Nested Classes

Nested Classes and Interfaces

- Classes and interfaces can be declared inside other classes and interfaces, either as members or within blocks of code.

Some Definitions

- Nested = a class or interface definition is somewhere inside another one
- Top-level class or interface = an instance of a type **does not** need to be instantiated with a reference to any enclosing instance
- Inner class = an instance of a class **does** need to be instantiated with an enclosing instance
- Inner Member class = defined inside another class, but not inside any methods.
- Inner Local class = defined inside a method
- Named Inner Local class = has a class name
- Anonymous Inner Local class = does not have a class name

Nested Classes

```
class TheEnclosingClass{
         ...
       class ANestedClass  {
            ...
        }
}
```

- **Definition**: A **nested class** is a class that is a member of another class.
- **Reason for making nested classes**:
  - the nested class **makes sense only in the context of its enclosing class**
  - the nested class **needs the enclosing class to have the right functionality**.

Nested Static Classes

- A **nested class** that is **declared static** **is attached to the enclosing class** and not to objects of the enclosing class. Instance fields and methods can not be directly accessed.

Example: *Linked List*

```java
public class LinkedList {
   private Node first;
   .....
   public static class Node{
      public Node next;
      public Object data;
   }
   .....
}
```

Static Nested Classes/Interfaces — Overview

- A nested class/interface which is declared as `static` acts just like any non-nested class/interface, except that its name and accessibility are defined by its enclosing type.
- Static nested types are members of their enclosing type
  - They can access all other members of the enclosing type including the private ones.
  - Inside a class, the static nested classes/interfaces can have private, package, protected or public access; while inside an interface, all the static nested classes/interfaces are implicitly public.
  - They serve as a structuring and scoping mechanism for logically related types

Static Inner Classes

- Since a static inner class has no connection to an object of the outer class, within an inner class method
  - Instance variables of the outer class cannot be referenced
  - Nonstatic methods of the outer class cannot be invoked
- To invoke a static method or to name a static variable of a static inner class within the outer class, preface each with the name of the inner class and a dot

Static Nested Classes/Interfaces (cont.)

- Static nested classes
  - If a class is nested in an interface, it’s always static (omitted by convention)
  - It can extend any other class, implement any interface and itself be extended by any other class to which it’s accessible
  - Static nested classes serve as a mechanism for defining logically related types within a context where that type makes sense.

Static Nested Classes/Interfaces (cont.)

- Nested interfaces
  - Nested interfaces are always static (omitted by convention) since they don’t provide implementation

Static Nested Classes/Interfaces (cont.)

```
public class BankAccount {
     private long number;     //account number
     private long balance;    //current balance
     public static class Permissions {
          public boolean canDeposit, canWithdraw,
  canClose;
     }
//  . . .
}
```

- Code outside the `BankAccount` class must use `BankAccount.Permissions` to refer to this class

```
BankAccount.Permissions perm =
  acct.permissionsFor(owner);
```

Inner Classes

- **A nested class that is not static is called an inner class.**
- An **inner class is associated with an object** of its enclosing class and it has **direct and unlimited access to that object's instance variables and methods**.
- A **nested class** can be **declared at** the **top level** inside a class **or inside any block of code**.

Inner classes

```
class Outer {
    int n;

    class Inner {
        int ten = 10;
        void setNToTen( ) { n = ten; }
    }

    void setN ( ) {
        new Inner( ).setNToTen( );
    }
}
```

Inner Class

- Name Reference
  - OuterClass inside : Use InnerClass Simple name
  - OuterClass outside : OuterClass.InnerClass

```
public static void main(String[] args) {
        OuterClass  outObj = new  OuterClass();
       OuterClass.InnerClass   inObj = outObj.new  InnerClass();
}
```

- Access Modifier
  - public, private, protected

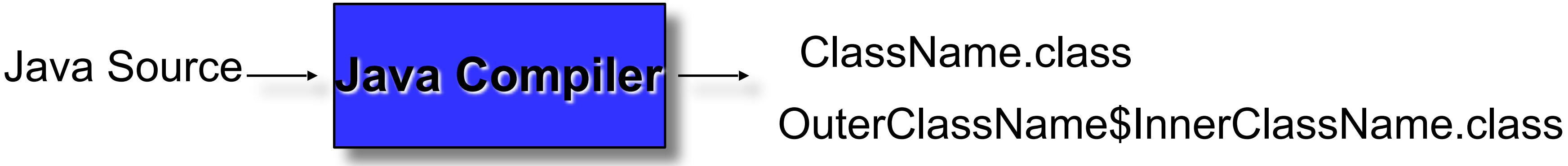
Inner class cannot have static variable

Nesting Inner Classes

- It is legal to nest inner classes within inner classes
  - The rules are the same as before, but the names get longer
  - Given class `A`, which has public inner class `B`, which has public inner class `C`, then the following is valid:

```
A aObject = new A();
A.B bObject = aObject.new B();
A.B.C cObject = bObject.new C();
```

Name of Inner Class



```
class Outer {
        class Inner1 {
            class Inner2 {   // …        }
            // ...
        }
        // ...
}
```

Outer.class
Outer$Inner1.class
Outer$Inner1$Inner2.class

Simple inner class example

```
class Outer{
  private int x1;

 Outer(int x1){
     this.x1 = x1;
  }

 public void foo(){ System.out.println(“fooing”);}

  public class Inner{
     private int x1 = 0;
     void foo(){
       System.out.println(“Outer value of x1: “ + Outer.this.x1);
       System.out.println(“Inner value of x1: “ + this.x1);
     }
  }
```

Simple example, cont -- driver

- Rules for instantiation

```
public class TestDrive{

  public static void main(String[] args){
     Outer outer = new Outer();
     Inner inner = outer.new Inner(); //must call new through
                                                     //outer object handle
      inner.foo();

      // note that this can only be done if inner is visible
      // according to the regular scoping rules
  }
}
```

Non-static Classes — Inner classes

- *Inner classes* are associated with instances of its enclosing class.

```
public class BankAccount {
    private long number;     //  account number
    private long balance;    // current balance
    private Action lastAct; //last action performed

    public class Action {
        private String act;
        private long amount;

        Action(String act, long amount) {
            this.act = act;
            this.amount = amount;
        }
    }
```

Non-static Classes — Inner classes

```
   public void deposit(long amount) {
      balance += amount;
      lastAct = new Action(“deposit”, amount);
   }

   public void withdraw(long amount) {
      balance -= amount;
      lastAct = new Action(“withdraw”, amount);
   }
   // . . .
}
```

Inner classes (cont.)

- When an inner class object is created, it MUST be associated with an object of its enclosing class.
- Usually, inner class objects are created inside instance methods of the enclosing class. When this occurs, the current enclosing object `this` is associated with the inner object by default.

```
lastAct = this.new Action(“deposit”, amount);
```

  - When `deposit` creates an `Action` object, a reference to the enclosing `BankAccount` object is automatically stored in the `Action` object.

Inner class

```
class BankAccount
{     ...
   private double balance;

   // Inner Class
   private class InterestAdder implements ActionListener
   {  private double rate;
      ...
      public void actionPerformed(ActionEvent event)
      {
         // update interest
         double interest = balance * rate / 100;
         balance += interest;
         ...
      }
   }
}
```

Inner classes

- Using the saved reference, the inner-class object can refer to the enclosing object's fields directly by their names. The full name will be the enclosing object `this` preceded by the enclosing class name

- To refer to the field number in the BankAccount part

```
BankAccount.this.balance
```

- With inner classes, Java defines a outer class reference with each inner class which can be accessed with **BankAccount.this**

```
public void actionPerformed(ActionEvent e)
{
   double interest = BankAccount.this.balance *
this.rate/100;
   BankAccount.this.balance += interest;
}
```

- The balance field is a private member of the outer class.

Inner classes (cont.)

- method for `transfer` is added

```
public void transfer(BankAccount other, long
  amount) {

   other.withdraw(amount);
   deposit(amount);

  lastAct = this.new Action(“transfer”, amount);
  other.lastAct = other.new Action(“transfer”,
    amount);
  }
```

Inner classes (cont.)

- The enclosing class can also access the private members of its inner class, but only via explicit reference to an inner class object.
- An object of the enclosing class need not have any inner class objects associated with it, or it could have many.
- An inner class acts as a top-level class except that it can’t have static members (except for final static fields).
- Inner classes can also be extended.

Inheritance, Scoping and Hiding

- All members declared within the enclosing class are said to be in *scope* inside the inner class.
- An inner class's own fields and methods can hide those of the enclosing object. Two possible ways:

1). A member with the same name is declared in the inner class

  - Any direct use of the name refers to the version inside the inner class

```
   class Host {
      int x;
      class Helper {
         void increment() {int x=0; x+
+;}
      } }
```

  - Access to the enclosing object's members needs be preceded by `this` explicitly

Inheritance, Scoping and Hiding

2). A member with the same name is inherited by the inner class

- The direct use of the name is not allowed

```
        class Host {
            int x;
            class Helper extends Unknown {      //
     Unknown class has a field x
                void increment~~()~~ {x++;}
            }
        }
```

- Use `enclosingClassName.this.name` to refer to the version in the outer class
- or `super.name` to refer to the version in the super class
- Use `this.name` in the inner class

Specifying which scope you want:

```
public class ScopeConflict {
  String s = "outer";

  class Inner extends SuperClass {

    String s = "inner";

    void foo(){
      System.out.println(this.s);
      System.out.println(super.s);

     System.out.println(ScopeConflict.this.s);
    }
  }
}

class SuperClass {
  String s = "super";
}
```

output:

```
inner (from this.s)
super (from super.s)
outer (from ScopeConflict.this.s)
```

Inheritance, Scoping and Hiding (cont.)

- A method within an inner class which has the same name as an enclosing **method hides all overloaded forms** of the enclosing method, even if the inner class itself does not declare those overloaded forms.

```
class Outer {
   void print() {}
   void print(int value) {}
   class Inner {
      void print() {}
      void show() {
         print();
         Outer.this.print();
         print(1); // no Inner.print(int)
      }
   }
}
```

Local Inner Classes

- You can define inner classes in code blocks. They are called *local inner classes.*
- You can actually declare an inner class inside of a method, just like you could declare a local variable.
- Local classes do not get an access modifier – they are automatically restricted to the method they are defined in
- Can only refer to final members of the enclosing class
  - They are NOT members of the class which contains the code but are local to that block, as a local variable.
  - They are completely inaccessible outside of the block.
  - Only one modifier is allowed—final—which makes them unextendable

Anonymous Inner classes

- When using a local inner class, if you only want to make one instance of it, you don’t even need to give it a name
- This is known as an anonymous inner class
- These are convenient for event programming
- However, the syntax is extremely cryptic.

Anonymous Inner classes

- You have to look very carefully to see a difference between construction of a new object, and construction of a new inner class extending a class.

```
//A person object from  Person class
Person queen=new Person("Mary");  //Person Object
```

```
//An object of an inner class extending Person interface
Person count = new Person() {
                        //class code here
                       };
```

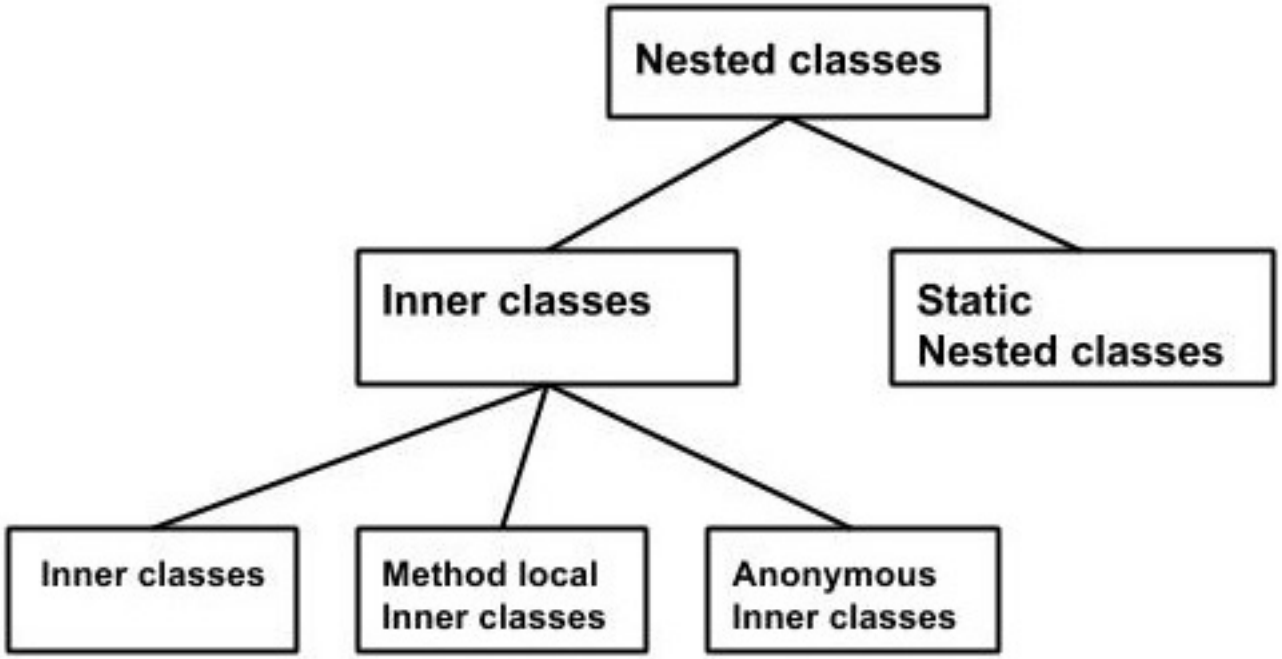
Anonymous Inner classes

- Anonymous Inner classes cannot have constructors, since constructors have to have the same name as the class, and these classes have no names.
- As you can see, the syntax for these is confusing – both for people writing and reading the code. Use this with care, if at all.

Anonymous Inner classes

```
public void start(final double rate)
{
    ActionListener adder = new ActionListener()
    {
        public void actionPerformed(ActionEvent evt)
        {
            double interest = balance * rate / 100;
            balance += interest;
        }
    };
```

- This is saying, construct a new object of a class that implements the ActionListener interface, where the one required method (actionPerformed) is defined inside the brackets.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Inner classes
Static
Nested classes
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Method local
Inner classes
Anonymous
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