CMSC 132: Object-Oriented Programming II

Java Language Constructs

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Review of Java Language Constructs

Basic elements
- Primitive types, variables, constants, operators
- If-else, switch, while, for

Classes
- Object instances
  - Creating objects with new
- Object references
  - The null reference
- Instance data, class (static) data
- Methods
  - Parameters, return values, polymorphism
Review of Java Language Constructs

- **Inheritance**
  - Base class, derived class, super
  - Method overriding (vs. overloading)
  - Abstract methods
  - Up- and down-casting, getClass(), instanceof
    - avoid overuse of these... leads to bad designs

- **Interfaces**

- **1D Arrays**
  - Creating, indexing

- **Exceptions**
  - Try-catch blocks
Java Language Constructs

- Enumerated types
- Autoboxing
- Generics
- Iterator Interface
- Enhanced for loop
Enumerated Types

- New type of variable with set of fixed values
  - Establishes all possible values by listing them
  - Supports values(), valueOf(), name(), compareTo()…
  - Can add fields and methods to enums

Example

```java
public enum Color { Black, White } // new enumeration
Color myC = Color.Black;
for (Color c : Color.values()) System.out.println(c);
```

- When to use enums
  - Natural enumerated types – days of week, phases of the moon, seasons
  - Sets where you know all possible values
Enumerated Types

From "Taming the Tiger" presentation by Joshua Bloch and Neal Gafter at Sun's 2004 Worldwide Java Developer Conference

```java
public class Card implements Serializable {
    public enum Rank { DEUCE, THREE, FOUR, FIVE, SIX,
                        SEVEN, EIGHT, NINE, TEN, JACK, QUEEN, KING, ACE }
    public enum Suit { CLUBS, DIAMONDS, HEARTS, SPADES }
    private final Rank rank;
    private final Suit suit;
    private Card( Rank rank, Suit suit ) {
        this.rank = rank;
        this.suit = suit;
    }
    public Rank rank( ) {
        return rank;
    }
    public Suit suit( ) {
        return suit;
    }
    public String toString( ) {
        return rank + " of " + suit;
    }
}
```
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 $\leftrightarrow$ Object (of matching class)
- Data types & classes converted
  - Boolean, Byte, Double, Short, Integer, Long, Float

Example

```java
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)
Iterator Interface

**Interface**

```java
public interface Iterator {
    boolean hasNext();
    Object next();
    void remove(); // optional, called once per next()
}
```

**Example usage**

```java
Iterator i = myCollection.iterator();
while (i.hasNext()) {
    myCollectionElem x = (myCollectionElem) i.next();
}
```
Enhanced For Loop

- Works for arrays and any class that implements the `Iterable` interface, including all Collections
  - 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

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);
Comparable Interface

Comparable

- public int compareTo(Object o)
- A.compareTo(B) returns
  - Negative if A < B, 0 if A == B, positive if A > B

Properties

- Referred to as the class's natural ordering
- Can sort using Collections.sort( ) & Arrays.sort( )
  - Example: Collections.sort(myList);
- Can use as keys in SortedMap & SortedSet
- Consistency w/ equals( ) strongly recommended
  - x.equals(y) if and only if  x.compareTo(y) == 0

Example (comparableExample)
Comparator Interface

**Comparator**

- **public int compare(Object A, Object B)**
  - Negative if A < B, 0 if A == B, positive if A > B

**Properties**

- Imposes total ordering on objects of a class
- Provide alternatives to natural ordering
- Supports generics
  - Example: `class myC implements Comparator<Foo>{ ... }`

- Use as parameter for sort function
  - Example: `Collections.sort(myFooList, new myC( ));`

**Example** (comparatorExample)
2-D Arrays of Primitives

- Each row in two-dimensional array is an array
- Rows can have different lengths
- Defining a primitive array where rows have the same length
  
  ```java
  int [][] data = new int[3][4];
  ```
- Defining a primitive data array where rows have different lengths (ragged array)
  
  ```java
  int [][] ragged = new int[2][];
  ragged[0] = new int[3];
  ragged[1] = new int[1];
  ```
2-D Arrays of Objects

- Each row in two-dimensional array is an array
- Rows can have different lengths
- Defining an array where rows have the same length

```java
String[][] data = new String[3][4];
```

- Important – Note we have created a 2-D array of references to String objects; no String objects yet exist
- Can also create ragged arrays of objects
- Example (Roster.java)