Last time

We covered:

- primitive data types
- declaration, initialization, assignment of variables
- expressions and operator precedence
- data conversions
- accepting input from the user

Review: Primitive Data Types

Of the following types, which one cannot store a numeric value?

A) int

B) byte

C) float

D) char

E) all of these can store numeric values

Review: Primitive Data Types

Of the following types, which one cannot store a numeric value?

A) int

B) byte

C) float

D) char

E) all of these can store numeric values

Correct Mistakes

- // The following program has several errors
- Fix these errors

```
public class CorrectMe
    public static main(String[] args) {
        System.out.println(Hello world);
        system.out.Pritnln("Do you like this program"?);
        System.out. println()

        System.println("I wrote it myself.";
    {
}
```

See [CorrectMe.java]

Review: What is the result of these?

```
int z = 5 / 2;
float z = 5 / 2;
double z = 5 / 2;
```

Review: Remainder

- The remainder operator (%) returns the remainder after dividing the first operand by the second

`14 % 3`	equals	2
`8 % 12`	equals	8

What do the following expressions evaluate to?

3.0 / 2.0 + 4.1

"hi" + (1 + 1) + "u“

12 / 5 + 8 / 4

42 % 5 + 16 % 3

"cs“ + 2 + 6

2 + 6 + "cs"

Review of Type Casting

- See `Char.java`

Conditionals and Loops

- Now we will examine programming statements that allow us to:
  - make decisions
  - repeat processing steps in a loop

Outline

Boolean Expressions

The `if` Statement

The Conditional Operator (`?  :`)

The `switch` Statement

Flow of Control

- The order of statement execution is called the *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

Conditional Statements

- A *conditional statement* lets us choose which statement will be executed next
- The Java conditional statements are the:
  - if and if-else statement
  - switch statement

Boolean expression

- Boolean expression is just a *test for a condition*
  - Eventually, evaluates to true or false

Value comparisons

- 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 (=)

Relational Operators

- Note that these relational operators are for comparing primitive data types only.
- char values are compared according to their positions in the UNICODE table
- You can only use == or != for boolean data type
- Since computations may generate a round-off error in 15th decimal place in a double value, use

```
    Math.abs(calculated-expected) <=1E-15
```

  Instead of

```
    calculated == expected
```

- See BoolTest.java

Logical Operators

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

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

- They all take boolean operands and produce boolean results

Logical NOT

- The *logical NOT* operation is also called *logical negation* or *logical complement*
- If some boolean condition `a` is true, then `!a` is false; if `a` is false, then `!a` is true
- Logical expressions can be shown using a *truth table*:

`a`	`!a`
true	false
false	true

Logical AND and Logical OR

- 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`	`a || b`
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

Logical Operators

- Expressions that use logical operators can form complex conditions

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

- All logical operators have lower precedence than the relational operators

- The `!` operator has higher precedence than `&&` and `||`

Boolean Expressions

- Specific expressions can be evaluated using truth tables

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

Short-Circuit Evaluations

- The processing of `&&` and `||` is "short-circuited"
- Stop evaluating the boolean expression as soon as we know the answer
- Consider:

```
   boolean flag = true, p;

   p = 5 > 3 || flag;
```

The second test, flag, is not evaluated at all

A useful example

- If the left operand is sufficient to determine the result, the right operand is not evaluated

```
    p = (count != 0) && (total/count > MAX)
```

Outline

Boolean Expressions

➡ The `if` Statement

The Conditional Operator (`?  :`)

The `switch` Statement

The if Statement

```
 if ( condition ){
     statements;
 }


if ( condition )   // can omit braces
   statement;      // if there is one statement
```

The if Statement

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

`if` is a Java reserved word

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

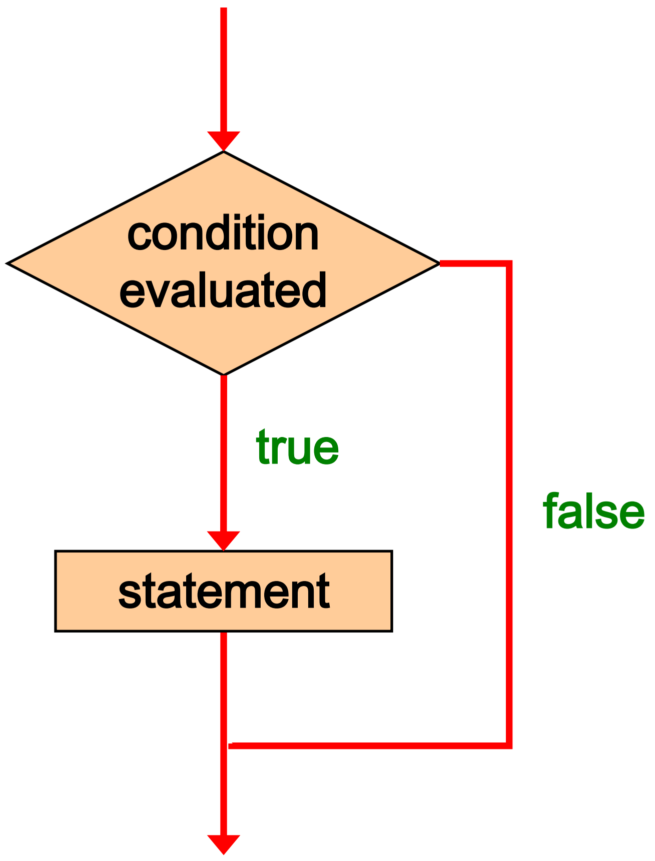
```
if ( condition )
   statement;
```

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

If statement

```
if((num % 2) == 0 ){
    System.out.println ( “num is 
even”);
}
```

Logic of an if statement



Indentation

- The statement controlled by the `if` statement is indented to indicate that relationship

- The use of a consistent indentation style makes a program easier to read and understand

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

-- Martin Golding

Quick Check

What do the following statements do?

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

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

Quick Check

What do the following statements do?

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

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

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

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

If Statement

- See `Age.java`

```java
//********************************************************************
//  Age.java       Author: Lewis/Loftus
//
//  Demonstrates the use of an if statement.
//********************************************************************

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

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.");
   }
}
```

Sample Run

```
Enter your age: 47
You entered: 47
Age is a state of mind.
```

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.");
   }
}
```

Another Sample Run

```
Enter your age: 12
You entered: 12
Youth is a wonderful thing. Enjoy.
Age is a state of mind.
```

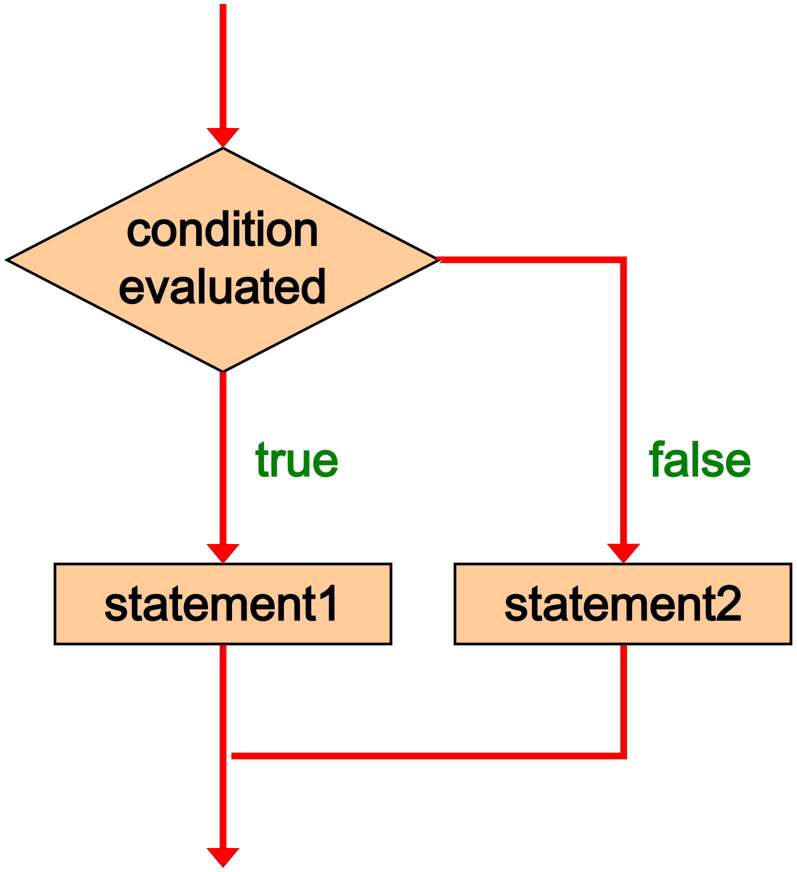
The if-else Statement

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

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

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

Logic of an if-else statement



```
//********************************************************************
//  Wages.java       Author: Lewis/Loftus
//
//  Demonstrates the use of an if-else statement.
//********************************************************************

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;

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

continue

```
      System.(
      int hou

      System.(

      // 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)
   }
}
```

Sample Run

```
Enter the number of hours worked: 46

Gross earnings: $404.25
```

```
 ");
```

If statement

```
  if ((num % 2) == 0 )
  {
       System.out.println ( “num is
even”);
   }
  else
  {
     System.out.println ( “num is odd”);
  }
```

NOTICE

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

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

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

Block Statements

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

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

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

Block Statements

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

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

- See `Guessing.java`

```
//********************************************************************
//  Guessing.java       Author: Lewis/Loftus
//  Modified by Oznur Tastan
//  Demonstrates the use of a block statement in an if-else.
//********************************************************************

import java.util.*;

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

      answer = 9;
      Scanner scan = new Scanner (System.in);
```

continue

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
```

```
         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*

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

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

- See `MinOfThree.java`

```
//********************************************************************
//  MinOfThree.java       Author: Lewis/Loftus
//
//  Demonstrates the use of nested if statements.
//********************************************************************

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
            min = num3;
      else
         if (num2 < num3)
            min = num2;
         else
            min = num3;

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

continue

```
      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
```

Finding the minimum of 3 integers

- Do we really need a nested if statement to find the minimum of 3 integer numbers?
- The answer is no, see MinOfThree2.java

```
// Assume num1 is the minimum
    min = num1;

// Test if num2 is less than min, and update min if necessary
    if (num2 < min)
            min = num2;

// Test if num3 is less than min, and update min if necessary
    if (num3 < min)
            min = num3;
```

Question

Write a Java program to input the overall grade of a student and output his/her letter grade according to the criteria below:

90-100	A
80-89	B
70-79	C
60-69	D
0-59	F

Solution

- ComputeLetterGrade1.java uses if-statement only
- ComputeLetterGrade2.java uses nested-if
- ComputeLetterGrade3.java uses switch (NEXT TOPIC!)

Outline

Boolean Expressions

The `if` Statement

➡ The Conditional Operator (`?  :`)

The `switch` Statement

Conditional Operator (? :)

- Conditional operator is also known as the ternary operator. Another name is arithmetic if. This operator consists of three operands and is used to evaluate boolean expressions. The goal of the operator is to decide which value should be assigned to the variable. The operator is written as :
- (expression) ? value if true : value if false

Conditional Operator (? :) Example

- Test.java

```
public class Test {

   public static void main(String args[]){
      int a , b;
      a = 10;
      b = (a == 1) ? 20: 30;
      System.out.println( "Value of b is : " +  b );

      b = (a == 10) ? 20: 30;
      System.out.println( "Value of b is : " + b );

      System.out.println ( (a>5) ? a%2 : -a);
   }
}
```

```
public class Test {

   public static void main(Str
      int a , b;
      a = 10;
      b = (a == 1) ? 20: 30;
      System.out.println( "Value of b is : " +  b );

      b = (a == 10) ? 20: 30;
      System.out.println( "Value of b is : " + b );

      System.out.println ( (a>5) ? a%2 : -a);
   }
}
```

Sample Run

```
Value of b is : 30

Value of b is : 20

0
```

Outline

Boolean Expressions

The `if` Statement

The Conditional Operator (`?  :`)

➡ The `switch` Statement

The switch Statement

- The *switch statement* provides another way 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 case 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 may be appropriate, but often we want to execute only the statements associated with one case

The switch Statement

- An example of a switch statement:

```
switch (option)
{
   case 'A':
      aCount++;
      break;
   case 'B':
      bCount++;
      break;
   case 'C':
      cCount++;
      break;
}
```

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

- If there is no default case, and no other value matches, control falls through to the statement after the switch

The switch Statement

- The type of a switch expression must be integers, characters, or enumerated types
- As of Java 7, a switch can also be used with strings
- You cannot use a switch with floating point values
- The implicit boolean condition in a `switch` statement is equality
- You cannot perform relational checks with a `switch` statement
- See [`GradeReport.java`]()

```java
//********************************************************************
//  GradeReport.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a switch statement.
//********************************************************************

import java.util.Scanner;

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

      Scanner scan = new Scanner (System.in);

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

      category = grade / 10;

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

continue

continue

```
      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.");
      }
   }
}
```

continue

Sample Run

```
Enter a numeric grade (0 to 100): 91
That grade is well above average. Excellent.
```

```
      swi
      {
            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.");
      }
   }
}
```