

CMSC 132: Object-Oriented Programming II

Java Inner Classes



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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
- Nested class

```
public class MyOuterClass {  
    public class MyInnerClass { ...  
    }  
  
    static public class MyNestedClass { ...  
    }  
}
```

Inner Classes

■ Description

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

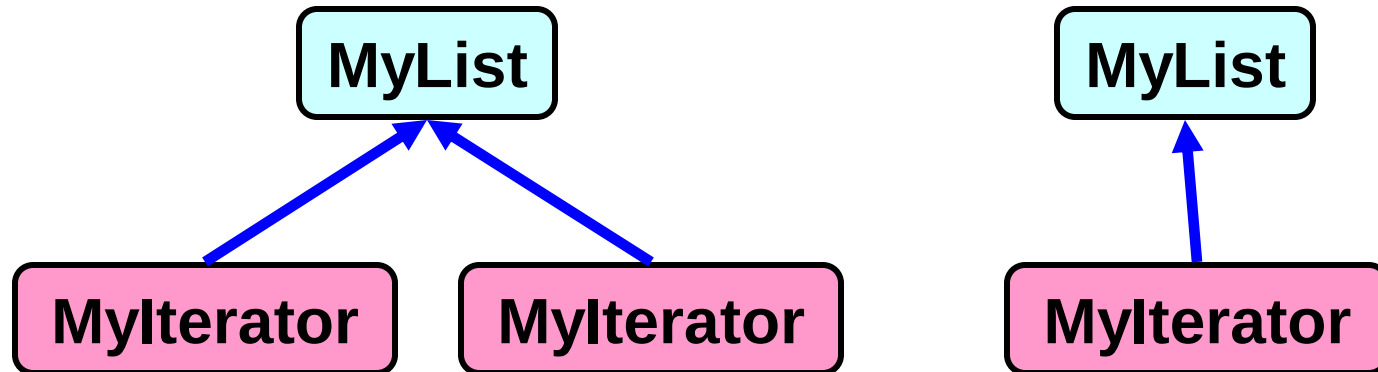
■ Useful property

- Outer & inner class **can directly access** each other's fields & methods (even if private)

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)



Syntax

```
Class Outer {  
    class Inner {  
    }  
    Inner x = new Inner();  
}
```

```
Outer out = new Outer();  
Outer.Inner in = out.new Out.Inner();
```

Using Inner Class *Inside* Outer Class

■ Code

```
public class OC {           // outer class
    private int x = 2;
    private class IC {      // inner class
        private int y = 4;
        private int getSum() { return x + y; }
    }
    void bar( ) {
        IC z = new IC( );   // create new IC assoc. w/ this
        z.getSum( );        // treat z like normal object
    }
}
```

Inner Classes

■ Example

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

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

Iterable Interface

- 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

Iterator Example

■ **MyList**

```
public class MyList {  
    private Object [ ] a;  
    private int size;  
}
```

■ **Want to make MyList implement Iterable**

- **Skipping generic types at the moment**
- **Need to be able to return an Iterator**

(Problematic) Mylterator Design

```
public class Mylterator implements Iterator {  
    private MyList list;  
    private int pos;  
    Mylterator(MyList list) {  
        this.list = list;  
        pos = 0;  
    }  
    public boolean hasNext() {  
        return pos < list.size;  
    }  
    public Object next() {  
        return list.a[pos++];  
    }  
    ...  
}
```

MyIterator Design

■ Problems

- Need to maintain reference to MyList
- Need to access **private** data in MyList

■ Solution

- Define MyIterator as inner class for MyList
 - Instance of MyIterator tied to instance of MyList
 - MyIterator methods can access private MyList fields
- MyIterator objects can iterate through elements of MyList

(Successful) Mylterator Design

■ Code

```
public class MyList implements Iterable {  
    private Object [ ] a;  
    private int size;  
    public Iterator iterator() {  
        return new Mylterator();  
    }  
    public class Mylterator implements Iterator {  
        private int pos = 0;  
        public boolean hasNext() { return pos < size; }  
        public Object next()      { return a[pos++]; }  
        ...  
    }  
}
```

■ Notice that class implements Iterable

Another Example

■ **EXAMPLE: PrimeNumberList**

Accessing Outer Scope

■ Code

```
public class OC {                                // outer class
    int x = 2;
    private class IC {                            // 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( OC.this.x );      // prints 2
        }
    }
}
```

Method Invocations

- **Method invocations on inner class**
 - **Can be transparently redirected to outer instance**

- **Resolving method call on inner object**
 1. **See if method can be resolved on inner object**
 2. **If not, see if method can be resolved on corresponding instance of outer object**
 3. **If nested multiple levels, keep on looking**

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

```
new Type( ) {                // unnamed inner class
    body of class... // implementing Type
};
```

Example Anonymous Inner Classes

■ Use

```
new Foo( ) {  
    public int one() { return 1; }  
    public int add(int x, int y) { return x + y; }  
};
```

- To define an anonymous inner class that
 - Extends class Foo / implements interface Foo
 - Defines methods one & add

Anonymous Inner Class

■ Code

```
public class MyList {  
    public Iterator iterator() {  
        return new Iterator() { // unnamed inner class  
            ... // implementing Iterator  
        };  
    }  
}  
  
MyList m = new MyList();  
Iterator it = m.iterator();
```

MyList With *Explicit* Inner Class

■ Code

```
public class MyList implements Iterable {  
    private Object [ ] a;  
    private int size;  
    public Iterator iterator( ) {  
        return new Mylterator( );  
    }  
    public class Mylterator implements Iterator {  
        private int pos = 0;  
        public boolean hasNext( ) { return pos < size; }  
        public Object next( )      { return a[pos++]; }  
    }  
}
```

MyList With *Anonymous* Inner Class

■ Code

```
public class MyList implements Iterable {  
    private Object [ ] a;  
    private int size;  
    public Iterator iterator( ) {  
        return new Iterator ( ) {  
            private int pos = 0;  
            public boolean hasNext( ) { return pos < size; }  
            public Object next( )      { return a[pos++]; }  
        } ;  
    }  
}
```

Another Example

■ **PrimeNumberList2**

Support For Java GUIs

- **Graphical User Interface (GUI)**
 - **Java AWT & Swing libraries**
- **Event-driven programming model**
 - **Components may generate events**
 - **E.g., `ActionEvent`, `KeyEvent`, `MouseEvent`**
 - **Requires **event listeners** to handle event**
- **Event listeners frequently implemented using anonymous classes**
 - **Used only in one location**
 - **Implements event listener interfaces**

Using Inner Classes in GUIs

```
javax.swing.SwingUtilities.invokeLater(new Runnable() {  
    public void run() {  
        createAndDisplayGUI();  
    }  
});
```

```
button.addActionListener (new ActionListener ( ) {  
    public void actionPerformed (ActionEvent evt) {  
        System.out.println("Button pushed");  
    }  
});
```

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;  
}
```

Summary of Inner / Nested Classes

- **All inner / nested classes**
 - Defined inside another class
 - Can access private members of enclosing class
- **Inner class**
 - Each instance of an inner class is transparently associated with an instance of the outer class
- **Anonymous inner class**
 - Unnamed inner class defined & used in one place
- **Nested class**
 - Defined as static class