Inner Classes

- Introduction
  - Inner classes
  - The state design pattern revisited.
  - Summary

- Moving on with Inner Classes (NOT TODAY)
  - Accessing data in the outer classes
  - A callback mechanism implemented with interfaces and inner classes
  - Nesting interfaces
  - Creating instances of inner classes
  - Anonymous inner classes
  - The template design pattern
  - Summary

What is an Inner Class?

- Fundamental new language feature, added in Java 1.1.
- Used a lot in JFC/Swing (GUI programming).
- Nest a class within a class.
- Class name can be hidden.
- More than hiding and organization
  - Call-back mechanism.
  - Can access members of enclosing object.

Inner Classes, Example

```
public class Parcel1 {  // [Source: bruceeckel.com]
  class Contents {
    private int i = 11;
    public int value() { return i; }
  }
  class Destination {
    private String label;
    Destination(String whereTo) {
      label = whereTo;
    }
    String readLabel() { return label; }
  }
  public void ship(String dest) {
    Contents c = new Contents();
    Destination d = new Destination(dest);
    System.out.println(d.readLabel());
  }
  public static void main(String[] args) {
    Parcel1 p = new Parcel1();
    p.ship("Tanzania");
  }
}
```

Interfaces and Inner Classes

- An outer class will often have a method that returns a reference to an inner class.

```
// [Source: bruceeckel.com]

public interface Contents {
   int value();
}

public interface Destination {
   String readLabel();
}
```

Interfaces and Inner Classes, cont

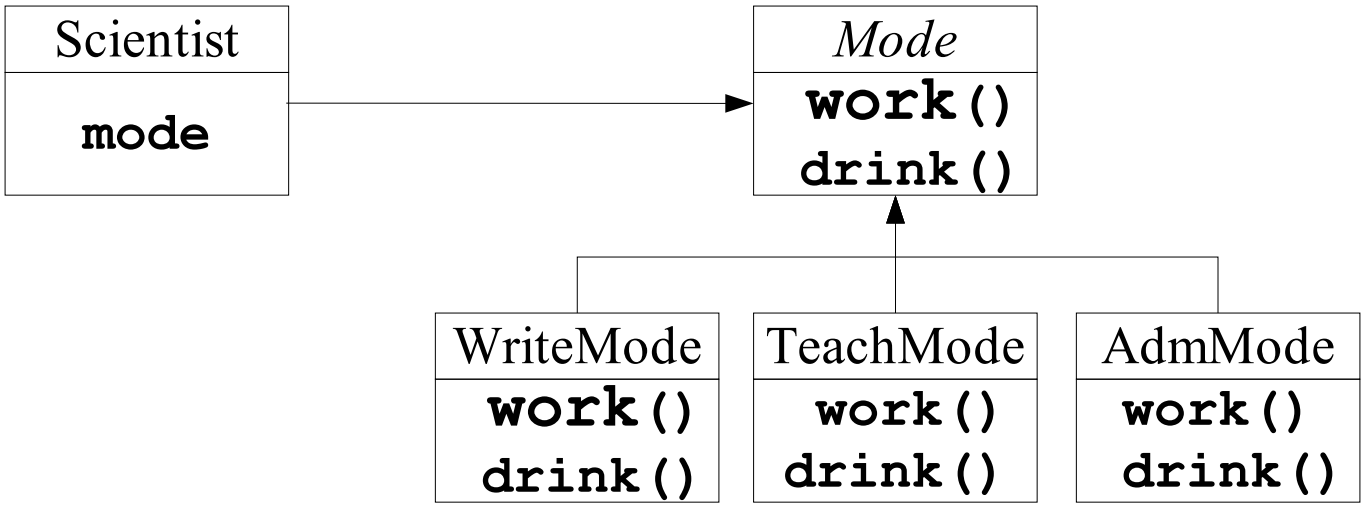
```
public class Parcel3 { // [Source: bruceeckel.com]
  private class PContents implements Contents {
    private int i = 11;
    public int value() { return i; }
  }
  protected class PDestination implements Destination {
    private String label;
    private PDestination(String whereTo) {
      label = whereTo;
    }
    public String readLabel() { return label; }
  }
  public Destination dest(String s) {
    return new PDestination(s);
  }
  public Contents cont() {
    return new PContents();
  }
}
```

Interfaces and Inner Classes, cont

```
class Test { // [Source: bruceeckel.com]
  public static void main(String[] args) {
    Parcel3 p = new Parcel3();
    Contents c = p.cont();
    Destination d = p.dest("Tanzania");
    // Illegal -- can't access private class:
    //! Parcel3.PContents pc = p.new PContents();
  }
}
```

The State Design Pattern Revisited

- A scientist does three very different things (modes)
  - Writes paper (and drinking coffee)
  - Teaches classes (and drinking water)
  - Administration (and drinking tea)
- The implementation of each is assumed to be very complex
- Must be able to change dynamically between these modes



Implementing of State Design Pattern

```
public class Scientist{
    private interface Mode{
        void work();
        void drink();
    }
    private class WriteMode implements Mode{
        public void work(){ System.out.println("write");}
        public void drink(){ System.out.println("coffee");}
    }
    protected class TeachMode implements Mode{
        public void work(){ System.out.println("teach");}
        public void drink(){ System.out.println("water");}
    }
    public class AdmMode implements Mode{
        public void work(){ System.out.println("administrate");}
        public void drink(){ System.out.println("tea");}
    }
    snip
}
```

Implementing of State Design Pattern, cont.

```
public class Scientist{ // nothing has changed here
    snip
    private Mode mode;
    public Scientist(){
       mode = new WriteMode(); /* default mode */
    }
    // what scientist does
    public void doing() { mode.work();}
    public void drink() { mode.drink();}

    // change modes methods
    public void setWrite() { mode = new WriteMode();}
    public void setTeach() { mode = new TeachMode();}
    public void setAdministrate() { mode = new AdmMode();}

    public static void main(String[] args){
       Scientist einstein = new Scientist();
       einstein.doing();
       einstein.setTeach();
       einstein.doing();
    }
}
```

Evaluation of State Design Pattern

- Can change modes dynamically
  - Main purpose!
- Different modes are isolated in separate classes
  - Complexity is reduced (nice side-effect)
- Client of the **`Scientist`** class can see the **`Mode`** class (and its subclasses).
  - This may unnecessarily confuse these clients. (FIXED)
- **`Scientist`** class *cannot* change mode added after it has been compiled, e.g., **`SleepMode`**. (CANNOT BE FIXED)
- Can make instances of **`Mode`** class. This should be prevented. (FIXED)
- The *state design pattern*
  - Nice design!

Why Inner Classes?

- Each inner class can independently inherit from other classes, i.e., the inner class is not limited by whether the outer class is already inheriting from a class.
- With concrete or abstract classes, inner classes are the only way to produce the effect of "multiple implementation inheritance".
- Make design modular
- Reduce complexity

Summary for Introduction

- Classes can be nested in Java
  - Named inner classes

Moving-on with Inner Classes

- Accessing data in the outer classes
- A callback mechanism implemented with interfaces and inner classes
- Creating instances of inner classes
- Anonymous inner classes
- The template design pattern

Access to Outer Data

```
public interface Diplomat{
    /** Attend a meting */
    void attendMeeting();
    /** Talk nicely */
    void talkNice();
}
public class Embassy{
   private String[] secrets = new String[100];
   private int counter = 0;

   private class Agent implements Diplomat {
      public void attendMeeting() {
         System.out.println("Be nice)");
      }
      public void talkNice() {
         System.out.println("Talk nice");
      }
      protected void tellSecrets(){
         System.out.println("Tell a secret");
         secrets[counter++] = new String("A new secret");
      }
   }
```

Callback Mechanism

```
public class Embassy{
    snip

    public class Secretary implements Diplomat {
        public void attendMeeting() {
            System.out.println("Secretary.attendMeeting()");
        }
    }

    boolean sendAgent = true;
    // send out diplomats some are secret agents (call-back)
    public Diplomat sendDiplomat(){
        if (sendAgent){
            sendAgent = false; return new Agent();
        }
        else {
            sendAgent = true; return new Secretary();
        }
    }
```

Callback Mechanism, cont

```
public class Embassy{
    snip
    // get reports back from diplomats
    public void getReport(Diplomat dip){
        if (dip instanceof Agent) {
            ((Agent)dip).tellSecrets();
        }
        else {dip.talkNice();}
    }

    public static void main(){
        Diplomat[] dips = new Diplomat[10];
        Embassy cccp = new Embassy();
        for(int i = 0; i < 10; i++){
            dips[i] = cccp.sendDiplomat();
        }
        for(int j = 0; j < 10; j++){
            cccp.getReport(dips[j]);
        }
    }
}
```

Nesting Interfaces

- Interfaces can also be nested however public rule still apply

```
public interface NestedInterface{
    int outer();
    private interface A{ /* not allowed compile error */
        int aData = 1;
        int a();
    }
    protected interface B{ /* not allowed compile error */
        int bData = 2;
        int b();
    }
    interface C {           /* default public */
        int cData = 3;
        int c();
    }
    public interface D{
        int dData = 4;
        int d();
    }
}
```

Nesting Interfaces, cont

- Private and protected interfaces are possible

```
public class NestedInterfacesInClass{
    private interface A{
        int aData = 1;
        int a();
    }
    protected interface B{
        int bData = 2;
        int b();
    }
    interface C {
        int cData = 3;
        int c();
    }
    public interface D{
        int dData = 4;
        int d();
    }
}
```

Creating Instances of Inner Classes

- Cannot create inner classes without an instance of outer class is available (special cases see *nested classes* pp. 344 in the book)
- The syntax for creating instances of inner classes is awkward

```
public class A{
   public A(){ System.out.println("A");   }
   public class BB {
      public BB(){ System.out.println("BB"); }
      public class CCC{
      public CCC(){ System.out.println("CCC");  }
      }
   }
   public static void main(String[] args){
      A a = new A();
      A.BB bb = a.new BB();
      A.BB.CCC ccc = bb.new CCC();
   }
}
```

Anonymous Inner Classes, Example

- When a class in only needed in one place.
- Convenient shorthand.
- Works for both interfaces and classes.

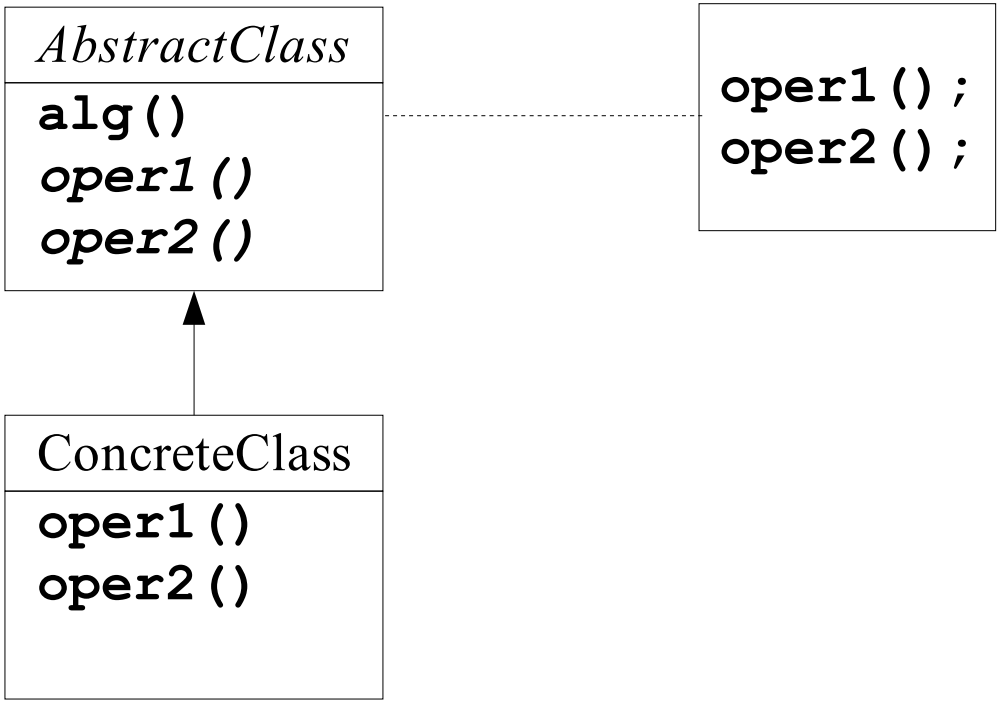
```
// [Source: bruceeckel.com]

public class Parcel6 {
  public Contents cont() {
    return new Contents() {
      private int i = 11;
      public int value() { return i; }
    };
  }
  public static void main(String[] args) {
    Parcel6 p = new Parcel6();
    Contents c = p.cont();
  }
}
```

Note the semicolon

The Template Design Pattern

- Intent: Define the skeleton for an algorithm in an operation, deferring some steps to subclasses [GOF pp 325].
- Well-suited to be implemented using inner classes (+ interfaces)
- Used extensively in many application frameworks e.g., Swing
  - "Factoring out common code"



The Template Design Pattern, cont

- Make interface for abstract methods in design pattern.

```
// for modeling an event
public interface Event{
   public void open();
   public void doStuff();
   public void close();
}
```

The Template Design Pattern, cont

- Build the abstract class and make use of the interface defined.

```
public abstract class Controller {
   private Event[] events;
   private int counter;
   public Controller(){
      events = new Event[100];
      counter = 0;
   }
   public final void add(Event e){events[counter++] = e;}

   /** final to make sure not overwritten in subclass */
   public final void run(){
      Event e;
      for(int i = 0; i <= counter - 1; i++){
         e = (Event)events[i];
         e.open();
         e.doStuff();
         e.close();
      }
   }
}
```

The Template Design Pattern, cont

```
public class StudentController extends Controller{
   // calls constructor on abstract class!
   public StudentController(){
      super();
   }
   public class DoMath implements Event{
     public void open() { System.out.println("open math book");}
     public void doStuff() { System.out.println("read");}
     public void close() { System.out.println("close math book");
   }

   public class WakeUp implements Event{
     public void open() { System.out.println("open eyes");}
     public void doStuff() { System.out.println("leave bed);}
     public void close() { System.out.println("turn-on light");}
   }

   // similar Events for sleep and eat
}
```

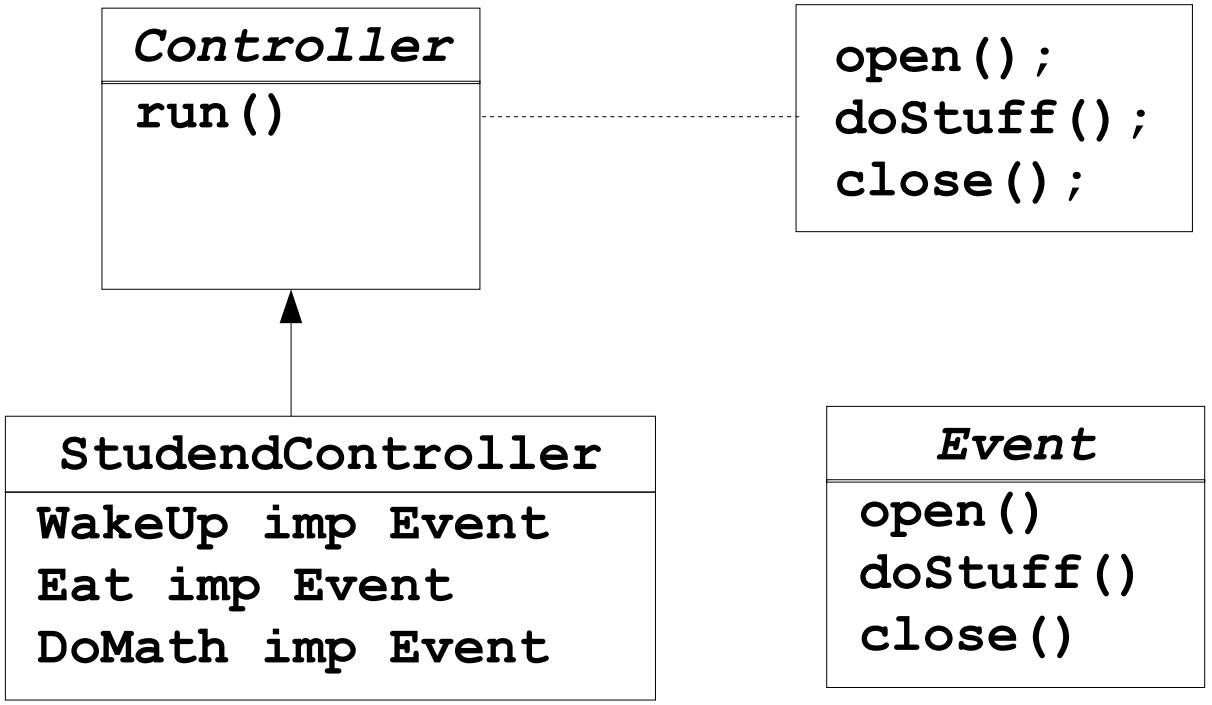
The Template Design Pattern, cont

```
public class StudentController extends Controller{
   public static void main(String[] args){
      StudentController sc = new StudentController();

      sc.add(sc.new WakeUp());
      sc.add(sc.new Eat());
      sc.add(sc.new DoMath());
      sc.add(sc.new GoToSleep());
      sc.run(); // template method
   }
}
```

The Template Design Pattern, cont.

- **`run`** method is final, i.e., cannot be redefined
- All methods used in **`run`** are defined in **`Event`** interface
- **`Event`** interface implemented by inner classes.



Summary

- Very many details for using inner classes
- All four access modifiers can be used on inner classes and inner interfaces
- Anonymous inner classes
  - Do not have to invent a name for a class you only need one off
- Template design pattern shows usage of
  - interfaces
  - inner classes