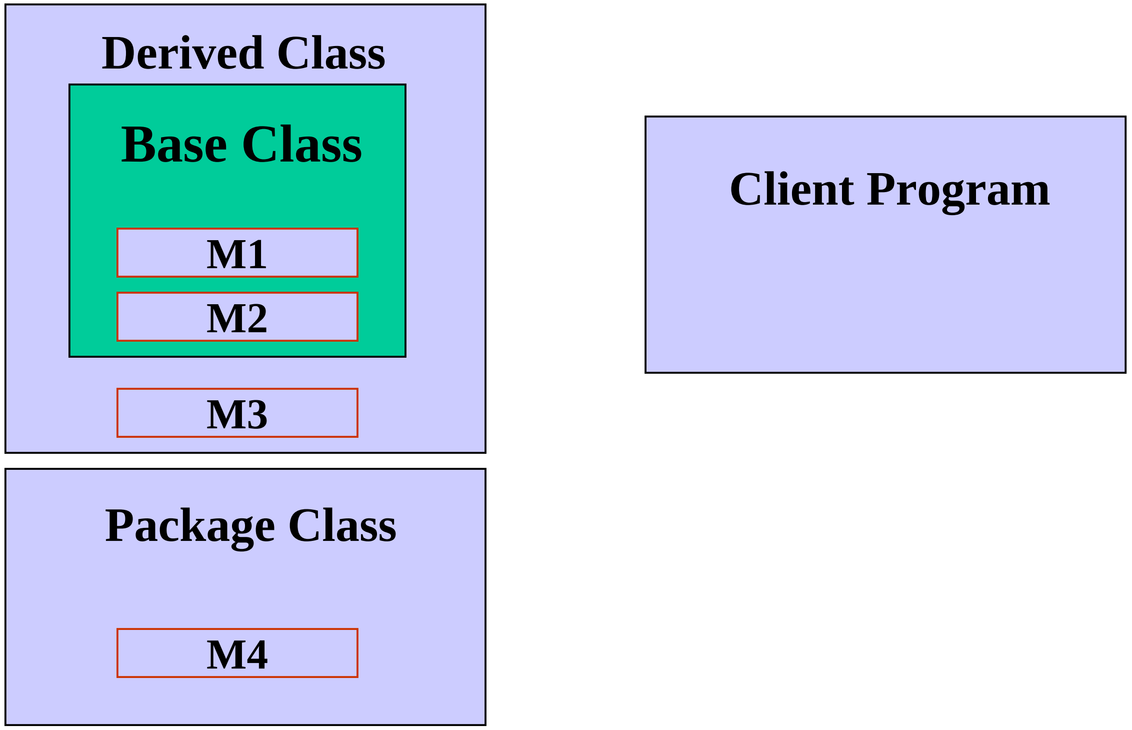
Access Restrictions of Methods/Fields



Access Restrictions of Methods/Fields

- Clients have access to only public methods.
- Derived classes have access to public & protected members of the base class.
- Classes within the same package have access to protected and package members of the base class.

- Private – only to methods in the same class.
- Public – to any method or client program.
- Package – to methods in the same package.
- Protected – to methods in the same class, in derived classes, and in the same package.

Functors

- A functor is an object with no data and a single method.
- Functors can be passed as parameters.
- Since these classes are very "small", they are usually implemented as a Nested Class wherever they are needed.
- Nested classes are defined inside other classes and it is essential that it be declared as "static". If it is not declared as "static", then it is an "inner" class (not nested).
- Nested classes act as members of the "outer" class, and can be declared as private, public, protected, or package visible.
- A nested class can access private fields and members of the "outer" class.
- Functors can also be implemented as a Local Class or as an Anonymous Class.

Functors

Create a class for this functor.

```
// Fig 4.30 & 4.31, pg 127-8

import java.util.Comparator;

class OrderRectByArea implements Comparator
{
   public int compare( Object obj1, Object obj2 )
   {
      SimpleRectangle r1 = (SimpleRectangle) obj1;
      SimpleRectangle r2 = (SimpleRectangle) obj2;

      return( r1.getWidth()*r1.getLength() -
            r2.getWidth()*r2.getLength() );
   }
}
```

```
public class CompareTest
{
   public static Object findMax( Object [ ] a,
                                 Comparator cmp )
   {
      int maxIndex = 0;
      for( int i = 1; i < a.length; i++ )
         if( cmp.compare( a[ i ], a[ maxIndex ] ) > 0 )
            maxIndex = i;
      return a[ maxIndex ];
   }

   public static void main( String [ ] args )
   {
      Object [ ] rects = new Object[ 4 ];
      rects[ 0 ] = new SimpleRectangle( 1, 10 );
      rects[ 1 ] = new SimpleRectangle( 20, 1 );
      rects[ 2 ] = new SimpleRectangle( 4, 6 );
      rects[ 3 ] = new SimpleRectangle( 5, 5 );

      System.out.println( "MAX WIDTH: " +
        findMax( rects, new OrderRectByWidth( ) ) );
      System.out.println( "MAX AREA: " +
        findMax( rects, new OrderRectByArea( ) ) );
   }
}
```

```
import java.util.Comparator;
// Fig 4.32 pg 130
class CompareTestInner1
{
    public static Object findMax( Object [ ] a,
                                                  Comparator cmp )
    {
        int maxIndex = 0;
        for( int i = 1; i < a.length; i++ )
            if( cmp.compare( a[ i ], a[ maxIndex ] ) > 0 )
                maxIndex = i;

        return a[ maxIndex ];
    }

    private static class OrderRectByArea
                implements Comparator
    {
        public int compare( Object obj1, Object obj2 )
        {
            SimpleRectangle r1 = (SimpleRectangle) obj1;
            SimpleRectangle r2 = (SimpleRectangle) obj2;

            return( r1.getWidth()*r1.getLength() -
                    r2.getWidth()*r2.getLength() );
        }
    }
```

```
    public static void main( String [ ] args )
    {
        Object [ ] rects = new Object[ 4 ];
        rects[ 0 ] = new SimpleRectangle( 1, 10 );
        rects[ 1 ] = new SimpleRectangle( 20, 1 );
        rects[ 2 ] = new SimpleRectangle( 4, 6 );
        rects[ 3 ] = new SimpleRectangle( 5, 5 );

        System.out.println( "MAX WIDTH: " +
            findMax( rects, new OrderRectByWidth( ) ) );
        System.out.println( "MAX AREA: " +
            findMax( rects, new OrderRectByArea( ) ) );
    }
}
```

Nested Classes

Local Classes

```
import java.util.Comparator;
// Fig 4.33 pg 131
class CompareTestInner2
{
    public static Object findMax( Object [ ] a,
                   Comparator cmp )
    {
        int maxIndex = 0;
        for( int i = 1; i < a.length; i++ )
            if( cmp.compare( a[ i ], a[ maxIndex ] ) > 0 )
                maxIndex = i;

        return a[ maxIndex ];
    }
```

```
public static void main( String [ ] args )
    {  Object [ ] rects = new Object[ 4 ];
        rects[ 0 ] = new SimpleRectangle( 1, 10 );
        rects[ 1 ] = new SimpleRectangle( 20, 1 );
        rects[ 2 ] = new SimpleRectangle( 4, 6 );
        rects[ 3 ] = new SimpleRectangle( 5, 5 );

        // neither public nor static
       class OrderRectByArea implements Comparator
        {
            public int compare( Object obj1, Object obj2 )
            {
                SimpleRectangle r1 = (SimpleRectangle) obj1;
                SimpleRectangle r2 = (SimpleRectangle) obj2;

                return( r1.getWidth()*r1.getLength() -
                        r2.getWidth()*r2.getLength() );
            }
        }

        System.out.println( "MAX AREA: " +
                 findMax( rects, new OrderRectByArea( ) ) );
    }
}
```

Anonymous Classes

```
class CompareTestInner3 // Fig 4.34, pg 132
{
    public static void main( String [ ] args )
    {
        Object [ ] rects = new Object[ 4 ];
        rects[ 0 ] = new SimpleRectangle( 1, 10 );
        rects[ 1 ] = new SimpleRectangle( 20, 1 );
        rects[ 2 ] = new SimpleRectangle( 4, 6 );
        rects[ 3 ] = new SimpleRectangle( 5, 5 );
        System.out.println( "MAX WIDTH: " + findMax( rects, new Comparator( )
            {  // no name class, no constructor
                public int compare( Object obj1, Object obj2 )
                {
                    SimpleRectangle r1 = (SimpleRectangle) obj1;
                    SimpleRectangle r2 = (SimpleRectangle) obj2;
                    return( r1.getWidth() - r2.getWidth() );
                }
            }
        ) );
        System.out.println( "MAX AREA: " + findMax( rects, new Comparator( )
            {
                public int compare( Object obj1, Object obj2 )
                {
                    SimpleRectangle r1 = (SimpleRectangle) obj1;
                    SimpleRectangle r2 = (SimpleRectangle) obj2;
                    return( r1.getWidth()*r1.getLength() -  r2.getWidth()*r2.getLength() );
                }
            }
        ) );
    }
}
```

Packages

- Group of related classes.
- Specified by package statement.
- Fewer restrictions on access among each other;
  - if class is called public, then it is visible to all classes
  - if no visibility modifier is specified, it is equivalent to the friend specification from C++, and its visibility is termed as "package visibility" and is somewhere between:
    - private (other classes in package cannot access it) and
    - public (other classes outside package can also access it)
  - A class cannot be private or protected. Only methods & fields are allowed to be declared as such.
- Package locations can be specified by the CLASSPATH environmental variables.
- The import statement helps to get multiple packages. It saves typing.

Notes on access restrictions

- A source code file MyClass.java is a compilation unit and can contain at most one public class. Furthermore, if there is a public class in that file, it must be called MyClass. Upon compilation, a .class file is created for each class.
- Creating a package implies a certain directory structure for each package, and the directory must be searchable using the CLASSPATH environmental variable.
- A class (except inner classes) cannot be private/protected. But one could make all constructors of a class private.

Algorithm Analysis

```
public final class MaxSumTest
{  // Fig 5.4, p155
    static private int seqStart = 0;
    static private int seqEnd = -1;
    public static int maxSubSum1( int [ ] a )
    {
        int maxSum = 0;

        for( int i = 0; i < a.length; i++ )
            for( int j = i; j < a.length; j++ )
            {
                int thisSum = 0;

                for( int k = i; k <= j; k++ )
                    thisSum += a[ k ];

                if( thisSum > maxSum )
                {
                    maxSum   = thisSum;
                    seqStart = i;
                    seqEnd   = j;
                }
            }

        return maxSum;
    }
}
```

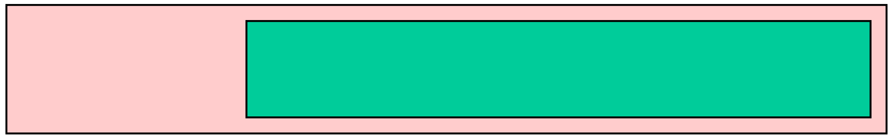
$O(n^3)$

```
public final class MaxSumTest
{  // Fig 5.5, p157
    public static int maxSubSum2( int [ ] a )
    {
        int maxSum = 0;

        for( int i = 0; i < a.length; i++ )
        {
            int thisSum = 0;
            for( int j = i; j < a.length; j++ )
            {
                thisSum += a[ j ];

                if( thisSum > maxSum )
                {
                    maxSum = thisSum;
                    seqStart = i;
                    seqEnd   = j;
                }
            }
        }

        return maxSum;
    }
}
```

$O(n^2)$

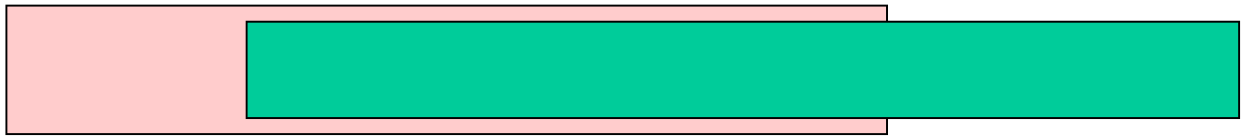
Improved Algorithm: 2 Observations

Fix the start (s) and end (e). Assume it results in a positive sum for every block ending at e or to the left of e.



No other start (s') with the same end (e) can result in a larger sum.

Fix the start (s) and end (e). Assume it results in a positive sum for every block ending to the left of e and a negative sum for the block ending at e.



No other start (s') between s and e can result in a larger sum.

Algorithm Analysis

```
public final class MaxSumTest
{  // Fig 5.8, p160
    public static int maxSubSum3( int [ ] a )
    {
        int maxSum = 0;
        int thisSum = 0;

        for( int i = 0, j = 0; j < a.length; j++ )
        {
            thisSum += a[ j ];

            if( thisSum > maxSum )
            {
                maxSum = thisSum;
                seqStart = i;
                seqEnd   = j;
            }
            else if( thisSum < 0 )
            {
                i = j + 1;
                thisSum = 0;
            }
        }

        return maxSum;
    }
}
```

O(n)

Algorithm Analysis

```
public class BinarySearch // Fig 5.11, pg168
{
    public static final int NOT_FOUND = -1;

   public static int binarySearch
               ( Comparable [ ] a, Comparable x )
    {
        int low = 0;
        int high = a.length - 1;
        int mid;
        while( low <= high )
        {
            mid = ( low + high ) / 2;
            if( a[ mid ].compareTo( x ) < 0 )
                low = mid + 1;
            else if( a[ mid ].compareTo( x ) > 0 )
                high = mid - 1;
            else
                return mid;
        }
        return NOT_FOUND;     // NOT_FOUND = -1
    }
```

```
    // Test program
    public static void main( String [ ] args )
    {
        int SIZE = 8;
        Comparable [ ] a = new Integer [ SIZE ];
        for( int i = 0; i < SIZE; i++ )
            a[ i ] = new Integer( i * 2 );

        for( int i = 0; i < SIZE * 2; i++ )
            System.out.println( "Found " + i + " at " +
                  binarySearch( a, new Integer( i ) ) );

    }
}
```