independent manner. Figure 11.4 NewsFeed Display, version 3: display method in subclasses and superclass Post ... The reason we could use the constants from class Color is that they were declared public. It is only by exploring and trying things out that we gain a full understanding of what it is we are trying to achieve. Each of the nouns should now be assigned to a CRC card, ready to have its responsibilities and collaborators identified. We have not changed the functionality of the application at all, but have worked exclusively at improving the implementation structure so that future changes become easier. 12.6.6 Library support through abstract classes and interfaces In Chapter 6, we pointed out the importance of paying attention to the names of the collection classes: ArrayList, LinkedList, HashSet, TreeSet, etc. Barnes and Michael Kölling University of Kent Sixth Edition Boston Columbus Indianapolis New York San Francisco Hoboken Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto Delhi Mexico City Sao Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo A01_BARN7367_06_SE_FM.indd 1 4/15/16 6:10 PM Vice President, Editorial Director, ECS: Marcia Horton Executive Editor: Tracy Johnson Editorial Assistant: Kristy Alaura Vice President of Marketing: Christy Lesko Director of Field Marketing: Tim Galligan Field Marketing Manager: Demetrius Hall Marketing Assistant: Jon Bryant Director of Product Management: Erin Gregg Team Lead, Program and Project Management: Scott Disanno Program Manager: Carole Snyder Project Manager: Camille Trentacoste Senior Specialist, Program Planning and Support: Maura Zaldivar-Garcia Cover Designer: Marta Samsel Cover Art: brm1949/Fotolia Inventory Manager: Ann Lam Media Project Manager: Leslie Sumrall Full-Service Project Management, Composition, and Art: Chandrasekar Subramanian, SPi Global Printer/Bindery: R.R. Donnelley/Crawfordsville Cover printer: Phoenix Color/Hagerstown Copyright © 2017, 2012, 2009, 2006, 2005, 2003 by Pearson Education. 6.18 Summary Dealing with class libraries and class interfaces is essential for a competent programmer. The writer of the client class might argue that there is nothing in the method's documentation to say that the key must be valid. First, the class Post has a constructor, even though we do not intend to create an instance of class Post directly.2 This constructor receives the 2 Currently, there is nothing actually preventing us from creating a Post object, although that was not our intention when we designed these classes. Loops offer the option to repeat statements, either a definite or an indefinite number of times. In addition, because they are defined inside a method, they are able to access the local variables and parameters of that method. Place just a small number of hunters in the field at the start of the simulation. The functionality that we want to provide with this prototype should include at least the following: ■ ■ ■ ■ ■ ■ It should allow us to create text and photo posts. You also need to specify a username for the mail client. Here is a summary of their features: ■ ■ ■ ■ M02_BARN7367_06_SE_C02.indd 79 All three kinds of variables are able to store a value that is appropriate to their defined types. Can you explain what you observe? Maybe next year . . . A01_BARN7367_06_SE_FM.indd 14 4/15/16 6:10 PM Preface New to the sixth edition This is the sixth edition of this book, and—as always with a new edition—the content has been adapted to the latest developments in object-oriented programs. Exercise 16.9 Do you feel it is necessary to address how vehicles move between locations at this stage? This anticipated part of the work of one of the later stages. The call to setValue ill need to include a nu erical ara eter alue se the recorded ethod calls in the Terminal window to help you with the correct way of writing these method calls. There we saw that abstraction allows us to simplify a problem by identifying discrete components that can be viewed as a whole, rather than being concerned with their detail. We will fix this last problem later in the chapter. In this case, the typing rule allows all the following assignments: Vehicle v1 = new Vehicle(); Vehicle v2 = new Car(); Vehicle v3 = new Bicycle(); The type of a variable declares what it can store. | 437 say that each animal can act, but we cannot describe exactly how it acts without referring to a more specific subclass. display 4/11/16 3:34 PM 394 | Chapter 11 ■ More about Inheritance Exercise 11.1 Open your last version of the network project. The project can then be shared by using the Share this Project function from the Team menu. Add a check to this method to prevent a negative value from being assigned to increment. A variable of an object type holds a reference (or "pointer") to an object. Exercise 13.69 Open the musicplayer project. Both of these must be taken into account when writing the loop's condition. If you want to use the files provided in the audio folder within the cha ter ou ust include the folder na e in the filena e ara eter as ell as the file na e and suffi or e a le to use the file BlindBlakeEarlyMorningBlues.mp3 from the audio folder, you must pass the string "../audio/BlindBlake-EarlyMorningBlues.mp3" to the addFile method. The object inspector is an enlarged view of the object that shows the attributes stored inside it (Figure 1.6). Both of these concepts are central to the idea of object orientation, and you will discover later how they appear in various forms in everything we discuss from now on. 5. The other is to indicate that there was something wrong with its request, such as passing bad parameter values. Do you think an AddressBook should print an error message whenever it receives a bad parameter value to one of its methods? This reflects common practice. 12.3.3 Abstract classes It is not only methods that can be declared abstract; classes can be declared abstract as well. An object might be used in ways that have not been anticipated by the class designer, leading to the object being left in an inconsistent or inappropriate state. We will discuss static variables later, and this class does not have any. 12.2.2 The Rabbit class The source code of the Rabbit class is shown in Code 12.1. The Rabbit class contains a number of class variables that define configuration settings that are common to all rabbits. We can, for example, define the Post's display method in terms of a call to its toString method. Note that the actual posts that we get out of the list are of type MessagePost or PhotoPost, not of type Post. This will allow you to see the result of your interactions with objects, which will be useful when we look in detail at the full clock-display project. Test methods have the annotation @Test in the source of the test class. cohesion The term cohesion describes how well a unit of code maps to a logical task or entity. Other authors choose to adopt different styles, and this is mostly a question of preference. Draw object diagrams as part of your explanations. With the music-organizer project we might want to find all the tracks by a particular artist. An alternative approach is to use an event-based, or asynchronous, simulation style. It works especially well on portraits. We will learn more about method calling between objects in Chapter 3. They are: ■ ■ ■ Message dialog: This is a dialog that displays a message and has an OK button to close the dialog. ■ Interfaces do not contain any instance fields. Now imagine that we change the requirements a bit: event posts in our network application will not have a "Like" button or comments attached. And this, it turns out, is not what we want. In this diagram, you see that we are dealing with three objects. In one sense, the sort of testing we discussed in Chapter 9 is an attempt to establish whether we have implemented an accurate representation of what a class or method should do. Upgrading your processor should solve all performance problems. Does the Graph View give you any new insights or help you understand or explain what you see? Brooks Jr., Addison-Wesley. A consequence of this is that a method with a non-void return type is not required to execute a return statement on a route that throws an exception. } private int computeAverage() { ... internal method call Methods can call other methods of the same class as part of their implementation. The condition is evaluated when program control first reaches the loop, and it is re-evaluated each time the loop body has been executed. We also believe that it is easier for students to follow the motivation of the introduction, and that it makes much more interesting reading. Thus, you might write one class while making calls to methods of other classes. The listFile and removeFile methods illustrate that the range of valid index numbers at any one time is [0 to (size()–1)]. When questioned about this, students often say: "Well, that's just a number, so I just use an int. M04_BARN7367_06_SE_C04.indd 153 4/11/16 3:10 PM 154 | Chapter 4 ■ Grouping Objects or int index = 0; boolean found = false; while(index < files.size() && !found) Take some time to make sure you understand these two fragments, which accomplish exactly the same loop control, but expressed in slightly different ways. Because the components are not resized to fill the available space, there will be spare space around them if the window is resized. Code 12.7 shows an example of class Animal as an abstract class. ■ The steps we have outlined represent the fundamental activity of the taxi company, repeated over and over as each new passenger requests the service. */ public int getBreedingAge() { return BREEDING_AGE; } Concept Superclass method calls. Click OK and you have added the student to the LabClass. What should the hour object do when a whole day has elapsed? Such expressions are usually found in the test expressions of if-else statements and loops. In this style, the simulation is driven by maintaining a schedule of future events. If the two values of a particular class variable (BREEDING_AGE, say) were identical, would it make any difference to your assessment of which methods are truly identical? Event-based simulations are often more efficient and are preferable where large systems and large amounts of data are involved, while synchronous simulations are better for producing time-based visualizations (such as animations of the actors) because time flows more evenly. Playing through scenarios works best when a group of people sit around a table and move the cards around on it. (A lambda that takes an element and returns true or false is called a predicate.) If the result is true, the element is included in the output stream, otherwise it is left out. The constructor's name immediately follows the word public, with nothing in between.1 We should expect a close connection between what happens in the body of a constructor and the fields of the class. These are called methods in Java. ■ How can a client anticipate failure of a request to a server? In terms of easy changeability, we have gone backwards. M15_BARN7367_06_SE_C15.indd 575 4/11/16 3:45 PM 576 | Chapter 15 ■ Designing Applications Exercise 15.16 Three additional commonly used patterns are the State pattern, the Strategy pattern, and the Visitor pattern. It might show the text in a text area in a graphical user interface; save it to a file; send it over a network; show it in a web browser; or, as before, print it to the terminal. Taxis drop their passengers at their target locations before taking on new passengers. Try inserting the exact amount required for a ticket, and use getBalance to ensure that the balance is increased correctly. Try changing the state of an object (for example, by calling the moveLeft method) while the object inspector is open. In object-oriented programming, these components and subcomponents are objects. Although we cannot create an instance of an abstract class directly, we can otherwise use an abstract class as a type in the usual ways. Exercise 6.3 Look up the startsWith method in the documentation for String. class BufferedReader BufferedReader is a class that provides buffered character-based access to a source of input. 6.15 Class methods So far, all methods we have seen have been instance methods: they are invoked on an instance of a class. However, in practice, it also needs to provide both a test for coincidence of two locations (equals), and a way for a vehicle to find out where to move to next, based on its current location and its destination (nextLocation). class FileWriter The FileWriter class is used to open an external file ready for writing character-based data. 13.4.5 Event handling Concept An object can listen to component events by implementing an event-listener interface. For the design of the Student class, you now have two choices: Either you implement getStreet, getCity, and getZipCode methods in the Student class—which just pass the method call on to the Address object and hand the result back—or you implement a getAddress method in Student that returns the complete Address object to the Database and lets the Database object call the Address object's methods directly. M02_BARN7367_06_SE_C02.indd 65 4/11/16 3:02 PM 66 | Chapter 2 ■ Understanding Class Definitions The header of insertMoney has a void return type and a single formal parameter, amount, of type int. A collection might be large (all the students in a university), small (the courses one of the students is taking), or empty even (the paintings by Picasso that I own!). Right-click on the Circle class and choose new Circle() Figure 1.1 The figures project in BlueJ 1 We regularly expect you to undertake some activities and exercises while reading this book. What happens if you create a number display with limit 800, for instance? The initial design is one of the most important parts of the project. M06_BARN7367_06_SE_C06.indd 238 4/11/16 3:17 PM 6.14 Class variables and constants | 239 6.13.3 The bouncing-balls demo Open the bouncing-balls project and find out what it does. Do we need to distinguish between "shuttle" and "taxi"? 14.3.2 Notifying the client object A radically different approach from those we have discussed so far is for the server object to feedback an indication to the client object when something has gone wrong. Something to do with flying . In it, create a method that accepts an array of int values as a parameter and prints the elements sorted out to the terminal (smallest element first). B.3 Object types All types not listed in Section B.1, Primitive types, are object types. Exercise 13.58 What is a spinner? Explain the behavior you observe. M12_BARN7367_06_SE_C12.indd 454 4/11/16 3:38 PM 12.9 Abstract class or interface? That is, if the current time is 3:05 a.m., we want the display to read 03:05, and not 3:5. Concept Collection A collection object can store an arbitrary number of other objects. If we add two new transporter rooms, we have to add two more instance variables or an array (to store references to those rooms), and we have to modify our goRoom method to add a check for those rooms. Explain why this is. The Simulator would simply store a collection of ActorFactory objects, and it would ask each of them to produce a number of actors. We would write a loop that looks like this: public int getCount(String animal) { int total = 0; for(Sighting sighting : sightings) { if(animal.equals(sighting.getAnimal())) { total = total + sighting.getCount(); } } return total; } The process of calculating the sum involves the following steps: ■ ■ Declare a variable to hold the final value and give it an initial value of 0. If fields or methods are declared with the protected access modifier, subclasses are allowed to access them, but other classes are not. Implement a similar method in the PhotoPost class. Suppose we have a method that saves the contents of an address book to a file. Exercise 8.45 suggested that you implement a transporter room (a room that beams you to a random location in the game if you try to enter or leave it). The method body is the remainder of the method after the header. You can find this in the version called musicorganizer-v2. A map can be organized in such a way that looking up a value for a key is easy. We will use this base version to develop several improved versions that progressively introduce new abstraction techniques. How many NumberDisplay objects would a ClockDisplay object need to use? It is not usually a problem if a programmer knows the implementation details, but a class should not "know" (depend on) the internal details of another class. Z11_BARN7367_06_SE_APPK.indd 638 4/11/16 3:59 PM K: Important Library Classes K.3 | 639 The java.io and java.nio.file packages The java.io and java.nio.file packages contain classes that support input and output and access to the file system. This aspect of the application has been deferred until a later resolution. It translates the code line by line, so it looks at the last line in isolation without knowing what is currently stored in variable v. It shouldn't surprise you, therefore, that there is also a Class class! This is where talking about classes and objects can become very confusing. If we want to store them in a common collection, then all filters will need a common superclass, which we name Filter and give an apply method (Figure 13.10 shows the structure, Code 13.11 shows the source code). Both are followed by freetext, and there is no required format for either. } } An anonymous inner class is created by naming a supertype (often an abstract class or an interface—here MouseAdapter), followed by a block that contains an implementation for its abstract methods, or any methods we wish to override. Our application can then receive a notification of the event (by having one of its methods invoked), and we can take appropriate action. During the CRC card exercise, you should have gained a good understanding of how your application is structured and how your classes cooperate to solve the program's tasks. Pairs of constructors determine whether an existing file will be appended to, or its existing contents discarded. In our animal monitoring project, this would be useful for counting how many elephants we have seen: Once we have a stream of all elephant sightings, we can use reduce to add them all up. Exercise 5.16 If a pipeline contains a filter operation and a map operation, does the order of the o erations atter to the final result ustif our ans er Exercise 5.17 Rewrite the printEndangered method in your project to use strea s Test To test this ethod it a e easiest to rite a test ethod that creates an ArrayList of animal names and calls the printEndangered method ith it Exercise 5.18 Challenge exercise The printSightingsBy method of AnimalMonitor contains the following terminal operation: forEach(details –> System.out.println(details)); Replace it with the following: forEach(System.out::println); Take care to use the exact syntax. If so, how much further would you have taken the development? public String generateResponse(String word) { String response = responseMap.get(word); if(response != null) { return response; } else { // If we get here, the word was not recognized. The part we are concentrating on is the news feed—the list of messages that should appear on screen when a user opens the network's main page. Templates are stored in the folders /lib//templates/ and /lib//templates/newclass/ where is the BlueJ installation folder and is your currently used language setting (for example, english). Then we need another group of scenarios: those dealing with setting up the theater, and scheduling shows. Try the following: sum = 99 + 3; You will see the following error message: Error: cannot find symbol - variable sum This is because Java requires that every variable (sum, in this case) be given a type before it can be used. Multiple inheritance exists in cases where one class has more than one immediate superclass.4 The subclass then has all the features of both superclasses and those defined in the subclass itself. M13_BARN7367_06_SE_C13.indd 508 4/15/16 3:07 PM 13.11 Summary 13.11 | 509 Summary In this chapter, we have supplied an introduction to GUI programming using the Swing and AWT libraries. It is important to note that this code segment will generate a random number in the range 0 to listSize–1 (inclusive). The taxi company does not operate particularly intelligently at present. Figure F.2 A breakpoint attached to a line of code F.2 The control buttons Figure F.3 shows the control buttons that are active at a breakpoint. Which solution is better? Imagine that you had to read all that in order to understand how an application works! You would never succeed. The instanceof operator One of the consequences of the introduction of inheritance into the network project has been that the NewsFeed class knows only about Post objects and cannot distinguish between message posts and photo posts. We can read the complete type definition ArrayList as "ArrayList of String." We use this type definition as the type for our files variable. And we have added one more filter, called Fish Eye, to give you some more ideas about what you can do. These concepts form the basis of all programming in object-oriented languages. Here, both parameter lists are empty, so they match. The passenger source calls the taxi company to request a pickup for a passenger. Their lifetime is the time of the method execution: they are created when a method is called and destroyed when a method finishes. M06_BARN7367_06_SE_C06.indd 206 4/11/16 3:17 PM 6.3 Reading class documentation | 207 Figure 6.3 The Java class library documentation In the list of classes on the left, find and select the class String. This is because that can be worked out by the compiler from the final statement in the lambda's body. The first collection being used is an ArrayList. Code 14.8 The try and catch blocks of an exception handler Concept Program code that protects statements in which an exception might be thrown is called an exception handler. Exercise 2.30 Create a ticket machine with a ticket price of your choosing. Exercise 6.17 Write a method called getResponse that randomly returns one of the strings "yes", "no", or "maybe". This rule applies in simple assignment between variables, but also when passing an object as an actual parameter to a method. The toString method is generally useful for debugging purposes. The example we discuss to introduce these new structures is called network. (Lambda expressions implement interfaces just by virtue of providing an implementation that matches the signature of the method in the functional interface.) This now allows us to use lambda expressions as action listeners for the menu items. A stream could potentially be infinite! The stream concept is used to unify the processing of sets of data, independent of where this data set comes from. 14.8.2 Error avoidance It should be clear that arriving at a situation where an exception is thrown will be, at worst, fatal to the execution of a program and, at best, messy to recover from in the client. As a first cut, we can use one class for each noun. To construct interesting applications, it is not enough to build individual working objects. The steps in which method execution takes place are exactly the same as steps 1 through 4 from scenario 1. When the debugger window pops up, use Step Into to step through the code. Carefully read the description of this class, and then write a class Person that can be inserted into a TreeSet, which will then sort the Person objects by age. Try to predict their results, and then type them in the Code Pad to check your answers. For instance, one event might occur at time t and the next two events occur at times t + 2 and time t + 8, while the following three events might all occur at time t + 9. Exercise 6.75 What constant names are defined in the java.lang.Math class? A modal dialog blocks all interaction with other parts of the application until the dialog has been closed. This is allowed, and the result of calling it will be to leave a blank line between this output and any that follows after. J.3.4 Code comments (only) where necessary Comments in the code should be included where the code is not obvious or is difficult to understand (and preference should be given to make the code obvious or easy to understand where possible) and where comments facilitate understanding of a method. Exercise 1.17 Add a second sun to the picture. A small part is shown in Figure 10.6. We can see that a poodle is a dog, which is a mammal, which is an animal. With methods that return primitive-type values, there will sometimes be an out-of-bounds value that can fulfill a similar role: for instance, the indexOf method of the String class returns a negative value to indicate that it has failed to find the character sought. Design patterns help in our task in two ways. Concept A subclass is a class that extends (inherits from) another class. Code 2.4 The constructor of the Ticket Machine class We can see from this that one of the most important roles of a field is to remember external information passed into the object, so that that information is available to an object throughout its lifetime. assertion An assertion is a statement of a fact that should be true in normal program execution. A set, on the other hand, does not maintain any specific order (the elements may be returned in a for-each loop in a different order from that in which they were entered) and ensures that each element is in the set at most once. This means that both menu items will invoke the same actionPerformed method when they are activated. 6 Make sure that you understand why a test for reference equality is the most appropriate here. M12_BARN7367_06_SE_C12.indd 457 4/11/16 3:38 PM 458 | 12.12 Chapter 12 ■ Further Abstraction Techniques Summary In this chapter, we have discussed the fundamental structure of computer simulations. This method filters the full list of Sighting objects to create a new List of only those for a specific animal. This experiment now shows that the method in class Post is then not executed at all, but the subclass methods are. An InputStream is not normally used directly when it is necessary to read user input from the terminal, because it delivers input one character at a time. As we have seen above, the ClockDisplay class has a method with the following signature: private void updateDisplay() The method call above invokes this method. For instance, we have hardly developed the Shuttle class at all, so there are plenty of challenges to be found in completing its implementation. However, there is still some key functionality missing if we want a genuinely useful program—most obvious is the lack of any way to list the whole collection, for instance. Our code then looks like this: sightings.forEach((record) –> { System.out.println(record.getDetails()); }); The next simplification concerns parentheses and curly brackets: ■ ■ If the parameter list contains only a single parameter, then the parentheses may be omitted. Chapter sequence Chapter 1 deals with the most fundamental concepts of object orientation: objects, classes, and methods. Before we analyze the source code needed to make use of such a class, it is helpful to explore the starting behavior of the music organizer. As we could see from our diagrams, primitive values are stored directly in a variable (we have written the value directly into the variable box—for example, in Chapter 2, Figure 2.3). Several layout managers can do this. Investigate the features of the class for text-based diagnostic error logging. When we create an ArrayList object, however, we have to be specific about the type of objects that will be stored in that particular instance. The following will throw a NullPointerException, with the associated string, if the value of key is null; otherwise it will do nothing: Objects.requireNonNull(key, "null key passed to getDetails"); Exercise 14.26 Review all of the methods of the AddressBook class and decide whether there are any additional situations in which they should throw an IllegalArgumentException. The fields from Post are inherited and do not need to be listed here. * application. In the Code Pad, we can type Java code that does the same things we did interactively before. Using integer values as indices also makes it easy to express expressions in program code such as "the next item" and "the previous item" with respect to an item in the collection. Note that, because both the try and catch blocks make use of the filename and successful variables, they have to be declared outside the try statement in this example, for reasons of scope. There are two main ways to do this: ■ ■ A server can use a non-void return type of a method to return a value that indicates either success or failure of the method call. In the first half of this chapter, we have used the most fundamental technique to analyze a given program: code reading. You will notice very quickly that the response is always the same: "That sounds interesting. Abstract classes may have both abstract methods— methods that have a header but no body—and full method implementations. The goals of the first stage were deliberately set to be quite modest, yet still relevant to the fundamental activity of the application—collecting and delivering passengers. The field should be set through a parameter to the constructor, and the field is immutable. In BlueJ, the state of an object can be inspected by selecting the Inspect function from the object's pop-up menu. In this case, Z04_BARN7367_06_SE_APPD.indd 610 4/11/16 3:52 PM D: Java Control Structures ■ ■ ■ ■ | 611 all three of the first values will execute the first statements section, whereas values four and five will execute the second statements section. You can find the examples illustrated here in the layouts project. With this version, we have solved the central task; we can now open an image file from disk and display it on screen. Remembering this pattern will help you when you write your own classes. Because EventPost is a subclass of Post, it automatically inherits all fields and methods that we have already defined in Post. Much of programming in Java is about learning to write class definitions. ■ The need for something like the City class was identified during development of stage one. Typically, the main simulation loop will not need to be concerned with the concrete event types, but will be able to use polymorphic method calls when an event occurs. Examining the mail system project, we see that: ■ M03_BARN7367_06_SE_C03.indd 117 It has three classes: MailServer, MailClient, and MailItem. However, in Section 11.9, we shall introduce a further type of access designed specifically to support the superclass–subclass relationship. Explain what you see. There are many other types of events. 2.12 Reflecting on the design of the ticket machine From our study of the internals of the TicketMachine class, you should have come to appreciate how inadequate it would be in the real world. If this happens, the body won't be executed at all. That still leaves the question of whether we can include some internal checks to ensure that the server object behaves as it should. As you can see, scopes are often nested: the if-statement is inside a method, which is inside a class. We want to find a design that lets us add new filters without having to add a new dispatch method for the filter every time. Users need to be aware of this possible change of indices when adding or removing items. Do calls to their showPrice methods show the same output, or different? ■ A static getInstance method is defined, which provides access to the single instance. The logic and the structure of the application should not change any more, but we try to note complete information about method signatures and instance fields. M10B_BARN7367_06_SE_C10.indd 375 4/11/16 3:32 PM 376 | Chapter 10 ■ Improving Structure with Inheritance Code 10.4 Initialization of subclass and superclass fields parameters needed to initialize the Post fields, and it contains the code to do this initialization. This will affect this particular object, but not others. A menu item (class JMenuItem) raises an ActionEvent when it is activated by a user. A version number can be a simple number, a date, or other format. We will now complete the picture with a more advanced example. Assignment statements are used frequently in programming, as a means to store a value into a variable. The data stored in fields is accessible to all of the object's methods. One thing all possible actors have in common is that they perform some kind of action. If access to a private field is channeled through accessor and mutator methods, then an object has the ability to ensure that the field is never set to a value that would be inconsistent with its overall state. Indeed, as we look closely at the source code of different classes, you will see patterns such as this one emerging over and over again. It is also common for beginners to forget some scenarios. All subclasses of the Java standard class RuntimeException are unchecked exceptions; all other subclasses of Exception are checked exceptions. You will need to find out about a method of the String class that generates a substring. You will find that we write very few class methods in the examples in this book. All the techniques we have discussed throughout this book work toward this. However, they also have a M06_BARN7367_06_SE_C06.indd 244 4/11/16 3:17 PM 6.17 Further advanced material | 245 considerable number of similarities and methods in common. Modify the findFood method so that rabbits in all adjacent locations are eaten at a single step. The next obvious idea for an improvement of our application is to add some more interesting filters. Make sure printing messages also prints the subject line. Here is the code of the ClockDisplay constructor that makes this work: public class ClockDisplay { private NumberDisplay hours; private NumberDisplay minutes; Remaining fields omitted. We contrast internal and external method calls in the next section. The issues of coupling and information hiding are very important, and we shall have more to say about them in later chapters. The class describes the kind of object; the objects represent individual instances of the class ■ Objects and Classes You will notice that we cannot answer these questions until we talk about one specific car. We have discussed the fact that objects are specified by classes. It is vital, therefore, to have a good grasp of its essential elements. The pen provides us with an abstraction that holds a current position, rotation, and color, and this makes producing some kinds of drawings easier. } // Gain access to the other student's fields. The string following the colon symbol will be passed to the constructor of AssertionError to provide a diagnostic string. Based on estimates of the number of potential customers in the new area, the company wishes to know whether an expansion would be profitable, and how many cabs it would need in the new location in order to operate effectively. If an odd number of equal-size components cannot fill a 2D grid, there may be spare space in some configurations. J.4.7 Initialize all fields in the constructor Include assignments of default values. Inheritance is sometimes also called an is-a relationship. Inheritance allows the design of class structures that are easier to maintain and more flexible. The hashCode method is used by data structures such as HashMap and HashSet to provide efficient placement and lookup of objects in these collections. Look up the library documentation for any classes and methods involved. 13.8 Inner classes Up to this point, we have implemented event-handling listeners using lambda notation. The overriding method takes precedence for method calls on subclass objects. G.2 Creating a test class A test class is created by right-clicking a class in the class diagram and choosing Create Test Class. When we used the Java library classes, such as HashSet or Random, we relied exclusively on the documentation to find out how to use them. So add to PassengerSource the responsibility Generate pickup and destination locations for a passenger, with Location as a collaborator; and add to Passenger the responsibilities Receive pickup and destination locations and Provide destination location. Java library The Java standard class library contains many classes that are very useful. Exercise 6.26 How do you check how many entries are contained in a map? We can sometimes avoid getting into situations that require an exception to be handled, by using the Files class and a Path object to check whether or not a file exists. In the methods of Post, only the fields declared in Post are available. They now want to develop the TechSupport system to give the impression that support is still provided. You will see an option labeled Open Editor. The reason is complexity. BlueJ reports this as a NullPointerException and highlights the statement from which it resulted. 5.5.3 The filter method As discussed, the filter method creates a subset of the original stream. If recovery were possible at the point of discovery, then there would be no point in throwing an exception. It is reasonably simple. conditional statement A conditional statement takes one of two possible actions based upon the result of a test. The first is useful for code reuse, the second for polymorphism and specialization. It handles the exchange of messages. In our while-loop version, it is possible to make a mistake that results in an infinite loop. What we have left out, of course, is the implementation of the findRandomRoom method. For a fox-and-rabbits simulation, the sort of events we are talking about would be birth, movement, hunting, and death from natural causes. String fish = swimmer; fish Try it out. Return types and return statements work together. Note that the final call to println contains no string parameter. G.1 Enabling unit-testing functionality In order to enable the unit-testing functionality of BlueJ, it is necessary to ensure that the Show unit testing tools box is ticked under the Tools–Preferences–Miscellaneous menu. The pixel at the top left corner will move to the top right, and vice versa, producing the effect of viewing the image in a mirror. In the model, it does so from the company, which received it originally from the passenger source. fter e er si ulation ste it rints out one line in the for Foxes: 121 Rabbits: 266 Use TextView instead of GridView for some tests. Prototypes are also useful for single classes to aid a team development process. The key differences between them are the ways in which they position components, and how the available space is distributed between the components. Create an object of class PhotoPost in your project, and then invoke the toString method from the Object submenu in the object's pop-up menu. external method call Methods can call methods of other objects using dot notation. M13_BARN7367_06_SE_C13.indd 493 4/15/16 3:07 PM 494 | Chapter 13 ■ Building Graphical User Interfaces Now, after finishing the refactoring, we should test that all existing functionality still works as expected. Does it matter if the tests we create fail at this stage? For example, Car myCar = new Car(); is a valid assignment, because an object of type Car is assigned to a variable declared to hold objects of type Car. Alternatively, the customer could ask to be refunded the remaining balance, and that is what the refundBalance method does, as we shall see in section 2.16. For Java in particular, countless books, tutorials, exercises, compilers, environments, and quizzes already exist, in many different kinds and styles. Code 12.6 The fully improved solution to animal action Several observations are important at this point: ■ ■ ■ ■ The variable we are using for each collection element (animal) is of type Animal. While one or more versions of each problem are discussed in detail in the book, the projects are designed so that further extensions and improvements can be done as student projects. Table C.1 Java operators, highest precedence at the top [] . The AddressBookFileHandler class also includes further examples of the basic reading and writing techniques used with text files. 5.4 The forEach method of collections When introducing the idea of a lambda above, we mentioned the idea of a doThisForEachElement method in the collection class. (This will become the basis of your own image viewer.) Create an instance of class ImageViewer. imagePanel.addMouseListener(new MouseHandler()); Notice a couple of typical usage characteristics of these listener inner classes: ■ ■ We do not bother storing the instances in variables—so, in effect, they are anonymous objects. Now we have solved the problem caused by spaces surrounding the input, but we have not yet solved the problem with capital letters. We now want to introduce a second application to provide another example to learn from. The purpose of the toString method is to create a string representation of an object. Knowing that each file name in the collection has a unique index number, one way to express what we want would be to say that we wish to display the file name stored at consecutive increasing index numbers starting from zero. Pay special attention to the makeMenuBar and applyFilter methods. In the next section, we shall look at the way in which items are stored into (and retrieved from) arrays. This worked because these classes were sufficiently well documented (although even this documentation could be improved). If, for instance, the above method is defined in a class called Calendar, the following call invokes it: int days = Calendar.getNumberOfDaysThisMonth(); Note that the name of the class is used before the dot—no object has been created. It is used as a case study to bring together many of the concepts and techniques discussed throughout the book. Exercise 3.28 Open an inspector for this object. M12_BARN7367_06_SE_C12.indd 439 4/11/16 3:38 PM 440 | Chapter 12 ■ Further Abstraction Techniques If you have done all the exercises in this chapter so far, then your version of the project will be the same as foxes-and-rabbits-v2 and similar to foxes-and-rabbits-graph, except for the graph display. All these new components would act in the simulation, but they are clearly not animals, so it would be inappropriate to have them as subclasses of Animal. It should be borne in mind that default methods were added to the language primarily to support the addition of new methods to interfaces in the API that existed before Java 8. Indicate which types are concrete classes, abstract classes, and interfaces. So the for-each loop abstracts the task of processing a complete collection, element by element, and is able to handle different types of collection. ■ Exercise 15.3 Make a CRC card for the newly identified ShowCollection class, and add it to your system. Every one of the colored rectangles in the diagram represents a class in our project. Most programmers work on their own when writing the code, and other people are brought in only after the implementation is finished, to test or review the code. 4. Breakpoints are set via the editor window. This is a practical illustration of the divide and conquer principle we referred to earlier in our discussion of abstraction. Event listeners are often implemented using lambda notation. One specific difference is that the new version has an additional method, refundBalance. It then contains the following line of code: super(author); M10B_BARN7367_06_SE_C10.indd 376 4/11/16 3:32 PM 10.5 Network: adding other post types Concept Superclass constructor The constructor of a subclass must always invoke the constructor of its superclass as its first statement. At the end, it has two methods called printWelcome and printGoodbye. As you might expect, a complementary set of three input steps is required: opening the file, reading from it, and closing it. (Most importantly, perhaps, we will later add the possibility of playing the music files. We recommend, however, that you implement it yourself as an extension of the base version. Can you find an explanation of what might have happened when you removed the first file name from the collection? Our investigation in Section 11.2 has shown that the compiler insisted on a display method in class Post—methods in the subclasses were not enough. The header provides some information about the method in question. Exercise 12.18 Compare the results of running a simulation with a single large field, and two simulations with fields that each have half the area of the single field. We can use this area to add our toolbar buttons. Exercise 12.66 Look at the java.util package to see if there are any classes that might be well suited to storing an event queue in an event-based simulation. In Java, a subclass constructor must always call the superclass constructor as its first statement. (To be exact, we double or halve both the width and the height, not the area.) One way to do this is to implement filters for these tasks. For example, class Game is stored in a file called Game.java. Here is an example of an abstract act method: abstract public void act(List newAnimals); An abstract method is characterized by two details: 1. They contribute to the behavior that their defining method implements, but their values are lost once that constructor or method finishes its execution. The initial position and speed of the ball should be random. It usually contains the window title and a few window controls. Find an image on the web to use, or make your own. The authors of this book have many years of teaching experience with the BlueJ environment (and many more years without it before that). Code 14.17 Checking for internal consistency in the address book 14.7.3 Guidelines for using assertions Assertions are primarily intended to provide a way to perform consistency checks during the development and testing phases of a project. Exercise 4.12 Write a method call to remove the third object stored in a collection called dates. The differences really lie in the behavior of each collection. Review the TaxiCompany class with this goal in mind. 16.5 Another example There are many other projects that you could undertake along similar lines to the taxi company application. Doing so helps in reducing the complexity of implementing larger applications, because it enables us to implement, test, and maintain individual classes separately. Cinema-booking-system (Chapter 15) A system to manage advance seat bookings in a cinema. We can translate directly from the cards into Java. Tech-support (Chapter 6, 14) An implementation of an Eliza-like dialog program used to provide "technical support" to customers; introduces use of library classes in general and some specific classes in particular; reading and writing of documentation. 12.2.5 The Simulator class: a simulation step The central part of the Simulator class is the simulateOneStep method shown in Code 12.4. It uses separate loops to let each type of animal move (and possibly breed or do whatever it is programmed to do). They have a lifetime that lasts as long as their object lasts. 15.4 Cooperation pair programming Implementation of classes is traditionally done alone. In BlueJ, Figure 13.5 FlowLayout (a) (b) M13_BARN7367_06_SE_C13.indd 479 4/15/16 3:07 PM 480 | Chapter 13 ■ Building Graphical User Interfaces Figure 13.6 BorderLayout (a) (b) for example, both the main window and the editor use a BorderLayout as the main layout manager. Consider the following statement: Car c1 = new Car(); M11_BARN7367_06_SE_C11.indd 394 4/11/16 3:34 PM 11.2 Static type and dynamic type | 395 We say that the type of c1 is Car. Rather, returning a value means that some information is passed internally between two different parts of the program. This documentation is available in HTML format (so that it can be read in a web browser). SimulatorView has the following field to map one to the other: private Map, but this description should be sufficient to enable you to understand the code shown in the previous section. 11.7 Concept Every object in Java has a toString method that can be used to return a string representation of itself. The other important point to note here is that ImagePanel has a setImage method that takes an OFImage as a parameter to display any given OFImage. Software maintenance, code reading (rather than just writing), 4 An excellent book describing the problems of software development and some possible approaches to solutions is The Mythical Man-Month by Frederick P. This applies to all the classes we use; we shall not point this out every time from now on, but just expect you to do it. Multiple inheritance is made more complicated by the presence of conflicting default methods. We have written this as hourCounts[hour]++; Note that it is the value stored in the array element that is being incremented and not the hour variable. Exercise 4.4 Write a declaration of a private field named library that can hold an ArrayList. In the last code fragment examined above, a method called startsWith is used. Explain what is happening. The fact that a Vehicle moves between locations suggests that it has a responsibility to Maintain a current location. This is important for real-world software development, where teams have to deal with large projects and maintenance of software over time. The reduce function takes a stream and collapses all elements into a single result (Figure 5.3). The result is that the value will be converted to a string and no other characters will be prefixed to it. For example, XML parsers, which used to be downloaded separately, are now built into the platform. Code 13.14 Adding a toolbar panel with two buttons Exercise 13.45 Add two buttons labeled Larger and Smaller to your latest version of the project, using code similar to Code 13.14. Having a reference to this object can be useful in providing information that will support recovery from, or reporting of, the problem— e.g., accessing any diagnostic message placed in it by the throwing method. Figure 11.5 Method lookup with a simple object v1.display( ); PhotoPost ... This form is called try with resource or automatic resource management (ARM). This is because one of the main roles of the constructor is to initialize the fields. This information, taken together, is called the interface of a class. 6.15.1 Static methods In Section 6.14, we discussed class variables. Often, novice programmers will prefer the two-line version, whereas more experienced programmers get used to the one-line style. Add one or more other students as well. M06_BARN7367_06_SE_C06.indd 208 4/11/16 3:17 PM 6.3 Reading class documentation | 209 The interface of a method consists of the header of the method and a comment (shown here in italics). When a free vehicle has been identified, it must be directed to the pickup location. It then provides two methods for adding items: one for adding message posts, one for adding photo posts. net to write our own music-player class. Modify printDetails so that it includes the value of this field with an explanatory piece of text. The OFImage class is our own custom format for representing an image in memory. } Where a server method already has a non-void return type—effectively preventing a boolean diagnostic value from being returned—there may still be a way to indicate that an error has occurred through the return type. The set of methods an object makes available to other objects is called its interface. Instead, we introduce a toolbar on the left side of our frame with two buttons in it labeled Larger and Smaller (Figure 13.11). Thus, hooks serve as a reminder of the existence of the topic, and as a placeholder indicating a point in the sequence where discussion can be inserted. We have seen that building a GUI usually starts with creating a top-level frame, such as a JFrame. If you are not sure, tr to find out hat eans hen usin a a la das e ill look at this in the ad anced sections of ha ter 6. So we assume that each show has a link to a Theater object. Every primitive type in Java has a corresponding wrapper class that represents the same type but is a real object type. Exercise 10.9 Order these items into an inheritance hierarchy: apple, ice cream, bread, fruit, food item, cereal, orange, dessert, chocolate mousse, baguette. When an image is opened, they should be enabled, and when it is closed, they should be disabled again. Add instructors to the project (every lab class can have many students and a single instructor). Concept An object is said to be immutable if its contents or state cannot be changed once it has been created. However, the address book needs at least a name or phone number from each entry to use as a unique index value, so an entry with both name and phone fields blank would be impossible to index. The Java API has been documented using this same tool, and its value is appreciated when using library classes. The filtering criterion (the test in the if-statement) can be whatever we want. The Picture class is written so that, when you create an instance, the instance creates two square objects (one for the wall, one for the window), a triangle, and a circle. You might need to look at the API for the java.util.Random class to help you with this. It will be screened for the next two weeks, three times each day (4:40 p.m., 6:30 p.m., and 8:30 p.m.). All the data values of an object together are referred to as the object's state. We shall now investigate it in more detail by using a debugger. Code reuse Existing code can be reused. It, too, is quite simple. M15_BARN7367_06_SE_C15.indd 565 4/11/16 3:45 PM 566 | Chapter 15 ■ Designing Applications 15.2.2 User interface design One part that we have left out of the discussion so far is the design of the user interface.3 At some stage, we have to decide in detail what users see on the screen and how they interact with our system. For instance: ■ ■ ■ The programmer of a client might have misunderstood the state or the capabilities of a particular server object. First, they document good solutions to problems so that these solutions can be reused later for similar problems. Exercise 3.30 rite a a state ents that define a aria le na ed window of type Rectangle, and then create a Rectangle object and assign it to that variable. In Chapter 8 we discuss more formally the issues of dividing a problem domain into classes for implementation. By combining these functions in different ways, many different operations can be achieved. It works by calling the getDisplayValue methods of each of the NumberDisplay objects. Is this a problem? At the end, leave it in a state that makes the simulation look useful on your computer. In particular, the full effect depends upon whether or not any code has been written to catch the exception. Here, although each particular animal has a specific set of actions to perform, we cannot describe in any detail the actions for animals in general. toString Every object in Java has a toString method that can be used to return a string representation of itself. It has only a single abstract method in its original version. In the case of canBreed, the problem is the BREEDING_AGE variable, while breed depends on BREEDING_PROBABILITY and MAX_LITTER_SIZE. This models something close to splitting an area in half with a freeway. The new functional language constructs allow us to write more elegant and expressive programs. The expression !a is true if a is false and false if a is true. Cards that cooperate closely can be placed close together to give an impression of the degree of coupling in the system. You can do so by selecting new Circle() from the pop-up menu of the Circle class. So, when a notification is received, the company needs to be able to work out which passenger has been assigned to that vehicle. Someday, a maintenance programmer will come along who does not realize that these fields should not be used and try to process them. Play this through. As this is a simple machine, a ticket will not be issued automatically, so once you have inserted enough money, call the printTicket method. What will be its index after the objects at index 0 and index 9 are removed? */ public Room getExit(String direction) { return findRandomRoom(); } /* * Choose a random room. For a good Java programmer, it is essential to be able to work with the Java library and make informed choices about which classes to use. This means that both of the following examples give the result 100: 51 * 3 − 53 154 − 2 * 27 Binary operators with the same precedence level are evaluated from left to right, and unary operators with the same precedence level are evaluated right to left. method We can communicate with objects by invoking methods on them. As a result, those checks will often be duplicated in both client and server. If this number is the same in two calls, we are looking at the same object. If we own a collection of stamps, autographs, concert posters, ornaments, music, or whatever, then there are some common actions we will want to perform to the collection from time to time, regardless of what it is we collect. It is strongly recommended to use them only for very short handler functionality and for well-established code idioms. The class variable GRAVITY, on the other hand, is stored in the class itself. In order to understand how an exception handler works, it is essential to appreciate that an exception prevents the normal flow of control from being continued in the caller. Where a method contains a return statement, it is always the final statement of that method, because no further statements in the method will be executed once the return statement is executed. Thus, the if-statement does not need an else part. 6.6.3 Using a map for the TechSupport system In the TechSupport system, we can make good use of a map by using known words as keys and associated responses as values. These kinds of classes, which are not intended for creating objects but serve only as superclasses, are known as abstract classes. Some, such as Notepad or WordPad, are distributed with Windows, but if you really want to use the editor for more than a quick test, you will soon want to get a better one. But now I forgot what it was. We strive for loose coupling in a system—that is, a system where each class is largely independent and communicates with other classes via a small, well-defined interface. We can see that everything in that class is done twice—once for message posts, and once for photo posts. Exercise 12.56 What are the errors in the following interface? The Canvas class provides a window on screen that can be used to draw on. A File object can be created for a nonexistent file, which may be a first step in creating a physical file on the file system. First, however, we will take another, more general look at inheritance hierarchies. An example of this approach is shown in Code 14.18, which is an expanded version of Code 14.9. The efforts to compose an alternative filename could involve trying a list of possible folders, for instance, or prompting an interactive user for different names. interface Runnable An interface that takes no parameters and returns no result and used as the type for lambdas with those characteristics. If no matching entry can be found, then this represents a programming error, as the methods cannot complete their task. The environment supports important teaching tools not available in other environments. It is more a reflection of the fact that project development is often a discovery process. encapsulation Proper encapsulation in classes reduces coupling and thus leads to a better design. The keyword static is Java's syntax to define class variables. Now is the time to look at it a little more closely. This project is a simplified part of a student database designed to keep track of students in laboratory classes, and to print class lists. As this will usually require the intervention of a human user of the application, the chances of dealing with it successfully are obviously application- and context-specific. An example of the use of environmental simulations is to try to predict the effects of human activity on natural habitats. Every growth step is carefully designed. The behavior of the compiler is reasonable in this respect, because it has no guarantee that all subclasses of Post will, indeed, define a display method, and this is impossible to check in practice. This means we shall use three colors: black, white, and medium-gray. To do this, select Checkout Project from the Team menu. Because we have created three objects, we have three independent copies of these variables. Exercise 2.9 Put back the word public, and then check whether it is possible to leave out the word class by trying to compile again. There is no return type specified. You could place the file handling in the Game class and implement a toString method in the Command class to return the String to be written for each command. display M11_BARN7367_06_SE_C11.indd 393 PhotoPost ... The first significant change can be seen in the insertMoney method. In contrast, an object type is manipulated by storing a reference to the object (not the object itself). Create a method in the Filter class that iterates over the image and applies a filter-specific transformation to each individual pixel. They include int and boolean. What should you do each time you call increment on minutes to decide whether it has rolled over and whether increment should therefore be called on the hours object? Try storing keywords and responses on alternating lines; keep the text of each response on a single line. M03_BARN7367_06_SE_C03.indd 97 4/11/16 3:05 PM 98 | Chapter 3 ■ Object Interaction Figure 3.2 03 A two-digit number display For our clock display, we shall first program a class for a two-digit number display (Figure 3.2), then give it an accessor method to get its value, and two mutator methods to set the value and to increment it. Mail system (Chapter 3) A simple simulation of an email system. Every element of the sightings list will be used as a parameter to this lambda in turn, and the body of the lambda executes. "Objects first" has been a battle cry for many textbook authors and teachers for some time. How can we tell what the effect is likely to be without building the freeway? We will use this as the basis for our following discussion of inheritance. Exercise 1.8 Make sure you have several objects on the object bench, and then inspect each of them in turn. Another example of object interaction We shall now examine the same concepts with a different example, using different tools. The reuse in this case is not at the level of source code, but at the level of class structures. local variable A local variable is a variable declared and used within a single method. We know now that his problem was that although his class contained reasonable method calls for testing, it did not include any assertions on the method results, and thus did not detect test failure. Code 6.4 Associating selected words with possible responses M06_BARN7367_06_SE_C06.indd 221 4/11/16 3:17 PM 222 | Chapter 6 ■ More-Sophisticated Behavior A first attempt at writing a method to generate the responses could now look like the generateResponse method below. Because Path is an interface rather than a class, a concrete instance of an implementing class is created via a static get method of the Paths class (plural again), which is also in the java.nio.file package. Instead, we would write simple implementations for those methods that simulate the task. Write pseudo-code to determine the total number of times tracks the artist Bi Bill Broon ha e een la ed M05_BARN7367_06_SE_C05.indd 190 4/11/16 3:13 PM trea s | 191 Intermediate operations always produce a new stream to which the next operation can be applied, while terminal operations produce a result, or are void (such as forEach which is a terminal operation). If, for example, there were four strings in the list, the println statement would be executed four times. SupportSystem is the main class, which uses the InputReader to get some input from the terminal and the Responder to generate a response. Figure 1.7 Circle A class and its objects with fields and values int diameter int xPosition int yPosition String color boolean isVisible is instance of... Declarations are used to create additional, temporary variable space, while statements describe the actions of the method. For instance, IntBinaryOperator takes two int parameters and returns an int result. Exercise 6.13 Write a small code fragment (on paper) that generates a random integer number using this class. Do you need to know which methods are abstract? We can, for example, specify that a particular component should be below this other one, or that this component should be stretched if the window gets resized but this other should always have a constant size. You run it by creating an object of class SupportSystem and calling its start method. Such simulations are often used to model the variation in population sizes that result from a predator species feeding on a prey species. Part of the task of the constructor is to receive that value and store it in the price field of the newly created ticket machine, so the machine can remember what that value was without you having to keep reminding it. ■ Having done this, we can write a generic applyFilter method that receives a filter as a parameter and applies this filter to the current image. (Note: To increase readability and cohesion, it may be a good idea to move the creation of the menus into a separate method, perhaps named makeMenuBar, which is called from our makeFrame method.) 3 In Mac OS, the native display is different: the menu bar is at the top of the screen, not the top of each window. In addition, we provide some suggestions on how to report errors when they occur. Rather, the exception arises indirectly, passed back from a method in the server object, which is called from M14_BARN7367_06_SE_C14.indd 532 4/11/16 3:43 PM 14.5 Exception handling | 533 the statements within the try block. This is especially interesting in conditional statements: we can clearly see which branch of an if-statement is executed and use this to see whether it matches our expectations. We shall describe this feature in detail in Section 14.4. Both techniques have the benefit of encouraging the programmer of the client to take into account that a method call could fail. The Java library contains a good number of ready-made components, and we can also write our own. Constructors can also have local variables. Access modifiers are the keywords public or private at the beginning of field declarations and method signatures. The Observer pattern not only supports a decoupled view on the model, but it also allows for multiple different views (either as alternatives or simultaneously). Swing makes use of some of the AWT classes, replaces some AWT classes with its own versions, and adds many new classes (Figure 13.1). Introductory textbooks and reference books have different, partly competing, goals. If we simply use the variable name "from" in the constructor (for example, in a statement System.out.println(from)), which variable will be used—the parameter or the field? Rewrite the body of the method you wrote for the previous exercise so that it now calls this new method to generate its result. So those parts of the simulation that do not need to know whether they are dealing with a specific subclass can use the superclass type instead. You do not need to implement the load and save functions just yet—you might want to wait with that until you have read the next chapter. The direct way is for a vehicle to store a reference to its company. It then calls the nextInt method to receive a random number, stores it in the index variable, and eventually prints it out. New notes are added as future events are arranged, and old notes are deleted as details of past events are no longer needed. Both while and do-while are well suited for indefinite iteration. We hope that our projects serve to give teachers good starting points and many ideas for a wide variety of interesting assignments. We can now use this construct to implement a MouseListener, say, within the ImageViewer class. There are three details worth noting: Contrary to the case of super calls in constructors, the method name of the superclass method is explicitly stated. Essentially, this has to be something that can progressively accumulate the elements of its input stream in some way. M12_BARN7367_06_SE_C12.indd 446 4/11/16 3:38 PM 12.6 Interfaces | 447 A class is said to implement an interface if it includes an implements clause in its class header. Try out your solution by creating a MessagePost object. ■ It does not refund any money if the customer pays too much for a ticket. 3.7 Concept The primitive types in a a are the nonobject types. Instead of writing the code multiple times, we can write it once in a single private method, and then call this method from several different places. Following an organized process such as this one serves several purposes. Which technique was most useful? However, the situation here is rather different from the situation we encountered with the display method in Chapter 11. We deliberately left vague the issue of how much real time a time step represents, and the various actions actually require significantly different amounts of time (eating and movement should occur much more frequently than giving birth, for instance). Used to gain practice with array programming. Template files are pure text files and can be edited in any standard text editor. 2 Exception is one of two direct subclasses of Throwable; the other is Error. The header of a method includes (in this order): ■ an access modifier (here public), which we shall discuss below; ■ the return type of the method (here int); ■ the method name; a list of parameters (which is empty in this example); the name and parameters together are also called the signature of the method. The Pearson team also has done a terrific job in making this book happen, managing to bring it into the world and avert every author's worst fear—that his book might go unnoticed. Code 6.3 shows a version of the Responder source code with these additions. Concept Variables and subtypes Variables may hold objects of their declared type or of any subtype of their declared type. * @param animal The type of animal. To generate a random number, we have to: ■ create an instance of class Random and ■ make a call to a method of that instance to get a number. Because the interactive dialog has no import statement (and thus the Color class is not automatically known), we have to write the fully qualified class name to refer to the class (Figure 6.5). if(n < 0) { handleNegative(); } else if(n == 0) { handleZero(); } else { handlePositive(); } D.2.2 switch The switch statement switches on a single value to one of an arbitrary number of cases. Characteristic of that style of testing is that the tests are external to the class being tested. Once all these have been set up, the simulator's populate method is called (indirectly, via the reset method) to create the initial populations. If a user requests from the organizer information about the number of file names in it, the organizer will pass the question on to the files object, and then return whatever answer it gets from there. M06_BARN7367_06_SE_C06.indd 225 4/11/16 3:17 PM 226 | Chapter 6 ■ More-Sophisticated Behavior Code 6.6 Final version of the start method Code 6.7 Final version of the generateResponse method Exercise 6.42 Implement the final changes discussed above in your own version of the program. You will know from experimenting with creating TicketMachine objects within BlueJ that you had to supply the cost of the tickets whenever you created a new ticket machine. To be valid, the parameter must lie in the range 0 to size()–1. The class could have fields to record the name and age of a person, for instance. Custom-made Swing components can easily be created by writing a subclass of an existing component. Exercise 2.56 Write an if-statement that will compare the value in price against the value in budget. We saw in Section 4.10.1 and Exercise 4.29 that we can often express this positively or negatively, via appropriately set boolean variables: A variable called searching (or missing, say) initially set to true could keep the search going until it is set to false inside the loop when the item is found. They also provide the essential stimulus and motivation that makes teaching so much fun. One is the limit to which it can count before rolling over to zero. One important detail about String objects is that they are immutable—that is, they cannot be modified once they have been created. Test the main method by invoking it from BlueJ. (The choice of "main" for the name of the initial method actually goes back to the C language, from which Java inherits much of its syntax.) Let us consider, for example, the following command, entered at a command line such as the Windows command prompt or a Unix terminal: java Game The java command starts the Java virtual machine. Correct it. The main focus of the book is general object-oriented and programming concepts from a software engineering perspective. Exercise 12.20 Currently, a fox will eat at most one rabbit at each step. Abstract methods do not have to include the keyword abstract in their header. Code 14.14 A try statement with a finally clause At first sight, a finally clause would appear to be redundant. The code to add the listener then looks as follows: openItem.addActionListener(e -> openFile()); M13_BARN7367_06_SE_C13.indd 473 4/15/16 3:07 PM 474 | Chapter 13 ■ Building Graphical User Interfaces Version 0-3 of the imageviewer project implements its listeners in this way. Figure F.4 Active-variable displays Z06_BARN7367_06_SE_APPF.indd 623 4/11/16 3:54 PM 624 | Appendices When a breakpoint is reached, execution will be halted at a statement of an arbitrary object within the current program. Each of those two, the model and the view, may consist of multiple classes, but every class should be clearly in one or the other group to achieve a clear separation. We see that this object has two instance variables (or fields), server and user, and we can see the current values. For example: public int getAge() { statements } Z10_BARN7367_06_SE_APPJ.indd 633 4/11/16 3:58 PM 634 | Appendices J.2.4 For all other blocks, braces open at the end of a line All other blocks open with braces at the end of the line that contains the keyword defining the block. | Kolling, Michael, author. Concept A superclass is a class that is extended by another class. Unfortunately, there is no general satisfactory way to resolve the conflict simply by using return values. 14.4.2 Checked and unchecked exceptions An exception object is always an instance of a class from a special inheritance hierarchy. Your life is suddenly much easier. M05_BARN7367_06_SE_C05.indd 185 4/11/16 3:13 PM 186 | Chapter 5 ■ unctional Processin of ollections d anced Once again, we encourage you to make sure you understand how this reduced syntax fits the description, as many lambdas are written in this form in practice. In this case, when the getPrice method is called on a ticket machine, the question is, What do tickets cost? Primitive types are stored in variables directly, and they have value semantics (values are copied when assigned to another variable). Concept We can communicate with objects by invoking methods on them. Once the API view is correctly displayed in the browser, copy the URL (web address) from your browser's address field, open BlueJ, open the Preferences dialog, go to the Miscellaneous tab, and paste the copied URL into the field labeled JDK documentation URL. The collection hierarchy defines (among other types) the interface List and the classes ArrayList and LinkedList (Figure 12.5). The musicplayer project provides a GUI interface to classes based on the music-organizer projects from Chapter 4. Instances are constructed using new, and the classes have fields, constructors, and methods. Through subtyping and substitution rules, we now have situations where the type of the variable and the type of the object stored in it are not exactly the same. 4/11/16 3:02 PM 2.9 Printing from methods | 69 When used between a string and anything else, "+" is a string-concatenation operator (i.e., it concatenates or joins strings together to create a new string) rather than an arithmeticaddition operator. The existence of the List interface makes it very easy to do this. However, streams neatly capture many of the most commonlyoccurring tasks we want to perform on collections, in a form that makes them much simpler to program than we have become used to, as well as being easier to understand. It defines what fields and methods a class has, and precisely what happens when a method is invoked. There are two complementary issues that go with error reporting: error recovery and error avoidance. In the main window, select the Tools/ Project Documentation menu item, and the documentation will be generated (if necessary) and displayed within a browser window. It turns out to be significantly more complicated to program a class to be able to issue tickets of different values, than it does to offer a single price. It turns out, for reasons we will discuss later, that the functional style of processing collections has advantages in some situations over the imperative style. Play through the scenarios again. If not, do you see broadly similar patterns emerging anyway? M01B_BARN7367_06_SE_C01.indd 43 4/11/16 2:54 PM 44 | Chapter 1 1.14 ■ Objects and Classes Objects as parameters Exercise 1.23 Create an object of class LabClass. iterator An iterator is an object that provides functionality to iterate over all elements of a collection. Z03_BARN7367_06_SE_APPC.indd 606 4/11/16 3:51 PM C: Operators C.3 | 607 Short-circuit operators Both && and || are slightly unusual in the way they are applied. } The outer wrappings of different classes all look much the same. Exercise 3.47 Predict which line will be marked as the next line to execute after the next step. However, there are several drawbacks to this approach if we simply implement the interface as a normal class within a project, at the same level as all the other classes: There is usually a very tight coupling between a listener and the object managing the multiple components of the full GUI. Which concrete classes extend them? In order to add the action listeners, you need to create the three methods makeDarker, makeLighter, and threshold as private methods in your ImageViewer class. Are there any further scenarios that need to be addressed before we move on to class design? The way to test for content equality between two objects is to test whether the values of their two sets of fields are equal. .) { if(the keys are in the next place) { ... We notice that constant declarations look similar to field declarations, with two differences: ■ they include the keyword final before the type name; and ■ they must be initialized with a value at the point of declaration. Then follows a colon and the variable holding the collection that we wish to process. Then we will use CRC cards to perform the initial application design. M13_BARN7367_06_SE_C13.indd 487 4/15/16 3:07 PM 488 | Chapter 13 ■ Building Graphical User Interfaces Exercise 13.32 Find the documentation for showMessageDialog. Code 4.3 Using a for-each loop to list the file names M04_BARN7367_06_SE_C04.indd 144 4/11/16 3:10 PM 4.9 Processing a whole collection | 145 In this for-each loop, the loop body—consisting of a single System.out.println statement —is executed repeatedly, once for each element in the files ArrayList. Weblog-analyzer (Chapter 7, 14) A program to analyze web access log files; introduces arrays and for loops. 16.1 The case study The case study we will be using is the development of a model for a taxi company. Versions of the same method in any superclasses are also not automatically executed. We note on the CinemaBookingSystem card: Accepts seat reservations from user. The refundBalance method contains three statements and a single declaration. This version checks that the value in the balance field is at least as large as the value in the price field. Chapter 12 ■ Further Abstraction Techniques At first glance, interfaces are similar to classes. A01_BARN7367_06_SE_FM.indd 26 4/15/16 6:10 PM List of Projects Discussed in Detail in This Book | 27 Foxes-and-rabbits (Chapter 12) A classic predator–prey simulation; reinforces inheritance concepts and adds abstract classes and interfaces. The oldest is called AWT (Abstract Window Toolkit) and was introduced as part of the original Java API. Local variables have a scope that is limited to the block in which they are defined. Clearly there must be something wrong with the filter operation, but you cannot immediately spot the problem. Accessor methods have non-void return types and return information about the object's state. The most important characteristic of interfaces is that they almost completely separate the definition of the functionality (the class's "interface" in the wider sense of the word) from its implementation. Figure 2.4 illustrates how values are passed via parameters. For example, "the items at indices 0, 1, and 2" or "the last four" could be "the items at indices (list.size()-4) to (list.size()-1)". Try them out. J.3 Documentation J.3.1 Every class has a class comment at the top The class comment contains at least: ■ a general description of the class ■ the author's name(s) ■ a version number Every person who has contributed to the class has to be named as an author or has to be otherwise appropriately credited. Using unit test classes has the advantage that—once they have been set up—tests can be replayed any number of times. Z11_BARN7367_06_SE_APPK.indd 637 4/11/16 3:59 PM 638 | Appendices K.2 The java.util package The java.util package is a relatively incoherent collection of useful classes and interfaces. When you use the listFile method, you will need to use a parameter value of 0 (zero) to print the first file, 1 (one) to print the second, and so on. We did not want to distract too much attention from the important software-development issues in the early stages of learning about object-oriented programming. That depends on what precisely we mean by "type of v1." The type of the variable v1 is Vehicle; the type of the object stored in v1 is Car. When sending a message, a mail client creates a mail item with all this information, then stores the mail item on the mail server. This means that we can use them on both sides of assignments, for instance. This makes it slightly harder for us to distinguish these loops, but we will get used to recognizing the different header structures. In almost all cases, when you use a cast in your code, you could restructure your code to avoid this cast and end up with a better-designed program. If that value is zero, then we know that the display just rolled over and we should increment the hours. For every filter, it creates a menu item and uses the filter's getName method to determine the item's label. A variable in any of these areas that is an object reference may be inspected by doubleclicking on it. What is the structure of class documentation? public Student(String name) Exercise 2.19 How many parameters does the following constructor have, and what are their types? We have made the collections more powerful: Instead of just being able to hand out their elements to us, so that we can do some work on them, the collection is now able to do work on the elements for us. The final statement in the constructor is a call to updateDisplay that sets up the displayString field. Figure F.5 A call sequence F.5 The Threads display The Threads display area is beyond the scope of this book and will not be discussed further. void moveHorizontal(int distance) This is called the header of the method. The line-termination character is always removed from the String that readLine returns, and a null value is used to indicate the end of file. Exercise 6.84 Can a class count how many instances have been created of that class? It will be good practice to try things out without a compiler. All of these e-mail addresses should be valid keys. The documentation of the String class tells us that it has a method called trim to remove spaces at the beginning and the end of the string. The Java definition for starting applications is quite simple: the user specifies the class that should be started, and the Java system will then invoke a method called main in that class. Such a comment immediately preceding the class declaration is read as a class comment. If the comment is directly above a method signature, it is considered a method comment. walkthrough A walkthrough is an activity of working through a segment of code line by line while observing changes of state and other behavior of the application. The ideas and techniques of functional programming, while fairly old and well known in principle, have seen a marked boost of popularity in recent years, with new languages being developed and selected functional techniques being incorporated into existing, traditionally imperative languages. Exercise 2.64 List the name and return type of this method: public String getCode() { return code; } M02_BARN7367_06_SE_C02.indd 81 4/11/16 3:02 PM 82 | Chapter 2 ■ Understanding Class Definitions Exercise 2.65 List the name of this method and the name and type of its parameter: public void setCredits(int creditValue) { credits = creditValue; } Exercise 2.66 Write out the outer wrapping of a class called Person. A vehicle, on the other hand, may or may not be a car—we do not know. The purpose of the program is to simulate the airport in operation. After assigning a variable to another one, both variables refer to the same object. Command-line parameters are not very often used with Java. Other scenarios to play through next would include the following: A customer requests five seats together. If you are interested in really understanding how this animation works, you may want to study this class as well. For instance, there is nothing significant in the "#" character that is in the string—it is simply one of the characters we wish to be printed. Enter some problems you might be having with your software to try out the system. You may not succeed in becoming a good programmer without fully understanding the contents of this chapter. (You can switch off the Record method calls function now and close the terminal.) Exercise 1.11 Select Show Code Pad from the View menu. Understanding these object interactions is essential in planning, implementing, and debugging applications. There is no single solution to this task. This is a nuisance since four of the five method bodies will be empty, and we will often face similar issues when implementing other multi-method listener interfaces. Exercise 6.44 Ensure that the same default response is never repeated twice in a row. 2.18 Summary of the better ticket machine In developing a better version of the TicketMachine class, we have been able to address the major inadequacies of the naïve version. If the void type is replaced by a boolean type, then the method can return true to indicate that the removal was successful, and false to indicate that it failed for some reason (Code 14.3). For example: private static final int SIZE = 10; The definition of GRAVITY from our bouncing-ball project is another example of such a constant. The name of the file is passed to the constructor of File. Many different solutions are possible and can be made to work. A field that has not explicitly been initialized will contain the value null by default. The Object class defines the method getClass to return the Class associated with an object. Have we adequately covered what happens, for instance, if there is no vehicle available when a request is received? At each simulation step, the run method will be called and a rabbit will increase its age; if old enough, it might also breed, and it will then try to move. What is its return type? Population sizes could also be affected by the size and nature of the environment. For now, we just call it ourselves to test the display. Exercise 5.24 ind the P docu entation for trea in the java.util. If the statement evaluates to false, then an AssertionError will be thrown. What do you observe about the placement of the text in the frame? These can be called on any stream. This method returns the current value of the minutes. We shall discuss both styles in the next two sections. Code 4.5 Using a while loop to list the tracks It is immediately obvious that the while-loop version requires more effort on our part to program it. In fact, there are at least two cases where these two examples would have different effects: ■ ■ A finally clause is executed even if a return statement is executed in the try or catch blocks. Exercise 3.34 Open the house project from Chapter 1 and review the Picture class. mutator method Mutator methods change the state of an object. Exercise 6.69 Which type of collection (ArrayList, HashMap, or HashSet) is most suitable for storing the balls for the new bounce method? We also looked at further collection types in Chapter 6, such as HashSet and HashMap. Replace the bodies of the apply methods in the three Filter subclasses with a call to this method, passing the image and something that can apply the appropriate transformation. Duplication of information or behavior is something we often work hard to avoid. A filter is a function that is applied to the whole image. Package java.lang —Summary of the most important classes interface Comparable Implementation of this interface allows comparison and ordering of objects from the implementing class. Concept Arranging the layout of components is achieved by using layout managers. That is, it specifies that the first three are of type int, while the color is of type String and the isVisible flag is of type boolean. However, doing it the other way is not allowed: Car c1 = new Vehicle(); // this is an error! This statement attempts to store a Vehicle object in a Car variable. Constructions like this are very common. However, if there is a need to catch an unchecked exception, then an exception handler can be written for it, exactly as for a checked exception. M12_BARN7367_06_SE_C12.indd 448 4/11/16 3:38 PM 12.6 Interfaces | 449 There is a new syntax involving the keyword super for calling a default method from one of the interfaces in an overriding method. 13.5 ImageViewer 1.0: the first complete version We shall now work on creating the first complete version—one that can really accomplish the main task: display some images. M06_BARN7367_06_SE_C06.indd 209 4/11/16 3:17 PM 210 | Chapter 6 ■ More-Sophisticated Behavior After studying the interface of the trim method, we can see that we can remove the spaces from an input string with the following line of code: input = input.trim(); This code will request the String object stored in the input variable to create a new, similar string with the leading and trailing spaces removed. Make any necessary changes to the Post class and to the display method of MessagePost so that it produces the output shown in Figure 11.11. With foxes eating rabbits regardless of the fox's age, there is a risk that either the rabbit population will be killed off before it has a chance to reproduce, or that the fox population will die of hunger. Use getBalance to check that the machine has kept an accurate record of the amount just inserted. More about collections and loops, this time with iterators. Choose one of these images and recreate it using the shapes from the figures project. M06_BARN7367_06_SE_C06.indd 246 4/11/16 3:17 PM 6.17 Further advanced material | 247 Code 6.9 A functional version of the getSightingsOf method A subtle point to note is that the toList method of Collectors does not actually return a List object to be passed into the collect method. Sometimes we wish to know whether two different variables are referring to the same object. testing Testing is the activity of finding out whether a piece of code (a method, class, or program) produces the intended behavior. M11_BARN7367_06_SE_C11.indd 406 4/11/16 3:35 PM 11.9 Protected access | 407 It will not always be necessary to compare every field in two objects in order to establish that they are equal. We note on the Seat card: Stores reservation status (free/ reserved). While we will not always be searching for something, situations in which we want to keep doing something until the repetition is no longer necessary are frequently encountered. The intention is that the program should end once a user types the word "bye". However, it is not only the following chapters that rely heavily on these concepts. Exercise 2.60 What is wrong with the following version of the constructor of TicketMachine? Default methods made it possible to change existing interfaces without breaking the many classes that already implemented the older versions of those interfaces. We have seen an example of this (without discussing it explicitly) at the end of Section 12.3. There, we investigated the foxes-and-rabbits-graph project, which added another view of the populations in the form of a line graph. In real life, a taxi meets its passenger for the first time when it arrives at the pickup location, so this is the natural point for the vehicle to receive its next passenger. Code 12.3 Part of the Simulator class M12_BARN7367_06_SE_C12.indd 429 4/11/16 3:38 PM 430 | Chapter 12 ■ Further Abstraction Techniques Code 12.3 continued Part of the Simulator class M12_BARN7367_06_SE_C12.indd 430 4/11/16 3:38 PM 12.2 The foxes-and-rabbits simulation | 431 Code 12.3 continued Part of the Simulator class The Simulator has three important parts: its constructor, the populate method, and the simulateOneStep method. M01B_BARN7367_06_SE_C01.indd 31 4/11/16 2:54 PM 32 | Chapter 1 Concept Objects are created from classes. So cost is a formal parameter, and a user-supplied value such as 500 is an actual parameter. Good class design exhibits a high degree of cohesion. ■ We have seen that a lambda expression has full access to even the private elements of the enclosing GUI class—this is how the very tight coupling arises. The mail client has three methods: getNextMailItem, printNextMailItem, and sendMailItem. 15.8 Summary In this chapter, we have moved up one step in terms of abstraction levels, away from thinking about the design of single classes (or cooperation between two classes) and toward the design of an application as a whole. Null parameter values are usually the result of making invalid assumptions in the client. This design works a bit better. Classification: LCC QA76.64 .B385 2017 | DDC 005.1/17—dc23 LC record available at 10 9 8 7 6 5 4 3 2 1 ISBN-10: 0-13-447736-7 ISBN-13: 978-0-13-447736-7 A01_BARN7367_06_SE_FM.indd 2 4/15/16 6:10 PM To my wife Helen, djb To K.W. mk A01_BARN7367_06_SE_FM.indd 3 4/15/16 6:10 PM This page intentionally left blank Contents Part 1 Chapter 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12 1.13 1.14 1.15 Chapter 2 2.1 2.2 2.3 2.4 2.5 2.6 A01_BARN7367_06_SE_FM.indd 5 Foreword Preface List of Projects Discussed in Detail in This Book Acknowledgments 14 15 25 28 Foundations of Object Orientation 29 Objects and Classes 31 Objects and classes Creating objects Calling methods Parameters Data types Multiple instances State What is in an object? Code 3.3 Implementation of the NumberDisplay class M03_BARN7367_06_SE_C03.indd 101 4/11/16 3:06 PM 102 | Chapter 3 ■ Object Interaction Code 3.3 Implementation of the NumberDisplay class Exercise 3.5 Open the number-display project. Even though the Java language allows us to declare public fields, we consider this bad style and will not make use of this option. The playSample method plays the beginning of a track (about 15 seconds) and then returns. .).terminal(. Look it up.) M13_BARN7367_06_SE_C13.indd 486 4/15/16 3:07 PM 13.5 ImageViewer 1.0: the first complete version | 487 Exercise 13.28 Implement the lighter filter in OFImage. It provides reporting and/or recovery code should one arise. Exercise 4.22 Create an ArrayList in the Code Pad by typing the following two lines: import java.util.ArrayList; new ArrayList() If you write the last line without a trailing semicolon, you will see the small red object icon. Suppose that we have the following legal declarations and assignments: Person p1 = new Person(); Person p2 = new Person(); PhDStudent phd1 = new PhDStudent(); Teacher t1 = new Teacher(); Student s1 = new Student(); Based on those just mentioned, which of the following assignments are legal, and why or why not? scope The scope of a variable defines the section of source code from which the variable can be accessed. Java also supports class methods (also known as static methods), which are methods that belong to a class. 4/11/16 3:02 PM 68 | Chapter 2 ■ Understanding Class Definitions Code 2.7 The printTicket method Concept The method System.out. return book.size() / 2; Exercise 14.7 How easy do you think it would be to add a String field for an email address to the ContactDetails class, and then to use this as a third key in the AddressBook? The car company will just buy the tire from the tire company and then view it as a single entity. display Overriding The next design we shall discuss is one where both the superclass and the subclasses have a display method (Figure 11.4). It is a complete case study, starting with the application design, through design of the class interfaces, down to discussing many important functional and non-functional characteristics and implementation details. Public versus private It is time to discuss in more detail one aspect of classes that we have already encountered several times without saying much about it: access modifiers. In fact, it is perfectly possible to mix calls to the different next methods when parsing a complete file, where the data it contains is to be interpreted as consisting of mixed types. As with output, the question arises as to what to do about any exceptions thrown during the whole process. In addition, it would be worth reviewing the advanced material in Chapter 12, as significant use is made of abstract classes and interface types in the Java GUI libraries. Which class does this second method belong to? We have only one collection, only one method to add posts, and one loop in the show method. If we examine the AddressBook class with these issues in mind, we shall see that the class has been written to trust completely that its clients will use it appropriately. Write down an example call to that method on a String variable called text. How to do this is described in Section 14.5.2. We have already seen use of the unchecked IllegalArgumentException; this is thrown by a constructor or method to indicate that its parameter values are inappropriate. Music-organizer (Chapter 4, 11) An implementation of an organizer for music tracks; used to introduce collections and loops. Strings are an example of immutable objects. Some are aimed at helping with understanding fundamental concepts (such as the scope highlighting in the editor), some are designed to introduce additional tools and techniques, such as integrated testing using JUnit, or teamwork using a version control system, such as Subversion, once the students are ready. They then have one single starting point, which defines where execution begins when a user starts an application. M02_BARN7367_06_SE_C02.indd 70 4/11/16 3:02 PM 2.12 Reflecting on the design of the ticket machine | 71 Exercise 2.44 Give the class two constructors. ■ SimulatorView provides a visualization of the state of the field. This chapter contains only an introduction to the use of inheritance for the purpose of improving program structures. To discover initial classes, we use the verb/noun method. Z10_BARN7367_06_SE_APPJ.indd 635 4/11/16 3:58 PM 636 | J.5 Appendices Code idioms J.5.1 Use iterators with collections To iterate over a complete collection, use a for-each loop. In our example, the method does not have any parameters, so the parameter list is empty. Exercise 1.35 Look at the book you are reading right now. One consequence of this similarity is that we can often ignore details of the implementation when declaring a variable that will refer to a particular collection object. Enter the posts into the news feed, and then display the feed's contents. 6.13 Learning about classes from their interfaces We shall briefly discuss another project to revisit and practice the concepts discussed in this chapter. unchecked exception An unchecked exception is a type of exception whose use will not require checks from the compiler. add a menu item 2. Find out how you can use moveHorizontal to move the circle 70 pixels to the left. In that way, there is a chance that an incorrectly written client will be fixed. direct access via integer indices to the objects it stores. As such, they can be inserted into a Swing container and displayed in our GUI like any other Swing component. Title: Objects first with Java : a practical introduction using BlueJ / David J. As before, this project contains a single class: TicketMachine. We shall take the study from the initial discussion of a problem, through class discovery, design, and an iterative process of implementation and testing. If you can explain this example in detail, then you probably already have a good understanding of most of the concepts that we have introduced in this and the previous chapter! Here is a detailed explanation of the single println statement inside the loop. In order to figure out necessary interactions between the classes in our system, we play through scenarios. What are the differences between them? The updateDisplay method then uses string concatenation to join these two values, separated by a colon, into a single string. Exercise 2.24 If a call to getPrice can be characterized as "What do tickets cost?" how would you characterize a call to getBalance? A file will be located in a particular folder or directory on a particular disk drive, for instance, and different operating systems have different conventions for which characters are used in file pathnames. Assess the impacts on the resulting simulation of implementing this choice. So, the valid indices for the hourCounts array are 0 to 23, inclusive. Exercise 15.7 Make a class design for an airport-control-system simulation. Before discussing further, let us look at an example of real Java code. A character can be written as a single Unicode character in single quotes or as a four-digit Unicode value, preceded by "\u". M13_BARN7367_06_SE_C13.indd 461 4/15/16 3:06 PM 462 | Chapter 13 ■ Building Graphical User Interfaces GUIs give our applications an interface consisting of windows, menus, buttons, and other graphical components. Among other things, the class contains methods to print the list, count the total number of sightings of a given animal, list all of the sightings by a particular spotter, remove records containing no sightings, and so on. Could a HashMap have been used in place of the TreeMap? ■ How do we arrange those elements? On the other hand, handling the menu invocation also includes some GUI-related code (for instance, we have to check whether an image is open at all when we invoke the filter), and this belongs in the ImageViewer class. The file sightings.csv in the project directory contains a small sample of sighting records in comma-separated values forat Pass the na e of this file "sightings.csv" to the addSightings method of the AnimalMonitor object and then call printList to show details of the data that has een read Exercise 5.2 Try out the other methods of the AnimalMonitor object, using animal names, spotter and area IDs shown in the output from printList. Examples are @param limit The maximum value allowed. We shall concentrate on the content pane first. Exercise 16.24 Review the tests implemented in the test classes of taxicompany-stage-one. Exercise 14.13 Are there any other methods in the AddressBook class that are vulnerable to similar errors? The answer will depend upon the information we want from the model. Researchers have, over time, proposed many algorithms to produce seemingly random sequences of numbers. This scenario is the most important one for understanding the behavior of our network application, and in finding a solution to our display method problem. Its size method returns that count. (You can, of course, look at it if you feel adventurous, but don't e sur rised if ou find it sli htl afflin lain in ritin ho the MailClient and MailItem classes interact. Here are some typical examples: @see @see @see @see "The Java Language Specification, by Joy et al" The BlueJ web site #isAlive java.util.ArrayList#add The first simply embeds a text string with no hyperlink; the second embeds a hyperlink to the specified document; the third links to the documentation for the isAlive method in the same class; the fourth links to the documentation for the add method in the ArrayList class of the java.util package. In this chapter, we discuss this aspect of the development process. As a result, weather forecasts have improved significantly in accuracy (but are far from perfect, as we all have experienced at some time). Can you think of a better solution? interface Iterator Iterator defines a simple and consistent interface for iterating over the contents of a collection. 4.8 Playing the music files A nice feature of our organizer, beyond keeping a list of music files, would allow us to play them. For instance, the different ways in which taxis and shuttles respond to a pickup request is reflected in the fact that Vehicle defines setPickupLocation as an abstract method, which will have separate concrete implementations in the subclasses. Chapter 14 then picks up the difficult issue of how to deal with errors. It is quite common that the design of a system's functionality is not perfect at the start. Can you see a possible conflict here for shuttles? In particular, we discuss the ArrayList class as an example of flexible-size collections. We will discuss other sorts of collections in this chapter and see that they share many attributes among themselves, so that we can often abstract from the individual details of a specific collection and talk about collection classes in general. Scrollbars can be created by using a special container, an instance of class JScrollPane. M03_BARN7367_06_SE_C03.indd 127 4/11/16 3:06 PM This page intentionally left blank Chapter 4 Grouping Objects Main concepts discussed in this chapter: ■ collections ■ iterators ■ loops Java constructs discussed in this chapter: ArrayList, Iterator, for-each loop, while loop, null, anonymous objects The main focus of this chapter is to introduce some of the ways in which objects may be grouped together into collections. Make a class diagram for each situation and list arguments either way. Java has more predefined data types. Swing has many different types of components and many different containers and layout managers. 3 In fact, it is still all too easy for the writer of the client to adhere to the rules in principle, but to fail to attempt a proper recovery from the problem, which rather subverts their purpose! M14_BARN7367_06_SE_C14.indd 526 4/11/16 3:43 PM 14.4 Exception-throwing principles | 527 This neatly illustrates the power of exceptions to prevent a client from carrying on, regardless of the fact that a problem has arisen. Exercise 3.42 Open the mail-system project, which you can find in the book's support material. some code to apply to each element of list . (Note this on the card: Accepts reservation request.) How does it deal with it? If the access code has already been revealed, it may no longer be valid. Two Random objects starting from the same seed will return the same sequence of values to identical calls. M13_BARN7367_06_SE_C13.indd 465 4/15/16 3:07 PM 466 | Chapter 13 ■ Building Graphical User Interfaces We shall now discuss the ImageViewer class shown in Code 13.1 in some detail. The model used by the Java library for this is event-based: if a user activates a component (e.g., clicks a button or selects a menu item) the system will generate an event. In short: ■ Type checking uses the static type, but at runtime, the methods from the dynamic type are executed. Image files exist in the images folder for a shuttle to do the same. Apart from Integer and Character, the wrapper class names are the same as the primitive-type names, but with an uppercase first letter. } } 4.10.2 Iterating with an index variable For our first while loop in correct Java code, we shall write a version of the listAllFiles method shown in Code 4.3. This does not really illustrate the indefinite character of while loops, but it does provide a useful comparison with the equivalent, familiar for-each example. Code 14.6 Checking for an illegal parameter value M14_BARN7367_06_SE_C14.indd 527 4/11/16 3:43 PM 528 | Chapter 14 ■ Handling Errors It is well worth having a method conduct a series of validity checks on its parameters before proceeding with the main purpose of the method. (Arrays will be discussed in more detail in the next chapter.) The parameter to the split method defines at what kind of characters the original string should be split. Their names consist of two parts, e.g., "array" and "list." The second half tells us what kind of collection we are dealing with (List, Map, Set), and the first tells us how it is implemented (for instance, using an array (covered in Chapter 7) or hashing (covered in Chapter 11). However, many applications will then go on to decompose the individual lines into component pieces representing multi-typed data values. Along the way, though, watch out for one or two further new concepts that we will then cover in more detail in later chapters! Open the lab-classes project that we introduced in Chapter 1, and then examine the Student class in the editor (Code 2.9). This keeps a count of the number of times a book has been borrowed. This is all very straightforward and not surprising. Exercise 6.66 In your DrawDemo class, type myCanvas.er and then press Ctrl-Space (with the cursor immediately behind the typed text) to activate code completion. Up to this point, there has been no discussion about how many passengers a shuttle can carry. private class MouseHandler implements MouseListener { public void mouseClicked(MouseEvent event) { // perform click action } public void mouseEntered(MouseEvent event) { // perform entered action } ... ImagePanel is a custom Swing component to show the image in our GUI. The example we will use to discuss this process is the design of a cinema booking system. Unchecked exceptions are the easiest to use from a programmer's point of view, because the compiler enforces few rules on their use. 6.12.1 Information hiding Concept Information hiding is a principle that states that internal details of a class's implementation should be hidden from other classes. The following alternatives are both equivalent, as we can use an array element in exactly the same way as we would an ordinary variable: hourCounts[hour] = hourCounts[hour] + 1; hourCounts[hour] += 1; By the end of the analyzeHourlyData method, we have a complete set of cumulative counts for each hour of the log period. However, there is still a lot that can be added. In order to do this, we shall introduce the concept of an abstract class. There have always been different kinds of languages: Java, for example, is an imperative object-oriented language, and the style of collection processing we started to introduce in Chapter 4 is the typical imperative way to do things. lang.2 The java.lang package defines a number of commonly seen exception classes that you might already have run across inadvertently in developing programs, such as NullPointerException, IndexOutOfBoundsException, and ClassCastException. For instance, we would expect a ContactDetails object to always contain at least one non-blank field, or, when the removeDetails method is called with a particular key, we would expect that key to no longer be in use at the end of the method. However, one of the main reasons for defining new exception classes is to include further information within the exception object to support error diagnosis and recovery. Brain (Chapter 7) A version of Brian's Brain, which we use to discuss two-dimensional arrays. System.out.println("# price cents."); Exercise 2.40 Could either of the previous two versions be used to show the price of tickets in different ticket machines? You will obviously have to rewrite the condition to make things happen this way around. If so, what exactly will happen when you try to execute? Are there any situations where a printed error message would be inappropriate? Library classes are used in exactly the same way as we would use our own classes. However, our view would be that it is better to sacrifice efficiency for the sake of safer programming, where the choice is available. So the effect is to increase the value in balance by the value in amount.3 Exercise 2.31 How can we tell from just its header that setPrice is a method and not a constructor? Of course, strictly speaking, the loop's condition actually expresses whether we want to continue, and it is the negation of this that causes the loop to stop. When an exception is thrown, the execution of the throwing method finishes immediately; it does not continue to the end of the method body. Is it acceptable in all cases for the method simply to do nothing if its parameter values are inappropriate? Create a collection containing objects of this class and sort the collection. If the playing of the scenarios was done well, then the responsibilities noted for each class describe the class's public methods (and maybe some of the instance fields). In Swing, they are represented by a class called JFrame. A few questions may help us to make a decision. You might note that all of the nouns have been written in their singular form. So we can note on the CinemaBookingSystem CRC card, as a responsibility: Can find shows by title and day. We discuss a part of a social network to illustrate the concepts. You have to be careful at the image's edges, where some neighbors do not exist. The parameter is a String array. Exercise 6.59 Write down four more color constants that are available in the Color class. Exercise 13.63 The JMenu class is actually a subclass of JMenuItem. Make them visible, then move them around on the screen using the "move" methods. Doing this activity well, carefully stepping through all necessary steps, and recording steps in sufficient detail takes some practice and a lot of discipline. This has to do with the fact that we can create multiple objects from the same class. Java's try statement is the key to supplying an error-recovery mechanism when an exception is thrown. When control returns from the superclass method, the remaining statements of the subclass method print the distinctive fields of the PhotoPost class. 6.4.3 Generating random responses Now we can look at extending the Responder class to select a random response from a list of predefined phrases. Why? The expression is tested after execution of the loop body, so the body always executes at least once. Thus, an assert statement serves two purposes. ■ The search method should check that the key is not null. It is worth pointing out that, at every stage of the project life cycle, we should expect to find errors or loose ends in what we have done in earlier stages. While that might not seem like a particularly big problem, it does have a rather "cheap" feel about it, and it should be possible to do better with just a little more effort. For instance, the first assert statement in Code 14.16 asserts that keyInUse should return false at that point, either because the key wasn't in use in the first place or because it is no longer in use as the associated details have now been removed from the address book. An important point to note here is that the price of a ticket is initially determined externally and then has to be passed into the constructor. Imagine that someone wanted to translate your game into another language—say, to German. ■ Methods marked with the static keyword have a method body. Note that we need to find a way to indicate to the method's caller if the search has failed. 3.12.2 External method calls Now let us examine the next method: timeTick. For now, collections such as ArrayList, and some other collections that we shall encounter shortly, are the only generic classes we need to deal with. But, in practice this is not happening on a large scale. Scribble (Chapter 6) A shape-drawing program to support learning about classes from their interfaces. While this enables you to study the complete solution, you are encouraged to follow the path through the exercises in this chapter. A proper solution would not require us either to know in advance how many items we wish to group together, or to fix an upper limit to that number. It must then find the right Seat object (we can note that as a responsibility: Can find seats by number) and can make a reservation for that seat. When you execute the command to start Java and execute your application, make sure that the project directory is the active directory in your command terminal. Is there a problem? Exercise 13.77 Improve the button look. Then change your code to work correctly again in reading in the responses from this file. Exercise 10.15 Use the documentation of the Java standard class libraries to find out a out the inheritance hierarch of the collection classes Dra a diagram showing the hierarchy. Exercise 14.34 In the address-book-v3t project, define a new checked exception class: DuplicateKeyException. First, an exception object is created using the new keyword (in this case, an IllegalArgumentException object); then the exception object is thrown using the throw keyword. However, exceptions are primarily used to anticipate and handle error situations, rather than the normal flow of control. PhDStudent is a subclass of Student. He will think of the spark plug as a complex artifact of many parts. The call sequence operates as a stack, with the method at the top of the sequence being the one where the flow of execution currently lies. It could be the processing of elements from a collection (as we have discussed), processing messages coming in over a network, processing lines of text from a text file, or all characters from a string. Internal method calls have the syntax methodName (parameter-list) An internal method call does not have a variable name and a dot before the method name, which you will have observed in all of the method calls recorded in the Terminal window. M12_BARN7367_06_SE_C12.indd 451 4/11/16 3:38 PM 452 | Chapter 12 ■ Further Abstraction Techniques 12.6.7 Functional interfaces and lambdas (advanced) Java 8 introduced a special classification for interfaces that contain just a single abstract method (regardless of the number of default and/or static methods they contain). Remember that the range of indices for an ArrayList of size listSize is 0 to listSize–1. To create an executable .jar file in BlueJ, use the Project—Create Jar File function, and specify in the resulting dialog the class that contains the main method. Non-void return types allow us to pass a value out of a method to the place where the method was called from. Exercise 2.7 Does it matter whether we write public class TicketMachine or class public TicketMachine in the outer wrapper of a class? We try to avoid declaring as fields variables that really only have a local (method-level) usage, whose values don't have to be retained beyond a single method call. Note that you will probably not understand everything that is stated in the documentation. Beginning students can typically use the BlueJ environment in a competent manner after 20 minutes of introduction.

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