

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

- **Iterator Interface**
- **Enhanced for loop**
- **Enumerated types**
- **Generics**
- **Autoboxing**
- **Comparable Interface**
- **Comparator Interface**

Iterator Interface

■ Interface

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

■ Example usage

```
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**

- ```
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);
```

# 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

```
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

```
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

```
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)

# 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

```
int [][] data = new int[3][4];
```

- Defining a primitive data array where rows have different lengths (ragged array)

```
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

`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)