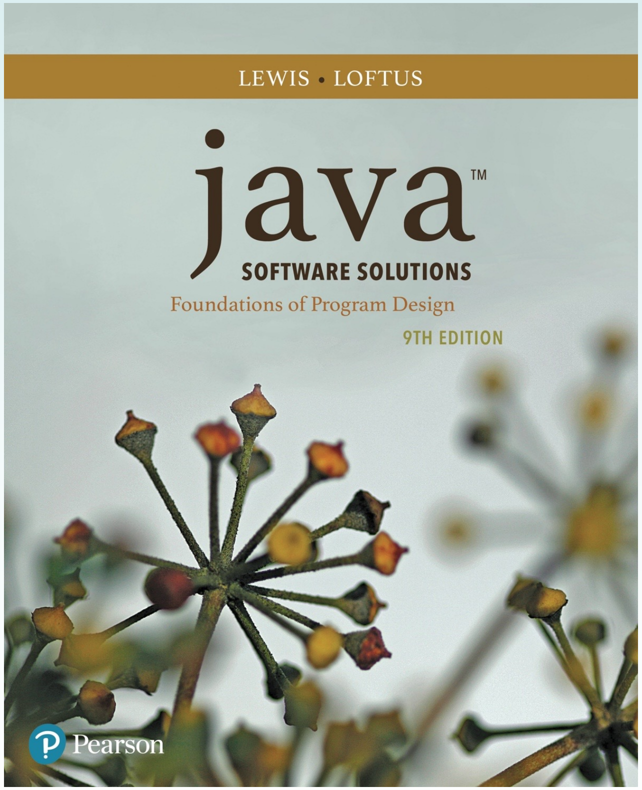
Chapter 5
Conditionals and Loops



Java Software Solutions

Foundations of Program Design

9th Edition

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Conditionals and Loops

- Now we will examine programming statements that allow us to:
  - make decisions
  - repeat processing steps in a loop
- Chapter 5 focuses on:
  - boolean expressions
  - the if and if-else statements
  - comparing data
  - while loops
  - iterators
  - the `ArrayList` class
  - more GUI controls

Outline

Boolean Expressions

The `if` Statement

Comparing Data

The `while` Statement

Iterators

The `ArrayList` Class

Determining Event Sources

Managing Fonts

Check Boxes and Radio Buttons

Flow of Control

- Unless specified otherwise, the order of statement execution through a method is linear: one after another

- Some programming statements allow us to make decisions and perform repetitions

- These decisions are based on *boolean expressions* (also called *conditions*) that evaluate to true or false

- The order of statement execution is called the *flow of control*

Conditional Statements

- A *conditional statement* lets us choose which statement will be executed next
- They are sometimes called *selection statements*
- Conditional statements give us the power to make basic decisions
- The Java conditional statements are the:
  - `if` and `if-else` statement
  - `switch` statement
- We'll explore the `switch` statement in Chapter 6

Boolean Expressions

- A condition often uses one of Java's *equality operators* or *relational operators*, which all return boolean results:

`==`	equal to
`!=`	not equal to
`<`	less than
`>`	greater than
`<=`	less than or equal to
`>=`	greater than or equal to

- Note the difference between the equality operator (==) and the assignment operator (=)

Boolean Expressions

- An `if` statement with its boolean condition:

```
if (sum > MAX)
   delta = sum - MAX;
```

- First, the condition is evaluated: the value of `sum` is either greater than the value of `MAX`, or it is not
- If the condition is true, the assignment statement is executed; if it isn't, it is skipped
- See `Age.java`

Logical Operators

- Boolean expressions can also use the following *logical operators*:

`!`	Logical NOT
`&&`	Logical AND
`||`	Logical OR

- They all take boolean operands and produce boolean results

- Logical NOT is a unary operator (it operates on one operand)

- Logical AND and logical OR are binary operators (each operates on two operands)

Logical NOT

- The *logical NOT* operation is also called *logical negation* or *logical complement*

- If some boolean condition `a` is true, then `!a` is false; if `a` is false, then `!a` is true

- Logical expressions can be shown using a *truth table*:

`a`	`!a`
true	false
false	true

Logical AND and Logical OR

- The *logical AND* expression

  ```
  a && b
  ```

  is true if both `a` and `b` are true, and false otherwise

- The *logical OR* expression

  ```
  a || b
  ```

  is true if `a` or `b` or both are true, and false otherwise

Logical AND and Logical OR

- A truth table shows all possible true-false combinations of the terms
- Since `&&` and `||` each have two operands, there are four possible combinations of `a` and `b`

`a`	`b`	`a && b`	`a || b`
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

Logical Operators

- Expressions that use logical operators can form complex conditions

```
if (total < MAX+5 && !found)
   System.out.println("Processing…");
```

- All logical operators have lower precedence than the relational operators
- The `!` operator has higher precedence than `&&` and `||`

Boolean Expressions

- Specific expressions can be evaluated using truth tables

`total < MAX`	`found`	`!found`	`total < MAX && !found`
false	false	true	false
false	true	false	false
true	false	true	true
true	true	false	false

Short-Circuited Operators

- The processing of `&&` and `||` is “short-circuited”
- If the left operand is sufficient to determine the result, the right operand is not evaluated

```
if (count != 0 && total/count > MAX)
   System.out.println("Testing.");
```

- This type of processing should be used carefully

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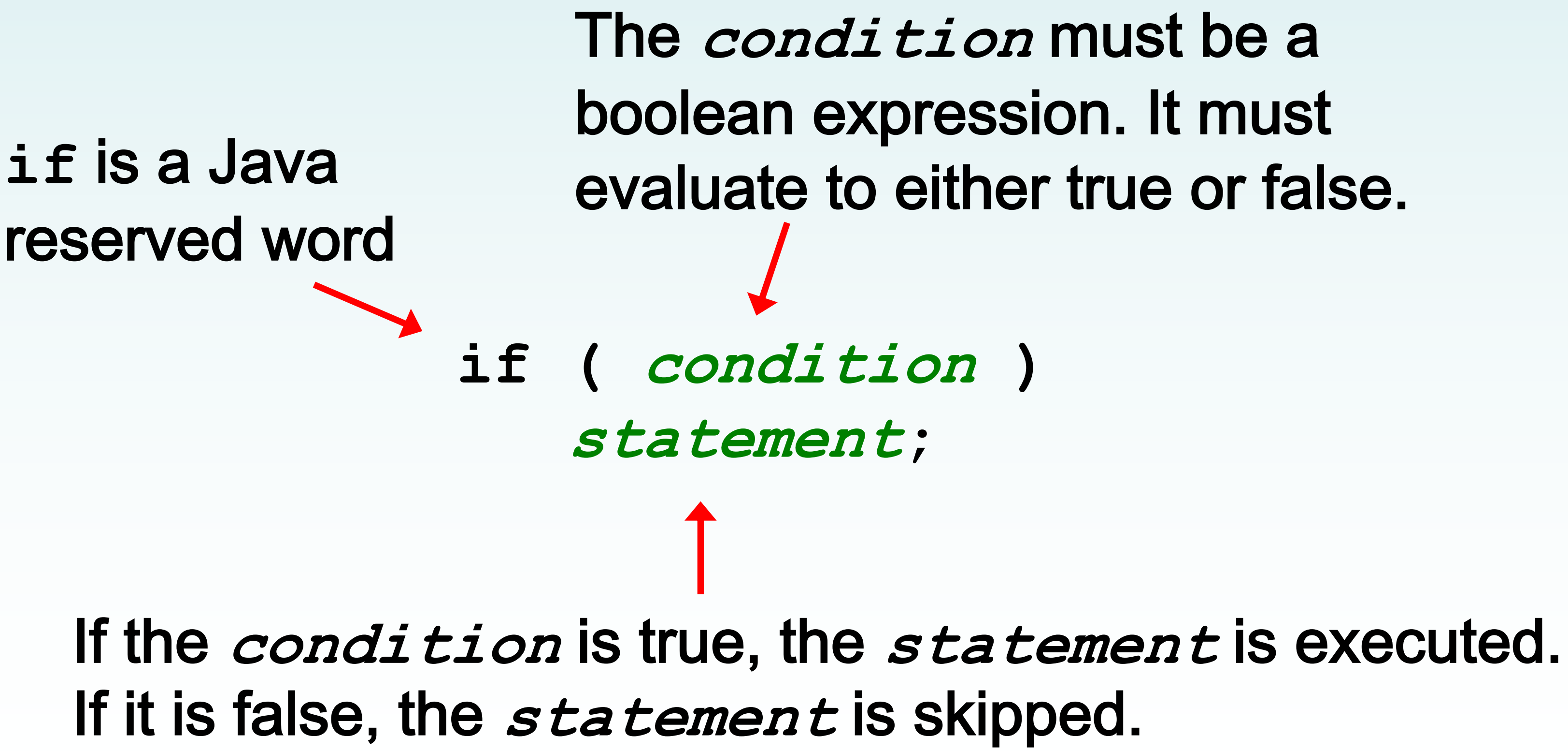
The if Statement

- Let's now look at the `if` statement in more detail
- The *if statement* has the following syntax:



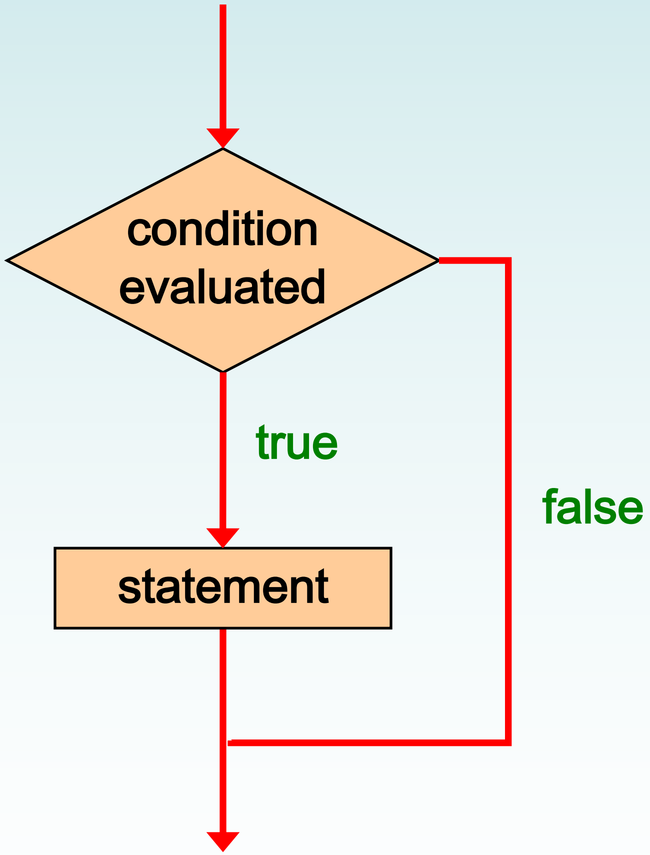
`if` is a Java reserved word

The *`condition`* must be a boolean expression. It must evaluate to either true or false.

```
if ( condition )
   statement;
```

If the *`condition`* is true, the *`statement`* is executed. If it is false, the *`statement`* is skipped.

Logic of an if statement



Indentation

- The statement controlled by the `if` statement is indented to indicate that relationship
- The use of a consistent indentation style makes a program easier to read and understand
- The compiler ignores indentation, which can lead to errors if the indentation is not correct

"Always code as if the person who ends up maintaining your code will be a violent psychopath who knows where you live."

-- Martin Golding

Quick Check

What do the following statements do?

```
if (total != stock + warehouse)
   inventoryError = true;
```

```
if (found || !done)
   System.out.println("Ok");
```

Quick Check

What do the following statements do?

```
if (total != stock + warehouse)
   inventoryError = true;
```

Sets the boolean variable to true if the value of `total` is not equal to the sum of `stock` and `warehouse`

```
if (found || !done)
   System.out.println("Ok");
```

Prints "Ok" if `found` is true or `done` is false

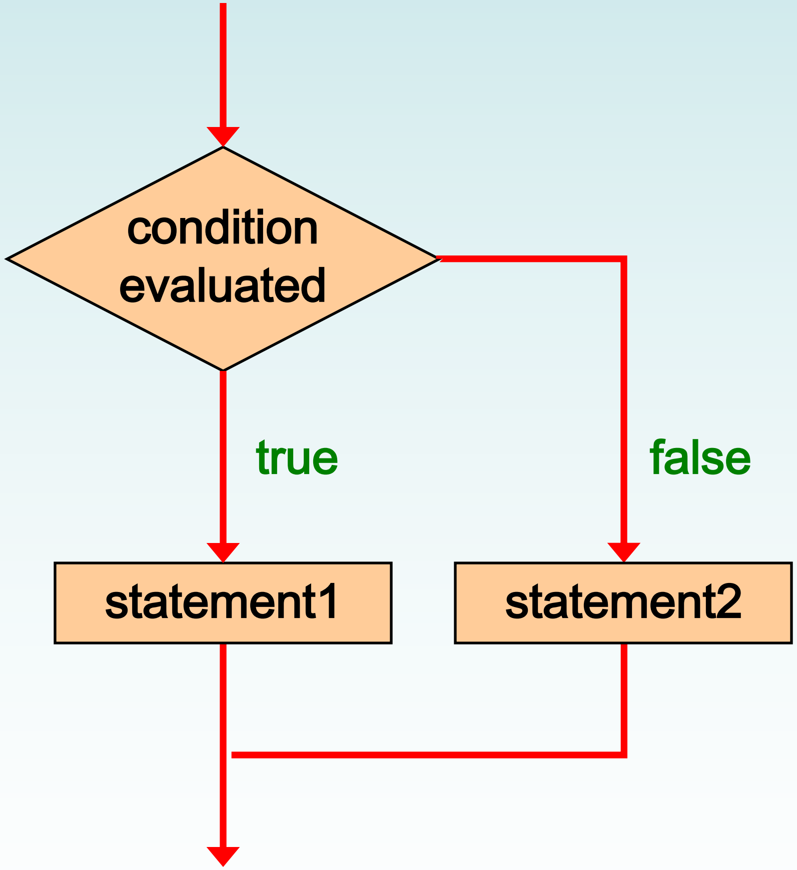
The if-else Statement

- An *else clause* can be added to an `if` statement to make an *if-else statement*

```
if ( condition )
    statement1;
else
    statement2;
```

- If the *condition* is true, *statement1* is executed; if the condition is false, *statement2* is executed
- One or the other will be executed, but not both
- See `Wages.java`

Logic of an if-else statement



The Coin Class

- Let's look at an example that uses a class that represents a coin that can be flipped

- Instance data is used to indicate which face (heads or tails) is currently showing

- See `CoinFlip.java`
- See `Coin.java`

Indentation Revisited

- Remember that indentation is for the human reader, and is ignored by the compiler

```
if (depth >= UPPER_LIMIT)
   delta = 100;
else
   System.out.println("Reseting Delta");
   delta = 0;
```

- Despite what the indentation implies, `delta` will be set to 0 no matter what

Block Statements

- Several statements can be grouped together into a *block statement* delimited by braces

- A block statement can be used wherever a statement is called for in the Java syntax rules

```
if (total > MAX)
{
   System.out.println("Error!!");
   errorCount++;
}
```

Block Statements

- The `if` clause, or the `else` clause, or both, could govern block statements

```
if (total > MAX)
{
   System.out.println("Error!!");
   errorCount++;
}
else
{
   System.out.println("Total: " + total);
   current = total*2;
}
```

- See `Guessing.java`

Nested if Statements

- The statement executed as a result of an `if` or `else` clause could be another `if` statement

- These are called *nested if statements*

- An `else` clause is matched to the last unmatched `if` (no matter what the indentation implies)

- Braces can be used to specify the `if` statement to which an `else` clause belongs

- See `MinOfThree.java`

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Comparing Data

- When comparing data using boolean expressions, it's important to understand the nuances of certain data types

- Let's examine some key situations:
  - Comparing floating point values for equality
  - Comparing characters
  - Comparing strings (alphabetical order)
  - Comparing object vs. comparing object references

Comparing Float Values

- You should rarely use the equality operator (`==`) when comparing two floating point values (`float` or `double`)
- Two floating point values are equal only if their underlying binary representations match exactly
- Computations often result in slight differences that may be irrelevant
- In many situations, you might consider two floating point numbers to be "close enough" even if they aren't exactly equal

Comparing Float Values

- To determine the equality of two floats, use the following technique:

```
if (Math.abs(f1 - f2) < TOLERANCE)
   System.out.println("Essentially equal");
```

- If the difference between the two floating point values is less than the tolerance, they are considered to be equal

- The tolerance could be set to any appropriate level, such as 0.000001

Comparing Characters

- As we've discussed, Java character data is based on the Unicode character set
- Unicode establishes a particular numeric value for each character, and therefore an ordering
- We can use relational operators on character data based on this ordering
- For example, the character `'+'` is less than the character `'J'` because it comes before it in the Unicode character set
- Appendix C provides an overview of Unicode

Comparing Characters

- In Unicode, the digit characters (0-9) are contiguous and in order

- Likewise, the uppercase letters (A-Z) and lowercase letters (a-z) are contiguous and in order

Characters	Unicode Values
0 – 9	48 through 57
A – Z	65 through 90
a – z	97 through 122

Comparing Strings

- Remember that in Java a character string is an object

- The `equals` method can be called with strings to determine if two strings contain exactly the same characters in the same order

- The `equals` method returns a boolean result

```
if (name1.equals(name2))
   System.out.println("Same name");
```

Comparing Strings

- We cannot use the relational operators to compare strings
- The `String` class contains the `compareTo` method for determining if one string comes before another
- A call to `name1.compareTo(name2)`
  - returns zero if `name1` and `name2` are equal (contain the same characters)
  - returns a negative value if `name1` is less than `name2`
  - returns a positive value if `name1` is greater than `name2`

Comparing Strings

- Because comparing characters and strings is based on a character set, it is called a *lexicographic ordering*

```
int result = name1.compareTo(name2);
if (result < 0)
   System.out.println(name1 + "comes first");
else
   if (result == 0)
      System.out.println("Same name");
   else
      System.out.println(name2 + "comes first");
```

Lexicographic Ordering

- Lexicographic ordering is not strictly alphabetical when uppercase and lowercase characters are mixed
- For example, the string `"Great"` comes before the string `"fantastic"` because all of the uppercase letters come before all of the lowercase letters in Unicode
- Also, short strings come before longer strings with the same prefix (lexicographically)
- Therefore `"book"` comes before `"bookcase"`

Comparing Objects

- The == operator can be applied to objects – it returns true if the two references are aliases of each other
- The `equals` method is defined for all objects, but unless we redefine it when we write a class, it has the same semantics as the == operator
- It has been redefined in the `String` class to compare the characters in the two strings
- When you write a class, you can redefine the `equals` method to return true under whatever conditions are appropriate

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Repetition Statements

- *Repetition statements* allow us to execute a statement multiple times
- Often they are referred to as *loops*
- Like conditional statements, they are controlled by boolean expressions
- Java has three kinds of repetition statements: `while`, `do`, and `for` loops
- The `do` and `for` loops are discussed in Chapter 6

The while Statement

- A *while statement* has the following syntax:

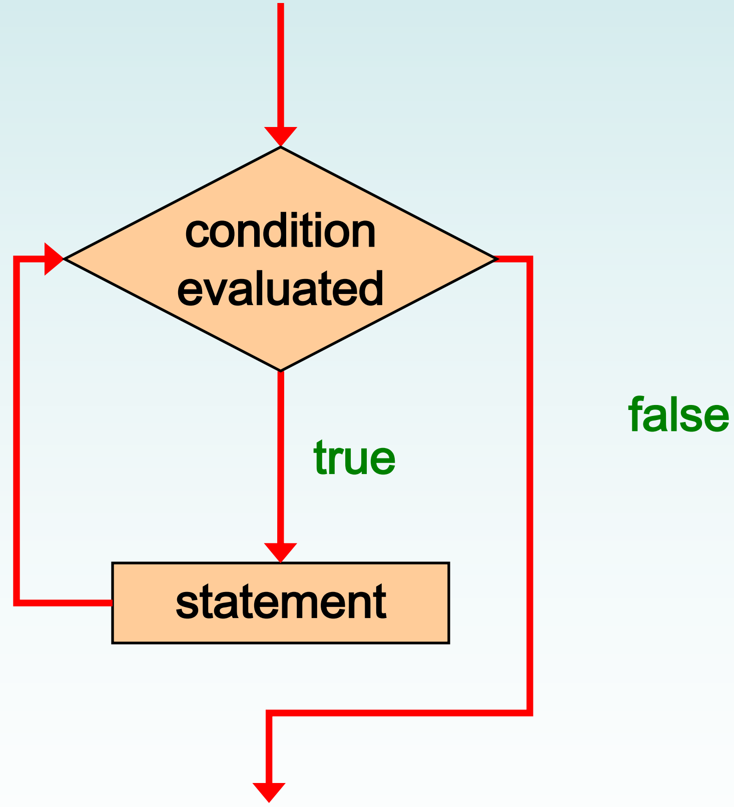
```
while ( condition )
   statement;
```

- If the `condition` is true, the `statement` is executed

- Then the condition is evaluated again, and if it is still true, the statement is executed again

- The statement is executed repeatedly until the condition becomes false

Logic of a while Loop



The while Statement

- An example of a while statement:

```
int count = 1;
while (count <= 5)
{
   System.out.println(count);
   count++;
}
```

- If the condition of a `while` loop is false initially, the statement is never executed
- Therefore, the body of a `while` loop will execute zero or more times

Sentinel Values

- Let's look at some examples of loop processing
- A loop can be used to maintain a *running sum*
- A *sentinel value* is a special input value that represents the end of input
- See `Average.java`

Input Validation

- A loop can also be used for *input validation*, making a program more *robust*
- It's generally a good idea to verify that input is valid (in whatever sense) when possible
- See `WinPercentage.java`

Infinite Loops

- The body of a `while` loop eventually must make the condition false
- If not, it is called an *infinite loop*, which will execute until the user interrupts the program
- This is a common logical error
- You should always double check the logic of a program to ensure that your loops will terminate normally

Infinite Loops

- An example of an infinite loop:

```
int count = 1;
while (count <= 25)
{
    System.out.println(count);
    count = count - 1;
}
```

- This loop will continue executing until interrupted (Control-C) or until an underflow error occurs

Nested Loops

- Similar to nested `if` statements, loops can be nested as well

- That is, the body of a loop can contain another loop

- For each iteration of the outer loop, the inner loop iterates completely

- See `PalindromeTester.java`

Quick Check

How many times will the string "Here" be printed?

```
count1 = 1;
while (count1 <= 10)
{
   count2 = 1;
   while (count2 < 20)
   {
      System.out.println("Here");
      count2++;
   }
   count1++;
}
```

Quick Check

How many times will the string "Here" be printed?

```
count1 = 1;
while (count1 <= 10)
{
   count2 = 1;
   while (count2 < 20)
   {
      System.out.println("Here");
      count2++;
   }
   count1++;
}
```

10 * 19 = 190

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Iterators

- An *iterator* is an object that allows you to process a collection of items one at a time
- It lets you step through each item in turn and process it as needed
- An iterator has a `hasNext` method that returns true if there is at least one more item to process
- The `next` method returns the next item
- Iterator objects are defined using the `Iterator` interface, which is discussed further in Chapter 7

Iterators

- Several classes in the Java standard class library are iterators

- The `Scanner` class is an iterator
  - the `hasNext` method returns true if there is more data to be scanned
  - the `next` method returns the next scanned token as a string

- The `Scanner` class also has variations on the `hasNext` method for specific data types (such as `hasNextInt`)

Iterators

- The fact that a `Scanner` is an iterator is particularly helpful when reading input from a file

- Suppose we wanted to read and process a list of URLs stored in a file

- One scanner can be set up to read each line of the input until the end of the file is encountered

- Another scanner can be set up for each URL to process each part of the path

- See `URLDissector.java`

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➡ **The `ArrayList` Class**

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The ArrayList Class

- An `ArrayList` object stores a list of objects, and is often processed using a loop
- The `ArrayList` class is part of the `java.util` package
- You can reference each object in the list using a numeric index
- An `ArrayList` object grows and shrinks as needed, adjusting its capacity as necessary

The ArrayList Class

- Index values of an `ArrayList` begin at 0 (not 1):

0	"Bashful"
1	"Sleepy"
2	"Happy"
3	"Dopey"
4	"Doc"

- Elements can be inserted and removed
- The indexes of the elements adjust accordingly

ArrayList Methods

- Some `ArrayList` methods:

```
boolean add(E obj)

void add(int index, E obj)

Object remove(int index)

Object get(int index)

boolean isEmpty()

int size()
```

The ArrayList Class

- The type of object stored in the list is established when the `ArrayList` object is created:

```
ArrayList<String> names = new ArrayList<String>();

ArrayList<Book> list = new ArrayList<Book>();
```

- This makes use of Java *generics*, which provide additional type checking at compile time
- An `ArrayList` object cannot store primitive types, but that's what wrapper classes are for
- See `Beatles.java`

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Determining Event Sources

- Recall that you must establish a relationship between controls and the event handlers that respond to events
- When appropriate, one event handler object can be used to listen to multiple controls
- The source of the event can be determined by using the `getSource` method of the event passed to the event handler
- See `RedOrBlue.java`

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Managing Fonts

- The `Font` class represents a character font, which specify what characters look like when displayed

- A font can be applied to a `Text` object or any control that displays text (such as a `Button` or `Label`)

- A font is specifies:
  - *font family* (Arial, Courier, Helvetica)
  - *font size* (in units called points)
  - *font weight* (boldness)
  - *font posture* (italic or normal)

Managing Fonts

- A `Font` object is created using either the `Font` constructor or by calling the static `font` method
- The `Font` constructor can only take a font size, or a font family and size
- To set the font weight or font posture, use the `font` method, which can specify various combinations of font characteristics
- See `FontDemo.java`

Managing Fonts

- Note that setting the text color is not a function of the font applied
- It's set through the `Text` object directly
- The same is true for underlined text (or a "strike through" effect)

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⇨ Check Boxes and Radio Buttons

Check Boxes

- A *check box* is a button that can be toggled on or off
- It is represented by the JavaFX `CheckBox` class
- Checking or unchecking a check box produces an action event
- See `StyleOptions.java`
- See `StyleOptionsPane.java`

Check Boxes

- The `StyleOptionsPane` class uses two layout panes: `HBox` and `VBox`

- The `HBox` pane arranges its nodes into a single row horizontally

- The `VBox` pane arranges its nodes into a single column vertically

- `StyleOptionsPane` extends `VBox`, and is used to put the text above the check boxes

- The `HBox` puts the check boxes side by side

Check Boxes

- The event handler method is called when either check box is toggled
- Instead of tracking which box was changed, the method just checks the current status of both boxes and sets the font accordingly

Radio Buttons

- Let's look at a similar example that uses *radio buttons*
- A group of radio buttons represents a set of mutually exclusive options – only one button can be selected at any given time
- When a radio button from a group is selected, the button that is currently "on" in the group is automatically toggled off
- See `QuoteOptions.java`
- See `QuoteOptionsPane.java`

Radio Buttons

- To establish a set of mutually exclusive options, the radio buttons that work together as a group are added to a `ToggleGroup` object
- The `setToggleGroup` method is used to specify which toggle group a button belongs to
- The `isSelected` method of a radio button returns true if that button is currently "on"

Summary

- Chapter 5 focused on:
  - boolean expressions
  - the if and if-else statements
  - comparing data
  - while loops
  - iterators
  - the `ArrayList` class
  - more GUI controls