

CMSC 132:

OBJECT-ORIENTED PROGRAMMING II



Java Inner Classes

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Announcements

- Midterm on Monday
- There will be lab on Monday as usual
- <http://proquest.safaribooksonline.com/>
- MOOC (Massive Open Online Course)
 - <https://www.coursera.org/>
 - <https://www.udacity.com/>
 - <http://class2go.stanford.edu/>

Overview

- Classes
 - Top-level vs. inner & nested
- Inner classes
 - Iterator example
 - Used inside outer class
- Anonymous inner classes
 - Syntax
 - Uses for GUIs
- Nested classes

Java Classes

- Top level classes
 - Declared inside package
 - Visible throughout package, perhaps further
 - Normally declared in their own file
 - Public classes must be defined in their own file
 - Not required for other classes
- Inner and nested classes
 - Declared inside class (or method)
 - Normally used only in **outer** (enclosing) class
 - Can have wider visibility

Inner / Nested Classes

- Inner class
- Anonymous inner class
- Nested class
- Examples

```
public class MyOuterClass {  
    public class MyInnerClass { ... }  
    Iterator iterator( ) { return new Iterator( ) { ... } } /* anonymous */  
    static public class MyNestedClass { ... } /* nested */  
}
```

Inner Classes

- **Description**

- Class defined in scope of another class
- May be named or anonymous

- **Useful property**

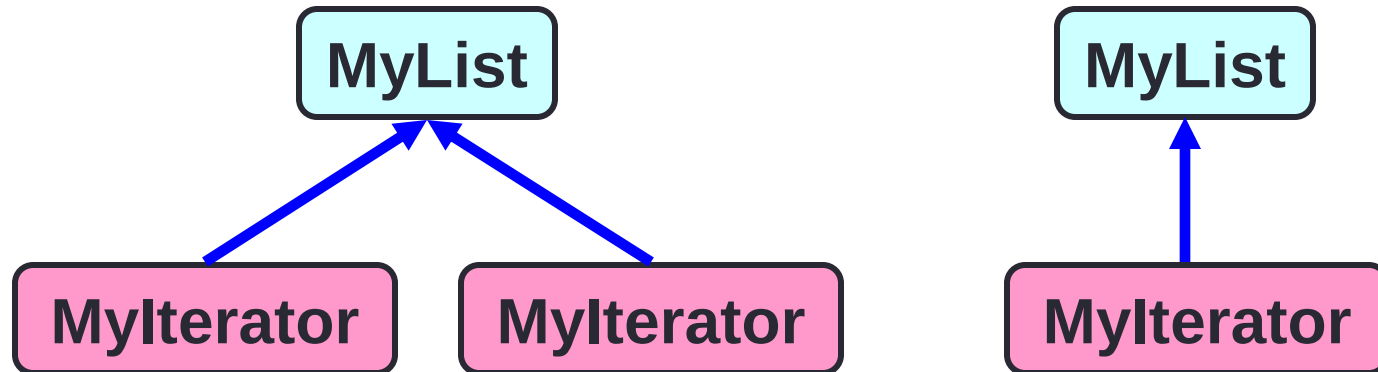
- Outer & inner class **can directly access** each other's fields & methods (even if private)
- Inside methods of outer class, use inner class as any other class
 - `ic = new MyInnerClass()`

- **Example**

```
public class MyOuterClass {  
    private int x;  
    private class MyInnerClass {  
        private int y;  
        void foo( ) { x = 1; } // access private field  
    }  
    void bar( ) {  
        MyInnerClass ic = new MyInnerClass( );  
        ic.y = 2;           // access private field  
    }  
}
```

Inner Class Link To Outer Class

- Inner class **instance**
 - Has association to an instance of outer class
 - Must be instantiated with an enclosing instance
 - Is **tied** to outer class object at moment of creation (can not be changed)



Inner Classes

- Useful for
 - Private helper classes
 - Logical grouping of functionality
 - Data hiding
 - Linkage to outer class
 - Inner class object **tied** to outer class object
- Examples
 - **Iterator** for Java Collections
 - **ActionListener** for Java GUI widgets

Iterator Example

- Team class example

```
public class Team {  
    private Player[] list;  
    private int size;  
    ...  
}
```

- Goal: Implement iterator for the class using inner classes
- We will see different versions

Team Class Example

- **Version 1**
 - No iterator
- **Version 2**
 - Iterator implemented without inner class
 - Illustrates problems of accessing private data of Team class
- **Version 3**
 - Iterator implemented using inner class
- **Version 4**
 - Iterator implemented using inner class with class implementing `Iterable<Player>`
 - Iterable interface defines the method **`iterator<T> iterator()`**
 - Part of `java.lang`
 - Returns an iterator over a set of elements of type `T`
 - Implementing this interface allows an object to be the target of the enhanced for loop "foreach" statement
- **Version 5**
 - Iterator implemented using anonymous inner class with class implementing `Iterable<Player>`
 - Will see this version once we have discussed anonymous inner classes

Method Invocations

- Method invocations on inner class
 - Can be transparently redirected to outer instance
- Resolving method call on unspecified object
 - See if method can be resolved on inner object
 - If not, see if method can be resolved on corresponding instance of outer object
 - If nested multiple levels, keep on looking

Accessing Outer Scope

- Example

```
public class MyOuter {                                // outer class
    int x = 2;
    private class MyInner {                            // inner class
        int x = 6;
        private void getX() {                        // inner class method
            int x = 8;
            System.out.println( x );                  // prints 8
            System.out.println( this.x );              // prints 6
            System.out.println( MyOuter.this.x );      // prints 2
        }
    }
}
```

Anonymous Inner Class

- Description
 - Inner class without name
 - Defined where you create an instance of it
 - In the middle of a method
 - Returns an instance of anonymous inner class
 - Useful if the only thing you want to do with an inner class is create instances of it in one location
- Syntax

```
ReturnType x = new ReturnType( ) {           // unnamed inner class
    body of class...
};
```
- **ReturnType** must be **existing class or interface!!**
 - If class → inner class extends provided class
 - If interface → inner class implements provided interface
- See anonymousClasses package
- See Team Version 5

Nested Class

- Description
 - Similar to inner class, but declared as **static** class
 - No link to an instance of the outer class
 - Can only access static fields & methods of the outer class
 - Useful if inner class object
 - Associated with different outer class objects
 - Survives longer than outer class object

- Example

```
class LinkedList {  
    static class Node { Node next; }  
    Node head;  
}
```

Miscellaneous

- Local variables accessed by inner class method must be declared final

```
public static Runnable task(int x) {  
    final int value = x * 10;  
    Runnable r = new Runnable() {  
        public void run() {  
            for (int i = 1; i <= value; i++) {  
                System.out.println(value + 1);  
            }  
        }  
    };  
    return r;  
}
```

```
public static void main(...) {  
    Runnable r2 = task(10);  
    ...  
}
```