Chapter 3: Program Statements

Presentation slides for

Java Software Solutions

Foundations of Program Design

Second Edition

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Program Statements

- **We will now examine some other program statements**

- **Chapter 3 focuses on:**
  - **the flow of control through a method**
  - **decision-making statements**
  - **operators for making complex decisions**
  - **repetition statements**
  - **software development stages**
  - **more drawing techniques**

Flow of Control

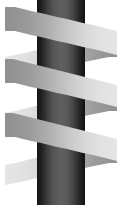
- **Unless indicated otherwise, the order of statement execution through a method is linear: one after the other in the order they are written**

- **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**

- **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*, and 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);
```

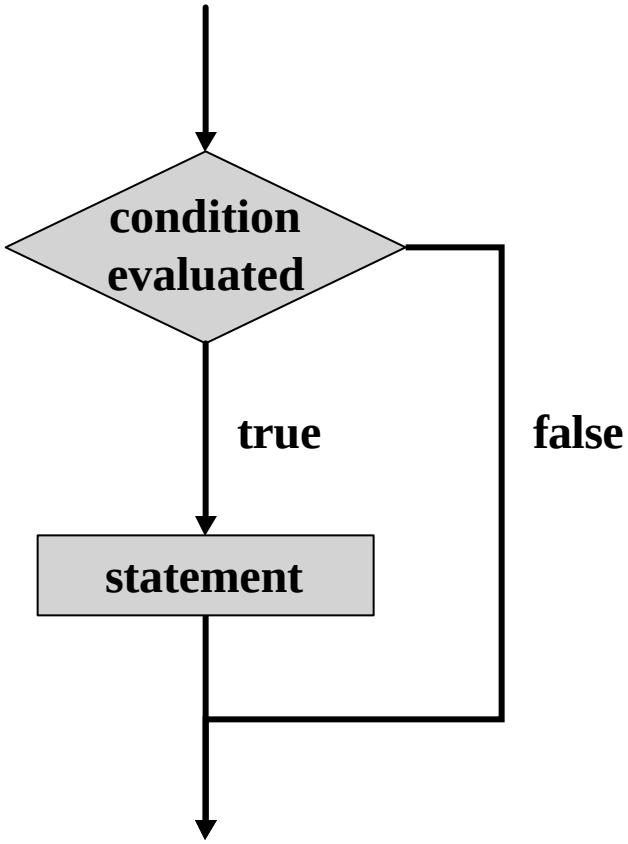
First, the condition is evaluated. The value of `sum` is either greater than the value of `MAX`, or it is not.

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.

- **See Age.java (page 112)**

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 (=)**

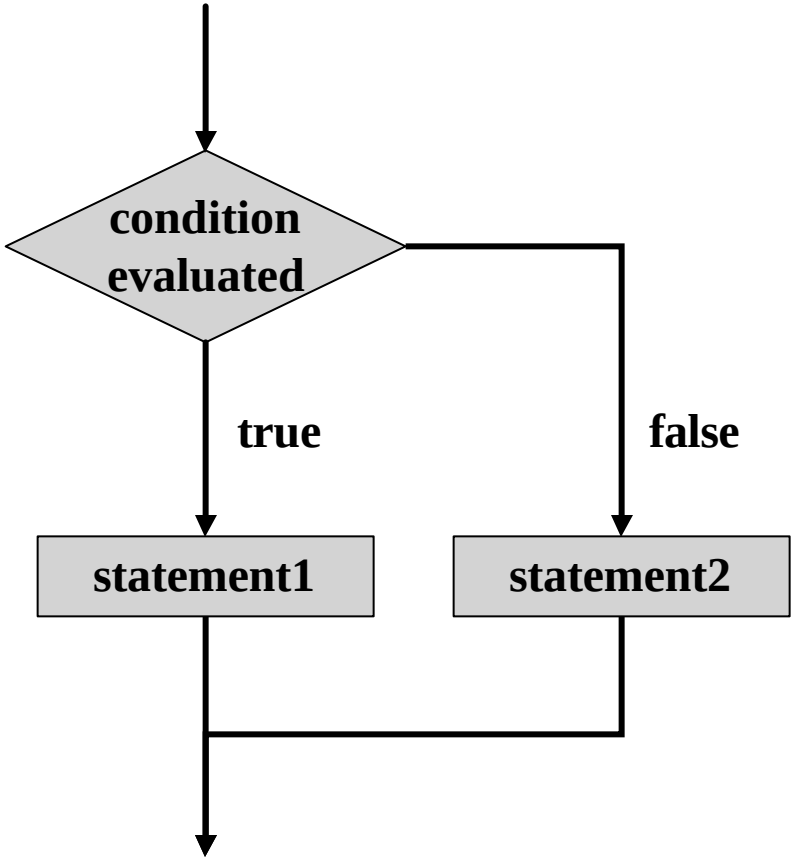
The if-else Statement

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

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

- **If the condition is true, statement1 is executed; if the condition is false, statement2 is executed**
- **One or the other will be executed, but not both**
- **See Wages.java (page 116)**

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 in the Java syntax**
- **For example, in an if-else statement, the if portion, or the else portion, or both, could be block statements**
- **See Guessing.java (page 117)**

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***
- **See MinOfThree.java (page 118)**
- **An else clause is matched to the last unmatched if (no matter what the indentation implies)**

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 Unicode:**

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

- **The uppercase alphabet (A-Z) and the lowercase alphabet (a-z) both appear in alphabetical order in Unicode**

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 on a string 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 alphabetically (as determined by the Unicode character set)**

Comparing Floating Point 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.");
```

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 list associated with the first value that matches**

The switch Statement

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

switch and case are reserved words

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

}
```

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 helpful, but usually we only want to execute 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, it is usually 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 data type*, like an integer or character; it cannot be a floating point value**
- **Note that 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**
- **See GradeReport.java (page 121)**

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 has one operand), but logical AND and logical OR are binary operators (they each have 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 true and false**

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 in selection statements and loops can use logical operators to form complex expressions**

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

- **Logical operators have precedence relationships between themselves and other operators**

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

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**
  - **assignment operators**
  - **conditional operator**

Increment and Decrement Operators

- **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 essentially equivalent to

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

Increment and Decrement Operators

- **The increment and decrement operators can be applied in *prefix form* (before the variable) or *postfix form* (after the variable)**

- **When used alone in a statement, the prefix and postfix forms are basically equivalent. That is,**

```
count++;
```

is equivalent to

```
++count;
```

Increment and Decrement Operators

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

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

Increment and Decrement Operators

- If `count` currently contains 45, then

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

  assigns 45 to `total` and 46 to `count`

- If `count` currently contains 45, then

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

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

Assignment Operators

- **Often we perform an operation on a variable, 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 complete 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);
```

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 is 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*, meaning that 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 repetitively**
- **They are often simply 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*, and the *for loop***
- **The programmer must choose the right kind of loop for the situation**

The while Statement

- **The *while statement* has the following syntax:**

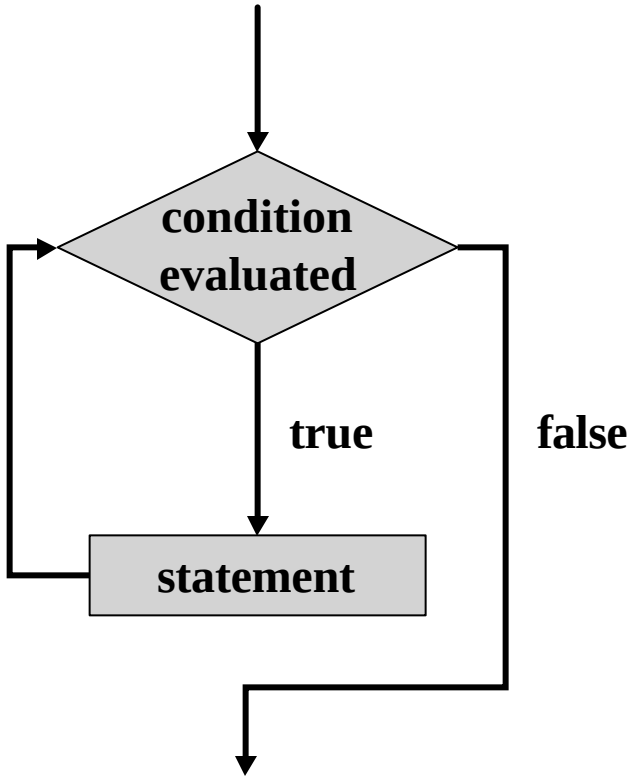
`while` **is a reserved word**

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

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

The statement is executed repetitively 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**
- **See Counter.java (page 133)**
- **See Average.java (page 134)**
- **See WinPercentage.java (page 136)**

Infinite Loops

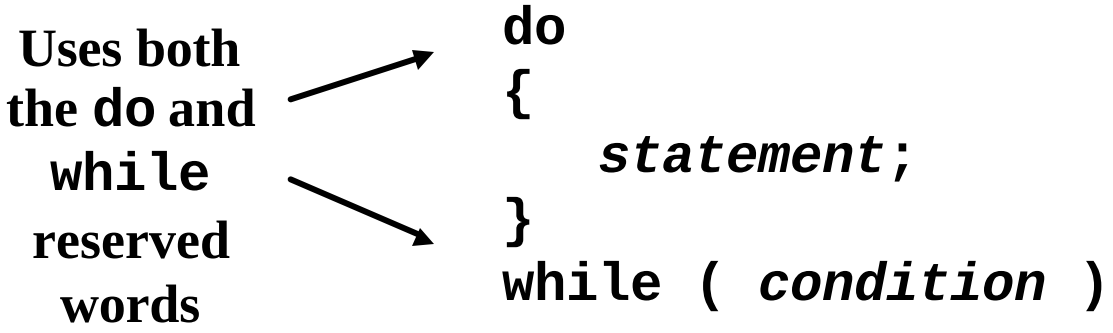
- **The body of a while loop must eventually make the condition false**
- **If not, it is an *infinite loop*, which will execute until the user interrupts the program**
- **See Forever.java (page 138)**
- **This is a common type of logical error**
- **You should always double check to ensure that your loops will terminate normally**

Nested Loops

- **Similar to nested if statements, loops can be nested as well**
- **That is, the body of a loop could contain another loop**
- **Each time through the outer loop, the inner loop will go through its entire set of iterations**
- **See PalindromeTester.java (page 137)**

The do Statement

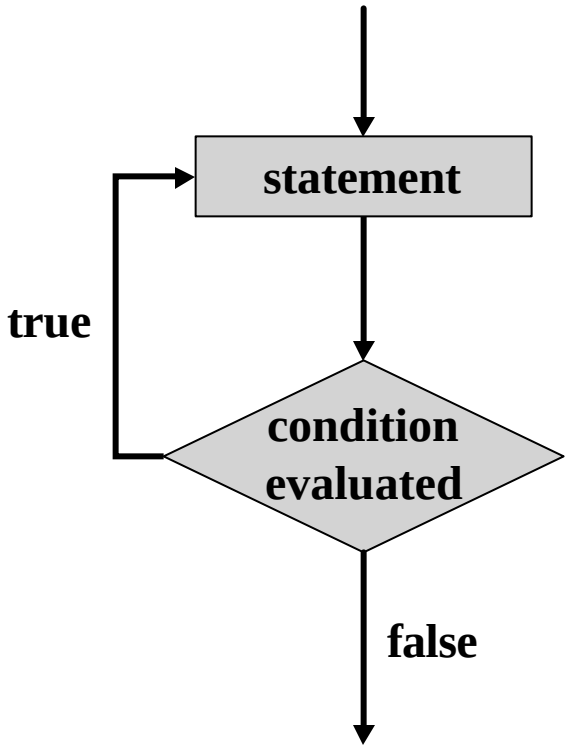
- **The *do statement* has the following syntax:**



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

The statement is repetitively executed until the condition becomes false

Logic of a do loop

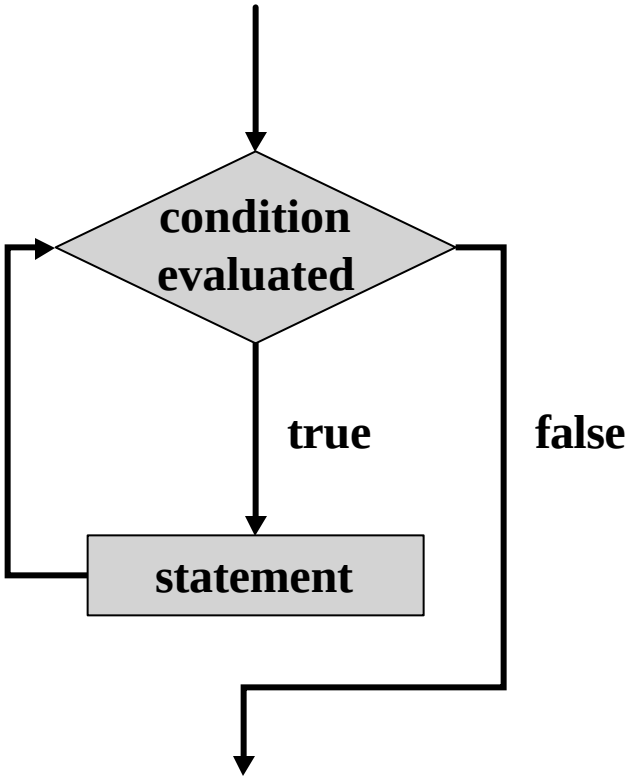


The do Statement

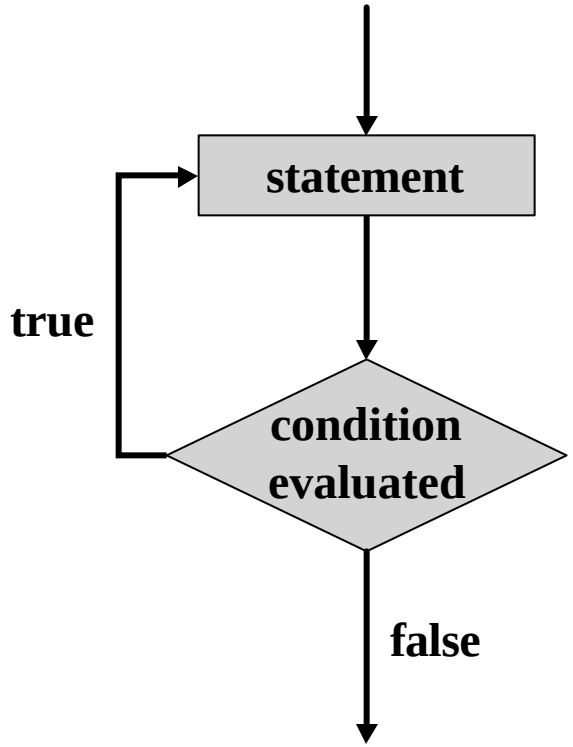
- **A do loop is similar to a while loop, except that the condition is evaluated after the body of the loop is executed**
- **Therefore the body of a do loop will execute at least one time**
- **See Counter2.java (page 143)**
- **See ReverseNumber.java (page 144)**

Comparing the while and do loops

while loop

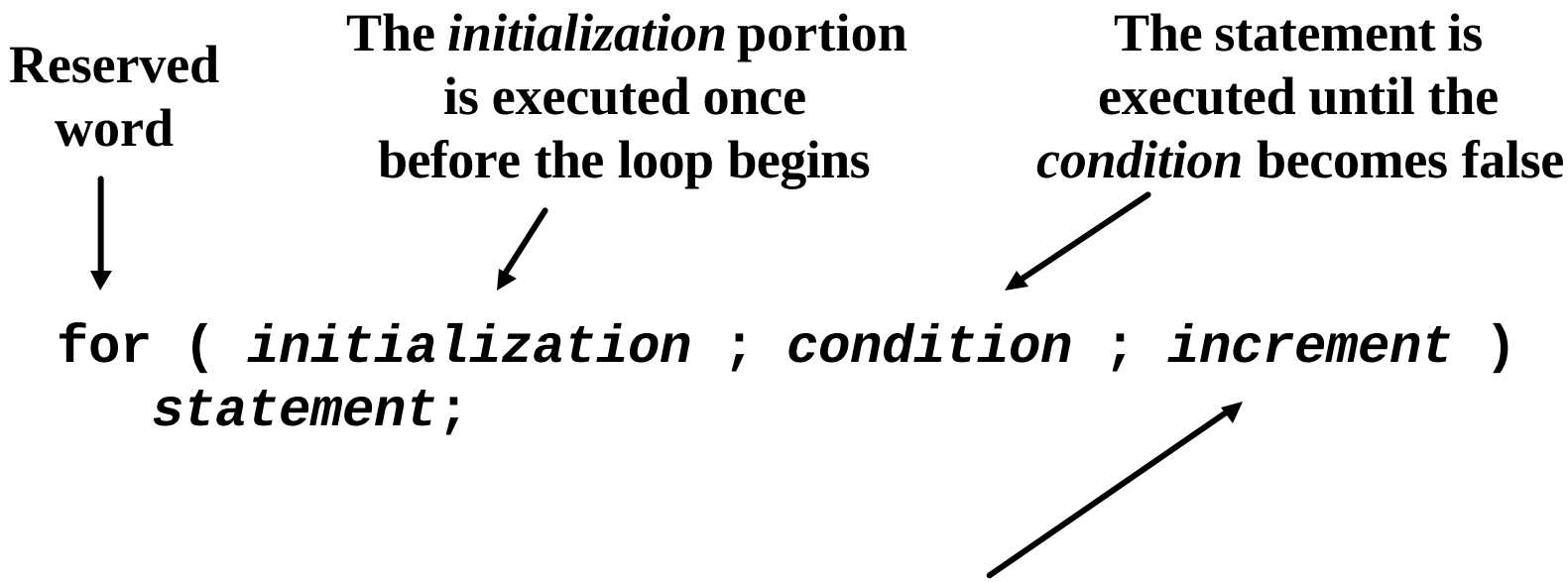


do loop



The for Statement

- **The *for statement* has the following syntax:**

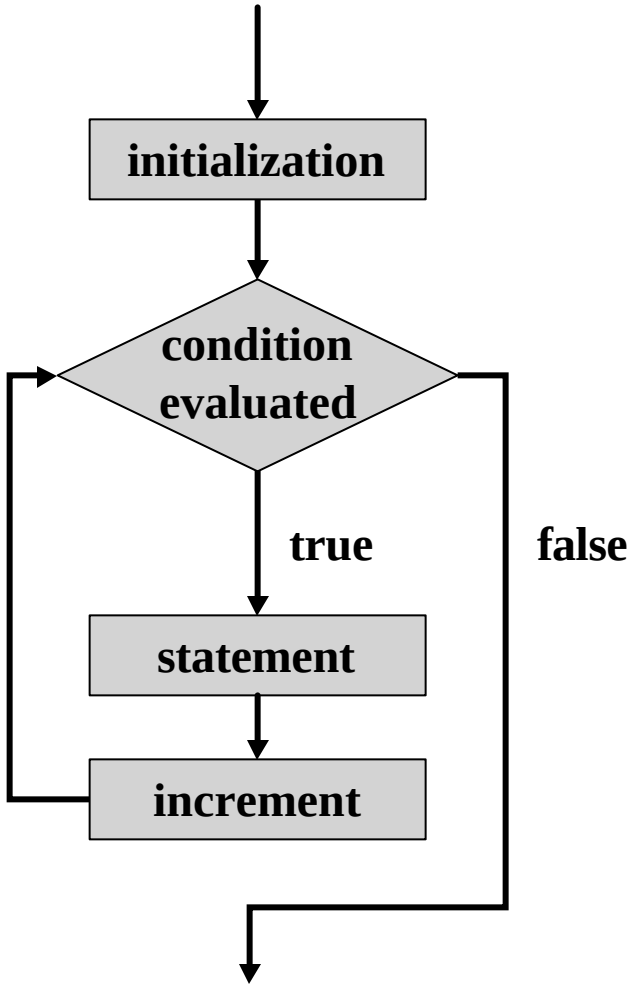


The for Statement

- **A for loop is 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 specific number of times that can be determined in advance**

- **See Counter3.java (page 146)**

- **See Multiples.java (page 147)**

- **See Stars.java (page 150)**

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**

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 basic steps are a good starting point**

Requirements

- ***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 are often provided, but usually must be critiqued, modified, and expanded**
- **It is often difficult to establish detailed, unambiguous, complete requirements**
- **Careful attention to the requirements can save significant time and money in the overall project**

Design

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

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 it actually should be the least creative step**
- **Almost all important decisions are made during requirements analysis and design**
- **Implementation should focus on coding details, including style guidelines and documentation**

- **See ExamGrades.java (page 155)**

Testing

- **A program should be executed multiple times with various input in an attempt to find errors**
- ***Debugging* is the process of discovering the cause of a problem and fixing it**
- **Programmers often erroneously think that there is "only one more bug" to fix**
- **Tests should focus on design details as well as overall requirements**

More Drawing Techniques

- **Conditionals and loops can greatly enhance our ability to control graphics**
- **See Bullseye.java (page 157)**
- **See Boxes.java (page 159)**
- **See BarHeights.java (page 162)**