Victoria University
of Wellington, New Zealand
Te Whare Wananga o te
Upoko o te Ika a Maui
Aotearoa

SWEN221: Software Development

20: Inner & Anonymous Classes

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Static Inner classes
Hierarchical code organization

```
public interface Exp {
  public static class StringLiteral implements Exp{
    String value;
  }
  public static class FieldAccess implements Exp{
    Exp receiver; String fName;
  }
  public static class MethodCall implements Exp{
    Exp receiver; String mName; List<Exp> parameters;
  }
  public static class BinOp implements Exp{
    Op op; Exp left; Exp right;
    public static enum Op{ PLUS, MINUS, AND, OR, ... }
  }
  ...
}
```

(Non-static) Inner classes, are much more complex, that Static Inner classes!

Static Inner classes, often called nested classes in other languages, are just a way to do Hierarchical code organization.

Their type is simply a composed type, like `Exp.BinOp` or `Exp.BinOp.Op`

The fact that the static class `BinOp` is inside `Exp` have no operational semantic.

Static Inner classes
Hierarchical code organization

```
class Foo {
  public static class Bar {...}
  private static class Beer {...}
  ...
}
public class Main {
  public static void main(String[ ] args){
    Foo.Bar bar= new Foo.Bar();
    System.out.println(bar);
    System.out.println(Exp.Op.PLUS);
  }
}
```

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(Non-static) Inner Classes

- static inner classes → property of classes
  - a single `Foo.Bar` class exists
- inner classes → property of instances
  - each instance have its own (non-static) inner classes

- In the same way as

  static fields → property of classes

  fields → property of instances

Inner Classes: Example

```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  public IntList() {this.data = new int[4];}
  public Iterator<Integer> iterator() {
    return new InternalIter();
  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public boolean hasNext() {return pos < size;}
    public Integer next(){return data[pos++];}
    /* ... */
  }
}
```

Inner Class

Inner Classes: Example

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class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  public IntList() {this.data = new int[4];}
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  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public boolean hasNext() {return pos < size;}
    public Integer next(){return data[pos++];}
    /* ... */
  }
}
```

Can access private fields/methods of enclosing class

Inner Classes: Example

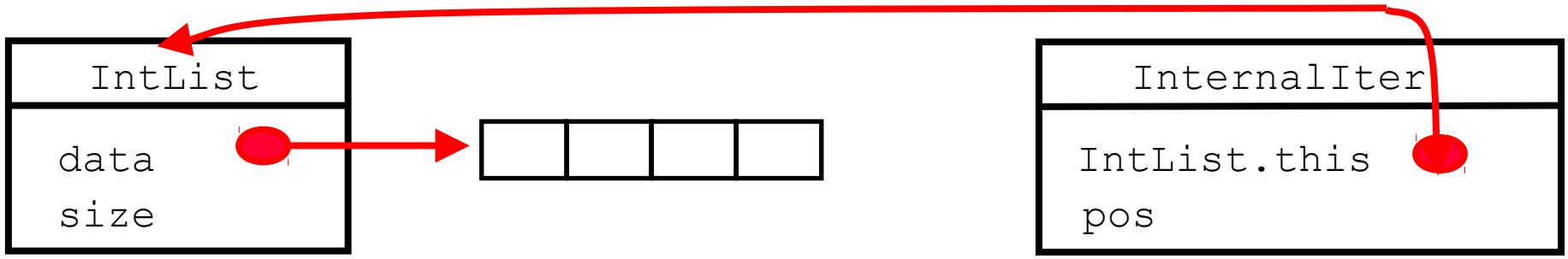
```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  public IntList() {this.data = new int[4];}
  public Iterator<Integer> iterator() {
    return new InternalIter();
  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public boolean hasNext() {return pos < size;}
    public Integer next(){return data[pos++];}
    /* ... */
  }
}
```

Enclosing class can construct and return instances of inner class

Other classes cannot construct instances as it's private

Inner Classes: Scoping

- Inner classes have *outer pointer*
  - For accessing fields/methods of enclosing class (outer)
  - Outer pointer automatically supplied for new inner class




```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;/* ... */
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;/* ... */
  }
}
```

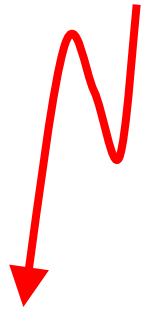
Inner Classes: Explicit Scoping

```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public Integer next(){
      return IntList.this.data[InternalIter.this.pos++];
    }
    /* ... */
  }
}
```

This line is now fully explicit in this-scoping

Inner Classes: Explicit Scoping

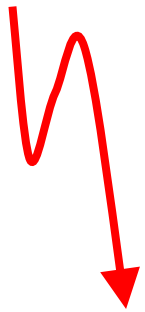
```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public Integer next(){
      return this.data[IntList.this.pos++];
    }
    /* ... */
  }
}
```



Wrong explicit scoping here

Inner Classes: Explicit Scoping

```
class IntList implements Iterable<Integer> {
  private int[] data;
  private int size = 0;
  /* ... */
  }
  private class InternalIter implements Iterator<Integer>{
    private int pos = 0;
    public Integer next(){
      return InternalIter.this.data[this.pos++];
    }
    /* ... */
  }
}
```



Wrong explicit scoping here

Inner Classes: External Construction

```
class Shape {
  /* ... */
  public class Square {
    private int x, y, width, height;
    public Square(int x, int y, int width, int height){
      /* ... */
    }
  }
}
    /* ... */
    Shape outer = new Shape();
    Shape.Square square = outer.new Square(0,0,8,42);
    square = new Shape().new Square(0,0,8,42);
```

- External Construction
  - If constructing inner class outside outer, or in static method, must supply outer pointer **explicitly**

Inner Classes - Static Inner Classes

- Static Inner Classes have no outer pointer!
  - So, can not access fields/methods of enclosing class
  - But, can construct without providing outer pointer
  - If no need to access enclosing info, then this is more convenient (and potentially more efficient)
- (Non-Static) Inner Classes have outer pointer!
  - So, they have multiple `this` and can use it to (implicitly/explicitly) access fields/methods of enclosing instance
  - But, can not be instantiated without providing the outer pointer

Method Local Inner Classes

```
class Outer {
  public Outer create(final int field) {
    class Inner extends Outer {
      private int myfield = field;
      /*...*/
    };

    return new Inner();
  }
}
```

Non-static method local class

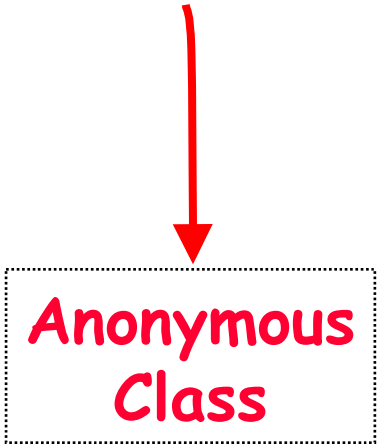
Can access local variables + parameters provided they are final.

- Can even define classes within a method!
  - These are only visible within that method
  - But, their instances can still be returned
  - Cannot have static method-local classes

Anonymous Classes: Example

```
public static void main(String[] args) {
  List<String> myList = new ArrayList<String>(){
      // override ArrayList.add
      public boolean add(String x) {
        System.out.println("ADDED: " + x);
        return super.add(x);
      }
    };
}
```

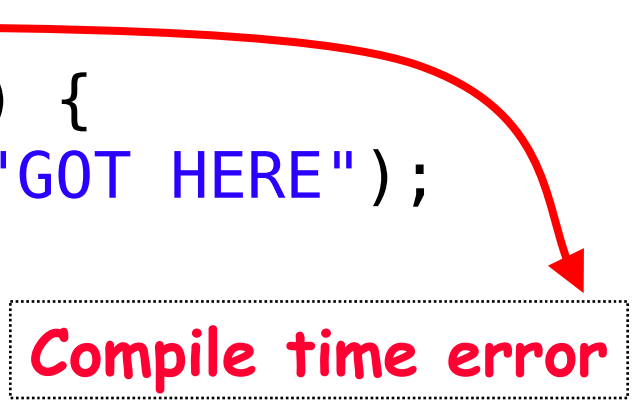
- Anonymous Class
  - Has no class definition and, hence, no name
  - Defined as an extension of existing class
  - Can override methods and/or define fields



Anonymous Classes: Syntax

```
public class Test {
    private int field;
    public Test(int field) { this.field = field; }
    public void aMethod() { /*...*/ }

    public static void main(String[] args) {
     Test x = new Test() {
          public void aMethod() {
           System.out.println("GOT HERE");
          }
         };
    }
}
```



Anonymous Classes: Syntax

```
public class Test {
   private int field;
   public Test(int field) { this.field = field; }
   public void aMethod() { /*...*/ }

   public static void main(String[] args) {
    Test x = new Test(1) {
         public void aMethod() {
          System.out.println("GOT HERE");
         }
        };
   }
}
```

Can provide arguments to super constructor

Anonymous Classes: Syntax

```
public class Test {
   private int field;
   public Test(int field) { this.field = field; }
   public void aMethod() { /*...*/ }

   public static void main(final String[] a) {
    Test x = new Test(1) {
         public void aMethod() {
          System.out.println("GOT "+a+" "+field);
         }
        };
   }
}
```

Can access local variables and parameters (provided they are final) and enclosing fields

Anonymous Classes: Interfaces

```
ArrayList<String> ls=/*...*/;
Collections.sort(ls,new Comparator<String>(){
  public int compare(String s1, String s2) {
    return s1.compareToIgnoreCase(s2);
    }});
```

Can even make anonymous class from an interface!!!

Anonymous Classes: Interfaces

```
ArrayList<String> ls=/*...*/;
Collections.sort(ls,new Comparator<String>(){
  public int compare(String s1, String s2) {
    return s1.compareToIgnoreCase(s2);
    }});
```

- Learn how to read the code through the syntax: fading away the anonimus class+method declaration, what you obtain read like:

  Sort `ls` using `s1.compareToIgnoreCase(s2)`

Anonymous Classes: Interfaces

```
ArrayList<String> ls=/*...*/;
Collections.sort(ls,new Comparator<String>(){
  public int compare(String s1, String s2) {
    return s1.compareToIgnoreCase(s2);
    }});
```

- Learn how to read the code through the syntax: fading in the opposite way, we see
  - type informations-- they double check

    that we know what we are doing

```
int Comparator<String>.compare(String,String)
```

  - names: s1,s2 -- can be used to identify concepts

Extensive use for event handler

```
import java.awt.*; import java.awt.event.*; import javax.swing.*;

public class MiniGui extends JFrame {
  public static void main(String[] args) {
    SwingUtilities.invokeLater(new Runnable() {
      public void run() {
        MiniGui g = new MiniGui();
        g.setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
        g.getRootPane().setLayout(new BorderLayout());
        JButton b = new JButton("------Bar------");
        b.addActionListener(new ActionListener() {
          public void actionPerformed(ActionEvent e) {
            System.out.println("Button pressed");
          }});
        g.getRootPane().add(b, BorderLayout.CENTER);
        g.pack();
        g.setVisible(true);
      }});
  }}
```

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            System.out.println("Button pressed");
          }});
        g.getRootPane().add(b, BorderLayout.CENTER);
        g.pack();
        g.setVisible(true);
      }});
  }}
```

quiz

```
public class Exercise {
  static int x=1; int y=2;
  static int z=0;
  static class Foo{
    static int y=3; int x=4;
    static int m1(){
      return Foo.y+Exercise.x;}
    int m2(){
      return y+x;}
    class Bar{
      int x=5; int y=6;
      int m3(){
        return y+x+m1()+m2();}
      int m4(){
        return z+Foo.this.y
        +Foo.this.x;}
    }}
```

```
public static void main(String[] args){
  Foo foo=new Foo();
  Foo.Bar bar=foo.new Bar();
  System.out.println(foo.m1());
  System.out.println(foo.m2());
  System.out.println(bar.m3());
  System.out.println(bar.m4());
  }}
```