Chapter 5
Conditionals and Loops

Java Software Solutions
Foundations of Program Design
9th Edition

John Lewis
William Loftus
Try not to become a man of success. Rather become a man of value.
A. Einstein
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
  – more drawing techniques
  – more GUI controls
Flow Control

LET A = a loaf of bread
LET T = a toaster
LET P = a plate
LET B = some butter
LET M = some margarine
FOR every friend (F) eating toast{
    LET S = cut slice from A
    move S to T
    turn on T
    WHILE T is not finished{
        talk to F
    }
}
move S to P
IF F likes B {
    LET X = B }
ELSEIF F likes M {
    LET X = M }
ELSE {
    LET X = NOTHING }
spread S with X
move P to F
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
import java.util.Scanner;

public class Age {

    // -----------------------------------------------
    // Reads the user's age and prints comments accordingly.
    // -----------------------------------------------
    public static void main (String[] args) {
        final int MINOR = 21;

        Scanner scan = new Scanner (System.in);

        System.out.print ("Enter your age: ");
        int age = scan.nextInt();

        continue
    }
}

System.out.println("You entered: " + age);

if (age < MINOR)
    System.out.println("Youth is a wonderful thing. Enjoy.");

System.out.println("Age is a state of mind.");
System.out.println("You entered: \" + age);}

if (age < MINOR)
    System.out.println("Youth is a wonderful thing. Enjoy."mutable);

System.out.println("Age is a state of mind.");
}

Another Sample Run
Enter your age: 12
You entered: 12
Youth is a wonderful thing. Enjoy.
Age is a state of mind.
• What is the value of x, a, and b after the execution of the following statements?

```c
int x=1, a=2, b=3;
if (x < 0)
b=5;
a = b*2;
x=4;
```
Quiz

• What is the value of x, a, and b after the execution of the following statements?

```java
int x=1, a=2, b=3;
if (x < 0) // the Boolean expression is false
    b=5;    // this statement is not executed
a= b*2;
x=4;

x is 4
a is 6
b is 3
```
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 \( \neg a \) is false; if \( a \) is false, then \( \neg a \) is true

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

<table>
<thead>
<tr>
<th>( a )</th>
<th>( \neg a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
</tr>
</tbody>
</table>

*Note: \( a \) could be a boolean variable or an expression that evaluates to a boolean value*
Quiz

• What is the value of $x$, $a$, and $b$ after the execution of the following statements?

```c
int x=0, a=2, b=3;
if (!(x >1))
b=5;
a= b*2;
x=4;
```
Quiz

• What is the value of x, a, and b after the execution of the following statements?

```java
int x=0, a=2, b=3;
if (!(x >1)) // the boolean exp. is true
    b=5; // this statement is executed
    a= b*2;
    x=4;

x is 4
a is 10
b is 5
```
Logical AND and Logical OR

• The *logical AND* expression
  \[ a \land b \]
  is true if **both** \(a\) **and** \(b\) are true, and false otherwise

• The *logical OR* expression
  \[ a \lor b \]
  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 conditions `a` and `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

```java
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 `||`
Quiz

• Are the two following Boolean expressions equivalent? Assume that a and b are Boolean variables.

1) !(a && b)
2) !a && b
Quiz

• Are the two following Boolean expressions equivalent? Assume that \( a \) and \( b \) are Boolean variables.

1) \(! (a \land b)\)
2) \(! a \land b\)

NO, the first is always true except when \( a \) and \( b \) are true. The second is true only when \( a \) is false and \( b \) is true.
Boolean Expressions

- Specific expressions can be evaluated using truth tables

<table>
<thead>
<tr>
<th>total &lt; MAX</th>
<th>found</th>
<th>!found</th>
<th>total &lt; MAX &amp;&amp; !found</th>
</tr>
</thead>
<tbody>
<tr>
<td>false</td>
<td>false</td>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
<td>false</td>
<td>false</td>
</tr>
<tr>
<td>true</td>
<td>false</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td>true</td>
<td>true</td>
<td>false</td>
<td>false</td>
</tr>
</tbody>
</table>
Quiz

• Assuming that $c_1$ and $c_2$ are boolean variables, create a truth table for the expression:
  
  $$(c_1 \land \neg c_2) \lor (\neg c_1 \land c_2)$$

<table>
<thead>
<tr>
<th>$c_1$</th>
<th>$c_2$</th>
<th>$\neg c_1$</th>
<th>$\neg c_2$</th>
<th>$c_1 \land \neg c_2$</th>
<th>$\neg c_1 \land c_2$</th>
<th>$c_1 \land \neg c_2 \lor \neg c_1 \land c_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>true</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>true</td>
<td>false</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>
Quiz

- Assuming that `c1` and `c2` are boolean variables, create a truth table for the expression:

  \[(c1 \&\& !c2) \text{ || } (!c1 \&\& c2)\]

| c1  | c2  | !c1 | !c2 | c1 && !c2 | !c1 && c2 | c1 && !c2 || !c1 && c2 |
|-----|-----|-----|-----|-----------|-----------|--------------------------|
| true| true| false| false| false     | false     | false                     |
| true| false| false| true | true      | false     | true                      |
| false| true| true | false| false     | true      | true                      |
| false| false| true | true | false     | 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**

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

• This type of processing should be used carefully
Quiz

• What is the value of count and base after the execution of the following statements?

```c
int count=2, base=0;
if (count > 1 || ++base > count)
    count--;
```
Quiz

What is the value of count and base after the execution of the following statements?

```c
int count=2, base=0;
if (count > 1 || ++base > count)
    count--;
```

count is 1
base is 0
• What is the value of count and base after the execution of the following statements?

```java
int count=2, base=0;
if (++base > count || count > 1)
    count--;
```
Quiz

• What is the value of count and base after the execution of the following statements

```java
int count=2, base=0;
if (++base > count || count > 1)
    count--;

count is 1
base is 1
```
Quiz

• What is the value of count and base after the execution of the following statements?

```c
int count=2, base=0;
if (++base > count && --count > 1)
    count--;```

Quiz

• What is the value of count and base after the execution of the following statements?

```java
int count=2, base=0;
if (++base > count && --count > 1)
    count--;

count is 2
base is 1
```
Outline

- Boolean Expressions
  - The if Statement
- Comparing Data
- The while Statement
- Iterators
- The ArrayList Class
- Determining Event Sources
- Check Boxes and Radio Buttons
The if Statement

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

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

if is a Java reserved word

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

If the condition is true, the statement is executed. If it is false, the statement is skipped.
Logic of an if statement

Flowchart
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 you to make (logical) 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?

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

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

What do the following statements do?

```java
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`

```java
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*

  ```java
  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*
import java.text.NumberFormat;
import java.util.Scanner;

public class Wages
{
    // -----------------------------------------------------------------
    // Reads the number of hours worked and calculates wages.
    // -----------------------------------------------------------------
    public static void main (String[] args)
    {
        final double RATE = 8.25; // regular pay rate
        final int STANDARD = 40; // standard hours in a work week

        Scanner scan = new Scanner (System.in);

        double pay = 0.0;

        continue
continue

    System.out.print("Enter the number of hours worked: ");
    int hours = scan.nextInt();

    System.out.println();

    // Pay overtime at "time and a half"
    if (hours > STANDARD)
        pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
    else
        pay = hours * RATE;

    NumberFormat fmt = NumberFormat.getCurrencyInstance();
    System.out.println("Gross earnings: "+fmt.format(pay));
}
System.out.print("Enter the number of hours worked: ");
int hours = scan.nextInt();
System.out.println();

// Pay overtime at "time and a half"
if (hours > STANDARD)
    pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
else
    pay = hours * RATE;

NumberFormat fmt = NumberFormat.getCurrencyInstance();
System.out.println("Gross earnings: "+fmt.format(pay));
}

404.25 = 40*8.25 + 6*(8.25 * 1.5)
Logic of an if-else statement

- The condition is evaluated.
- If the condition is true, `statement1` is executed.
- If the condition is false, `statement2` is executed.
Flowcharts

for(A;B;C)
D;

A

B

D

C

FALSE

TRUE
Flowchart Symbols

- Beginning or ending of a program or sub-process. They usually contain the word "Start" or "End", or another phrase signaling the start or end of a process, such as "submit inquiry" or "receive product".

- Set of operations that change value, form, or location of data.

- Conditional operation determining which of two paths the program will take.

- Input and output of data, as in entering data or displaying results.
Exercise

• Draw the flowchart of a simple algorithm that will output EVEN/ODD depending on the parity of the input integer:
  – Start
  – Input N
  – Compute N%2 – remainder (N modulo 2)
  – If remainder is 0 the answer is “even” else is “odd”
  – Output the answer
  – End
Solution

Start

Input N

Remainder = N modulo 2

Remainder = 0?

YES

Answer = EVEN

NO

Answer = ODD

Output Answer

End
Quiz

What is printing the program described in this flowchart?
Syntax Diagram

If Statement

\[
\text{if} (\text{Expression}) \rightarrow \text{Statement} \rightarrow \text{else} \rightarrow \text{Statement}
\]
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
public class CoinFlip {
  // Creates a Coin object, flips it, and prints the results.
  public static void main (String[] args) {
    Coin myCoin = new Coin();
    myCoin.flip();
    System.out.println (myCoin);
    if (myCoin.isHeads())
      System.out.println ("You win.");
    else
      System.out.println ("Better luck next time.");
  }
}
public class CoinFlip
{
    // Creates a Coin object, flips it, and prints the results.
    public static void main (String[] args)
    {
        Coin myCoin = new Coin();

        myCoin.flip();

        System.out.println (myCoin);

        if (myCoin.isHeads())
            System.out.println("You win.");
        else
            System.out.println("Better luck next time.");
    }
}
public class Coin
{
    private final int HEADS = 0;
    private final int TAILS = 1;

    private int face;

    //--- Sets up the coin by flipping it initially.-----------------
    public Coin ()
    {
        flip();
    }
}

continue
public void flip()
{
    face = (int)(Math.random() * 2);
}

public boolean isHeads()
{
    return (face == HEADS);
}
public String toString() {
    String faceName;

    if (face == HEADS) {
        faceName = "Heads";
    } else {
        faceName = "Tails";
    }

    return faceName;
}
Indentation Revisited

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

```java
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
Consider the following code that will assign a letter grade of 'A', 'B', 'C', 'D', or 'F' depending on a student's test score.

```
if (score >= 90) grade = 'A';
if (score >= 80) grade = 'B';
if (score >= 70) grade = 'C';
if (score >= 60) grade = 'D';
else grade = 'F';
```

A) This code will work correctly in all cases
B) This code will work correctly only if grade >= 60
C) This code will work correctly only if grade < 60
D) This code will work correctly only if grade < 70
E) This code will not work correctly under any circumstances
Quiz

Consider the following code that will assign a letter grade of 'A', 'B', 'C', 'D', or 'F' depending on a student's test score.

```java
if (score >= 90) grade = 'A';
if (score >= 80) grade = 'B';
if (score >= 70) grade = 'C';
if (score >= 60) grade = 'D';
else grade = 'F';
```

A) This code will work correctly in all cases 
B) This code will work correctly only if grade >= 60 
C) This code will work correctly only if grade < 60 
D) This code will work correctly only if grade < 70 
E) This code will not work correctly under any circumstances
Quiz

Consider the following code that will assign a letter grade of 'A', 'B', 'C', 'D', or 'F' depending on a student's test score.

```java
    if (score >= 90) grade = 'A';
    if (score >= 80) grade = 'B';
    if (score >= 70) grade = 'C';
    if (score >= 60) grade = 'D';
    else grade = 'F';
```

Change the if-else conditions and the grade assignments in such a way that it correctly assigns the grades:

```java
    if (score < 60) grade = '???';
    if (score ???) grade = '???';
    if (score ???) grade = '???';
    if (score ???) grade = '???';
    else grade = '???';
```
Quiz

Consider the following code that will assign a letter grade of 'A', 'B', 'C', 'D', or 'F' depending on a student's test score.

```java
if (score >= 90) grade = 'A';
if (score >= 80) grade = 'B';
if (score >= 70) grade = 'C';
if (score >= 60) grade = 'D';
else grade = 'F';
```

Change the if-else conditions and the grade assignments in such a way that it correctly assigns the grades:

```java
if (score < 60) grade = 'F';
if (score < 70 && score >= 60) grade = 'D';
if (score < 80 && score >= 70) grade = 'C';
if (score < 90 && score >= 80) grade = 'B';
else grade = 'A';
```
Quiz

• Actually the previous solution does not always work … the last else is matched with the previous if, hence it will be executed also if score < 80 😊

```java
if (score < 60) grade = 'F';
if (score < 70 && score >= 60) grade = 'D';
if (score < 80 && score >= 70) grade = 'C';
if (score < 90 && score >= 80) grade = 'B';
if (score >= 90) grade = 'A';
```

Correct
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

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

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

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

- See Guessing.java
import java.util.*;

public class Guessing {
    public static void main (String[] args) {
        final int MAX = 10;
        int answer, guess;

        Scanner scan = new Scanner (System.in);
        Random generator = new Random();

        answer = generator.nextInt(MAX) + 1;
        continue
System.out.print("I'm thinking of a number between 1 and "+MAX+". Guess what it is: ");

guess = scan.nextInt();

if (guess == answer)
    System.out.println("You got it! Good guessing!");
else
    System.out.println("That is not correct, sorry.");
    System.out.println("The number was "+answer);
Sample Run

I'm thinking of a number between 1 and 10. Guess what it is: 6
That is not correct, sorry.
The number was 9

```java
if (guess == answer)
    System.out.println("You got it! Good guessing!");
else
{
    System.out.println("That is not correct, sorry.");
    System.out.println("The number was " + answer);
}
```
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
- Example:

```java
if (age < 21)
    if (age > 2)
        System.out.println("age is larger than" + " 2 and smaller than 21");
```
Nested if Statements

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

```java
if (age < 21)
    if (age > 2)
        System.out.println("age is larger than" + " 2 and smaller than 21");
    else
        System.out.println("age is " + "smaller than 21");
```

• Braces can be used to specify the if statement to which an else clause belongs.
Quiz

• What is printing the algorithm described in the flowchart below, given 3 numbers (A, B and C) as input:

START

READ A, B, C

IS B>C? NO

IS A>B? YES

IS A>C? NO

PRINT B

PRINT C

PRINT A

END
import java.util.Scanner;

public class MinOfThree
{
    //  Reads three integers from the user and determines the smallest value.
    public static void main (String[] args)
    {
        int num1, num2, num3, min = 0;

        Scanner scan = new Scanner (System.in);

        System.out.println ("Enter three integers: ");
        num1 = scan.nextInt();
        num2 = scan.nextInt();
        num3 = scan.nextInt();

        continue
    }
}
continue

    if (num1 < num2)
        if (num1 < num3)
            min = num1;
        else  //matches the last unmatched if
            min = num3;
    else
        if (num2 < num3)
            min = num2;
        else
            min = num3;

    System.out.println ("Minimum value: " + min);

}
```java
if (num1 < num2)
    if (num1 < num3)
        min = num1;
    else
        min = num3;
else
    if (num2 < num3)
        min = num2;
    else
        min = num3;

System.out.println("Minimum value: "+min);
```

**Sample Run**

Enter three integers:
84  69  90
Minimum value: 69
Quiz

• What happens in the MinOfThree program if two or more of the values are equal? If exactly two of the values are equal, does it matter whether the equal values are lower or higher than the third?
Quiz

• What happens in the MinOfThree program if two or more of the values are equal? If exactly two of the values are equal, does it matter whether the equal values are lower or higher than the third?

If two or more values are equal, the program still prints the lowest value.
Quiz

• What output is produced by the following code fragment given the assumptions below

```java
if (num1 < num2)
    System.out.println("red ");
if ((num1 + 5) < num2)
    System.out.println("white ");
else
    System.out.println("blue ");
System.out.println("yellow ");
```

a) num1=2, num2=10
b) num1=10, num2=2
c) num1=2, num2=2
Quiz

• What output is produced by the following code fragment given the assumptions below

```java
if (num1 < num2)
    System.out.println("red ");
if ((num1 + 5) < num2)
    System.out.println("white ");
else
    System.out.println("blue ");
System.out.println("yellow ");
```

a) num1=2, num2=10 -> red white yellow
b) num1=10, num2=2 -> blue yellow
c) num1=2, num2=2 -> blue yellow
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:

```java
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
Exercise

• Write a method called floatEquals that accepts three double parameters. The method should return true if the first two parameters are equal within the tolerance given by the third parameter.
Solution

public boolean floatEquals(double float1, double float2, double tolerance)
{
    return (Math.abs(float1 - float2) <= tolerance);
}
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.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Unicode Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 9</td>
<td>48 through 57</td>
</tr>
<tr>
<td>A – Z</td>
<td>65 through 90</td>
</tr>
<tr>
<td>a – z</td>
<td>97 through 122</td>
</tr>
</tbody>
</table>
Quiz

Is this snippet syntactically correct? If yes, what is going to be printed?

```java
if ('a' > 'b')
    System.out.println(true);
else
    System.out.println(false);
```
Quiz

Is this snippet syntactically correct? If yes, what is going to be printed?

```java
if ('a' > 'b')
    System.out.println(true);
else
    System.out.println(false);

YES it is correct and will print:
false
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
Exercise

• What is this code printing? Assume that equals() is not redefined.

```java
Coin coin1, coin2, coin3;
coin1 = new Coin();
coin2 = coin1;
coin3 = new Coin();
System.out.println(coin1 == coin3);
System.out.println(coin1 == coin2);
System.out.println(coin2.equals(coin3));
```
Solution

• What is this code printing?

```java
Coin coin1, coin2, coin3;
coin1 = new Coin();
coin2 = coin1;
coin3 = new Coin();
System.out.println(coin1 == coin3);
System.out.println(coin1 == coin2);
System.out.println(coin2.equals(coin3));
```

false
true
false
Exercise

- Define a **method of the Coin class** called `equals` that checks if a Coin object has the same state (face instance data) of another Coin object that is passed to the method as a parameter (it returns a boolean)

```java
public boolean equals(Coin coin) {
    ...
}

// usage example
Coin coin1 = new Coin();
Coin coin2 = new Coin();
System.out.println(coin1.equals(coin2));
```
Exercise

• Define a method of the Coin class called equals that checks if a Coin object has the same state of another Coin object that is passed to the method as a parameter (it returns a boolean)

```java
public boolean equals(Coin coin) {
    return face == coin.face;
}
```

Almost correct! See next slides.
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

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

• We cannot use the relational operators to compare strings (‘<’ or ‘>’)

• The String class contains the compareTo method for determining if one string comes before another – but it returns an integer!

• 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*

```java
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".
Quiz

• Write a `compareTo` method for the `Die` class of section 4.2

• A call to `die1.compareTo(die2)`
  – returns zero if `die1` and `die2` are equal (show the same face)
  – returns a negative value if the `faceValue` of `die1` is smaller than the `faceValue` of `die2`
  – returns a positive value in the other cases

```java
public int compareTo(Die die) {
    ...
}
```
Quiz

• Write a compareTo method for the Die class of section 4.2
• A call to `die1.compareTo(die2)`
  – returns zero if `die1` and `die2` are equal (show the same face)
  – returns a negative value if the `faceValue` of `die1` is smaller than the `faceValue` of `die2`
  – returns a positive value in the other cases

```java
public int compareTo(Die die) {
    return faceValue - die.faceValue;
}
```
Quiz

• Write an `equals` method for the `Die` class of section 4.2
Quiz

• Write an equals method for the Die class of section 4.2

```java
public boolean equals(Die die) {
    if (faceValue == die.faceValue)
        return true;
    return false;
}

public boolean equals(Die die) {
    return (faceValue == die.faceValue);
}
```
Quiz

• Write an `equals` method for the `Die` class of section 4.2

• Actually the previous solutions are not OK, if you want to override the `equals` method already defined in the class `Object`; because the parameter of `equals` must be of type `Object`

```java
public boolean equals(Object die) {
    if (die.getClass() == getClass())
        return faceValue == (((Die) die).faceValue);
    return false;
}
```
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
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:

```java
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

1. The `condition` is evaluated.
2. If the condition is `true`, the `statement` is executed.
3. The process repeats back to the condition evaluation.
4. If the condition is `false`, the loop stops.
The while Statement

• An example of a while statement:

```java
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*
import java.text.DecimalFormat;
import java.util.Scanner;

public class Average
{
    // Computed the average of a set of values entered by the user.
    // The running sum is printed as the numbers are entered.
    public static void main (String[] args)
    {
        int sum = 0, value, count = 0;
        double average;

        Scanner scan = new Scanner (System.in);

        System.out.print ("Enter an integer (0 to quit): ");
        value = scan.nextInt();

        continue
    }
}
while (value != 0)  // sentinel value of 0 to terminate loop
{
    count++; 

    sum += value;
    System.out.println("The sum so far is " + sum);

    System.out.print("Enter an integer (0 to quit): ");
    value = scan.nextInt();
}
continue
continue
continue

    System.out.println ();

    if (count == 0)
        System.out.println ("No values were entered.");
    else
    {
        average = (double)sum / count;

        DecimalFormat fmt = new DecimalFormat ("0.###");
        System.out.println ("The average is " + fmt.format(average));
    }
}
```java
continue
System.out.println();
if (count == 0)
System.out.println("No values were entered.");
else {
    average = (double)sum / count;
    DecimalFormat fmt = new DecimalFormat("0.###");
    System.out.println("The average is "+fmt.format(average));
}
}
```
Quiz

• Modify the code of the previous example so that 0 can be entered as any other int, i.e., 0 will not stop the input, but it will be stopped if the user enters anything that is not an int

• Hint: Use `hasNextInt()` method of Scanner in the while condition (it returns true if the input is an integer). If the input is an integer then in the while block you must scan that integer with `scan.nextInt()`.

```java
scan.nextInt();
```
Solution

System.out.print("Enter an integer ("q" to quit): ");
while (scan.hasNextInt())
{
    value = scan.nextInt();
    count++;
    sum += value;
    System.out.println("The sum so far is " + sum);
    System.out.print("Enter an integer ("q" to quit): ");
}

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
import java.text.NumberFormat;
import java.util.Scanner;

public class WinPercentage
{
    public static void main (String[] args)
    {
        final int NUM_GAMES = 12;
        int won;
        double ratio;

        Scanner scan = new Scanner (System.in);

        System.out.print ("Enter the number of games won (0 to " + NUM_GAMES + ": ");
        won = scan.nextInt();

        continue
continue

while (won < 0 || won > NUM_GAMES)
{
    System.out.print ("Invalid input. Please reenter: ");
    won = scan.nextInt();
}

ratio = (double)won / NUM_GAMES;

NumberFormat fmt = NumberFormat.getPercentInstance();

System.out.println ("");
System.out.println ("Winning percentage: "+ fmt.format(ratio));
}
continue

while (won < 0 || won > NUM_GAMES)
{
    System.out.print ("Invalid input. Please reenter: ");
    won = scan.nextInt();
}

ratio = (double)won / NUM_GAMES;

NumberFormat fmt = NumberFormat.getPercentInstance();

System.out.println ("");
System.out.println ("Winning percentage: " + fmt.format(ratio));
}
Exercise

• What output is produced by the following code fragment?

```java
int num = 1, max = 20;
while (num < max)
{
    if (num%2 == 0)
        System.out.println(num);
    num++;
}
```
What is going on here?

• An example of an "strange" loop:

```java
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
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
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`
import java.util.Scanner;

public class PalindromeTester {
    //Tests strings to see if they are palindromes.
    public static void main (String[] args) {
        String str, another = "y";
        int left, right;

        Scanner scan = new Scanner (System.in);

        while (another.equalsIgnoreCase("y")) // allows y or Y
        {
            System.out.println ("Enter a potential palindrome:");
            str = scan.nextLine();

            left = 0;
            right = str.length() - 1;

            continue
        }
    }
}
continue

while (str.charAt(left) == str.charAt(right) && left < right) {
    left++;
    right--;
}

System.out.println();

if (left < right) {
    System.out.println("That string is NOT a palindrome.");
} else {
    System.out.println("That string IS a palindrome.");
}

System.out.println();
System.out.print("Test another palindrome (y/n)? ");
another = scan.nextLine();
}
while (str.charAt(left) == str.charAt(right) & left < right) {
    left++;
    right--;
}
System.out.println();
if (left < right)
    System.out.println("That string is NOT a palindrome.");
else
    System.out.println("That string IS a palindrome.");
System.out.println();
System.out.print("Test another palindrome (y/n)? ");
another = scan.nextLine();
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
Quick Check

If $x$ is an int where $x = 1$, what will $x$ be after the following loop terminates?

```java
while (x < 100)
    x *= 2;
```
Quick Check

If $x$ is an int where $x = 1$, what will $x$ be after the following loop terminates?

```plaintext
    while (x < 100)
        x *= 2;
```

$x = 128$
Outline

Boolean Expressions
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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
import java.util.Scanner;
import java.io.*;

public class URLDissector
{
    //----------------------------------------------------------------------------
    //  Reads urls from a file and prints their path components.
    //----------------------------------------------------------------------------
    public static void main (String[] args) throws IOException
    {
        String url;
        Scanner fileScan, urlScan;

        fileScan = new Scanner (new File("urls.inp"));
        }
continue

    // Read and process each line of the file
    while (fileScan.hasNext())
    {
        url = fileScan.nextLine();
        System.out.println("URL: " + url);

        urlScan = new Scanner (url);
        urlScan.useDelimiter("/");

        // Print each part of the url
        while (urlScan.hasNext())
        {
            System.out.println("   " + urlScan.next());
        }
    }
}
Sample Run

URL: www.google.com
    www.google.com

URL: www.linux.org/info/gnu.html
    www.linux.org
    info
    gnu.html

URL: thelyric.com/calendar/
    thelyric.com
    calendar

URL: www.cs.vt.edu/undergraduate/about
    www.cs.vt.edu
    undergraduate
    about

URL: youtube.com/watch?v=EHCrimwRGLs
    youtube.com
    watch?v=EHCrimwRGLs
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:**

  ```java
  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:

  ```java
  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`
import java.util.ArrayList;

public class Beatles {
    public static void main (String[] args) {
        ArrayList<String> band = new ArrayList<String>();
        band.add("Paul");
        band.add("Pete");
        band.add("John");
        band.add("George");
        continue
    }
}
System.out.println (band);
int location = band.indexOf ("Pete");
band.remove (location);

System.out.println (band);
System.out.println ("At index 1: " + band.get(1));
band.add (2, "Ringo");

System.out.println ("Size of the band: " + band.size());
int index = 0;
while (index < band.size())
{
    System.out.println (band.get(index));
    index++;
}
}
System.out.println (band);
int location = band.indexOf ("Pete");
band.remove (location);
System.out.println (band);
System.out.println ("At index 1: " + band.get(1));
band.add (2, "Ringo");
System.out.println ("Size of the band: " + band.size());
int index = 0;
while (index < band.size())
{
    System.out.println (band.get(index));
    index++;
}
}
Why Generics

• A *generic type* is a generic class or interface that is *parameterized over types*
• Stronger type checking
• Elimination of casting

```java
ArrayList list = new ArrayList();
list.add("hello");
String s = (String) list.get(0);

ArrayList<String> list = new ArrayList<String>();
list.add("hello");
String s = list.get(0); // no cast
```

• Enabling programmers to implement generic algorithms.
Example

- Example where we do not use a generic class

```java
public class Box {
    private Object object;

    public void set(Object newObject) {
        object = newObject;
    }

    public Object get() {
        return object;
    }
}
```

- Since its methods accept or return an Object, you are free to pass in whatever you want
- There is no way to verify, at compile time, how the class is used.
A Generic Version

- A *generic class* is defined with the following format:

  ```java
class name<T1, T2, ..., Tn> { /* ... */ }
```

- All occurrences of `Object` are replaced by `T`

- A *type variable* can be any *non-primitive* type you specify: any class type, any interface type, any array type, or even another type variable.

```java
public class Box<T> {
    // T stands for "Type"
    private T t;
    public void set(T tIn) {
        t = tIn;
    }
    public T get() {
        return t;
    }
}
```
Instantiating a Generic Class

• To create a parameterized type of `Box<T>`, you supply an actual type argument for the formal type parameter `T`:

```java
Box<Integer> intBox = new Box<>();
Box<String> strBox = new Box<String>();
```

• If the actual type argument is omitted, you create a **raw type** of `Box<T>`:

```java
Box rawBox = new Box();
```

• `Box` is the **raw type** of the generic type `Box<T>`. 
Assignment

• Raw types show up in legacy code because lots of API classes (such as the Collections classes) were not generic prior to JDK 5.0.

• For backward compatibility, assigning a parameterized type to its raw type is allowed:

```java
Box<String> stringBox = new Box<>();
Box rawBox = stringBox; // OK
```

• But if you assign a raw type to a parameterized type, you get a warning:

```java
Box rawBox = new Box();
// rawBox is a raw type of Box<T>
Box<Integer> intBox = rawBox;
// warning: unchecked conversion
```
Invoking Methods

- You also get a warning if you use a raw type to invoke generic methods defined in the corresponding generic type:

```java
Box<String> stringBox = new Box<>();
Box rawBox = stringBox;
rawBox.set(8);
// warning: unchecked invocation to set(T)
```
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`
import javafx.application.Application;
import javafx.event.ActionEvent;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.layout.FlowPane;
import javafx.stage.Stage;

//****************************************************************************
// RedOrBlue.java       Author: Lewis/Loftus
//                          Demonstrates the use of one handler for multiple buttons.
//****************************************************************************

public class RedOrBlue extends Application {
    private Button redButton, blueButton;
    private FlowPane pane;

    continue
// Presents a GUI with two buttons that control the color of the pane background.

public void start(Stage primaryStage) {
    redButton = new Button("Red!");
    redButton.setOnAction(this::processColorButton);
    blueButton = new Button("Blue!");
    blueButton.setOnAction(this::processColorButton);

    pane = new FlowPane(redButton, blueButton);
    pane.setAlignment(Pos.CENTER);
    pane.setHgap(20);
    pane.setStyle("-fx-background-color: white");

    Scene scene = new Scene(pane, 300, 100);

    primaryStage.setTitle("Red or Blue?");
    primaryStage.setScene(scene);
    primaryStage.show();
}

continue
public void processColorButton(ActionEvent event) {
    if (event.getSource() == redButton)
        pane.setStyle("-fx-background-color: crimson");
    else
        pane.setStyle("-fx-background-color: deepskyblue");
}
```java
public void processColorButton(ActionEvent event) {
    if (event.getSource() == redButton)
        pane.setStyle("-fx-background-color: crimson");
    else
        pane.setStyle("-fx-background-color: deepskyblue");
}
```
Outline

Boolean Expressions
The `if` Statement
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The `ArrayList` Class
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Managing Fonts
Check Boxes and Radio Buttons
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 specified:
  – **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`
```java
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.Group;
import javafx.scene.paint.Color;
import javafx.scene.text.Font;
import javafx.scene.text.FontPosture;
import javafx.scene.text.FontWeight;
import javafx.scene.text.Text;
import javafx.stage.Stage;

//************************************************************************
//
FontDemo.java          Author: Lewis/Loftus
//
//  Demonstrates the creation and use of fonts.
//************************************************************************

public class FontDemo extends Application {

    //---------------------------------------------------------------------
    //  Displays three Text objects using various font styles.
    //---------------------------------------------------------------------
    public void start(Stage primaryStage) {
        Font font1 = new Font("Courier", 36);
        Font font2 = Font.font("Times", FontWeight.BOLD,
                                 FontPosture.ITALIC, 28);
        Font font3 = Font.font("Arial", FontPosture.ITALIC, 14);

        continue
    }
```
continue

Text text1 = new Text(30, 55, "Dream Big");
text1.setFont(font1);
text1.setUnderline(true);

Text text2 = new Text(150, 110, "Know thyself!");
text2.setFont(font2);
text2.setFill(Color.GREEN);

Text text3 = new Text(50, 150, "In theory, there is no difference " +
   "between theory\nand practice, but in practice there is.");
text3.setFont(font3);

Group root = new Group(text1, text2, text3);
Scene scene = new Scene(root, 400, 200, Color.LIGHTCYAN);

primaryStage.setTitle("Font Demo");
primaryStage.setScene(scene);
primaryStage.show();

}
continue

Text text1 = new Text(30, 55, "Dream Big");
text1.setFont(font1);
text1.setUnderline(true);

Text text2 = new Text(150, 110, "Know thyself!");
text2.setFont(font2);
text2.setFill(Color.GREEN);

Text text3 = new Text(50, 150, "In theory, there is no difference between theory and practice, but in practice there is.");
text3.setFont(font3);

Group root = new Group(text1, text2, text3);

Scene scene = new Scene(root, 400, 200, Color.LIGHTCYAN);

primaryStage.setTitle("Font Demo");
primaryStage.setScene(scene);
primaryStage.show();
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)
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
Check Boxes

• A check box is a button that can be toggled on or off

• It is represented by the JavaFX Check Box class

• Checking or unchecking a check box produces an action event

• See StyleOptions.java
• See StyleOptionsPane.java
import javafx.application.Application;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.stage.Stage;

//************************************************************************
// StyleOptions.java  Author: Lewis/Loftus
//
// Demonstrates the use of check boxes.
//************************************************************************

public class StyleOptions extends Application {

    //---
    // Creates and presents the program window.
    //---
    public void start(Stage primaryStage) {
        StyleOptionsPane pane = new StyleOptionsPane();
        pane.setAlignment(Pos.CENTER);
        pane.setStyle("-fx-background-color: skyblue");

        Scene scene = new Scene(pane, 400, 150);

        primaryStage.setTitle("Style Options");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}

import javafx.application.Application;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.stage.Stage;

//************************************************************************
// StyleOptions.java
// Author: Lewis/Loftus
// Demonstrates the use of check boxes.
//************************************************************************
public class StyleOptions extends Application {

    //--------------------------------------------------------------------
    // Creates and presents the program window.
    //--------------------------------------------------------------------
    public void start(Stage primaryStage) {
        StyleOptionsPane pane = new StyleOptionsPane();
        pane.setAlignment(Pos.CENTER);
        pane.setStyle("-fx-background-color: skyblue");
        Scene scene = new Scene(pane, 400, 150);
        primaryStage.setTitle("Style Options");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}
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
import javafx.event.ActionEvent;
import javafx.geometry.Pos;
import javafx.scene.control.CheckBox;
import javafx.scene.layout.HBox;
import javafx.scene.layout.VBox;
import javafx.scene.text.Text;
import javafx.scene.text.Font;
import javafx.scene.text.FontPosture;
import javafx.scene.text.FontWeight;

//************************************************************************
//
//  StyleOptionsPane.java   Author: Lewis/Loftus
//
//  Demonstrates the use of check boxes.
//  ************************************************************************

public class StyleOptionsPane extends VBox
{
    private Text phrase;
    private CheckBox boldCheckBox, italicCheckBox;

    continue
```java
public StyleOptionsPane() {
    phrase = new Text("Say it with style!");
    phrase.setFont(new Font("Helvetica", 36));

    boldCheckBox = new CheckBox("Bold");
    boldCheckBox.setOnAction(this::processCheckBoxAction);

    italicCheckBox = new CheckBox("Italic");
    italicCheckBox.setOnAction(this::processCheckBoxAction);

    HBox options = new HBox(boldCheckBox, italicCheckBox);
    options.setAlignment(Pos.CENTER);
    options.setSpacing(20); // between the check boxes
    setSpacing(20); // between the text and the check boxes
    getChildren().addAll(phrase, options); //because we add components
        //after the creation of the
        //VBox pane
```
public void processCheckBoxAction(ActionEvent event) {
    FontWeight weight = FontWeight.NORMAL;
    FontPosture posture = FontPosture.REGULAR;

    if (boldCheckBox.isSelected())
        weight = FontWeight.BOLD;

    if (italicCheckBox.isSelected())
        posture = FontPosture.ITALIC;

    phrase.setFont(Font.font("Helvetica", weight, posture, 36));
}
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
```java
import javafx.application.Application;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.stage.Stage;

//************************************************************************
// QuoteOptions.java   Author: Lewis/Loftus
//
// Demonstrates the use of radio buttons.
//************************************************************************

public class QuoteOptions extends Application {
    //---
    // Creates and presents the program window.
    //---
    public void start(Stage primaryStage) {
        QuoteOptionsPane pane = new QuoteOptionsPane();
        pane.setAlignment(Pos.CENTER);
        pane.setStyle("-fx-background-color: lightgreen");
        Scene scene = new Scene(pane, 500, 150);
        primaryStage.setTitle("Quote Options");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}
```
import javafx.application.Application;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.stage.Stage;

//************************************************************************
// QuoteOptions.java
// Author: Lewis / Loftus
// Demonstrates the use of radio buttons.
//************************************************************************
public class QuoteOptions extends Application {

    //--------------------------------------------------------------------
    // Creates and presents the program window.
    //--------------------------------------------------------------------
    public void start(Stage primaryStage) {
        QuoteOptionsPane pane = new QuoteOptionsPane();
        pane.setAlignment(Pos.CENTER);
        pane.setStyle("-fx-background-color: lightgreen");
        Scene scene = new Scene(pane, 500, 150);
        primaryStage.setTitle("Quote Options");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}

**Measure twice. Cut once.**

**Take my wife, please.**
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"
import javafx.event.ActionEvent;
import javafx.geometry.Pos;
import javafx.scene.control.RadioButton;
import javafx.scene.control.ToggleGroup;
import javafx.scene.layout.HBox;
import javafx.scene.layout.StackPane;
import javafx.scene.layout.VBox;
import javafx.scene.text.Text;
import javafx.scene.text.Font;

//****************************************************************************
// QuoteOptionsPane.java          Author: Lewis/Loftus
//****************************************************************************
// Demonstrates the use of radio buttons.
//****************************************************************************

public class QuoteOptionsPane extends HBox {
    private Text quote;
    private String philosophyQuote, carpentryQuote, comedyQuote;
    private RadioButton philosophyButton, carpentryButton, comedyButton;

    continue
Sets up this pane with a Text object and radio buttons that determine which phrase is displayed.

```java
public QuoteOptionsPane()
{
    philosophyQuote = "I think, therefore I am.";
    carpentryQuote = "Measure twice. Cut once.";
    comedyQuote = "Take my wife, please.";

    quote = new Text(philosophyQuote);
    quote.setFont(new Font("Helvetica", 24));

    StackPane quotePane = new StackPane(quote);
    quotePane.setPrefSize(300, 100);

    ToggleGroup group = new ToggleGroup();

    philosophyButton = new RadioButton("Philosophy");
    philosophyButton.setSelected(true);
    philosophyButton.setToggleGroup(group);
    philosophyButton.setOnAction(this::processRadioButtonAction);
}
```
carpentryButton = new RadioButton("Carpentry");
carpentryButton.setToggleGroup(group);
carpentryButton.setOnAction(this::processRadioButtonAction);

comedyButton = new RadioButton("Comedy");
comedyButton.setToggleGroup(group);
comedyButton.setOnAction(this::processRadioButtonAction);

VBox options = new VBox(philosophyButton, carpentryButton, comedyButton);
options.setAlignment(Pos.CENTER_LEFT);
options.setSpacing(10);

setSpacing(20);
getChildren().addAll(options, quotePane);
}
public void processRadioButtonAction(ActionEvent event) {
    if (philosophyButton.isSelected())
        quote.setText(philosophyQuote);
    else if (carpentryButton.isSelected())
        quote.setText(carpentryQuote);
    else
        quote.setText(comedyQuote);
}
Summary

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

• What is wrong with the following code fragment? Rewrite it so that it produces correct output.

```java
if (total == MAX)
if (total < sum)
    System.out.println("total == MAX and < sum.");
else
    System.out.println("total is not equal to MAX");
```

• What is wrong with the following code fragment? Will this code compile if it is part of an otherwise valid program? Explain.

```java
if (length = MIN_LENGTH)
    System.out.println("The length is minimal.");
```
Exercise

• What output is produced by the following code fragment?

```java
int limit = 100, num1 = 15, num2 = 40;
if (limit <= limit){
    if (num1 == num2)
        System.out.println("lemon");
    System.out.println("lime");
}
System.out.println("grape");
```

• What output is produced by the following code fragment?

```java
int num = 1, max = 20;
while (num < max) {
    System.out.println(num);
    num += 4;
}
```
Exercise

• Write a method called isAlpha that accepts a character parameter and returns true if that character is either an uppercase or lowercase alphabetic letter.
public boolean isAlpha(char ch) {
    return ((ch >= 'a' && ch <= 'z') ||
            (ch >= 'A' && ch <= 'Z'));
}
Exercises

• Write a method called *maxOfTwo* that accepts two integer parameters and returns the largest of the two.

• Write a method called *larger* that accepts two floating-point parameters (of type double) and returns true if the first parameter is greater than the second, and false otherwise.
Solution

```java
public int maxOfTwo(int num1, int num2) {
    int result = num1;
    if (num2 > num1)
        result = num2;
    return result;
}

public boolean larger(double num1, double num2) {
    return (num1 > num2);
}
```
Exercise

• Suppose that the variables $a$, $b$, $c$, and $t$ are all of the same numeric primitive type. Show that the following code reassigns to $a$, $b$, and $c$ their original values but in ascending order:

```java
if (a > b) { t = a; a = b; b = t; }
if (a > c) { t = a; a = c; c = t; }
if (b > c) { t = b; b = c; c = t; }
```
Exercise

• Draw the flowchart of the Euclid’s algorithm for finding the GCD

English-language description

Compute the greatest common divisor of two nonnegative integers p and q as follows: If q is 0, the answer is p. If not, divide p by q and take the remainder r. The answer is the greatest common divisor of q and r.

Java-language description

```java
public static int gcd(int p, int q)
{
    if (q == 0) return p;
    int r = p % q;
    return gcd(q, r);
}
```

Euclid’s algorithm
Start gcd(p,q)

q == 0

false

r = p % q

result = gcd(q, r)

true

result = p

return result

End gcd(p,q)
Start \( \text{gcd}(p,q) \)

1. \( \text{temp} = q \)
2. \( q = p \mod q \)
3. \( p = \text{temp} \)

\( q = 0 \):

- False:
  - \( q = 0 \)
  - \( \text{result} = p \)

- True:
  - Return \( \text{result} \)

End \( \text{gcd}(p,q) \)
Exercise

• Write a Flight class that describes a flight with: a flight number (int); airline (String), a particular type of airplane (String, with possible values: “fast”, “slow” and “average”); an origin (String); a destination (String); a distance (int) and a speed (int)

• Write an appropriate constructor (sets all the instance data). Consider that “fast’ flights have speed 1000km/h, slow 600 km/h and average 800 km/h. Speed is not an input of the constructor.

• Write a method that compute the time of the flight in hours:mins (String) of the flight depending on the distance and the airplane type

• Write a FlightTest class that creates three flights and print their flight times (implement a toString method for the class Flight).
public class Flight {
    private String airline, origin, destination, type;
    private int flightNumber, distance, speed;

    public Flight(String airlineInit, String originInit, String destinationInit, int flightNumberInit, String typeInit, int distanceInit) {
        airline = airlineInit;
        origin = originInit;
        destination = destinationInit;
        flightNumber = flightNumberInit;
        distance = distanceInit;
        type = typeInit;
        if (type.equals("fast"))
            speed = 1000;
        else if (type.equals("slow"))
            speed = 600;
        else
            speed = 800;
    }

    ...
}
public String timeFlight() {
    return "" + distance / speed + ":" + (int)((double)(distance % speed)/speed) * 60;
}

public String toString()
{
    return airline + " " + flightNumber + " -- From: " + origin + 
             ", To: " + destination + " -- Travel Time : " + timeFlight();
}

public class FlightTest {

    public static void main(String[] args) {
        Flight f2 = new Flight("Delta", "Philadelphia", "London", 212, "slow", 5000);
        Flight f3 = new Flight("Continental", "Atlanta", "Chicago", 822, "average", 750);
        System.out.println(f1);
        System.out.println(f2);
        System.out.println(f3);
    }
}