Programming

- For the next ten weeks you will learn basic programming principles
  - There is much more to programming than knowing a programming language
- When programming you need to use a tool, in this case the tool will be a language
  - In this course you will use java to explore programming
  - You ***will*** use other languages to program

Syntax and Semantics

- When using a programming language you must understand both the *syntax* and the *semantics* of the language.
  - Syntax refers to the rules you must follow to form valid statements in the language.
    - The syntax of a language is like English grammar.
  - Semantics describe the meaning of a statement in a language.

Language Translation

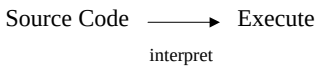
- The only language that a computers understands is machine language
- A program, written in a programming language other than machine language, must be translated into machine language in order for it to run on a computer
- Programs are typically either *compiled* or *interpreted*

Compiling

- When a program is compiled it is converted directly into machine language
  - Sort of like having a book translated from English to German
- The program that does the translation is called a *compiler*

Interpreted Languages

- Another approach is to convert the program to machine language while it is running
- An interpreter translates and immediately executes a program
  - Someone, who understands German, reads the book in German and translates while reading to English



What Is Java

- Java started as a programming language for embedded systems (toasters, microwave ovens, washers, etc.).
  - needed to be portable.
  - had to be reliable.
- The original language was called oak (rumor has it that Gosling has a large oak tree outside the window of his office). Marketing decided Java was a better name.

Sun's Slant

- According to Sun:
  - Java is a simple, object-oriented, distributed, interpreted, robust, secure, architecture neutral, portable, high-performance, multithreaded, and dynamic language
- Java is a lot like C/C++ but there are a number of important differences

Program Structure

- A program in Java consists of one or more class definitions. One of these classes must define a method *main()*, which is where the program starts running

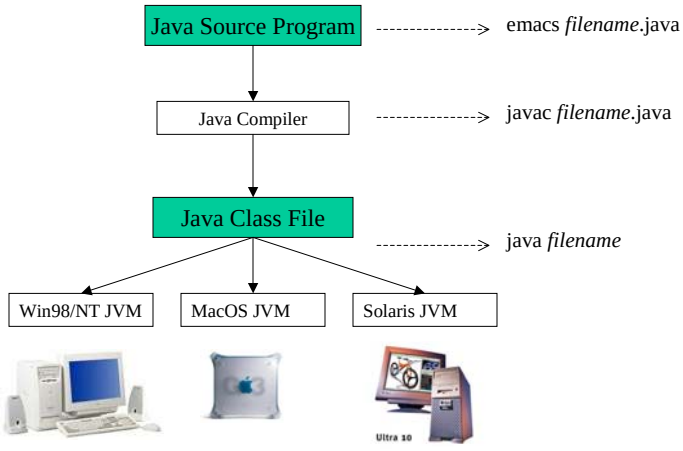
```
// A Java Hello World Program

public class HelloWorld {
  public static void main( String args[] ) {
    System.out.println( "Hello World" );
  }
}
```

How Is Java Different

- Java differs from other *popular* languages:
  - It is interpreted
  - Architecture neutral
  - There are no C/C++ style pointers, only references
  - Garbage collected
  - Comes with a sophisticated class library
  - Includes support for concurrency, networking, and graphics

Executing Java Programs



Java Environments

- There are lots of commercial Java programming environments.
  - IBM's Visual Age.
  - Visual J++.
  - Semantic Café.
  - many others (most of which cost money).
- Sun provides the JDK (Java development Kit) for free.

The JDK

- The JDK consists of the following:
  - The Java development tools, including the compiler, debugger and the Java Interpreter.
  - The Java class libraries organized as a collection of packages.
  - A number of demonstration programs.
  - Various supporting tools and components, including the source code of the classes in the library.
- Get it from `http://www.java.sun.com`.

Java Resources

- Java Home Page
  - http://www.java.sun.com (http://www.javasoft.com)
- The Java Tutorial
  - http://www.java.sun.com/docs/books/tutorial
- Java Developer Connection
  - http://developer.java.sun.com
- The Swing Connection
  - http://java.sun.com/products/jfc/tsc

Other Resources

- RIT Course Pages
  - http://www.cs.rit.edu/~cs1
  - http://www.cs.rit.edu/~cs2
  - http://www.cs.rit.edu/~cs3
- NT-EMACS
  - http://www.cs.washington.edu/homes/voelker/ntemacs.html
- JDE
  - http://sunsite.auc.dk/jde/

Applications and Applets

- Java programs come in two forms:
  - Applications.
  - Applets.
- Applets typically are downloaded into a browser and are run by the Java Virtual Machine that is part of the browser.
  - Usually are restricted as to what they can do.
- Applications are standalone programs that can do just about anything.

Basic Java Syntax

- The Java language will be described by working through its features:
  - variable types and expressions.
  - selection and iteration.
  - classes.
  - exceptions.
- Small sample programs will be provided to illustrate how each feature is used.

Applications and Applets

- Java programs come in two forms:
  - Applications.
  - Applets.
- Applets typically are downloaded into a browser and are run by the Java Virtual Machine that is part of the browser.
  - Usually are restricted as to what they can do.
- Applications are standalone programs.

Things & Stuff

- Any program that you will write will manipulate *things*
  - Numbers
  - Strings
  - Objects
  - …
- We need to be able to refer to these sorts of items in a program

Identifiers

- Identifiers are used in a programming language to refer to things
  - You can think of an identifier as a shortcut to a memory location somewhere in the computer
- Declarations in a program introduce identifiers and the type of thing they will refer to
- All identifiers must be declared before they may be used

Rules

- Identifiers
  - start with an alphabetic character
  - can contain letters, digits, or "_"
  - are unlimited in length
- Examples

```
Answer, total, last_total, relativePosition, gridElement
Person, Place, Stack, Queue
```

Declaring Variables

- The basic syntax for declaring variables is:
  - *typename identifer;*
- It is possible to declare two or more variables of the same type in a single declaration statement.

Categories of Variables

- There are two categories of variables:
  - Variables of primitive type which directly contain a representation of a value of a primitive type.
  - Variables of a reference type which hold a *reference* to an object or the value `null` (which is the null reference).
- All variables must be declared *and* initialized before being used.

Primitive Types

- The primitive types represent the basic, built-in types that are part of the Java language.
- Two basic categories:
  - Boolean - `boolean`.
  - Numeric.
    - Integral - `byte, short, int, long, char`.
    - Floating point - `float, double`.

Primitive Types

Type	*Description*
`boolean`	Has two values, `true` and `false`.
`byte`	8-bit signed 2's complement integers, range: -128 to 127
`short`	16-bit signed 2's complement integers, range: -32768 to 32767
`int`	32-bit signed 2's complement integers, range: -2147483648 to 2147483647
`long`	64-bit signed 2's complement integers, range: -9223372036854775808 to 9223372036854775807
`char`	16-bit unsigned values from 0 to 65535, representing Unicode characters
`float`	Single precision, 32-bit format IEEE 754 floating-point values, range: 1.40239846e-45 to 3.40282347e+38
`double`	Double precision, 64-bit format IEEE 754 floating-point values, range: 4.9406564581246544e-324 to 1.79769313486231570e+308 There are special floating point values: 'positive infinity', 'negative infinity', and 'not a number' (NaN).

Note: these types are platform independent

Unicode

- An International Standard that defines the representation of characters from a wide range of alphabets.
- Unicode stores characters as 16-bit values providing 65,536 different characters.
- ASCII happens to be the first 127 characters in the Unicode standard.
- Java uses Unicode as opposed to ASCII.

Unicode Escapes

- Unicode escapes allow any character to be represented regardless of the editor being used
- A Unicode escape stands for a character and is represented using the `\u` escape sequence followed by the hexadecimal digits of the character code
- Examples:

```
\u0343, \u2f4, \uabcd
```

Literals

Type	*Examples*

Integer	`0, 123, -456, 55665, …`
	`00, 0123, 0777, -045323, …`
	`0x0, 0x125, -0xffed, 0xfff`
	
	Literals of type `long` (64-bit) are denoted by appending `L` or `l` to any integer literal.

Floating point	`1.2345, 1234.423, 0.1, -1.23, …` By default floating point literals are of type `double`. If the literal is suffixed with F or f it will be of type float.
Boolean	`true, false`
Characters	`‘a’, ‘A’, ‘!’, …` `‘\b’, ‘\f’, ‘\n’, ‘\r’, ‘\t’, ‘\\’, ‘\’’`
Strings	`“This is a string”, “Hello World\n”`
Null	`null`

Assignment

- Declarations associates a *type* with an identifier
- Assignment associates a *value* with an identifier
  - Assignment is represented by an = sign
  - An identifier will always be on the left side of the equals sign
  - The computer will place a copy of the thing on the right into the area named by the identifier on the left
- Assignment is ***not*** the same as algebraic equality

Operators

Description	*Syntax*
unary postfix	`[]  .  ()  ++  --`
unary prefix	`++  --  +  -  ~  !`
creation and cast	`new  ( type )`
multiplicative	`*  /  %`
additive	`+  -`
shift	`<<  >>  >>>` (unsigned right shift)
relational	`<  >  >=  <=  instanceof`
equality	`==  !=`
and	`&`
xor	`^`
or	`|`
boolean and	`&&`
boolean or	`||`
conditional	`?:`
assignment	`=  +=  -=  *=  /=  %=  >>=  <<=  >>>=  &=  ^=  |=`

Mixed Mode Expressions

- What happens if an expression contains two different types of numbers?
  - `int a = 4 + 5 * .56;`
- In most cases Java will automatically convert the values in the expression so that it may be evaluated

Automatic Type Conversion

- Java provides a variety of automatic type conversions.
- The following conversions are supported:
  - *Widening primitive conversions.*
    - byte to short, int, long, float, or double.
    - short to int, long, float, or double.
    - int to long, float, or double.
    - long to float or double.
    - float to double.

Manual Type Conversion

- In some situations Java will not perform automatic conversions
  - `int x = 3.1456;`
- In these cases you can force a conversion by specifying a cast
  - `int x = (int)3.1456;`
- Here information is lost, but the assignment will take place

Reference Types

- Reference types are used to declare variables that will *refer* to objects
- The JDK provides a number of classes
  - The `String` class allows us to declare, create, and manipulate strings
- Declaring a string is no different from declaring a primitive type:
  - `String name;`

Creating Objects

- Before a reference to an object may be assigned to a variable, the object must be created
  - Operator `new` is used to create new objects
  - `String name = new String();`
  - `String name =`
    `new String( “Paul Tymann” );`
  - `String name = “Paul Tymann”;`

References

- Variables refer to objects, they do not contain the object
- Several different variables may all refer to the same object
- If an object is not referred to by any variables, the object will eventually be destroyed

Methods

- A reference to an object can be used to invoke a method of the object
  - The dot (.) operator specifies method invocation
  - String name = “Paul Tymann”;
  - System.out.println(name.substring(6));
- An attempt to invoke a method using a `null` reference is an error

What Methods?

- How do you know what methods are available for a given object?
  - Look at the class definition
  - Look at the documentation for the class
- The JDK provides documentation for its classes using a tool called JavaDoc