Java Program Statements

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Program Development

- The creation of software involves four basic activities:
  - establishing the requirements
  - creating a design
  - implementing the code
  - testing the implementation
- The development process is much more involved than this, but these are the four basic development activities

Program Development

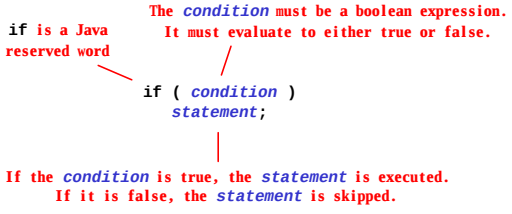
- *Software requirements* specify the tasks a program must accomplish (what to do, not how to do it)
- A *software design* specifies how a program will accomplish its requirements
  - In object-oriented development, the design establishes the classes, objects, methods, and data that are required
- *Implementation* is the process of translating a design into source code
  - Almost all important decisions are made during requirements and design stages
- A program should be executed multiple times with various input in an attempt to find errors
  - *Debugging* is the process of discovering the causes of problems and fixing them

Conditional Statements

- A *conditional statement* lets us choose which statement will be executed next
- Therefore they are sometimes called *selection statements*
- Conditional statements give us the power to make basic decisions
- Java's conditional statements are
  - the *if statement*
  - the *if-else statement*
  - the *switch statement*

The if Statement

- The *if statement* has the following syntax:



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 (=)

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

Example

```
import cs1.Keyboard;

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

      double pay = 0.0;

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

      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;

      System.out.println ("Gross earnings: " + pay);
   }
}
```


Block Statements

- Several statements can be grouped together into a *block statement*
- A block is delimited by braces : { … }
- A block statement can be used wherever a statement is called for by the Java syntax
- For example, in an `if-else` statement, the `if` portion, or the `else` portion, or both, could be block statements

Example

```
import cs1.Keyboard;
import java.util.Random;

public class Guessing
{
   //Plays a simple guessing game with the user.
   public static void main (String[] args)
   {
      final int MAX = 10;
      int answer, guess;

      Random generator = new Random();
      answer = generator.nextInt(MAX) + 1;

      System.out.print ("I'm thinking of a number between 1 and "
                        + MAX + ". Guess what it is: ");
      guess = Keyboard.readInt();

      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);
      }
   }
}
```


Logical Operators

- Boolean expressions can 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 Operators

- Conditions can use logical operators to form complex expressions

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

- Logical operators have precedence relationships among themselves and with other operators
  - all logical operators have lower precedence than the relational or arithmetic operators
  - logical NOT has higher precedence than logical AND and logical OR

Short Circuited Operators

- The processing of logical AND and logical OR 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 must be used carefully

Comparing Strings

- Remember that a character string in Java is an object
- We cannot use the relational operators to compare strings
- The `equals` method can be called with strings to determine if two strings contain exactly the same characters in the same order
- The `String` class also contains a method called `compareTo` to determine if one string comes before another (based on the Unicode character set)

Lexicographic Ordering

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

- We also have to be careful when comparing two floating point values (`float` or `double`) for equality
- You should rarely use the equality operator (==) when comparing two floats
- In many situations, you might consider two floating point numbers to be "close enough" even if they aren't exactly equal
- Therefore, to determine the equality of two floats, you may want to use the following technique:

```
if (Math.abs(f1 - f2) < 0.00001)
   System.out.println ("Essentially equal.");
```


More Operators

- To round out our knowledge of Java operators, let's examine a few more
- In particular, we will examine
  - the increment and decrement operators
  - the assignment operators

Increment and Decrement

- The increment and decrement operators are arithmetic and operate on one operand
- The *increment operator* (++) adds one to its operand
- The *decrement operator* (--) subtracts one from its operand
- The statement

```
count++;
```

  is functionally equivalent to

```
count = count + 1;
```

Increment and Decrement

- The increment and decrement operators can be applied in *prefix form* (before the operand) or *postfix form* (after the operand)
- When used alone in a statement, the prefix and postfix forms are functionally equivalent. That is,

```
count++;
```

is equivalent to

```
++count;
```


Increment and Decrement

- When used in a larger expression, the prefix and postfix forms have different effects
- In both cases the variable is incremented (decremented)
- But the value used in the larger expression depends on the form used:

Expression	Operation	Value Used in Expression
`count++`	add 1	old value
`++count`	add 1	new value
`count--`	subtract 1	old value
`--count`	subtract 1	new value

Assignment Operators

- There are many assignment operators, including the following:

Operator	Example	Equivalent To
`+=`	`x += y`	`x = x + y`
`-=`	`x -= y`	`x = x - y`
`*=`	`x *= y`	`x = x * y`
`/=`	`x /= y`	`x = x / y`
`%=`	`x %= y`	`x = x % y`

Assignment Operators

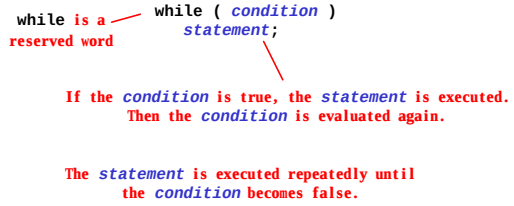
- The behavior of some assignment operators depends on the types of the operands
- If the operands to the += operator are strings, the assignment operator performs string concatenation
- The behavior of an assignment operator (+=) is always consistent with the behavior of the "regular" operator (+)

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:
  - the *while loop*
  - the *do loop*
  - the *for loop*
- The programmer should choose the right kind of loop for the situation

The while Statement

- The *while statement* has the following syntax:



Example

```
//********************************************************
//  Counter.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a while loop.
//********************************************************

public class Counter
{
   //Prints integer values from 1 to a specific limit.
   public static void main (String[] args)
   {
      final int LIMIT = 5;
      int count = 1;

      while (count <= LIMIT)
      {
         System.out.println (count);
         count = count + 1;
      }

      System.out.println ("Done");
   }
}
```


Example

```
import cs1.Keyboard;

public class WinPercentage
{
   //Computes the percentage of games won by a team.
   public static void main (String[] args)
   {
      final int NUM_GAMES = 12;
      int won;
      double ratio;

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

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

      ratio = (double)won / NUM_GAMES;

      System.out.println ();
      System.out.println ("Winning percentage: " + ratio);
   }
}
```

A loop is used to *validate the input*, making the program more *robust*

Infinite Loops

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

Example

```
//********************************************************
//  Forever.java       Author: Lewis/Loftus
//
//  Demonstrates an INFINITE LOOP.  WARNING!!
//********************************************************

public class Forever
{
   //Prints ever decreasing integers in an INFINITE LOOP!
   public static void main (String[] args)
   {
      int count = 1;

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

      System.out.println ("Done"); //this statement never reached
   }
}
```


The do Statement

- The *do statement* has the following syntax:

do and while are reserved words

```
do
{
   statement;
}
while ( condition )
```

The *statement* is executed once initially, and then the *condition* is evaluated

The *statement* is executed repeatedly until the *condition* becomes false

The do Statement

- A `do` loop is similar to a `while` loop, except that the condition is evaluated after the body of the loop is executed
- Therefore the body of a `do` loop will execute at least once

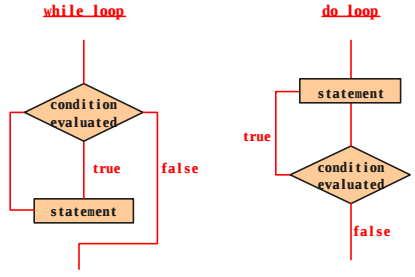
Example

```
//********************************************************
//  Counter2.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a do loop.
//********************************************************

public class Counter2
{
   //Prints integer values from 1 to a specific limit.
   public static void main (String[] args)
   {
      final int LIMIT = 5;
      int count = 0;

      do
      {
         count = count + 1;
         System.out.println (count);
      }
      while (count < LIMIT);

      System.out.println ("Done");
   }
}
```


Example

```
import cs1.Keyboard;

public class ReverseNumber
{
   //Reverses the digits of an integer mathematically.
   public static void main (String[] args)
   {
      int number, lastDigit, reverse = 0;

      System.out.print ("Enter a positive integer: ");
      number = Keyboard.readInt();

      do
      {
         lastDigit = number % 10;
         reverse = (reverse * 10) + lastDigit;
         number = number / 10;
      }
      while (number > 0);

      System.out.println ("That number reversed is " + reverse);
   }
}
```


Comparing while and do



The for Statement

- The *for statement* has the following syntax:

Reserved word

The *initialization* is executed once before the loop begins

The *statement* is executed until the *condition* becomes false

```
for ( initialization ; condition ; increment )
   statement;
```

The *increment* portion is executed at the end of each iteration

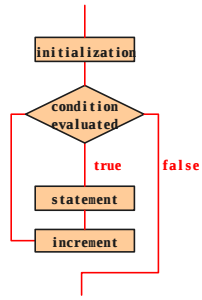
The *condition-statement-increment* cycle is executed repeatedly

The for Statement

- A `for` loop is functionally equivalent to the following `while` loop structure:

```
initialization;
while ( condition )
{
   statement;
   increment;
}
```


Logic of a for loop



The for Statement

- Like a `while` loop, the condition of a `for` statement is tested prior to executing the loop body
- Therefore, the body of a `for` loop will execute zero or more times
- It is well suited for executing a loop a specific number of times that can be determined in advance

Example

```
//********************************************************************
//  Counter3.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a for loop.
//********************************************************************

public class Counter3
{
   //-----------------------------------------------------------------
   //  Prints integer values from 1 to a specific limit.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      final int LIMIT = 5;

      for (int count=1; count <= LIMIT; count++)
         System.out.println (count);

      System.out.println ("Done");
   }
}
```


Example

```
import cs1.Keyboard;

public class Multiples
{
   //  Prints multiples of a user-specified number up to a user-
   //  specified limit.
   public static void main (String[] args)
   {
      final int PER_LINE = 5;
      int value, limit, mult, count = 0;

      System.out.print ("Enter a positive value: ");
      value = Keyboard.readInt();

      System.out.print ("Enter an upper limit: ");
      limit = Keyboard.readInt();

      System.out.println ();
      System.out.println ("The multiples of " + value + " between " +
                          value + " and " + limit + " (inclusive) are:");

      for (mult = value; mult <= limit; mult += value)
      {
         System.out.print (mult + "\t");

         // Print a specific number of values per line of output
         count++;
         if (count % PER_LINE == 0)
            System.out.println();
      }
   }
}
```


Example

```
//********************************************************************
//  Stars.java       Author: Lewis/Loftus
//
//  Demonstrates the use of nested for loops.
//********************************************************************

public class Stars
{
   //-----------------------------------------------------------------
   //  Prints a triangle shape using asterisk (star) characters.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      final int MAX_ROWS = 10;

      for (int row = 1; row <= MAX_ROWS; row++)
      {
         for (int star = 1; star <= row; star++)
            System.out.print ("*");

         System.out.println();
      }
   }
}
```


The for Statement

- Each expression in the header of a for loop is optional
  - If the *`initialization`* is left out, no initialization is performed
  - If the *`condition`* is left out, it is always considered to be true, and therefore creates an infinite loop
  - If the *`increment`* is left out, no increment operation is performed
- Both semi-colons are always required in the `for` loop header

Choosing a Loop Structure

- When you can't determine how many times you want to execute the loop body, use a `while` statement or a `do` statement
  - If it might be zero or more times, use a `while` statement
  - If it will be at least once, use a `do` statement
- If you can determine how many times you want to execute the loop body, use a `for` statement