CS1007: Object Oriented Design and Programming in Java

Lecture #2

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Announcements

- Posted basic background, will continue review in class
- Ta's
  - Ohan Oda
  - Stanley Tzeng
- Check courseworks tomorrow for office hours survey.
  - Let me know asap via email if you have problems logging in.

From Last Class

- Nice mix of background
- Most will be using Lewis & Loftus as background, as soon as I find a copy will post reading pages
- Most everyone has access to their own computer

Unix classes

- Unix review courses offered by CUIT
- Link on webpage, need to sign up

Friday, January 20, 10-12noon, 1pm-3pm

Tuesday, January 24, 5pm-6:45pm

Wednesday, January 25, 5pm-7pm

Friday, January 27, 10-12noon, 1pm-3pm, 3pm-5pm

Tuesday, January 31, 5pm-6:45pm

Outline

- Review of Java basics.
- Writing classes in Java.
- Types
- Object reference vs. Object values

Reading

- Background book on relevant subjects
- Obtain book and start on chapter 1

Status

- Should have plans on acquiring the text
- Should have tested your cunix access
- Should have seen the class website
- Should setup your work machine for
  - Java
  - Editor
  - (eventually) eclipse/netbeans/etc
- Cunix accounts, will be used for homework submissions

Class background

- There is a wide variety of both JAVA and programming skills
- We will do a super fast overview of JAVA basics before starting the meat and potatoes of the course.
- Please bear with me.

Suggestions

- Working outside of CUNIX:
  - Setup correct version of java (1.5)
  - Find comfortable programming environment
  - Save often
  - Don't forget to test on cunix before final submission
- Working on CUNIX
  - Don't telnet
  - Putty: available from acis
  - Work in the labs

IMPORTANT

- CS != Programming
- Java is a tool to teach programming and problem solving concepts
- So if you know everything in Java you still need to stay awake
- Will be introducing many advanced topics along with the background material

Basics I

- Program
- Class
- Methods

Java Program Structure

- In the Java programming language:
  - A program is made up of one or more *classes*
  - A class contains one or more *methods*
  - A method contains program *statements*
- A Java application always contains a method called **`main`**

Java Program

- A Java program contains at least one class definition.

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

- This code defines a class named Hello. The definition of the public class Hello must be in a file Hello.java.
- The main method is the code that runs when you call the java interpreter on the bytecode
  - java Hello
- Advanced: Can have private classes within the same file

Java Program Structure

```
//  comments about the class
public class Hello
{

}
```

class header

class body

Comments can be placed almost anywhere

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Java Program Structure

```
//  comments about the class
public class Hello
{
   //  comments about the method
   public static void main (String[] args)
   {

   }

}
```

method header

method body

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Comments

- Comments in a program are called *inline documentation*
- They should be included to explain the purpose of the program and describe processing steps
- They do not affect how a program works, they are simply ignored.
- Java comments can take three forms:

```
// this comment runs to the end of the line

/*  this comment runs to the terminating
    symbol, even across line breaks        */

/** this is a javadoc comment, will cover later */
```

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Identifiers

- Elements in a program are identified by some name. In Java, identifiers:
  - Always start with a letter.
  - Can include letters, digits, underscore (` ') and the dollar sign symbol ($).
  - Must be different from any Java reserved words (or keywords).
- Often we use special identifiers called reserved words that already have a predefined meaning in the language
  - Keywords that we've seen so far include: **`public`**, **`static`**, **`class`** and **`void`**.

Reserved Words

- The Java reserved words:

```
abstract    else        int         strictfp
boolean     enum        interface   super
break       extends     long        switch
byte        false       native      synchronized
case        final       new         this
catch       finally     null        throw
char        float       package     throws
class       for         private     transient
const       goto        protected   true
continue    if          public      try
default     implements  return      void
do          import      short       volatile
double      instanceof  static      while
```

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Case counts

- Identifiers and keywords in Java are case sensitive. In other words, capitalization matters. Keywords are always in lowercase. The following identifiers are all different:
  - **SHLOMO**
  - **shlomo**
  - **SHlomO**
- Bad idea: use all those in one program.
- WHY?

Spaces

- We use the word whitespace to describe blanks, tabs and newline characters. The Java compiler ignores whitespace except when it is used to separate words. E.g.:

```
y=m*x+b;total=total+y;
```

- Is the same as:

```
y = m*x + b ;
total = total + y ;
```

- Which is easier to read?
- Does anyone know the diffence between DOS and UNIX linebreaks? (hint: fixcrlf)

Types

The values a variable can take on and the operations we can perform on them is determined by its type. Java has the following type categories:

- Booleans
- Characters
- Integers
- Floating Points
- References to Objects

Integers

- The java integer type represents both positive and negative integers. An n-bit integer x, can represent the range:

$$-2^{n-1} \leq x \leq 2^{n-1}$$

- byte 8 bits
  short 16 bits
  int 32 bits
  long 64 bits

Integer Literal

- A integer value or literal can be specified in decimal, hex, or octal (base 8)
  - Decimal is a regular number which doesn't start with zero
  - Hex literals start with 0x…(0x1F = 31 base10)
  - Octal literals start with just zero (072 = 58 base10)
- Integer literals are by default of type int
- A long literal ends with L
- If an int is small enough to fit into a short, it will be automatically converted, else you need to cast. In general extra bits are thrown away (not always good).

Floating Point Type

- Floating point are used to represent the real numbers, i.e. fractional numbers
- 0.345 = 3.45 X 10

Traditional Program Development

- The mechanics of developing a program include several activities
  1. Skip design
  2. writing the program in a specific programming language (such as Java)
  3. translating the program into a form that the computer can execute
  4. investigating and fixing various types of errors that can occur
  5. Go back and design correctly
- Software tools can be used to help with all parts of this process

Development Environments

- There are many programs that support the development of Java software, including:
  - Sun Java Development Kit (JDK)
  - Sun NetBeans
  - IBM Eclipse
  - Borland JBuilder
  - MetroWerks CodeWarrior
  - Monash BlueJ
- Though the details of these environments differ, the basic compilation and execution process is essentially the same

Syntax and Semantics

- The *syntax rules* of a language define how we can put together symbols, reserved words, and identifiers to make a valid program
- The *semantics* of a program statement define what that statement means (its purpose or role in a program)
- A program that is syntactically correct is not necessarily logically (semantically) correct
- A program will always do what we tell it to do, not what we meant to tell it to do

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Errors

- Compile Time
- Run Time
- Logical

Errors

- A program can have three types of errors
- The compiler will find syntax errors and other basic problems (*compile-time errors*)
  - If compile-time errors exist, an executable version of the program is not created
- A problem can occur during program execution, such as trying to divide by zero, which causes a program to terminate abnormally (*run-time errors*)
- A program may run, but produce incorrect results, perhaps using an incorrect formula (*logical errors*)

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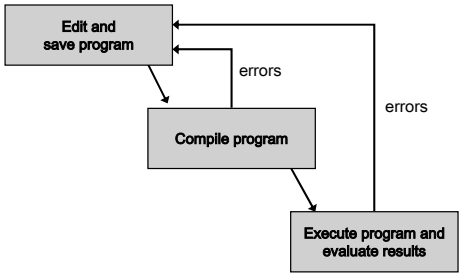
Basic Program Development



Problem Solving

- The purpose of writing a program is to solve a problem
- Solving a problem consists of multiple activities:
  - Understand the problem
  - Design a solution
  - Consider alternatives and refine the solution
  - Implement the solution
  - Test the solution
- These activities are not purely linear – they overlap and interact

Problem Solving

- The key to designing a solution is breaking it down into manageable pieces
- When writing software, we design separate pieces that are responsible for certain parts of the solution
- An *object-oriented approach* lends itself to this kind of solution decomposition
- We will dissect our solutions into pieces called objects and classes

Object-Oriented Programming

- Java is an object-oriented programming language
- As the term implies, an object is a fundamental entity in a Java program
- Objects can be used effectively to represent real-world entities
- We try to define all our data as objects, and define programs to work on those objects
- For instance, an object might represent a particular employee in a company
- Each employee object handles the processing and data management related to that employee

Objects

- An object has:
  - *state* - descriptive characteristics
  - *behaviors* - what it can do (or what can be done to it)
- The state of a bank account includes its current balance
- The behaviors associated with a bank account include the ability to make deposits and withdrawals
- Note that the behavior of an object might change its state

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Reusability

- OOP encourages the design of reusable components
- Vehicle as a general definition
- Mini-van as a more specific object

```
Public class miniVan{
  String manufacturer;
  String model;
  int year;
  Color color;
}
```

Classes

- An object is defined by a *class*
- A class is the blueprint of an object
- The class uses methods to define the behaviors of the object
- The class that contains the main method of a Java program represents the entire program
- A class represents a concept, and an object represents the embodiment of that concept
- Multiple objects can be created from the same class

Instantiating

- Once we define a class we create an instance of the class.
- The constructor method is responsible for initializing the object
- `new` creates an instance

Step by step example

- `String name = new String("test");`
- `name = "example";`
- `name.length();`
- `String s;`
  - `s.length;`

null

- null refers to no object
  - Uninitialized objects
  - Explicit assignment
- Can assign null to object variable:
  - `worldGreeter = null;`
- Can test whether reference is null
  - `if (worldGreeter == null) . . .`
- Dereferencing `null` causes `NullPointerException`

this

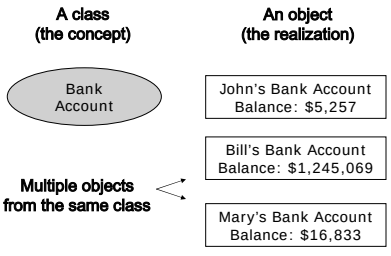
- Refers to implicit parameter of method call
- Example: Equality testing

```
public boolean equals(Greeter other)
{
   if (this == other) return true;
   return name.equals(other.name);
}
```

- Example: Constructor

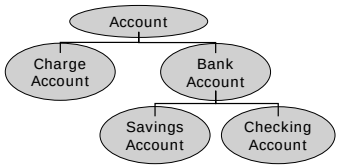
```
public Greeter(String name)
{
   this.name = name;
}
```

Objects and Classes



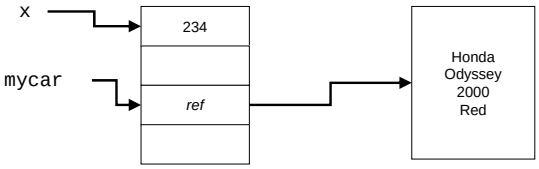
Basic Inheritance

- One class can be used to derive another via *inheritance*
- Classes can be organized into hierarchies



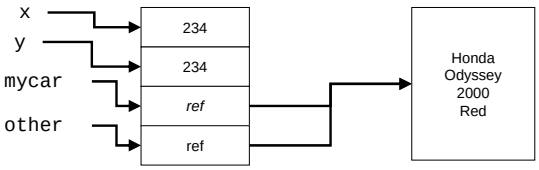
References

- A variable is a location in memory
- int x;
- x= 234;
- miniVan mycar;
- mycar = new miniVan(….)



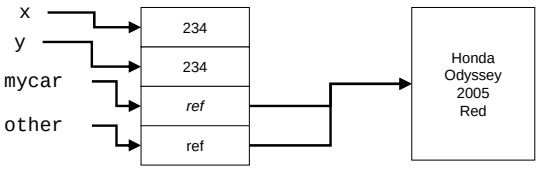
Difference References

- Create new variable y
- int y = x;
- Create another miniVan instance
  miniVan other = mycar;



Difference II

- Other.year = 2005;
- Surprise!



Why?

- Any ideas why we would want to create object using references?

References

- Object variable holds a reference
  - `Greeter worldGreeter = new Greeter("World");`
- Can have multiple references to the same object
  - `Greeter anotherGreeter = worldGreeter;`
- After applying mutator method, all references access modified object
  - `anotherGreeter.setName("Dave");`
  - `worldGreeter.sayHello() //returns "Hello, Dave!"`

Parameter Passing

- Java uses "call by value":
  Method receives copy of parameter value
- Copy of object reference lets method modify object

```
public void copyNameTo(Greeter other)
{
    other.name = this.name;
}
```

```
Greeter worldGreeter = new Greeter("World");
Greeter daveGreeter = new Greeter("Dave");
worldGreeter.copyNameTo(daveGreeter);
```

No reference passing

- No Reference Parameters
- Java has no "call by reference"

```
public void copyLengthTo(int n)
{
    n = name.length();
}

public void copyGreeterTo(Greeter other)
{
 other = new Greeter(name);
}
```

- Neither call has any effect after the method returns

```
int length = 0;
worldGreeter.copyLengthTo(length); // length still 0
worldGreeter.copyGreeterTo(daveGreeter) // daveGreeter unchanged
```

Packages

- Most programs have many class files
- Would like to organize them in some manner
- Example all utilities bundled with java
- java.util……

Java packages

- Collection of similar classes
- Package names are dot-separated identifier sequences

java.util
javax.swing
com.sun.misc
edu.columbia.cs.robotics

- Unique package names: start with reverse domain name
- Corresponds to directory structure
- Must match directory structure
- package statement to top of file
- Class without package name is in "default package"
- Full name of class = package name + class name

java.util.String

Next Class

- More background
  - File handling
  - Streams
  - Hierarchies
- Go online tomorrow and fill in office survey
  - required
- Get up to speed on Java
  - Read old notes
  - Dig out reference text
- Obtain text