CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Object-Oriented Programming Intro

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Object-Oriented Programming (OOP)

- Approach to improving software
  - View software as a collection of objects (entities)
- Motivated by software engineering concerns
  - To be discussed later in the semester
- OOP takes advantage of two techniques
  - Abstraction
  - Encapsulation

Techniques – Abstraction

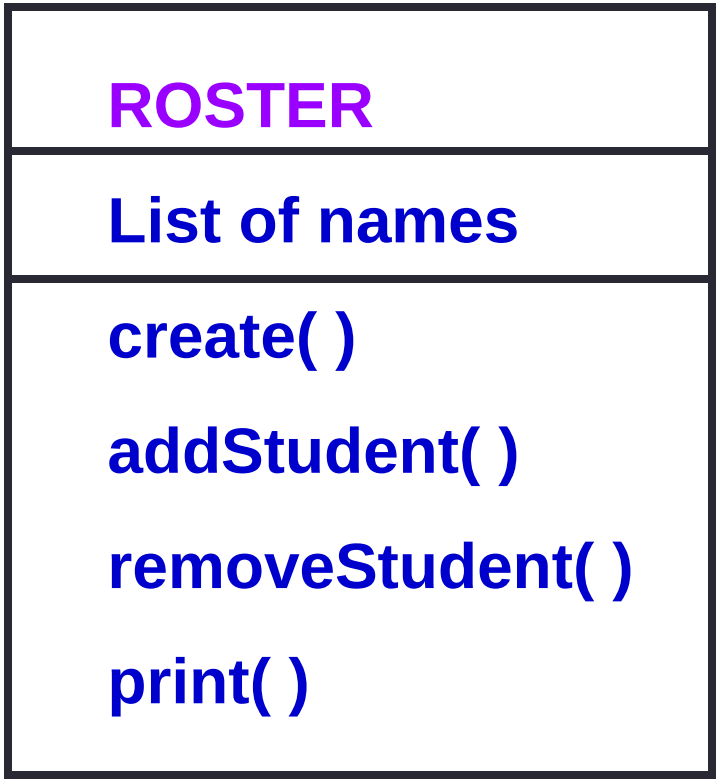
- Abstraction
  - Provide high-level model of activity or data
- Procedural abstraction
  - Specify what actions should be performed
  - Hide algorithms
- Data abstraction
  - Specify data objects for problem
  - Hide representation
- Abstract Data Type
  - Implementation independent interfaces
  - Data and operations on data

Techniques – Encapsulation

- Encapsulation
  - **Definition:** Hiding implementation details while providing an interface (methods) for data access
  - Allow us to use code without having to know its implementation
  - **Simplifies the process of code modification and debugging**

Abstraction & Encapsulation Example

- Abstraction of a Roster
  - Data
    - List of student names
  - Actions
    - Create roster
    - Add student
    - Remove student
    - Print roster
- Encapsulation
  - Only these actions can access names in roster



Java Programming Language

- Language constructs designed to support OOP
  - **Interfaces**
    - Specifies a contract
    - Provides abstract methods (no implementation)
    - Two views
      - Enforcing implementation of methods
      - Defining an IS-A relationship
  - **Class**
    - Implements/defines contract
    - Supports encapsulation of implementation (e.g., via private)
    - Class extending another class
      - Allows new class to inherit everything from original class
      - Defines an IS-A relationship
- Class libraries designed using OOP principles

Object & Class

- **Class**
  - Blueprint for objects (of same type)
  - Exists at compile time
- **Object**
  - Abstracts away (data, algorithms) details
  - Encapsulates data
  - Instance exist at run time

Java Collections Framework

- **Collection**
  - Object that groups multiple elements into one unit
  - Also called container
  - **Example:** ArrayList
- Collection framework consists of
  - Interfaces
  - Implementations

Java Collections Framework

- **Collection** → Java Interface
  - See Java API entry for Collection
    - http://docs.oracle.com/javase/7/docs/api/java/util/Collection.html
  - **Example:** CollectionExample.java
- **Collections** → Class
  - http://docs.oracle.com/javase/7/docs/api/java/util/Collections.html

About Style/Code

- Use Eclipse's "Quick Fix"
- Use Eclipse's source generation tools
  - Not for equals and hashCode methods
- Source→"Organize Imports"
- Source→Format
- About Eclipse Errors/Warnings
  - http://www.cs.umd.edu/eclipse/other.html#errors-warnings

Iterator Interface

- Interface

```
public interface Iterator<E> {
    boolean hasNext( );
    E next( );
    void remove( );
}
```

- Example usage

```
ArrayList<String> L = new ArrayList<String>();
L.add("Mary");
L.add("Pete");
Iterator<String> i = L.iterator();
while (i.hasNext())
        System.out.println(i.next());
```

Enhanced For Loop

- Works for arrays and any class that implements the Iterable interface, including all collections
  - http://docs.oracle.com/javase/7/docs/api/java/lang/Iterable.html
  - Has method iterator( ) returns Iterator<T> object
- For loop handles Iterator automatically
  - Test hasNext( ), then invoke next( )
- /* Iterating over a String array */

```
String[ ] roster = {"John", "Mary", "“Alice", "Mark"};
for (String student : roster)
    System.out.println(student);
```

Enhanced For Loop

```
ArrayList<String> roster = new ArrayList<String>( );
roster.add("John");
roster.add("Mary");
/* Using an iterator */
for (Iterator<String> it = roster.iterator( ); it.hasNext( ); )
        System.out.println(it.next( ));
/* Using for loop */
for (String student : roster)
        System.out.println(student);
```

Generics (Motivating Example)

- Problem
  - Utility classes handle arguments as Objects
  - Objects must be cast back to actual class
  - Casting can only be checked at runtime
- Example

```
class A { … }
class B { … }
List myL = new List();
myL.add(new A());      // Add an object of type A
…
B b = (B) myL.get(0);  // throws runtime exception
                       // java.lang.ClassCastException
```

Solution (Generic Types)

- Generic types
  - Provides abstraction over types
  - Can parameterize classes, interfaces, methods
  - Parameters defined using <X> notation
- Examples
  - public class foo<X, Y, Z> { … }
  - List<String> myNames = ...
- Improves
  - Readability & robustness
- Used in Java Collections Framework

Generics (Usage)

- Using generic types
  - Specify <type parameter> for utility class
  - Automatically performs casts
  - Can check class at compile time
- Example

```
class A { … }
class B { … }
List<A> myL = new List<A>( );
myL.add(new A( ));      // Add an object of type A
A a = myL.get(0);       // myL element ⇒ class A
…
B b = (B) myL.get(0);   // causes compile time error
```

Autoboxing & Unboxing

- Automatically convert primitive data types
  - Data value ⇔ Object (of matching class)
  - Data types & classes converted
    - Boolean, Byte, Double, Short, Integer, Long, Float
- Example

```
ArrayList<Integer> myL = new ArrayList<Integer>();
myL.add(1);   // previously myL.add(new Integer(1));
int y = mL.getFirst();
  //previously int y = mL.getFirst().intValue();
```

- **Example:** SortValues.java