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

Requirements

- *Software requirements* specify the tasks a program must accomplish (what to do, not how to do it)
- They often include a description of the user interface
- An initial set of requirements often are provided, but usually must be critiqued, modified, and expanded
- Often it is difficult to establish detailed, unambiguous, complete requirements
- Careful attention to the requirements can save significant time and expense in the overall project

Design

- A *software design* specifies how a program will accomplish its requirements
- A design includes one or more *algorithms* to accomplish its goal
- An *algorithm* is a step-by-step process for solving a problem
- An algorithm may be expressed in *pseudocode*, which is code-like, but does not necessarily follow any specific syntax
- In object-oriented development, the design establishes the classes, objects, methods, and data that are required

Implementation

- *Implementation* is the process of translating a design into source code
- Most novice programmers think that writing code is the heart of software development, but actually it should be the least creative step
- Almost all important decisions are made during requirements and design stages
- Implementation should focus on coding details, including style guidelines and documentation

Testing

- 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
- Programmers often think erroneously that there is "only one more bug" to fix
- Tests should consider design details as well as overall requirements

Flow of Control

- Unless specified otherwise, the order of statement execution through a method is linear: one statement after the other in sequence
- Some programming statements modify that order, allowing us to:
  - decide whether or not to execute a particular statement, or
  - perform a statement over and over, repetitively
- These decisions are based on a *boolean expression* (also called a *condition*) that evaluates 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
- 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:

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.

The if Statement

- An example of an `if` statement:

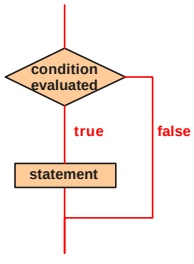
```
if (sum > MAX)
   delta = sum - MAX;
System.out.println ("The sum is " + sum);
```

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 is not, the assignment statement is skipped.

Either way, the call to **println** is executed next.

Logic of an if statement



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*

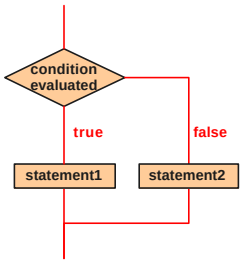
```
if ( condition )
     statement1;
else
     statement2;
```

- 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 java.text.NumberFormat;
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;

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


Logic of an if-else statement



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);
      }
   }
}
```


Nested if Statements

- The statement executed as a result of an `if` statement 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

Example

```
import cs1.Keyboard;

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;

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

      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);
   }
}
```


The switch Statement

- The *switch statement* provides another means to decide which statement to execute next
- The `switch` statement evaluates an expression, then attempts to match the result to one of several possible *cases*
- Each case contains a value and a list of statements
- The flow of control transfers to statement associated with the first value that matches

The switch Statement

- The general syntax of a `switch` statement is:

```
switch ( expression )
{
   case value1 :
      statement-list1
   case value2 :
      statement-list2
   case value3 :
      statement-list3
   case  ...

}
```

switch and case are reserved words

If *expression* matches *value2*, control jumps to here

The switch Statement

- Often a *break statement* is used as the last statement in each case's statement list
- A `break` statement causes control to transfer to the end of the `switch` statement
- If a `break` statement is not used, the flow of control will continue into the next case
- Sometimes this can be appropriate, but usually we want to execute only the statements associated with one case

The switch Statement

- A `switch` statement can have an optional *default case*
- The default case has no associated value and simply uses the reserved word `default`
- If the default case is present, control will transfer to it if no other case value matches
- Though the default case can be positioned anywhere in the switch, usually it is placed at the end
- If there is no default case, and no other value matches, control falls through to the statement after the switch

The switch Statement

- The expression of a `switch` statement must result in an *integral type*, meaning an `int` or a `char`
- It cannot be a `boolean` value, a floating point value (`float` or `double`), a `byte`, a `short`, or a `long`
- The implicit boolean condition in a `switch` statement is equality - it tries to match the expression with a value
- You cannot perform relational checks with a `switch` statement

Example

```
import cs1.Keyboard;

public class GradeReport
{
   //-----------------------------------------------------------------
   //  Reads a grade from the user and prints comments accordingly.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      int grade, category;

      System.out.print ("Enter a numeric grade (0 to 100): ");
      grade = Keyboard.readInt();

      category = grade / 10;

      System.out.print ("That grade is ");

      switch (category)
      {
         case 10:
            System.out.println ("a perfect score. Well done.");
            break;
         case 9:
            System.out.println ("well above average. Excellent.");
            break;
         case 8:
            System.out.println ("above average. Nice job.");
            break;
         case 7:
            System.out.println ("average.");
            break;
         case 6:
            System.out.println ("below average. You should see the");
            System.out.println ("instructor to clarify the material "
                               + "presented in class.");
            break;
         default:
            System.out.println ("not passing.");
      }
   }
}
```


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 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 *truth tables*

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

Truth Tables

- A truth table shows the 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	a || b
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

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

Truth Tables

- 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

Comparing Characters

- We can use the relational operators on character data
- The results are based on the Unicode character set
- The following condition is true because the character + comes before the character J in the Unicode character set:

```
if ('+' < 'J')
   System.out.println ("+ is less than J");
```

- The uppercase alphabet (A-Z) followed by the lowercase alphabet (a-z) appear in alphabetical order in the Unicode character set

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
  - the conditional operator

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

Increment and Decrement

- If `count` currently contains 45, then the statement

```
total = count++;
```

  assigns 45 to `total` and 46 to `count`
- If `count` currently contains 45, then the statement

```
total = ++count;
```

  assigns the value 46 to both `total` and `count`

Assignment Operators

- Often we perform an operation on a variable, and then store the result back into that variable
- Java provides *assignment operators* to simplify that process
- For example, the statement

```
num += count;
```

  is equivalent to

```
num = num + count;
```

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 right hand side of an assignment operator can be a complex expression
- The entire right-hand expression is evaluated first, then the result is combined with the original variable
- Therefore

```
result /= (total-MIN) % num;
```

is equivalent to

```
result = result / ((total-MIN) % num);
```


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 (+)

The Conditional Operator

- Java has a *conditional operator* that evaluates a boolean condition that determines which of two other expressions is evaluated
- The result of the chosen expression is the result of the entire conditional operator
- Its syntax is:
  condition ? *expression1* : *expression2*
- If the *condition* is true, *expression1* is evaluated; if it is false, *expression2* is evaluated

The Conditional Operator

- The conditional operator is similar to an `if-else` statement, except that it forms an expression that returns a value
- For example:

```
larger = ((num1 > num2) ? num1 : num2);
```

- If `num1` is greater that `num2`, then `num1` is assigned to `larger`; otherwise, `num2` is assigned to `larger`
- The conditional operator is *ternary* because it requires three operands

The Conditional Operator

- Another example:

```
System.out.println("Your change is " + count +
    ((count == 1) ? "Dime" : "Dimes"));
```

- If `count` equals 1, then `"Dime"` is printed
- If `count` is anything other than 1, then `"Dimes"` is printed

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:

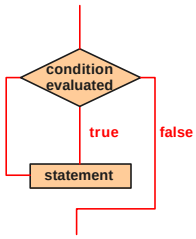
`while` is a reserved word

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

If the *condition* is true, the *statement* is executed.
Then the *condition* is evaluated again.

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

Logic of a while Loop



The while Statement

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

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

A *sentinel value* indicates the end of the input
The variable sum maintains a *running sum*

```
import java.text.DecimalFormat;
import cs1.Keyboard;

public class Average
{
   //-----------------------------------------------------------------
   //  Computes 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;

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

      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 = Keyboard.readInt();
      }

      System.out.println ();
      System.out.println ("Number of values entered: " + count);

      average = (double)sum / count;

      DecimalFormat fmt = new DecimalFormat ("0.###");
      System.out.println ("The average is " + fmt.format(average));
   }
}
```

Example

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

```
import java.text.NumberFormat;
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;

      NumberFormat fmt = NumberFormat.getPercentInstance();

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


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 is never reached
   }
}
```


Nested Loops

- Similar to nested `if` statements, loops can be nested as well
- That is, the body of a loop can contain another loop
- Each time through the outer loop, the inner loop goes through its full set of iterations

Example

```
import cs1.Keyboard;

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

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

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

         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 = Keyboard.readString();
      }
   }
}
```


The StringTokenizer Class

- The elements that comprise a string are referred to as *tokens*
- The process of extracting these elements is called *tokenizing*
- Characters that separate one token from another are called *delimiters*
- The `StringTokenizer` class, which is defined in the `java.util` package, is used to separate a string into tokens

The StringTokenizer Class

- The default delimiters are space, tab, carriage return, and the new line characters
- The `nextToken` method returns the next token (substring) from the string
- The `hasMoreTokens` returns a boolean indicating if there are more tokens to process

Example

```
import csi.Keyboard;
import java.util.StringTokenizer;

public class CountWords
{
   //-----------------------------------------------------------------
   //  Reads several lines of text, counting the number of words
   //  and the number of non-space characters.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      int wordCount = 0, characterCount = 0;
      String line, word;
      StringTokenizer tokenizer;

      System.out.println ("Please enter text (type DONE to quit):");

      line = Keyboard.readString();
      while (!line.equals("DONE"))
      {
         tokenizer = new StringTokenizer (line);
         while (tokenizer.hasMoreTokens())
         {
            word = tokenizer.nextToken();
            wordCount++;
            characterCount += word.length();
         }
         line = Keyboard.readString();
      }

      System.out.println ("Number of words: " + wordCount);
      System.out.println ("Number of characters: " + characterCount);
   }
}
```


The do Statement

- The *do statement* has the following syntax:

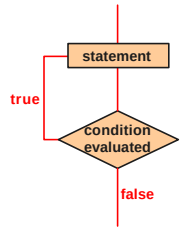
do and **while** are reserved words

```
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

Logic of a do Loop



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

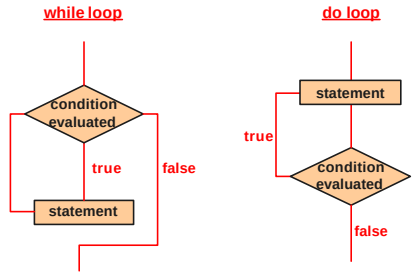
Example

```
//********************************************************************
//  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

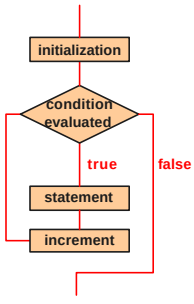
The *condition-statement-increment* cycle is executed repeatedly

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

Program Development

- We now have several additional statements and operators at our disposal
- Following proper development steps is important
- Suppose you were given some initial requirements:
  - accept a series of test scores
  - compute the average test score
  - determine the highest and lowest test scores
  - display the average, highest, and lowest test scores

Program Development

- Requirements Analysis – clarify and flesh out specific requirements
  - How much data will there be?
  - How should data be accepted?
  - Is there a specific output format required?
- After conferring with the client, we determine:
  - the program must process an arbitrary number of test scores
  - the program should accept input interactively
  - the average should be presented to two decimal places
- The process of requirements analysis may take a long time

Program Development

- Design – determine a possible general solution
  - Input strategy? (Sentinel value?)
  - Calculations needed?
- An initial algorithm might be expressed in pseudocode
- Multiple versions of the solution might be needed to refine it
- Alternatives to the solution should be carefully considered

Program Development

- Implementation – translate the design into source code
- Make sure to follow coding and style guidelines
- Implementation should be integrated with compiling and testing your solution
- This process mirrors a more complex development model we'll eventually need to develop more complex software
- The result is a final implementation

Example

```
import java.text.DecimalFormat;
import cs1.Keyboard;

public class ExamGrades
{
   public static void main (String[] args )
   {
      int grade, count = 0, sum = 0, max, min;
      double average;

      //  Get the first grade and give max and min that initial value
      System.out.print ("Enter the first grade (-1 to quit): ");
      grade = Keyboard.readInt ();

      max = min = grade;

      //  Read and process the rest of the grades
      while (grade >= 0)
      {
         count++;
         sum += grade;

         if (grade > max)
            max = grade;
         else
            if (grade < min)
               min = grade;

         System.out.print ("Enter the next grade (-1 to quit): ");
         grade = Keyboard.readInt ();
      }

      //  Produce the final results
      if (count == 0)
         System.out.println ("No valid grades were entered.");
      else
      {
         DecimalFormat fmt = new DecimalFormat ("0.##");
         average = (double)sum / count;
         System.out.println ();
         System.out.println ("Total number of students: " + count);
         System.out.println ("Average grade: " + fmt.format(average));
         System.out.println ("Highest grade: " + max);
         System.out.println ("Lowest grade: " + min);
      }
   }
}
```


Program Development

- Testing – attempt to find errors that may exist in your programmed solution
- Compare your code to the design and resolve any discrepancies
- Determine test cases that will stress the limits and boundaries of your solution
- Carefully retest after finding and fixing an error