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Object-Oriented Programming

Nested Class

Objectives

- Explain Nested class
- Explain Member class
- Explain Local class
- Explain Anonymous class
- Describe Static nested class

Nested Class 1-2

- Java allows defining a class within another class.
- Such a class is called a nested class as shown in the following figure:

- Following code snippet defines a nested class:

```
class Outer{
    ...
    class Nested{
        ...
    }
}
```

- The class **Outer** is the external enclosing class and the class **Nested** is the class defined within the class **Outer**.

Nested Class 2-2

- Nested classes are classified as static and non-static.
- Nested classes that are declared `static` are simply termed as `static` nested classes whereas non-static nested classes are termed as inner classes.
- This has been demonstrated in the following code snippet:

```
class Outer{
    ...
    static class StaticNested{
        ...
    }
    class Inner{
    ...
    }
}
```

- The class **StaticNested** is a nested class that has been declared as static whereas the non-static nested class, **Inner**, is declared without the keyword static.
- A nested class is a member of its enclosing class.
- Non-static nested classes or inner classes can access the members of the enclosing class even when they are declared as private.
- Static nested classes cannot access any other member of the enclosing class.

Benefits of Using Nested Class

- The reasons for introducing this advantageous feature of defining nested class in Java are as follows:

Creates logical grouping of classes

- If a class is of use to only one class, then it can be embedded within that class and the two classes can be kept together.
- In other words, it helps in grouping the related functionality together.
- Nesting of such 'helper classes' helps to make the package more efficient and streamlined.

Increases encapsulation

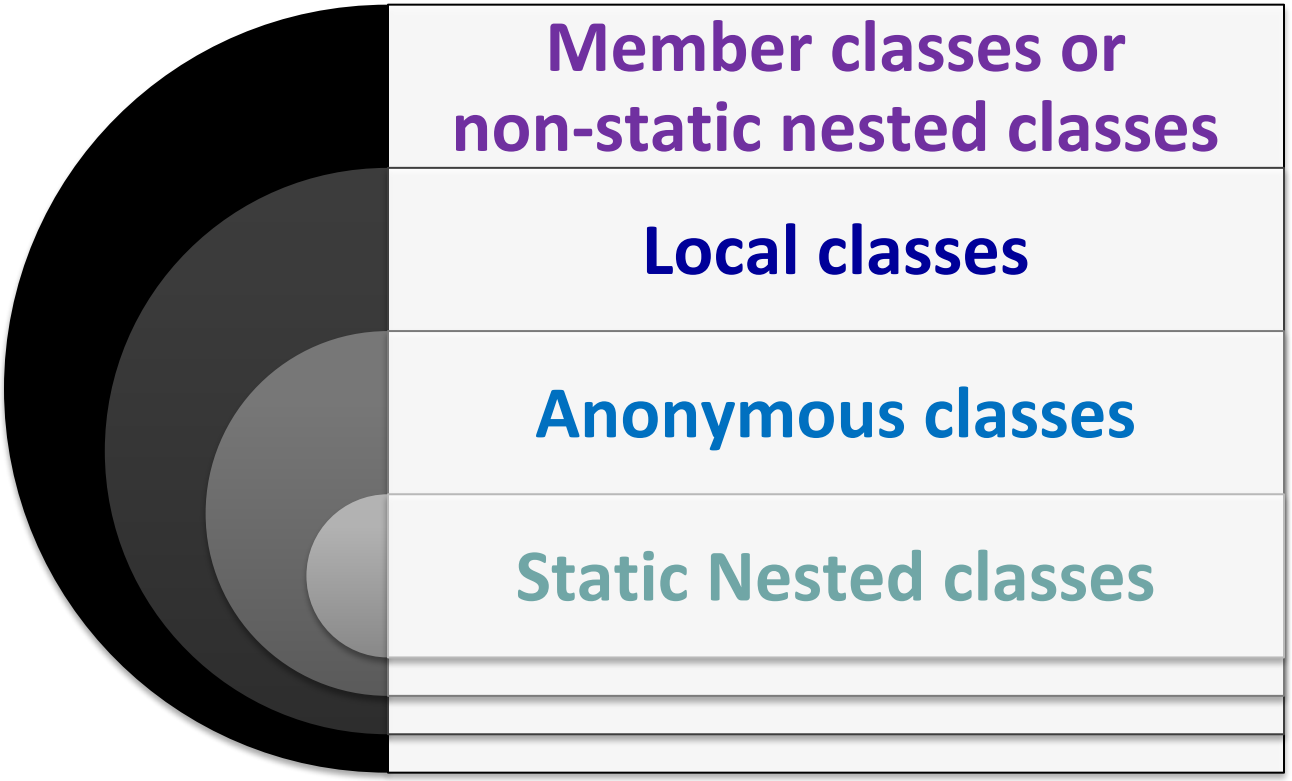
- In case of two top level classes such as class A and B, when B wants access to members of A that are `private`, class B can be nested within class A so that B can access the members declared as `private`.
- Also, this will hide class B from the outside world.
- Thus, it helps to access all the members of the top-level enclosing class even if they are declared as `private`.

Increased readability and maintainability of code

- Nesting of small classes within larger top-level classes helps to place the code closer to where it will be used.

Types of Nested Classes

- The different types of nested classes are as follows:



Member Classes 1-5

- A member class is a non-static inner class.
- It is declared as a member of the outer or enclosing class.
- The member class cannot have `static` modifier since it is associated with instances of the outer class.
- An inner class can directly access all members that is, fields and methods of the outer class including the private ones.
- However, the outer class cannot access the members of the inner class directly even if they are declared as `public`.
- This is because members of an inner class are declared within the scope of inner class.
- An inner class can be declared as `public`, `private`, `protected`, `abstract`, or `final`.
- Instances of an inner class exist within an instance of the outer class.
- To instantiate an inner class, one must create an instance of the outer class.

Member Classes 2-5

- One can access the inner class object within the outer class object using the statement defined in the following code snippet:

```
// accessing inner class using outer class object
Outer.Inner objInner = objOuter.new Inner();
```

- Following code snippet describes an example of non-static inner class:

```
package session11;
class Server {
    String port; // variable to store port number

    /**
     * Connects to specified server
     *
     * @param IP a String variable storing IP address of server
     * @param port a String variable storing port number of server
     * @return void
     */
    public void connectServer(String IP, String port) {

    System.out.println("Connecting to Server at:"+ IP + ":" + port);
}
```

Member Classes 3-5

```
    /**
     * Define an inner class
     *
     */
    class IPAddress
    {
        /**
         * Returns the IP address of a server
         *
         * @return String
         */
        String getIP() {
            return “101.232.28.12”;
        }
    }
}

/**
 * Define the class TestConnection.java
 *
 */
public class TestConnection {
```

Member Classes 4-5

```
/**
 * @param args the command line arguments
 */
public static void main(String[] args){
/**
 * @param args the command line arguments
 */
public static void main(String[] args)
{
    // Check the number of command line arguments
    if(args.length==1) {
        // Instantiate the outer class
        Server objServer1 = new Server();
        // Instantiate the inner class using outer class object
        Server.IPAddress objIP = objServer1.new IPAddress();
        // Invoke the connectServer() method with the IP returned from
        // the getIP() method of the inner class
        objServer1.connectServer(objIP.getIP(),args[0]);
    }
    else {
        System.out.println("Usage: java Server <port-no>"); }
}}
```

Member Classes 5-5

- The class **Server** is an outer class that consists of a variable port that represents the port at which the server will be connected.
- Also, the **connectServer(String, String)** method accepts the IP address and port number as a parameter.
- The inner class **IPAddress** consists of the **getIP()** method that returns the IP address of the server.
- Following figure shows the output of the code when user provides '**8080**' as the port number at command line:

Local Class 1-6

- **An inner class defined within a code block such as the body of a method, constructor, or an initializer, is termed as a local inner class.**
- **The scope of a local inner class is only within that particular block.**
- **Unlike an inner class, a local inner class is not a member of the outer class and therefore, it cannot have any access specifier.**
- **That is, it cannot use modifiers such as `public`, `protected`, `private`, or `static`.**
- **However, it can access all members of the outer class as well as `final` variables declared within the scope in which it is defined.**

- Following figure displays a local inner class:

Local Class 2-6

- Local inner class has the following features:
  - It is associated with an instance of the enclosing class.
  - It can access any members, including private members, of the enclosing class.
  - It can access any local variables, method parameters, or exception parameters that are in the scope of the local method definition, provided that these are declared as final.
- Following code snippet demonstrates an example of local inner class.

```
package session11;
class Employee {

    /**
     * Evaluates employee status
     *
     * @param empID a String variable storing employee ID
     * @param empAge an integer variable storing employee age
     * @return void
     */
    public void evaluateStatus(String empID, int empAge){
        // local final variable
        final int age=40;
```

Local Class 3-6

```
/**
 * Local inner class Rank
 *
 */
class Rank{

    /**
     * Returns the rank of an employee
     *
     * @param empID a String variable that stores the employee ID
     * @return char
     */
    public char getRank(String empID){
        System.out.println("Getting Rank of employee: "+ empID);
        // assuming that rank 'A' was returned from server
        return 'A';
    }
}

// Check the specified age
if(empAge>=age){
```

Local Class 4-6

```
            // Instantiate the Rank class
            Rank objRank = new Rank();

            // Retrieve the employee's rank
            char rank = objRank.getRank(empID);

            // Verify the rank value
            if(rank == 'A') {
                System.out.println("Employee rank is:"+ rank);
                System.out.println("Status: Eligible for upgrade");
            }
            else{
                System.out.println("Status: Not Eligible for upgrade");
            }
        }
        else{
            System.out.println("Status: Not Eligible for upgrade");
        }
    }
}
```

Local Class 5-6

```
/**
 * Define the class TestEmployee.java
 *
 */
public class TestEmployee {

    /**
     * @param args the command line arguments
     */
    public static void main(String[] args)
    {
        if(args.length==2) {
            // Object of outer class
            Employee objEmp1 = new Employee();
            // Invoke the evaluateStatus() method
            objEmp1.evaluateStatus(args[0], Integer.parseInt(args[1]));
        }
        else{
            System.out.println("Usage: java Employee <Emp-Id> <Age>");
        }
    }
}
```

Local Class 6-6

- The class **Employee** is the outer class with a method named **evaluateStatus(String,int)**.
- The class **Rank** is a local inner class within the method.
- The **Rank** class consists of one method **getRank()** that returns the rank of the specified employee Id.
- If the age of the employee is greater than 40, the object of **Rank** class is created and the rank is retrieved.
- If the rank is equal to '**A**' then, the employee is eligible for upgrade otherwise the employee is not eligible.
- Following figure shows the output of the code when user passes '**E001**' as employee Id and **50** for age:

Anonymous Class 1-6

An inner class declared without a name within a code block such as the body of a method is called an anonymous inner class.

An anonymous class does not have a name associated, so it can be accessed only at the point where it is defined.

It cannot use the `extends` and `implements` keywords nor can specify any access modifiers, such as `public`, `private`, `protected`, and `static`.

It cannot define a constructor, `static` fields, methods, or classes.

It cannot implement anonymous interfaces because an interface cannot be implemented without a name.

Since, an anonymous class does not have a name, it cannot have a named constructor but it can have an instance initializer.

Rules for accessing an anonymous class are the same as that of local inner class.

Anonymous Class 2-6

- Usually, anonymous class is an implementation of its super class or interface and contains the implementation of the methods.
- Anonymous inner classes have a scope limited to the outer class.
- They can access the internal or private members and methods of the outer class.
- Anonymous class is useful for controlled access to the internal details of another class.
- Also, it is useful when a user wants only one instance of a special class.
- Following figure displays an anonymous class:

Anonymous Class 3-6

- Following code snippet describes an example of anonymous class:

```
package session11;
class Authenticate {
    /**
     * Define an anonymous class
     *
     */
    Account objAcc = new Account() {
        /**
         * Displays balance
         *
         * @param accNo a String variable storing balance
         * @return void
         */
        @Override
        public void displayBalance(String accNo) {
        System.out.println("Retrieving balance. Please wait...");

        // Assume that the server returns 40000
        System.out.println("Balance of account number " + accNo.toUpperCase()
         + " is $40000");
        }
```

Anonymous Class 4-6

```
    }; // End of anonymous class
}
/**
 * Define the Account class
 *
 */
class Account {
    /**
     * Displays balance
     *
     * @param accNo a String variable storing balance
     * @return void
     */
    public void displayBalance(String accNo) {
    }
}

/**
 * Define the TestAuthentication class
 *
 */
public class TestAuthentication {
```

Anonymous Class 5-6

```
    /**
     * @param args the command line arguments
     */
    public static void main(String[] args) {
        // Instantiate the Authenticate class
        Authenticate objUser = new Authenticate()
        // Check the number of command line arguments
        if (args.length == 3) {
            if (args[0].equals("admin") && args[1].equals("abc@123")){
                // Invoke the displayBalance() method
                objUser.objAcc.displayBalance(args[2]);
            }
            else{
               System.out.println("Unauthorized user");
            }
        }
        else {
            System.out.println("Usage: java Authenticate <user-name> <password>
            <account-no>");
        }
    }
}
```

Anonymous Class 6-6

- The class **Authenticate** consists of an anonymous object of type **Account**.
- The **displayBalance(String)** method is used to retrieve and display the balance of the specified account number.
- Following figure shows the output of the code when user passes '**admin**', '**abc@123**', and '**akdle26152**', as arguments:

Static Nested Class 1-7

A `static` nested class is associated with the outer class just like variables and methods.

A `static` nested class cannot directly refer to instance variables or methods of the outer class just like `static` methods but can access only through an object reference.

A `static` nested class, by behavior, is a top-level class that has been nested in another top-level class for packaging convenience.

`Static` nested classes are accessed using the fully qualified class name, that is, **`OuterClass.StaticNestedClass`**.

A `static` nested class can have `public`, `protected`, `private`, default or package `private`, `final`, and `abstract` access specifiers.

- Following code snippet demonstrates the use of static nested class:

```
package session11;
import java.util.Calendar;
class AtmMachine {
    /**
     * Define the static nested class
     *
```

Static Nested Class 2-7

```
*/
static class BankDetails
{
    // Instantiate the Calendar class of java.util package
    static Calendar objNow = Calendar.getInstance();

    /**
     * Displays the bank and transaction details
     *
     * @return void
     */
    public static void printDetails(){
        System.out.println("State Bank of America");
        System.out.println("Branch: New York");
        System.out.println("Code: K3983LKSIE");

        // retrieving current date and time using Calendar object
        System.out.println("Date-Time:" + objNow.getTime());
    }
}
```

Static Nested Class 3-7

```
    /**
     * Displays balance
     * @param accNo a String variable that stores the account number
     * @return void
     */
    public void displayBalance(String accNo) {
        // Assume that the server returns 200000
        System.out.println("Balance of account number " + accNo.toUpperCase() +
         " is $200000");
    }
}

/**
 * Define the TestATM class
 *
 */
public class TestATM {
    /**
     * @param args the command line arguments
     */
    public static void main(String[] args) {
```

Static Nested Class 4-7

```
        if(args.length ==1) { // verifying number of command line arguments
            // Instantiate the outer class
            AtmMachine objAtm = new AtmMachine();
            // Invoke the static nested class method using outer class object
            AtmMachine.BankDetails.printDetails();
            // Invoke the instance method of outer class
            objAtm.displayBalance(args[0]);
        }
        else{
            System.out.println("Usage: java AtmMachine <account-no>");
        }
    }
}
```

- Following figure shows the output of the code when user passes '**akdle26152**' as account number:

Static Nested Class 5-7

- Notice that the output of date and time shows the default format as specified in the implementation of the getTime() method.
- The format can be modified according to the user requirement using the SimpleDateFormat class of java.text package.
- SimpleDateFormat is a concrete class used to format and parse dates in a locale-specific manner.
- SimpleDateFormat class allows specifying user-defined patterns for date-time formatting.
- The modified **BankDetails** class using **SimpleDateFormat** class is displayed in the following code snippet:

```
import java.text.SimpleDateFormat;
import java.util.Calendar;
class AtmMachine {
    /**
     * Define the static nested class
     *
     */
    static class BankDetails {
        // Instantiate the Calendar class of java.util package
        static Calendar objNow = Calendar.getInstance();
```

Static Nested Class 6-7

```
        /**
         * Displays the bank and transaction details
         *
         * @return void
         */
        public static void printDetails(){
            System.out.println("State Bank of America");
            System.out.println("Branch: New York");
            System.out.println("Code: K3983LKSIE");

            // Format the output of date-time using SimpleDateFormat class
            SimpleDateFormat objFormat = new SimpleDateFormat("dd/MM/yyyy
             HH:mm:ss");

            // Retrieve the current date and time using Calendar object
            System.out.println("Date-Time:" +
            objFormat.format(objNow.getTime()));
        }
    }
    …
    …
}
```

Static Nested Class 7-7

- The SimpleDateFormat class constructor takes the date pattern as a String.
- In the code, the pattern **dd/MM/yyyy HH:mm:ss** uses several symbols that are pattern letters recognized by the SimpleDateFormat class.
- Following table lists the pattern letters used in the code with their description:

Pattern Letter	Description
d	Day of the month
M	Month of the year
y	Year
H	Hour of a day (0-23)
m	Minute of an hour
s	Second of a minute

- Following figure shows the output of the modified code:

- The date and time are now displayed in the specified format that is more understandable to the user.

Summary

- Java allows defining a class within another class. Such a class is called a nested class.
- A member class is a non-static inner class. It is declared as a member of the outer or enclosing class.
- An inner class defined within a code block such as the body of a method, constructor, or an initializer, is termed as a local inner class.
- An inner class declared without a name within a code block such as the body of a method is called an anonymous inner class.
- A static nested class cannot directly refer to instance variables or methods of the outer class just like static methods but only through an object reference.