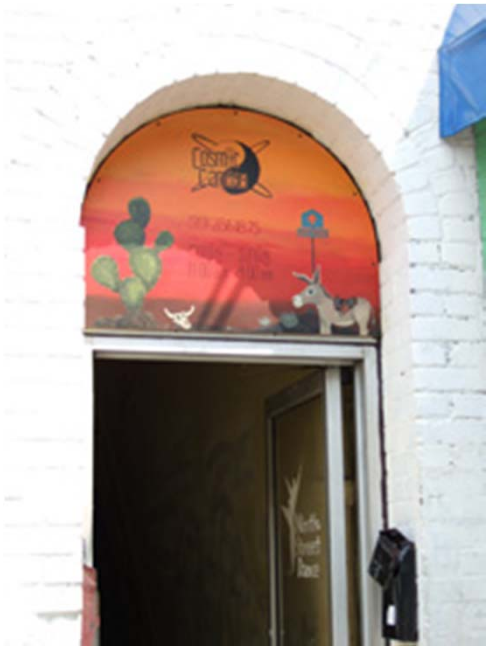
CompSci 100e
Program Design and Analysis II



February 10, 2011

Prof. Rodger

Announcements

- What is due/coming up?
  - Apt due Feb 15
  - Markov Assignment due Feb 17
    - Will look at parts of it in lab
  - Test on Feb 22
- Finish slides from last time

Simple Inheritance

- Allows you to reuse code
- Start with a Class (superclass)
- Create another class that extends the class (subclass)
- The subclass can use the methods from the superclass or override them (use the same name, but the code is different)
- If the subclass redefines a superclass method, can still call the superclass method with the word “super” added.

Access to Instance Variables(state)

- public
  - Any class can access
- private
  - subclasses cannot access
- protected
  - subclasses can access
  - other classes cannot access

Example

- Student (superclass)
- DukeStudent (extends Student)
- CosmicStudent (extends DukeStudent)

- Look at code, what is the output?

More on Inheritance -Abstract Class

- Abstract class – class that is declared abstract
- Cannot be instantiated – cannot create an object for this class
- Another class must extend this class
- May have some methods declared abstract
  - Abstract methods have no bodies
  - Those methods have to be implemented in the class that extends the abstract class
- Example:
  - AbstractModel.java is an abstract class
  - MarkovModel extends AbstractModel

More on Inheritance - Interface

- Class that is declared as an interface
- A group of related methods with empty bodies
- To implement the interface, your class would implement the methods for those named in the interface.
- Example

```
public interface IModel {
    public void initialize(Scanner s);
    public void process(Object o);
}
```

  - AbstractModel Implements IModel

What can an Object do (to itself)?

- http://www.cs.duke.edu/csed/java/jdk1.6/api/index.html
  - Look at java.lang.Object
  - What is this class? What is its purpose?

- `toString()`
  - Used to print (`System.out.println`) an object
  - overriding `toString()` useful in new classes
  - String concatenation: `String s = "value "+ x;`
  - Default is basically a pointer-value

What else can you do to an Object?

- `equals(Object o)`
  - Determines if guts of two objects are the same, must override, e.g., for using `a.indexOf(o)` in ArrayList a
  - Default is ==, pointer equality
- `hashCode()`
  - Hashes object (guts) to value for efficient lookup
- If you're implementing a new class, to play nice with others you *must*
  - Override `equals` and `hashCode`
  - Ensure that equal objects return same `hashCode` value

Objects and values

- Primitive variables are boxes
  - think memory location with value
- Object variables are labels that are put on boxes

```
String s = new String("genome");
String t = new String("genome");
if (s == t) {they label the same box}
if (s.equals(t)) {contents of boxes the same}
```

What's in the boxes? "genome" is in the boxes

Objects, values, classes

- For primitive types: int, char, double, boolean
  - Variables have names and are themselves boxes (metaphorically)
  - Two int variables assigned 17 are equal with ==

- For object types: String, ArrayList, others
  - Variables have names and are labels for boxes
  - If no box assigned, created, then label applied to *null*
  - Can assign label to existing box (via another label)
  - Can create new box using built-in *new*
- Object types are references/pointers/labels to storage