Object-Oriented Programming Intro

Department of Computer Science
University of Maryland, College Park
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](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](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](http://www.cs.umd.edu/eclipse/other.html#errors-warnings)
Iterator Interface

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

• Example usage
  
  ```java
  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](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 */
  ```java
  String[ ] roster = {"John", "Mary", "Alice", "Mark"};
  for (String student : roster)
      System.out.println(student);
  ```
**Enhanced For Loop**

```java
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