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CS/ENGRD 2110
SPRING 2013

Lecture 2: Introduction to Java
http://courses.cs.cornell.edu/cs2110

Java

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- The basic language looks much as you would expect from other languages : if, else, for, while, x= x+1; …
  - Braces { } around blocks of code
  - Functions: as in

```
int areaOfCircle(double r) {
    return Math.PI * r * r;
}
```

- Variable declarations:

```
int k;          (other primitive types: double, char, byte …)
Circle c;                              (where Circle is a class)
double[ ] b;    (b can contain an array of double values)
```

- Exceptions: "thrown" when something bad occurs (like dividing by zero or indexing off the end of an array). There is a way to "catch" such events.

A first surprise

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- In some languages, allocation is "automatic"

```
double[ ] b;
Circle c;
```

- … not in Java. These declarations created two useable variables, but neither is initialized.

- In Java, object creation is explicit:

```
b = new double[100];
c = new Circle(2.7651);
```

Hello World!

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Example of a JavaDoc comment

```
/** A simple program that
 * @author ken
 *
 */
public class myClass {

   /**  void main(String[ ] args):
    * @param args
    */
   public static void main(
      // At this point main is executing.  We'll just print "hello"
      System.out.println("Hello, world!");
   }

}
```

The class is public, meaning that its

This JavaDoc comment says that the

Class System is in package java.lang and doesn't need an import statement, but for other classes we would have been required to put an import statement at the top of the file after the initial comment. Eclipse can sometimes guess what class you had in mind and will offer to insert the needed import statement for you.

prints a string on the console

Hello World!

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```
/** A simple program that prints Hello, world!

 * @author ken
 *
 */
public class myClass {

   /**  void main(String[ ] args):  Starting point for my program
    * @param args                   Command line arguments
    */
   public static void main(String[ ] args) {
      // At this point main is executing.  We'll just print "hello"
      System.out.println("Hello, world!");
   }

}
```

An introduction to Java and objects

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- Some Java features seen in our example:
  - Packages contain classes that contain code
    - Here java.lang is such a package, which is always accessible
    - As noted, normally you need to "import" each package, but not java.lang
  - Variables always have specified "types"
    - For example, parameter arg of main has type String[ ]
    - Use arg.Length is the length of the vector
    - In Java, you are forced to be very precise about what kinds of value each variable can hold

An introduction to Java and objects

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- Some Java features already seen in our example:
  - Packages contain classes
  - Variables have specified "types"
  - A type is a set of values together with operations on them
  - Methods like main and println
    - main is static method of class myClass
    - out is a static variable of class System
    - Method out.println is a method associated with object out.
      - Eclipse knew which methods object out contains because it knows the type of out, which is PrintStream

More things to notice

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- Lots of curly braces
- Indentation reflects program structure
- Eclipse is your helper in code development
  - When you start to type, it guesses what you are trying to do and offers to fill things in
  - Eclipse knows about the methods you can use in the objects you are working with
  - And it can automatically help with things like indentation, although you can override its help

Java won't notice certain mistakes

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- What does this do?

Oops

```
n = 0;
while(n < myVec.Length && myVec[n] >= 0);
      n = n+1;
```

- *... this code is an infinite loop, stuck on the "while" stmt. Java doesn't pay attention to indentation...*

What are "classes"

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- In Java we distinguish between two kinds of variable
  - Variables declared with "primitive" types like **int**, **double**. Notice the lower-case **type names.**
  - Variables that contain a pointer to an object, or might contain **null** if no assignment has been done yet.
- A class defines a new type of object
  - It tells the value of the object, the operations you can do on it, how to initialize a new instance, etc.
  - We use upper-case names for class types

int and Inte...e!

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Variables x and y are of type int, which is a primitive type. x and y each contain one value of type int.

- int x, y;
- x = 77;
- y = x;

Variable name	Value
x	77
y	77

Variables x and y are "references": they can contain a pointer to an object of type Integer, which is a class.

- Integer x, y;
- x = **new** Integer(77);
- y = x;

Variable name	Value
x	Integer@0x74320
y	Integer@0x74320
Integer@0x74320	77

Auto-boxing, unboxing

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- Integer is what we call a "wrapper" class:
  - It is predefined as a class containing an int value field
  - All the normal int operations work, but an instance of Integer is an object, so object operations also work.
  - In contrast, an int is a base type, not an object
- Autoboxing/unboxing
  - In any situation where you need an int, Java will allow an Integer. It automatically "auto-unboxes" the int
  - In a situation where you need an Integer and supply an int, Java will "auto-box" the int by creating an Integer object

What's in x before the new?

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```
Integer x, y;
x = new Integer(77);
```

Java has 4 kinds of variables:
1. Field (of an object)
2. class variable (declared as a field but with the static modifier)
3. parameter of a method
4. local variable – declared within a method body.

- The answer depends on where we declared the variable.
  - If x is a **local** variable, it was undefined before the first value was assigned to it. Trying to access an undefined variable is illegal; your code won't compile
  - If x is a field in a class, its initial value is null
    - Means that x doesn't point to an object instance
    - If you try to reference a component of x (e.g. x.value, you get an *exception* and the program crashes.

Reference variables "point" to objects!

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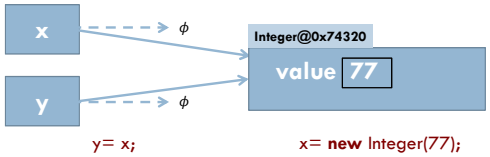

- A reference variable can't point to an object until you assign an object reference to it!
- All objects are created using the new-expression.

Reference variables "point" to objects!

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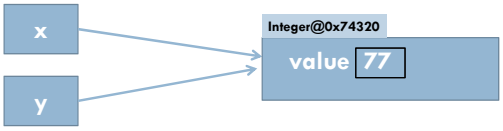

- We ended up with two names for a single object!
- It was created by execution of x = **new** Integer(77);
- y is a second way to reference this same object
- The value 77 lives inside the object, in a field that has primitive type **int**.
- **int** and Integer are not the same!

Classes and object instances

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- A class defines a type of objects.
  - Java predefines some classes, like System and Integer
- Each object has a type, which is the name of the class that was instantiated to create it
- Create an object using the new-expression, as in:

```
Integer x = new Integer(77);
Toy t1 = new myLittlePony("Apple Bloom");
```

What's in an object of a class?

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- An object contains fields
  - These are variables that live within each object
  - Each variable has a type, a name, and an initial value
  - We can control access
    - **private** field: can be accessed only inside the class
    - **public** field: can be accessed from outside the class. Software engineering principle: Make most fields **private**. Reason for the principle will become clear as the course progresses.

What's in an object of a class?

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- An object also contains methods
  - Functions (return values) or procedures (do something but return nothing, indicated by void)
  - There is a way to associate them with operators
    - For example you could define "+" to call "Add"…
  - You can define the same function name multiple times with different parameter types

What's in an object of a class?

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- Every class has a "constructor"
  - A method with the same name as the class
  - Its job is to initialize the class variables
  - If omitted, Java puts in this constructor:

    public class-name() {}

    It has no parameters. It does nothing, but very fast.
  - Expression **new** C(args)
    - 1. Create object of class C somewhere in memory
    - 2. Execute constructor call C(args)
    - 3. Result: a pointer to an intialized "C" object
      - Note: earlier we used the notation C@0x17610 for such pointers

Some slightly fancy things

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- We like "getter" and "setter" methods
  - **public** field: assignments to it could break the logic
  - **private** field: provide public methods to get/set the value of the field and check consistency
- Set/Get methods ensure that invariants are maintained.
  - Suppose class Circle has fields:

    private double radius, circum;
  - Make sure they are non-negative
  - Maintain the invariant circum = 2*pi*radius
  - If the fields were **public**, mistakes might sneak in

Let's create a simple demo program

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- Count the number of lines and characters in the file
- Fancier: could have it count the words, or make a list of words and the number of occurances of each, or even short phrases.
  - We could use this to do cutting edge research, answering questions like: When was "*wrong in so many ways*" first used?

    … 1880!

    books.google.com/ngrams

- We'll use a predefined class FileStream
  - I found it using "Google" but focused on the information from Java.Oracle.com
  - Once I found it, I decided to reuse this existing class rather than try to build one of my own.
  - In CS2110, using prebuilt Java technology is encouraged ***but we limit ourselves to Java.Oracle.com***

(Switch to Eclipse now)

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Ken posted some little videos of him running Eclipse to solve a little sample problem