UNIT 7

FILE HANDLING IN JAVA

INTRODUCTION

- **Java I/O** (Input and Output) is used *to process the input* and *produce the output*.
- Java uses the concept of stream to make I/O operation fast. The java.io package contains all the classes required for input and output operations.
- We can perform **file handling in java** by Java I/O API.

Stream

A stream can be defined as a sequence of data.

- A stream is a sequence of data.In Java a stream is composed of bytes. It's called a stream because it is like a stream of water that continues to flow.
- In java, 3 streams are created for us automatically. All these streams are attached with console.

1) **System.out:** standard output stream
2) **System.in:** standard input stream
3) **System.err:** standard error stream

There are two kinds of Streams –

- **InPutStream** − The InputStream is used to read data from a source.
- **OutPutStream** − The OutputStream is used for writing data to a destination.

Let's see the code to print **output and error** message to the console.

```
1. System.out.println("simple message");
2. System.err.println("error message");
```

Let's see the code to get **input** from console.

```
1. int i=System.in.read();//returns ASCII code of 1st character
2. System.out.println((char)i);//will print the character
```

Standard Streams

All the programming languages provide support for standard I/O where the user's program can take input from a keyboard and then produce an output on the computer screen. If you are aware of C or C++ programming languages, then you must be aware of three standard devices STDIN, STDOUT and STDERR. Similarly, Java provides the following three standard streams −

- **Standard Input** − This is used to feed the data to user's program and usually a keyboard is used as standard input stream and represented as **System.in**.
- **Standard Output** − This is used to output the data produced by the user's program and usually a computer screen is used for standard output stream and represented as **System.out**.
- **Standard Error** − This is used to output the error data produced by the user's program and usually a computer screen is used for standard error stream and represented as **System.err**.

7.1) INPUT STREAMS AND OUTPUT STREAMS:-

7.1.1) INPUT STREAMS

The InputStream class is the base class (superclass) of all input streams in the Java IO API. InputStream Subclasses include the FileInputStream, BufferedInputStreamand the PushbackInputStream among others.

Java InputStream Example

Java InputStream's are used for reading byte based data, one byte at a time. Here is a Java InputStream example:

```
InputStreaminputstream = new FileInputStream("c:\\data\\input-text.txt");

int data = inputstream.read();
while(data != -1) {
  //do something with data...
doSomethingWithData(data);

data = inputstream.read();
}
inputstream.close();
```

This example creates a new FileInputStream instance. FileInputStream is a subclass of InputStream so it is safe to assign an instance of FileInputStream to an InputStream variable (the inputstream variable).

From Java 7 you can use the **try-with-resources** construct to make sure the InputStream is properly closed after use. The link in the previous sentence points to an article that explains how it works in more detail, but here is a simple example:

```
try(InputStreaminputstream = new FileInputStream("file.txt") ) {

int data = inputstream.read();
while(data != -1){
System.out.print((char) data);
data = inputstream.read();
```

```
    }
}
```

Once the executing thread exits the try block, the inputstream variable is closed.

read()

The read() method of an InputStream returns an int which contains the byte value of the byte read. Here is an InputStream read() example:

```
int data = inputstream.read();
```

You can case the returned int to a char like this:

```
charaChar = (char) data;
```

Subclasses of InputStream may have alternative read() methods. For instance, theDataInputStream allows you to read Java primitives like int, long, float, double, boolean etc. with its corresponding methods readBoolean(), readDouble() etc.

End of Stream

If the read() method returns -1, the end of stream has been reached, meaning there is no more data to read in the InputStream. That is, -1 as int value, not -1 as byte or short value. There is a difference here!

When the end of stream has been reached, you can close the InputStream.

read(byte[])

The InputStream class also contains two read() methods which can read data from the InputStream's source into a byte array. These methods are:

- int read(byte[])
- int read(byte[], int offset, int length)

Reading an array of bytes at a time is much faster than reading one byte at a time, so when you can, use these read methods instead of the read() method.

The read(byte[]) method will attempt to read as many bytes into the byte array given as parameter as the array has space for. The read(byte[]) method returns an int telling how many bytes were actually read. In case less bytes could be read from the InputStream than the byte array has space for, the rest of the byte array will contain the same data as it did before the read started. Remember to inspect the returned int to see how many bytes were actually read into the byte array.

The read(byte[], int offset, int length) method also reads bytes into a bytearray, but starts at offset bytes into the array, and reads a maximum of length bytes into the array from that position. Again, the read(byte[], int offset, int length)method returns an int telling how many

bytes were actually read into the array, so remember to check this value before processing the read bytes.

For both methods, if the end of stream has been reached, the method returns -1 as the number of bytes read.

Here is an example of how it could looke to use the InputStream's read(byte[])method:

```
InputStreaminputstream = new FileInputStream("c:\\data\\input-text.txt");

byte[] data     = new byte[1024];
intbytesRead = inputstream.read(data);

while(bytesRead != -1) {
doSomethingWithData(data, bytesRead);

bytesRead = inputstream.read(data);
}
inputstream.close();
```

First this example create a byte array. Then it creates an int variable namedbytesRead to hold the number of bytes read for each read(byte[]) call, and immediately assigns bytesRead the value returned from the first read(byte[]) call.

Inside the while loop the doSomethingWithData() method is called, passing along the data byte array as well as how many bytes were read into the array as parameters. At the end of the while loop data is read into the byte array again.

It should not take much imagination to figure out how to use the read(byte[], int offset, int length) method instead of read(byte[]). You pretty much just replace the read(byte[]) calls with read(byte[], int offset, int length) calls.

mark() and reset()

The InputStream class has two methods called mark() and reset() which subclasses of InputStream may or may not support.

If an InputStream subclass supports the mark() and reset() methods, then that subclass should override the markSupported() to return true. If the markSupported()method returns false then mark() and reset() are not supported.

The mark() sets a mark internally in the InputStream which marks the point in the stream to which data has been read so far. The code using the InputStream can then continue reading data from it. If the code using the InputStream wants to go back to the point in the stream where the mark was set, the code calls reset() on the InputStream. The InputStream then "rewinds" and go back to the mark, and start returning (reading) data from that point again. This will of course result in some data being returned more than once from the InputStream.

The methods mark() and reset() methods are typically used when implementing parsers. Sometimes a parser may need to read ahead in the InputStream and if the parser doesn't find

what it expected, it may need to rewind back and try to match the read data against something else.

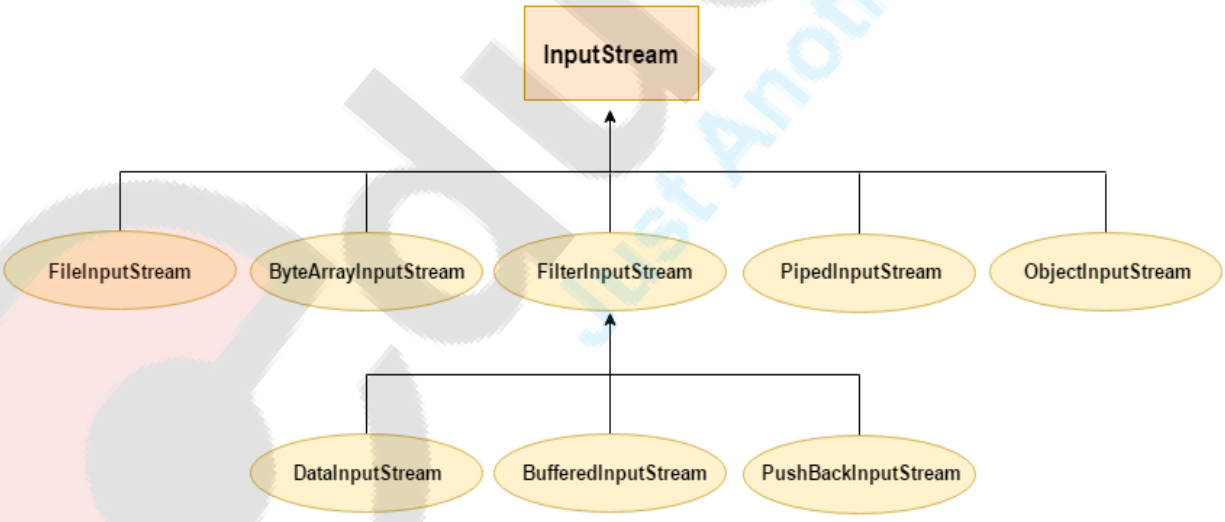
InputStream class

InputStream class is an abstract class. It is the super class of all classes representing an input stream of bytes.

Useful methods of InputStream

Method	Description
1) public abstract int read()throws IOException	reads the next byte of data from the input stream. It returns -1 at the end of file.
2) public int available()throws IOException	returns an estimate of the number of bytes that can be read from the current input stream.
3) public void close()throws IOException	is used to close the current input stream.

InputStream Hierarchy



7.1.2) OUTPUT STREAMS

- Java application uses an output stream to write data to a destination, it may be a file, an array, peripheral device or socket.
- The OutputStream class is the base class of all output streams in the Java IO API. Subclasses include the BufferedOutputStream and the FileOutputStream among others.

write(byte)

The write(byte) method is used to write a single byte to the OutputStream.
The write() method of an OutputStream takes an int which contains the byte value of the byte to write. Only the first byte of the int value is written. The rest is ignored.

Subclasses of OutputStream may have alternative write() methods. For instance, theDataOutputStream allows you to write Java primitives like int, long, float, double, boolean etc. with its corresponding methods writeBoolean(), writeDouble() etc.

Here is an OutputStream write() example:

```
OutputStream output = new FileOutputStream("c:\\data\\output-text.txt");

while(hasMoreData()) {
int data = getMoreData();
output.write(data);
}
output.close();
```

This OutputStream write() example first creates a FileOutputStream to which the data will be written. Then the example enters a while loop. The condition to exit the while loop is the return value of the method hasMoreData(). The implementation of hasMoreData() is not shown, but imagine that it returns true if there is more data to write, and false if not.

Inside the while loop the example calls the method getMoreData() to get the next data to write to the OutputStream, and then writes that data to the OutputStream. The while loop continues until hasMoreData() returns false.

Note: The proper exception handling has been skipped here for the sake of clarity. To learn more about correct exception handling, go to **Java IO Exception Handling**.

write(byte[])

The OutputStream class also has a write(byte[] bytes) method and a write(byte[] bytes, int offset, int length) which both can write an array or part of an array of bytes to the OutputStream.

The write(byte[] bytes) method writes all the bytes in the byte array to theOutputStream.

The write(byte[] bytes, int offset, int length) method writes length bytes starting from index offset from the byte array to the OutputStream.

flush()

The OutputStream's flush() method flushes all data written to the OutputStream to the underlying data destination. For instance, if the OutputStream is a FileOutputStreamthen bytes written to the FileOutputStream may not have been fully written to disk yet. The data might be buffered in memory somewhere, even if your Java code has written it to

the FileOutputStream. By calling flush() you can assure that any buffered data will be flushed (written) to disk (or network, or whatever else the destination of your OutputStream has).

close()

Once you are done writing data to the OutputStream you should close it. You close anOutputStream by calling its close() method. Since the OutputStream's various write()methods may throw an IOException, you should close the OutputStream inside a finally block. Here is a simple OutputStream close()

example:

```
OutputStream output = null;

try{
output = new FileOutputStream("c:\\data\\output-text.txt");

while(hasMoreData()) {
int data = getMoreData();
output.write(data);
  }
} finally {
if(output != null) {
output.close();
   }
}
```

This simple example calls the OutputStream close() method inside a finally block. While this makes sure that the OutputStream is closed, it still does not provide perfect exception handling.

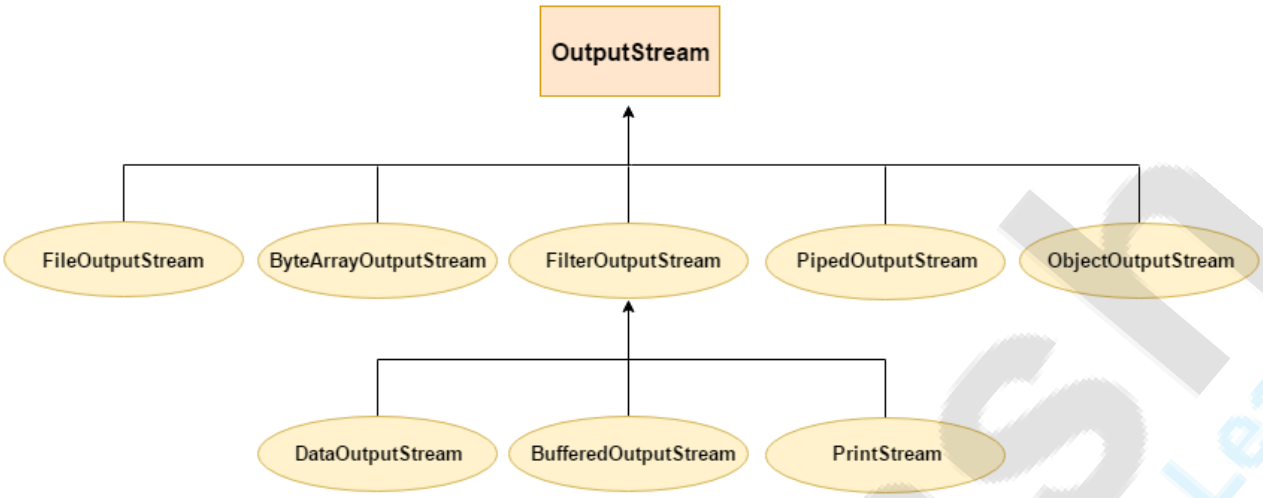
OutputStream class

OutputStream class is an abstract class. It is the super class of all classes representing an output stream of bytes. An output stream accepts output bytes and sends them to some sink.

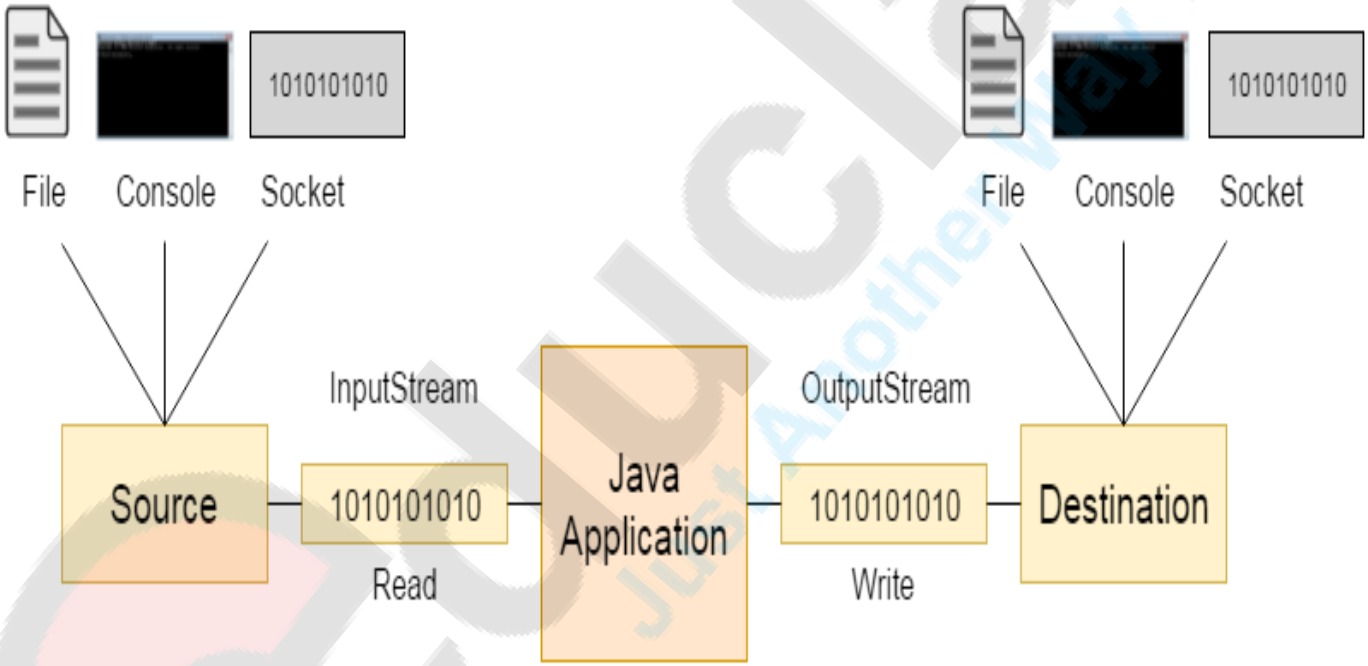
Useful methods of OutputStream

Method	Description
1) public void write(int)throws IOException	is used to write a byte to the current output stream.
2) public void write(byte[])throws IOException	is used to write an array of byte to the current output stream.
3) public void flush()throws IOException	flushes the current output stream.
4) public void close()throws IOException	is used to close the current output stream.

OutputStream Hierarchy



Let's understand working of Java OutputStream and InputStream by the figure given below.



7.2)FileInputStream and FileOutStream

7.2.1)FileInputStream:-

Java FileInputStream class obtains input bytes from a file. It is used for reading byte-oriented data (streams of raw bytes) such as image data, audio, video etc. You can also read character-stream data. But, for reading streams of characters, it is recommended to use FileReader class.

This stream is used for reading data from the files. Objects can be created using the keyword **new** and there are several types of constructors available.

Following constructor takes a file name as a string to create an input stream object to read the file −

```
InputStream f = new FileInputStream("C:/java/hello");
```

Following constructor takes a file object to create an input stream object to read the file. First we create a file object using File() method as follows −

```
File f = new File("C:/java/hello");
InputStream f = new FileInputStream(f);
```

Java FileInputStream class declaration

Let's see the declaration for java.io.FileInputStream class:

1. **public class** FileInputStream **extends** InputStream

Java FileInputStream class methods

Method	Description
int available()	It is used to return the estimated number of bytes that can be read from the input stream.
int read()	It is used to read the byte of data from the input stream.
int read(byte[] b)	It is used to read up to b.length bytes of data from the input stream.
int read(byte[] b, int off, intlen)	It is used to read up to len bytes of data from the input stream.
long skip(long x)	It is used to skip over and discards x bytes of data from the input stream.
FileChannelgetChannel()	It is used to return the unique FileChannel object associated with the file input stream.
FileDescriptorgetFD()	It is used to return the FileDescriptor object.
protected void finalize()	It is used to ensure that the close method is call when there is no more reference to the file input stream.
void close()	It is used to closes the stream.

Java FileInputStream example 1: read single character

```
import java.io.FileInputStream;
public class DataStreamExample {
public static void main(String args[]){
try{
FileInputStream fin=new FileInputStream("D:\\testout.txt");
int i=fin.read();
System.out.print((char)i);

fin.close();
}catch(Exception e){System.out.println(e);}
}
}
```

Note: Before running the code, a text file named as **"testout.txt"** is required to be created. In this file, we are having following content:

```
Welcome to MCA
```

After executing the above program, you will get a single character from the file which is 87 (in byte form). To see the text, you need to convert it into character.

Output:

```
W
```

Java FileInputStream example 2: read all characters

```
package com.MCA;


import java.io.FileInputStream;

public class DataStreamExample {

public static void main(String args[]){

try{

FileInputStream fin=new FileInputStream("D:\\testout.txt");

int i=0;

while((i=fin.read())!=-1){

System.out.print((char)i);

}

fin.close();
```

```
}catch(Exception e){System.out.println(e);}

}

}
```

Output:

Welcome to MCA

Once you have *InputStream* object in hand, then there is a list of helper methods which can be used to read to stream or to do other operations on the stream.

Sr.No.	Method & Description
1	**public void close() throws IOException{}** **This method closes the file output stream. Releases any system resources associated with the file. Throws an IOException.**
2	**protected void finalize()throws IOException {}** **This method cleans up the connection to the file. Ensures that the close method of this file output stream is called when there are no more references to this stream. Throws an IOException.**
3	**public int read(int r)throws IOException{}** **This method reads the specified byte of data from the InputStream. Returns an int. Returns the next byte of data and -1 will be returned if it's the end of the file.**
4	**public int read(byte[] r) throws IOException{}** **This method reads r.length bytes from the input stream into an array. Returns the total number of bytes read. If it is the end of the file, -1 will be returned.**
5	**public int available() throws IOException{}** **Gives the number of bytes that can be read from this file input stream. Returns an int.**

7.2.2) FileOutputStream

- FileOutputStream is used to create a file and write data into it. The stream would create a file, if it doesn't already exist, before opening it for output.
- Java FileOutputStream is an output stream used for writing data to a file.
- If you have to write primitive values into a file, use FileOutputStream class. You can write byte-oriented as well as character-oriented data through FileOutputStream class. But, for character-oriented data, it is preferred to use FileWriter than FileOutputStream.
- Here are two constructors which can be used to create a FileOutputStream object.

- Following constructor takes a file name as a string to create an input stream object to write the file −

```
OutputStream f = new FileOutputStream("C:/java/hello")
```

- Following constructor takes a file object to create an output stream object to write the file. First, we create a file object using File() method as follows −

```
File f = new File("C:/java/hello");
OutputStream f = new FileOutputStream(f);
```

FileOutputStream class declaration

Let's see the declaration for Java.io.FileOutputStream class:

1. **public class** FileOutputStream **extends** OutputStream

---

FileOutputStream class methods

Method	Description
protected void finalize()	It is sued to clean up the connection with the file output stream.
void write(byte[] ary)	It is used to write ary.length bytes from the byte array to the file output stream.
void write(byte[] ary, int off, intlen)	It is used to write len bytes from the byte array starting at offset off to the file output stream.
void write(int b)	It is used to write the specified byte to the file output stream.
FileChannelgetChannel()	It is used to return the file channel object associated with the file output stream.
FileDescriptorgetFD()	It is used to return the file descriptor associated with the stream.
void close()	It is used to closes the file output stream.

Java FileOutputStream Example 1: write byte

```
import java.io.FileOutputStream;
public class FileOutputStreamExample {
   public static void main(String args[]){
        try{
         FileOutputStream fout=new FileOutputStream("D:\\testout.txt");
         fout.write(65);
         fout.close();
```

```
        System.out.println("success...");
       }catch(Exception e){System.out.println(e);}
    }
}
```

Output:

```
Success...
```

The content of a text file **testout.txt** is set with the data **A**.

testout.txt

```
A
```

Java FileOutputStream example 2: write string

```
import java.io.FileOutputStream;
public class FileOutputStreamExample {
public static void main(String args[]){
try{
FileOutputStream fout=new FileOutputStream("D:\\testout.txt");
String s="Welcome to MCA.";
byte b[]=s.getBytes();//converting string into byte array
fout.write(b);
fout.close();
System.out.println("success...");
}catch(Exception e){System.out.println(e);}
}
}
```

Output:

```
Success...
```

The content of a text file **testout.txt** is set with the data **Welcome to MCA.**

testout.txt

```
Welcome to MCA.
```

Once you have *OutputStream* object in hand, then there is a list of helper methods, which can be used to write to stream or to do other operations on the stream.

Sr.No.	Method & Description
1	public void close() throws IOException{} This method closes the file output stream. Releases any system resources associated with the file. Throws an IOException.

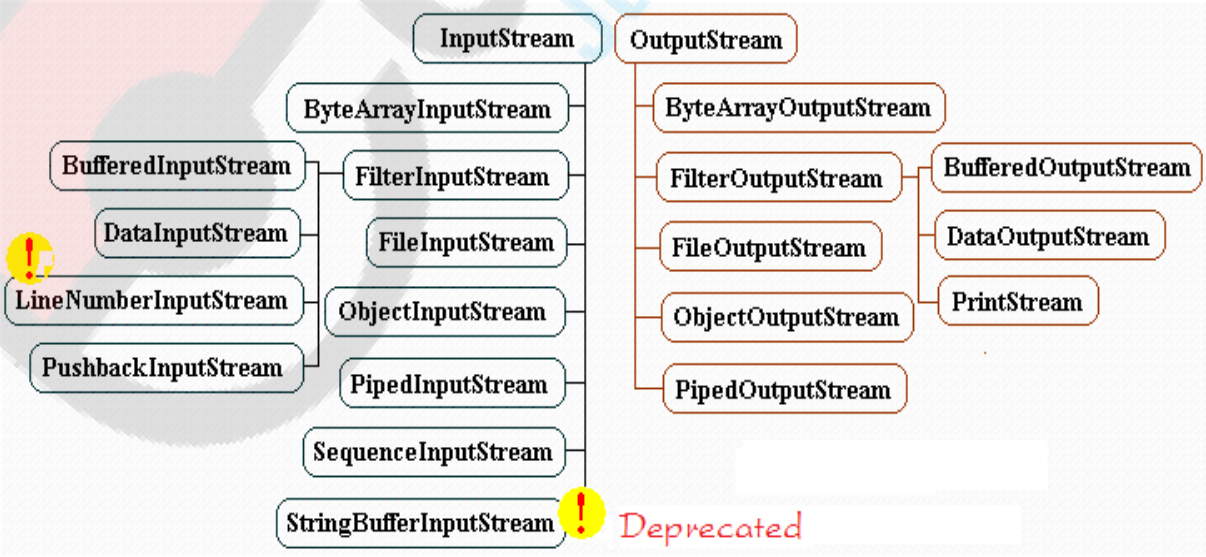
2	protected void finalize()throws IOException {} This method cleans up the connection to the file. Ensures that the close method of this file output stream is called when there are no more references to this stream. Throws an IOException.
3	public void write(int w)throws IOException{} This methods writes the specified byte to the output stream.
4	public void write(byte[] w) Writes w.length bytes from the mentioned byte array to the OutputStream.

7.3) BINARY AND CHARACTER STREAMS:-

7.3.1) BINARY STREAM

Overview of binary stream

Binary Stream is led by two classes: **InputStream** and **OutputStream**. Following two classes is a variety of affiliated classes. As for the balance of power, the relationship of binary stream is more diverse and sophisticated than that of character stream. Regarding JDK1.5 in binary stream, two classes, **LineNumberInputStream** and **StringBufferInputStream**, are advised not to use because they are deprecated.



Example

Following is the example to demonstrate Binary Stream forInputStream and OutputStream −

```
import java.io.*;
publicclassfileStreamTest{

publicstaticvoid main(Stringargs[]){

try{
bytebWrite[]={11,21,3,40,5};
OutputStreamos=newFileOutputStream("test.txt");
for(int x =0; x <bWrite.length; x++){
os.write(bWrite[x]);// writes the bytes
}
os.close();

InputStreamis=newFileInputStream("test.txt");
int size =is.available();

for(inti=0;i< size;i++){
System.out.print((char)is.read()+"  ");
}
is.close();
}catch(IOException e){
System.out.print("Exception");
}
}
}
```

The above code would create file test.txt and would write given numbers in binary format. Same would be the output on the stdout screen.

7.3.2) CHARACTER STREAM

Java **Byte** streams are used to perform input and output of 8-bit bytes, whereas Java **Character** streams are used to perform input and output for 16-bit unicode. Though there are many classes related to character streams but the most frequently used classes are, **FileReader** and **FileWriter**. Though internally FileReader uses FileInputStream and FileWriter uses FileOutputStream but here the major difference is that FileReader reads two bytes at a time and FileWriter writes two bytes at a time.

We can re-write the above example, which makes the use of these two classes to copy an input file (having unicode characters) into an output file −

Example

```
import java.io.*;
publicclassCopyFile{

publicstaticvoid main(Stringargs[])throwsIOException{
```

```
FileReaderin=null;
FileWriterout=null;

try{
in=newFileReader("input.txt");
out=newFileWriter("output.txt");

int c;
while((c =in.read())!=-1){
out.write(c);
}
}finally{
if(in!=null){
in.close();
}
if(out!=null){
out.close();
}
}
}
}
```

Now let's have a file **input.txt** with the following content −

```
This is test for copy file.
```

As a next step, compile the above program and execute it, which will result in creating output.txt file with the same content as we have in input.txt. So let's put the above code in CopyFile.java file and do the following −

```
$javac CopyFile.java
$java CopyFile
```

7.4)BUFFERED READER/WRITER

7.41) BUFFERED READER :-

Java BufferedReader class is used to read the text from a character-based input stream. It can be used to read data line by line by readLine() method. It makes the performance fast. It inherits Reader class.

The **Java.io.BufferedReader** class reads text from a character-input stream, buffering characters so as to provide for the efficient reading of characters, arrays, and lines.Following are the important points about BufferedReader −

- The buffer size may be specified, or the default size may be used.
- Each read request made of a Reader causes a corresponding read request to be made of the underlying character or byte stream.

Field

Following are the fields for **Java.io.BufferedReader** class −

- **protected Object lock** − This is the object used to synchronize operations on this stream.

Methods inherited

This class inherits methods from the following classes −

- Java.io.Reader
- Java.io.Object

Java BufferedReader class declaration

Let's see the declaration for Java.io.BufferedReader class:

```
1. public class BufferedReader extends Reader
```

Java BufferedReader class constructors

Constructor	Description
BufferedReader(Reader rd)	It is used to create a buffered character input stream that uses the default size for an input buffer.
BufferedReader(Reader rd, int size)	It is used to create a buffered character input stream that uses the specified size for an input buffer.

Java BufferedReader class methods

Method	Description
int read()	It is used for reading a single character.
int read(char[] cbuf, int off, intlen)	It is used for reading characters into a portion of an array.
booleanmarkSupported()	It is used to test the input stream support for the mark and reset method.
String readLine()	It is used for reading a line of text.
boolean ready()	It is used to test whether the input stream is ready to be read.

long skip(long n)	It is used for skipping the characters.
void reset()	It repositions the stream at a position the mark method was last called on this input stream.
void mark(intreadAheadLimit)	It is used for marking the present position in a stream.
void close()	It closes the input stream and releases any of the system resources associated with the stream.

Java BufferedReader Example

In this example, we are reading the data from the text file **testout.txt** using Java BufferedReader class.

```
package com.MCA;
import java.io.*;
public class BufferedReaderExample {
public static void main(String args[])throws Exception{
FileReader fr=new FileReader("D:\\testout.txt");
BufferedReader br=new BufferedReader(fr);

int i;
while((i=br.read())!=-1){
System.out.print((char)i);
}
br.close();
fr.close();
}
}
```

Here, we are assuming that you have following data in "testout.txt" file:

Welcome to MCA.

Output:

Welcome to MCA.

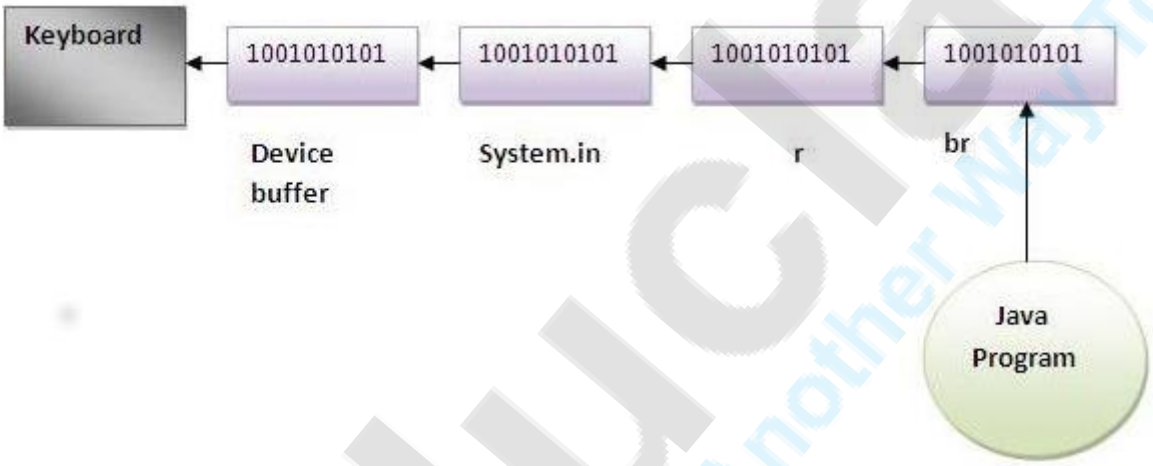
Reading data from console by InputStreamReader and BufferedReader

In this example, we are connecting the BufferedReader stream with the InputStreamReader stream for reading the line by line data from the keyboard.

```
package com.MCA;
import java.io.*;
public class BufferedReaderExample{
public static void main(String args[])throws Exception{
InputStreamReader r=new InputStreamReader(System.in);
BufferedReader br=new BufferedReader(r);
System.out.println("Enter your name");
String name=br.readLine();
System.out.println("Welcome "+name);
}
}
```

Output:

```
Enter your name
Nakul Jain
Welcome Nakul Jain
```



Another example of reading data from console until user writes stop

In this example, we are reading and printing the data until the user prints stop.

```
package com.MCA;
import java.io.*;
public class BufferedReaderExample{
public static void main(String args[])throws Exception{
InputStreamReader r=new InputStreamReader(System.in);
BufferedReader br=new BufferedReader(r);
String name="";
while(!name.equals("stop")){
System.out.println("Enter data: ");
name=br.readLine();
System.out.println("data is: "+name);
}
br.close();
r.close();
```

```
}
}
```

Output:

```
Enter data: Nakul
data is: Nakul
Enter data: 12
data is: 12
Enter data: stop
data is: stop
```

7.4.2)JAVA BUFFERED WRITER

Java BufferedWriter class is used to provide buffering for Writer instances. It makes the performance fast. It inherits Writer class. The buffering characters are used for providing the efficient writing of single arrays, characters, and strings.

The **Java.io.BufferedWriter** class writes text to a character-output stream, buffering characters so as to provide for the efficient writing of single characters, arrays, and strings.Following are the important points about BufferedWriter −

- The buffer size may be specified, or the default size may be used.
- A Writer sends its output immediately to the underlying character or byte stream.

Field

Following are the fields for **Java.io.BufferedWriter** class −

- **protected Object lock** − This is the object used to synchronize operations on this stream.

Methods inherited

This class inherits methods from the following classes −

- Java.io.Writer
- Java.io.Object

Class declaration

Let's see the declaration for Java.io.BufferedWriter class:

1. **public class** BufferedWriter **extends** Writer

Class constructors

Constructor	Description
BufferedWriter(Writer wrt)	It is used to create a buffered character output stream that uses the default size for an output buffer.
BufferedWriter(Writer wrt, int size)	It is used to create a buffered character output stream that uses the specified size for an output buffer.

Class methods

Method	Description
void newLine()	It is used to add a new line by writing a line separator.
void write(int c)	It is used to write a single character.
void write(char[] cbuf, int off, intlen)	It is used to write a portion of an array of characters.
void write(String s, int off, intlen)	It is used to write a portion of a string.
void flush()	It is used to flushes the input stream.
void close()	It is used to closes the input stream

Example of Java BufferedWriter

Let's see the simple example of writing the data to a text file **testout.txt** using Java BufferedWriter.

```
package com.MCA;
import java.io.*;
public class BufferedWriterExample {
public static void main(String[] args) throws Exception {
FileWriter writer = new FileWriter("D:\\testout.txt");
BufferedWriter buffer = new BufferedWriter(writer);
buffer.write("Welcome to MCA.");
buffer.close();
System.out.println("Success");
}
}
```

Output:

```
success
```

testout.txt:

```
Welcome to MCA.
```

7.5) OBJECT SERIALIZATION IN JAVA

Serialization in java is a mechanism of *writing the state of an object into a byte stream*.

It is mainly used in Hibernate, RMI, JPA, EJB and JMS technologies.

Java provides a mechanism, called object serialization where an object can be represented as a sequence of bytes that includes the object's data as well as information about the object's type and the types of data stored in the object.

After a serialized object has been written into a file, it can be read from the file and deserialized that is, the type information and bytes that represent the object and its data can be used to recreate the object in memory.

Most impressive is that the entire process is JVM independent, meaning an object can be serialized on one platform and deserialized on an entirely different platform.

Classes **ObjectInputStream** and **ObjectOutputStream** are high-level streams that contain the methods for serializing and deserializing an object.

The ObjectOutputStream class contains many write methods for writing various data types, but one method in particular stands out −

```
public final void writeObject(Object x) throws IOException
```

The above method serializes an Object and sends it to the output stream. Similarly, the ObjectInputStream class contains the following method for deserializing an object −

```
public final Object readObject() throws IOException, ClassNotFoundException
```

This method retrieves the next Object out of the stream and deserializes it. The return value is Object, so you will need to cast it to its appropriate data type.

To demonstrate how serialization works in Java, I am going to use the Employee class that we discussed early on in the book. Suppose that we have the following Employee class, which implements the Serializable interface −

Example

```
publicclassEmployeeimplementsjava.io.Serializable{
publicString name;
publicString address;
publictransientint SSN;
```

```
publicint number;

publicvoidmailCheck(){
System.out.println("Mailing a check to "+ name +" "+ address);
}
}
```

Notice that for a class to be serialized successfully, two conditions must be met −

- The class must implement the java.io.Serializable interface.
- All of the fields in the class must be serializable. If a field is not serializable, it must be marked **transient**.

If you are curious to know if a Java Standard Class is serializable or not, check the documentation for the class. The test is simple: If the class implements java.io.Serializable, then it is serializable; otherwise, it's not.

Serializing an Object

The ObjectOutputStream class is used to serialize an Object. The following SerializeDemo program instantiates an Employee object and serializes it to a file.

When the program is done executing, a file named employee.ser is created. The program does not generate any output, but study the code and try to determine what the program is doing.

Note − When serializing an object to a file, the standard convention in Java is to give the file a **.ser** extension.

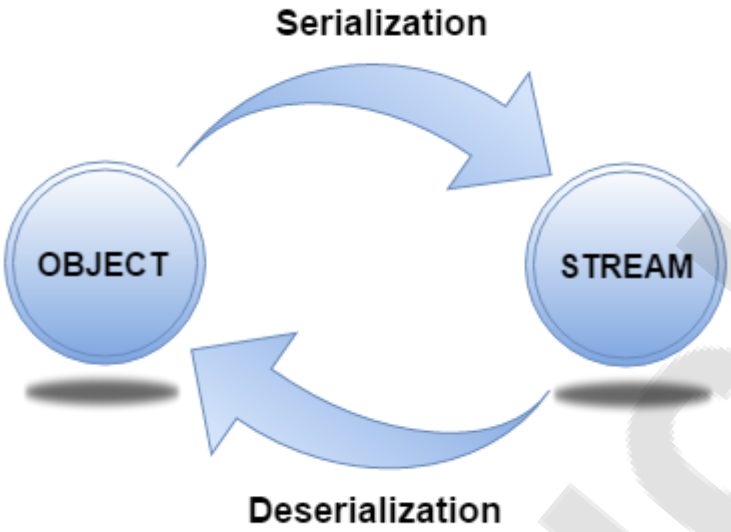
Example

```
import java.io.*;
publicclassSerializeDemo{

publicstaticvoid main(String[]args){
Employee e =newEmployee();
e.name ="Reyan Ali";
e.address="PhokkaKuan, Ambehta Peer";
e.SSN=11122333;
e.number=101;

try{
FileOutputStreamfileOut=
newFileOutputStream("/tmp/employee.ser");
ObjectOutputStreamout=newObjectOutputStream(fileOut);
out.writeObject(e);
out.close();
fileOut.close();
System.out.printf("Serialized data is saved in /tmp/employee.ser");
```

```
}catch(IOExceptioni){
i.printStackTrace();
}
}
}
```

Advantage of Java Serialization

It is mainly used to travel object's state on the network (known as marshaling).



java.io.Serializable interface

- Serializable is a marker interface (has no data member and method). It is used to "mark" java classes so that objects of these classes may get certain capability. The Cloneable and Remote are also marker interfaces.
- It must be implemented by the class whose object you want to persist.
- The String class and all the wrapper classes implements *java.io.Serializable* interface by default.

Let's see the example given below:

```
import java.io.Serializable;
public class Student implements Serializable{
int id;
String name;
public Student(int id, String name) {
this.id = id;
this.name = name;
}
}
```

In the above example, Student class implements Serializable interface. Now its objects can be converted into stream.

ObjectOutputStream class

The ObjectOutputStream class is used to write primitive data types and Java objects to an OutputStream. Only objects that support the java.io.Serializable interface can be written to streams.

Constructor

1) publicObjectOutputStream(OutputStream out) throws IOException {}creates an ObjectOutputStream that writes to the specified OutputStream.

Important Methods

Method	Description
1) public final void writeObject(Object obj) throws IOException {}	writes the specified object to the ObjectOutputStream.
2) public void flush() throws IOException {}	flushes the current output stream.
3) public void close() throws IOException {}	closes the current output stream.

Example of Java Serialization

In this example, we are going to serialize the object of Student class. The writeObject() method of ObjectOutputStream class provides the functionality to serialize the object. We are saving the state of the object in the file named f.txt.

```
1. import java.io.*;
2. class Persist{
3.  public static void main(String args[])throws Exception{
4.   Student s1 =new Student(211,"ravi");
5.
6.   FileOutputStream fout=new FileOutputStream("f.txt");
7.   ObjectOutputStream out=new ObjectOutputStream(fout);
8.
9.   out.writeObject(s1);
10.  out.flush();
```

```
11.  System.out.println("success");
12.  }
13. }
```

success

7.6) DESERIALIZATION IN JAVA

Deserialization is the process of reconstructing the object from the serialized state.It is the reverse operation of serialization.

The following DeserializeDemo program deserializes the Employee object created in the SerializeDemo program. Study the program and try to determine its output −

Example

```
import java.io.*;
publicclassDeserializeDemo{

publicstaticvoid main(String[]args){
Employee e =null;
try{
FileInputStreamfileIn=newFileInputStream("/tmp/employee.ser");
ObjectInputStreamin=newObjectInputStream(fileIn);
e =(Employee)in.readObject();
in.close();
fileIn.close();
}catch(IOExceptioni){
i.printStackTrace();
return;
}catch(ClassNotFoundException c){
System.out.println("Employee class not found");
c.printStackTrace();
return;
}

System.out.println("Deserialized Employee...");
System.out.println("Name: "+ e.name);
System.out.println("Address: "+e.address);
System.out.println("SSN: "+e.SSN);
System.out.println("Number: "+e.number);
}
}
```

This will produce the following result −

Output

```
Deserialized Employee...
Name: Reyan Ali
Address:PhokkaKuan, Ambehta Peer
SSN: 0
Number:101
```

Here are following important points to be noted −

- The try/catch block tries to catch a ClassNotFoundException, which is declared by the readObject() method. For a JVM to be able to deserialize an object, it must be able to find the bytecode for the class. If the JVM can't find a class during the deserialization of an object, it throws a ClassNotFoundException.
- Notice that the return value of readObject() is cast to an Employee reference.
- The value of the SSN field was 11122333 when the object was serialized, but because the field is transient, this value was not sent to the output stream. The SSN field of the deserialized Employee object is 0.

ObjectInputStream class

An ObjectInputStreamdeserializes objects and primitive data written using an ObjectOutputStream.

Constructor

1) public ObjectInputStream(InputStream in) throws IOException {}	creates an ObjectInputStream that reads from the specified InputStream.

Important Methods

Method	Description
1) public final Object readObject() throws IOException, ClassNotFoundException{}	reads an object from the input stream.
2) public void close() throws IOException {}	closesObjectInputStream.

Example of Java Deserialization

```
import java.io.*;
class Depersist{
public static void main(String args[])throws Exception{
```

```
ObjectInputStream in=new ObjectInputStream(new FileInputStream("f.txt"));
Student s=(Student)in.readObject();
System.out.println(s.id+" "+s.name);

in.close();
}
}
```

Output :-

```
211 ravi
```

Java Serialization with Inheritance (IS-A Relationship)

If a class implements serializable then all its sub classes will also be serializable. Let's see the example given below:

```
import java.io.Serializable;
class Person implements Serializable{
 int id;
 String name;
 Person(int id, String name) {
  this.id = id;
  this.name = name;
 }
}
class Student extends Person{
 String course;
 int fee;
 public Student(int id, String name, String course, int fee) {
  super(id,name);
  this.course=course;
  this.fee=fee;
 }
}
```

Now you can serialize the Student class object that extends the Person class which is Serializable.Parent class properties are inherited to subclasses so if parent class is Serializable, subclass would also be.

Java Serialization with Aggregation (HAS-A Relationship)

If a class has a reference of another class, all the references must be Serializable otherwise serialization process will not be performed. In such case, *NotSerializableException* is thrown at runtime.

```
class Address{
 String addressLine,city,state;
```

```
 public Address(String addressLine, String city, String state) {
  this.addressLine=addressLine;
  this.city=city;
  this.state=state;
 }
}
import java.io.Serializable;
public class Student implements Serializable{
 int id;
 String name;
 Address address;//HAS-A
 public Student(int id, String name) {
  this.id = id;
  this.name = name;
 }
}
```

Since Address is not Serializable, you can not serialize the instance of Student class.

Note: All the objects within an object must be Serializable.

Java Serialization with static data member

If there is any static data member in a class, it will not be serialized because static is the part of class not object.

```
class Employee implements Serializable{
 int id;
 String name;
 static String company="SSS IT Pvt Ltd";//it won't be serialized
 public Student(int id, String name) {
  this.id = id;
  this.name = name;
 }
}
```

Java Serialization with array or collection

Rule: In case of array or collection, all the objects of array or collection must be serializable. If any object is not serialiizable, serialization will be failed.

UNIT 8

EVENT HANDLING AND GUI PROGRAMMING

Q.1) comparison of awt and swing

AWT	Swing
AWT stands for Abstract windows toolkit.	Swing is also called as JFC's (Java Foundation classes).
AWT components are called Heavyweight component.	Swings are called light weight component because swing components sits on the top of AWT components and do the work.
AWT components require java.awt package.	Swing components require javax.swing package.
AWT components are platform dependent.	Swing components are made in purely java and they are platform independent.
This feature is not supported in AWT.	We can have different look and feel in Swing.
These feature is not available in AWT.	Swing has many advanced features like JTabel, Jtabbed pane which is not available in AWT. Also. Swing components are called "lightweight" because they do not require a native OS object to implement their functionality. JDialog and JFrame are heavyweight, because they do have a peer. So components like JButton, JTextArea, etc., are lightweight because they do not have an OS peer.
With AWT, you have 21 "peers" (one for each control and one for the dialog itself). A "peer" is a widget provided by the operating system, such as a button object or an entry field object.	With Swing, you would have only one peer, the operating system's window object. All of the buttons, entry fields, etc. are drawn by the Swing package on the drawing surface provided by the window object. This is the reason that Swing has more code. It has to draw the button or other control and implement its behavior instead of relying on the host operating system to perform those functions.
AWT is a thin layer of code on top of the OS.	Swing is much larger. Swing also has very much richer functionality.
Using AWT, you have to implement a lot of things yourself.	Swing has them built in.

Q.2) what is applet

An **applet** is a Java program that runs in a Web browser. An applet can be a fully functional Java application because it has the entire Java API at its disposal.
There are some important differences between an applet and a standalone Java application, including the following −

- An applet is a Java class that extends the java.applet.Applet class.
- A main() method is not invoked on an applet, and an applet class will not define main().
- Applets are designed to be embedded within an HTML page.
- When a user views an HTML page that contains an applet, the code for the applet is downloaded to the user's machine.
- A JVM is required to view an applet. The JVM can be either a plug-in of the Web browser or a separate runtime environment.
- The JVM on the user's machine creates an instance of the applet class and invokes various methods during the applet's lifetime.
- Applets have strict security rules that are enforced by the Web browser. The security of an applet is often referred to as sandbox security, comparing the applet to a child playing in a sandbox with various rules that must be followed.
- Other classes that the applet needs can be downloaded in a single Java Archive (JAR) file.

Q.3) Applet Classes

The Applet Class

Every applet is an extension of the *java.applet.Applet class*. The base Applet class provides methods that a derived Applet class may call to obtain information and services from the browser context.

These include methods that do the following −

- Get applet parameters
- Get the network location of the HTML file that contains the applet
- Get the network location of the applet class directory
- Print a status message in the browser
- Fetch an image
- Fetch an audio clip
- Play an audio clip
- Resize the applet

Additionally, the Applet class provides an interface by which the viewer or browser obtains information about the applet and controls the applet's execution. The viewer may −

- Request information about the author, version, and copyright of the applet
- Request a description of the parameters the applet recognizes
- Initialize the applet
- Destroy the applet
- Start the applet's execution
- Stop the applet's execution

The Applet class provides default implementations of each of these methods. Those implementations may be overridden as necessary.

The "Hello, World" applet is complete as it stands. The only method overridden is the paint method.

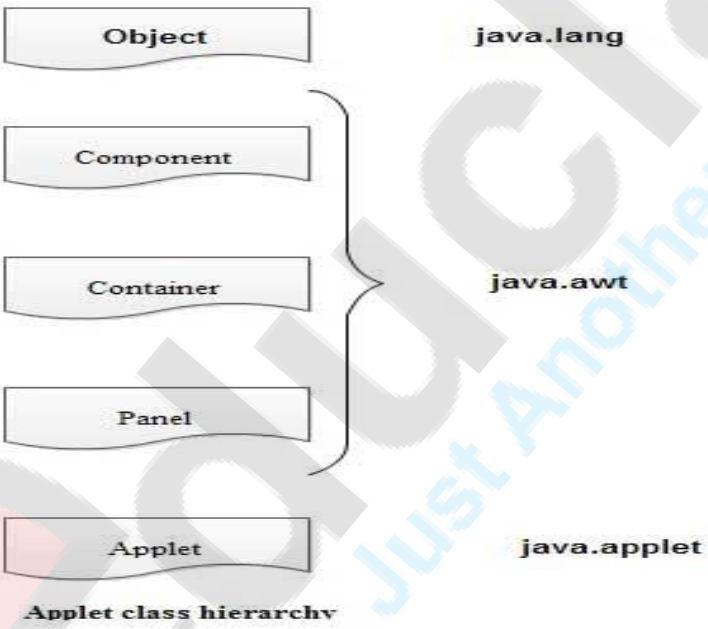
Q.4) Applet API hierarchy

The AWT allows us to use various graphical components. When we start writing any applet program we essentially import two packages namely - java.awt and java.applet.

The java.applet package contains a class Applet which uses various interfaces such as AppletContext, AppletStub and AudioCIip. The applet class is an extension of Panel class belonging to java.awt package.

To create an user friendly graphical interface we need to place various components on GUI window. There is a Component class from java.awt package which derives several classes for components. These classed include Check box, Choice, List, buttons and so on. The Component class in java.awt is an abstract class.

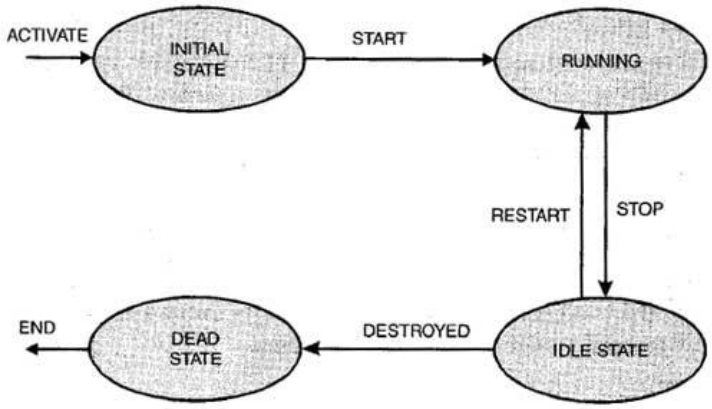
The class hierarchy for Applets is as shown in Fig.



Applet class hierarchy

Q.5) Explain Applet Life Cycle

Java *applet* inherits features from the class *Applet.* Thus, whenever an *applet* is created, it undergoes a series of changes from initialization to destruction. Various stages of an *applet* life cycle are depicted in the figure below:



Life Cycle of an Applet

Initial State

When a new *applet* is born or created, it is activated by calling *init()* method. At this stage, new objects to the *applet* are created, initial values are set, images are loaded and the colors of the images are set. An *applet* is initialized only once in its lifetime. It's general form is:

```
public void init( )
//Action to be performed
}
```

Running State

An *applet* achieves the running state when the system calls the *start()* method. This occurs as soon as the *applet* is initialized. An *applet* may also start when it is in idle state. At that time, the *start()* method is overridden. It's general form is:

```
public void start( )
{
//Action to be performed
}
```

Idle State

An *applet* comes in idle state when its execution has been stopped either *implicitly or explicitly*. An *applet* is *implicitly* stopped when we leave the page containing the currently running applet. An *applet* is *explicitly* stopped when we call *stop()* method to stop its execution. It's general form is:

```
public void stope
{
//Action to be performed
```

}

Dead State

An *applet* is in dead state when it has been removed from the memory. This can be done by using *destroy()* method. It's general form is:

```
public void destroy( )
{
//Action to be performed
}
```

Apart from the above stages, Java applet also possess *paint( )* method. This method helps in drawing, writing and creating colored backgrounds of the applet. It takes an argument of the graphics class. To use The graphics, it imports the package java.awt.Graphics

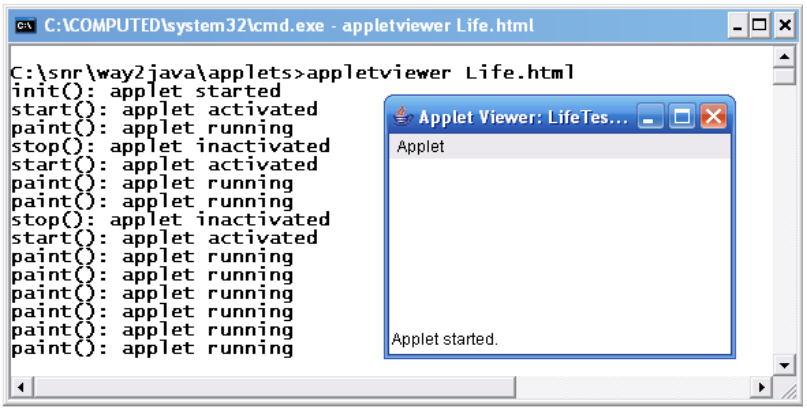
Example:

1st Program: Applet program – LifeTest.java

```
importjava.awt.Graphics;
importjava.applet.Applet;
public class LifeTest extends Applet
{
   public void init()
   {
         System.out.println("init(): applet started");
   }
   public void start()
   {
         System.out.println("start(): applet activated");
   }
   public void paint(Graphics g)
   {
         System.out.println("paint(): applet running");
   }
   public void stop()
   {
      System.out.println("stop(): applet inactivated ");
   }
   public void destroy()
   {
         System.out.println("destroy(): applet destroyed");
   }
}
```

2nd Program: HTML Program – Life.html

```
<applet code="LifeTest.class"  width="250"   height="125">
</applet>
```



Screenshot of Life.html of Applet Life Cycle

Q.6)Explain Java's delegation event model

The event model is based on the Event Source and Event Listeners. Event Listener is an object that receives the messages / events. The Event Source is any object which creates the message / event. The Event Delegation model is based on – The Event Classes, The Event Listeners, Event Objects.

There are three participants in event delegation model in Java;

- Event Source – the class which broadcasts the events
- Event Listeners – the classes which receive notifications of events
- Event Object – the class object which describes the event.

An event occurs (like mouse click, key press, etc) which is followed by the event is broadcasted by the event source by invoking an agreed method on all event listeners. The event object is passed as argument to the agreed-upon method. Later the event listeners respond as they fit, like submit a form, displaying a message / alert etc.

Q.7) Event handling mechanisms

What is an Event?

Change in the state of an object is known as event i.e. event describes the change in state of source. Events are generated as result of user interaction with the graphical user interface components. For example, clicking on a button, moving the mouse, entering a character through keyboard,selecting an item from list, scrolling the page are the activities that causes an event to happen.

Types of Event

The events can be broadly classified into two categories:

- **Foreground Events** - Those events which require the direct interaction of user.They are generated as consequences of a person interacting with the graphical components

in Graphical User Interface. For example, clicking on a button, moving the mouse, entering a character through keyboard,selecting an item from list, scrolling the page etc.

- **Background Events** - Those events that require the interaction of end user are known as background events. Operating system interrupts, hardware or software failure, timer expires, an operation completion are the example of background events.

What is Event Handling?

Event Handling is the mechanism that controls the event and decides what should happen if an event occurs. This mechanism have the code which is known as event handler that is executed when an event occurs. Java Uses the Delegation Event Model to handle the events. This model defines the standard mechanism to generate and handle the events.Let's have a brief introduction to this model.

The Delegation Event Model has the following key participants namely:

- **Source** - The source is an object on which event occurs. Source is responsible for providing information of the occurred event to it's handler. Java provide as with classes for source object.

- **Listener** - It is also known as event handler.Listener is responsible for generating response to an event. From java implementation point of view the listener is also an object. Listener waits until it receives an event. Once the event is received , the listener process the event an then returns.

The benefit of this approach is that the user interface logic is completely separated from the logic that generates the event. The user interface element is able to delegate the processing of an event to the separate piece of code. In this model ,Listener needs to be registered with the source object so that the listener can receive the event notification. This is an efficient way of handling the event because the event notifications are sent only to those listener that want to receive them.

Steps involved in event handling

- The User clicks the button and the event is generated.

- Now the object of concerned event class is created automatically and information about the source and the event get populated with in same object.

- Event object is forwarded to the method of registered listener class.

- the method is now get executed and returns.

Points to remember about listener

- In order to design a listener class we have to develop some listener interfaces.These Listener interfaces forecast some public abstract callback methods which must be implemented by the listener class.

- If you do not implement the any if the predefined interfaces then your class can not act as a listener class for a source object.

Callback Methods

These are the methods that are provided by API provider and are defined by the application programmer and invoked by the application developer. Here the callback methods represents an event method. In response to an event java jre will fire callback method. All such callback methods are provided in listener interfaces.

If a component wants some listener will listen to it's events the the source must register itself to the listener.

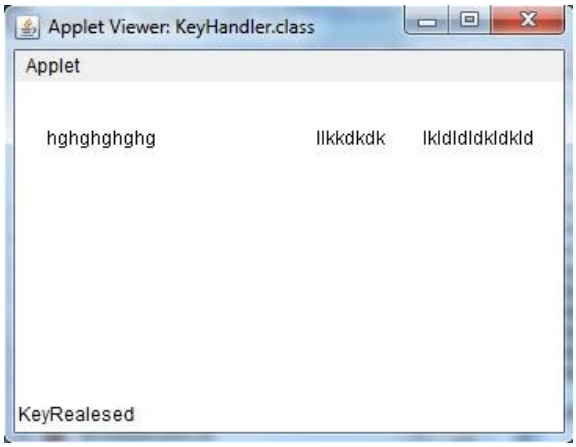
Example of Event Handling

```
importjava.awt.*;
importjava.awt.event.*;
importjava.applet.*;
importjava.applet.*;
importjava.awt.event.*;
importjava.awt.*;

public class Test extends Applet implements KeyListener
{
 String msg="";
public void init()
 {
addKeyListener(this);
 }
public void keyPressed(KeyEvent k)
 {
showStatus("KeyPressed");
 }
public void keyReleased(KeyEvent k)
 {
showStatus("KeyRealesed");
 }
public void keyTyped(KeyEvent k)
 {
msg = msg+k.getKeyChar();
```

```
repaint();
 }
public void paint(Graphics g)
 {
g.drawString(msg, 20, 40);
 }
}
```

HTML code :

```
<applet code="Test" width=300, height=100 >
```



Q.8) Swing components

A component is an independent visual control. Swing Framework contains a large set of components which provide rich functionalities and allow high level of customization. They all are derived from JComponent class. All these components are lightweight components. This class provides some common functionality like pluggable look and feel, support for accessibility, drag and drop, layout, etc.

A container holds a group of components. It provides a space where a component can be managed and displayed. Containers are of two types:

1. **Top level Containers**
   - It inherits Component and Container of AWT.
   - It cannot be contained within other containers.
   - Heavyweight.
   - Example: JFrame, JDialog, JApplet
2. **Lightweight Containers**
   - It inherits JComponent class.
   - It is a general purpose container.
   - It can be used to organize related components together.

- Example: JPanel

JButton

JButton class provides functionality of a button. JButton class has three constuctors,

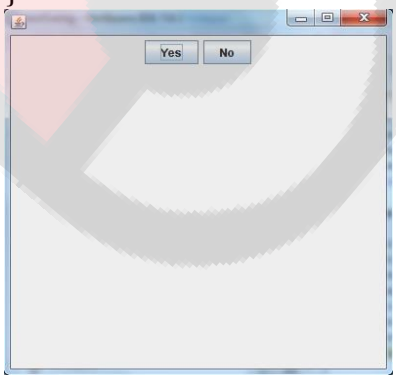
JButton(Icon *ic*)

JButton(String *str*)

JButton(String *str*, Icon *ic*)
It allows a button to be created using icon, a string or both. JButton supports **ActionEvent**. When a button is pressed an **ActionEvent** is generated.

Example using JButton

```
importjavax.swing.*;
importjava.awt.event.*;
importjava.awt.*;
public class testswingextendsJFrame
{

testswing()
 {
JButton bt1 = new JButton("Yes");              //Creating a Yes Button.
JButton bt2 = new JButton("No");               //Creating a No Button.
setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE)     //setting close operation.
setLayout(new FlowLayout());                   //setting layout using FlowLayout object
setSize(400, 400);                        //setting size of Jframe
add(bt1);                  //adding Yes button to frame.
add(bt2);                  //adding No button to frame.

setVisible(true);
 }
public static void main(String[] args)
 {
newtestswing();
 }
}
```



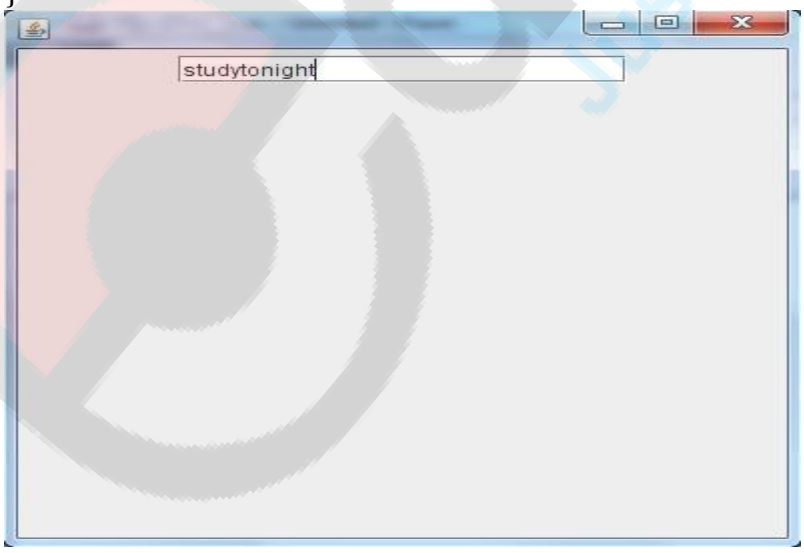
JTextField

JTextField is used for taking input of single line of text. It is most widely used text component. It has three constructors,

JTextField(int*cols*)
JTextField(String *str*, int*cols*)
JTextField(String *str*)
cols represent the number of columns in text field.

Example using JTextField

```
importjavax.swing.*;
importjava.awt.event.*;
importjava.awt.*;
public class MyTextFieldextendsJFrame
{
publicMyTextField()
 {
JTextFieldjtf = new JTextField(20);          //creating JTextField.
add(jtf);                                    //adding JTextField to frame.
setLayout(new FlowLayout());
setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
setSize(400, 400);
setVisible(true);
 }
public static void main(String[] args)
 {
newMyTextField();
 }
}
```



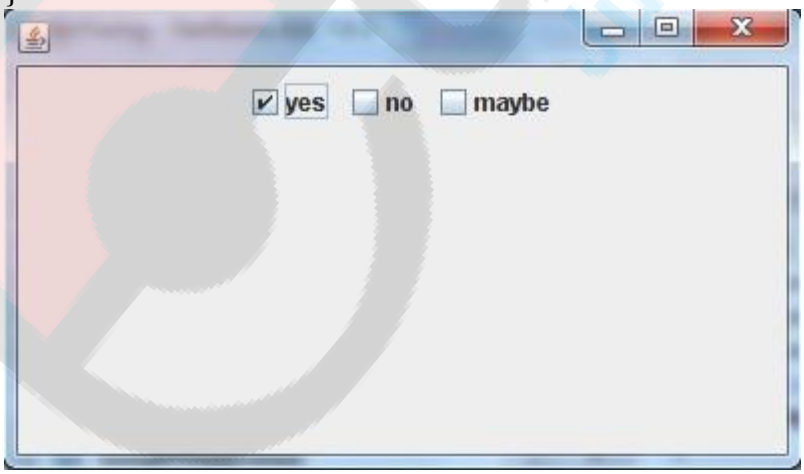
JCheckBox

JCheckBox class is used to create checkboxes in frame. Following is constructor for JCheckBox,

JCheckBox(String *str*)

Example using JCheckBox

```
importjavax.swing.*;
importjava.awt.event.*;
importjava.awt.*;
public class Test extendsJFrame
{
public Test()
 {
JCheckBoxjcb = new JCheckBox("yes");   //creating JCheckBox.
add(jcb);                              //adding JCheckBox to frame.
jcb = new JCheckBox("no");             //creating JCheckBox.
add(jcb);                              //adding JCheckBox to frame.
jcb = new JCheckBox("maybe");          //creating JCheckBox.
add(jcb);                              //adding JCheckBox to frame.
setLayout(new FlowLayout());
setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
setSize(400, 400);
setVisible(true);
 }
public static void main(String[] args)
 {
new Test();
 }
}
```



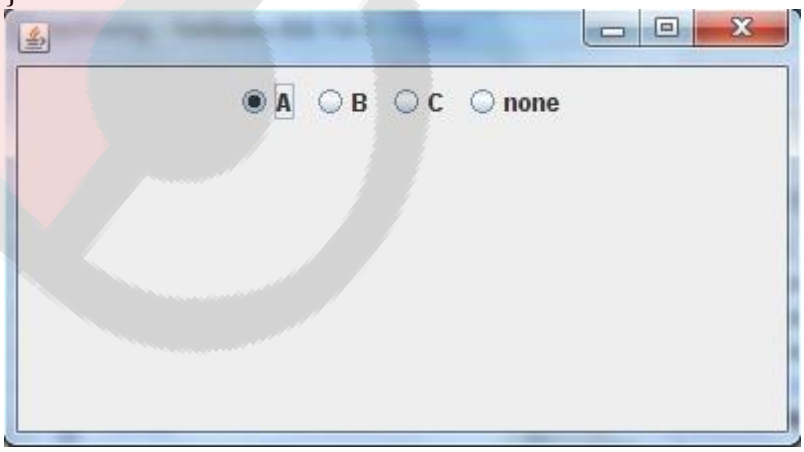
JRadioButton

Radio button is a group of related button in which only one can be selected. JRadioButton class is used to create a radio button in Frames. Following is the constructor for JRadioButton,

JRadioButton(String *str*)

Example using JRadioButton

```
importjavax.swing.*;
importjava.awt.event.*;
importjava.awt.*;
public class Test extendsJFrame
{
public Test()
 {
JRadioButtonjcb = new JRadioButton("A");      //creating JRadioButton.
add(jcb);                                     //adding JRadioButton to frame.
jcb = new JRadioButton("B");                  //creating JRadioButton.
add(jcb);                                     //adding JRadioButton to frame.
jcb = new JRadioButton("C");                  //creating JRadioButton.
add(jcb);                                     //adding JRadioButton to frame.
jcb = new JRadioButton("none");
add(jcb);
setLayout(new FlowLayout());
setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
setSize(400, 400);
setVisible(true);
 }
public static void main(String[] args)
 {
new Test();
 }
}
```



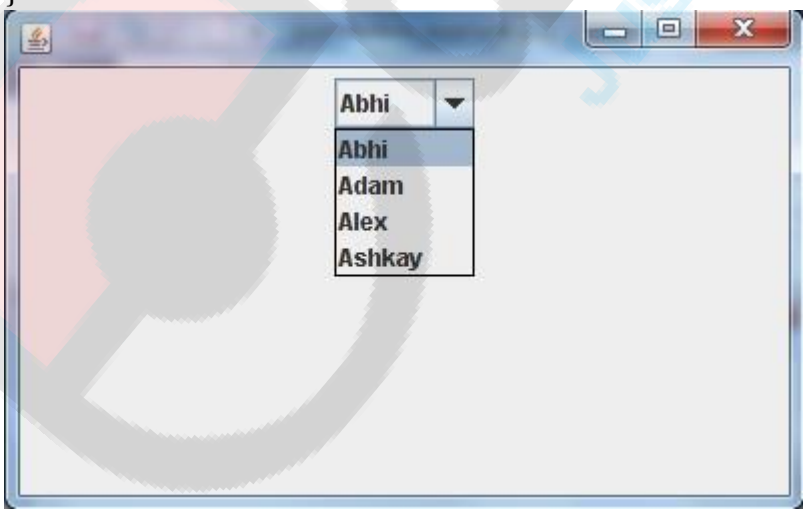
JComboBox

Combo box is a combination of text fields and drop-down list.**JComboBox** component is used to create a combo box in Swing. Following is the constructor for JComboBox,

JComboBox(String *arr[]*)

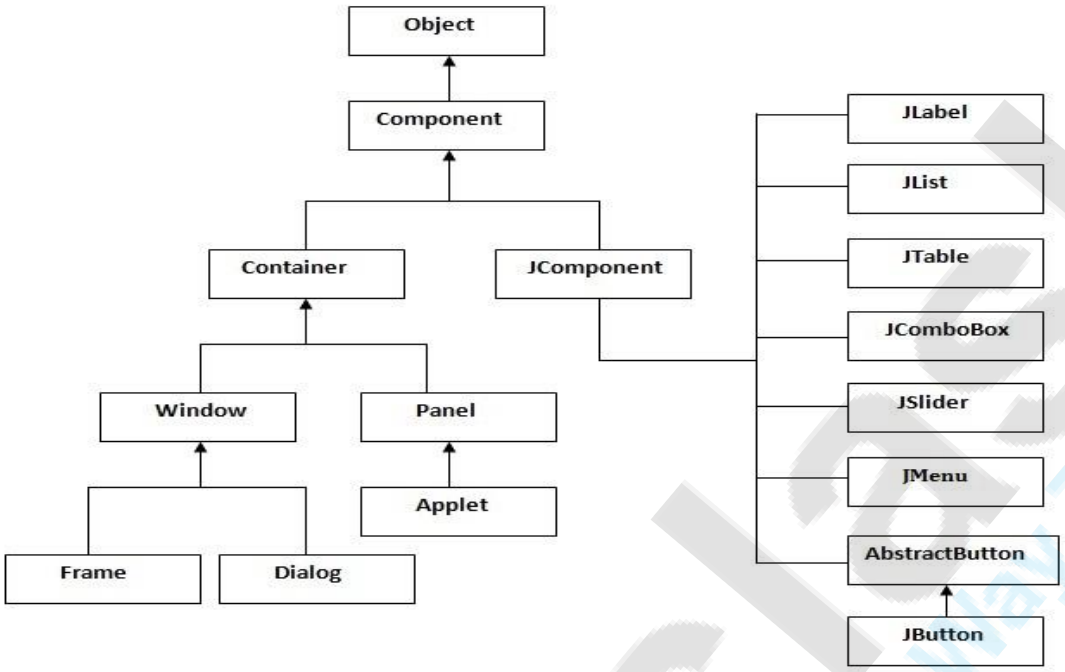
Example using JComboBox

```
importjavax.swing.*;
importjava.awt.event.*;
importjava.awt.*;
public class Test extendsJFrame
{
 String name[] = {"Abhi","Adam","Alex","Ashkay"};  //list of name.
public Test()
 {
JComboBoxjc = new JComboBox(name); //initialzing combo box with list of name.
add(jc);                                    //adding JComboBox to frame.
setLayout(new FlowLayout());
setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
setSize(400, 400);
setVisible(true);
 }
public static void main(String[] args)
 {
new Test();
 }
}
```



Q.9) Swing Component Hierarchy- Basic and Advanced Components// not sure

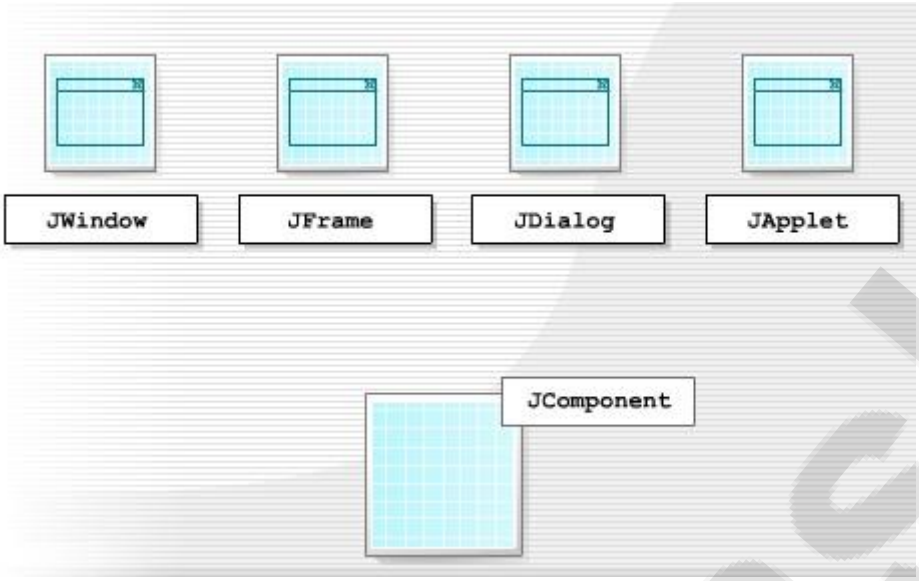
The hierarchy of java swing API is given below.



Swing components and container objects

- In Java, a component is the basic user interface object and is found in all Java applications. Components include lists, buttons, panels, and windows.

  To use components, you need to place them in a container.
- A container is a component that holds and manages other components. Containers display components using a layout manager.
- Swing components inherit from the javax.Swing.JComponent class, which is the root of the Swing component hierarchy. JComponent, in turn, inherits from the Container class in the Abstract Windowing Toolkit (AWT). So Swing is based on classes inherited from AWT.
- Swing provides the following useful top-level containers, all of which inherit from JComponent:



JWindow

JWindow is a top-level window that doesn't have any trimmings and can be displayed anywhere on a desktop. JWindow is a heavyweight component. You usually use JWindow to create pop-up windows and "splash" screens. JWindow extends AWT's Window class.

JFrame

JFrame is a top-level window that can contain borders and menu bars. JFrame is a subclass of JWindow and is thus a heavyweight component. You place a JFrame on a JWindow. JFrame extends AWT's Frame class.

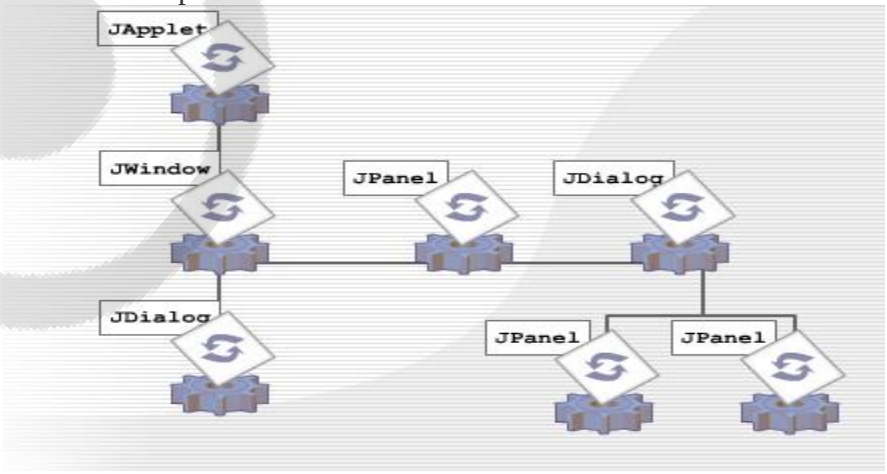
JDialog

JDialog is a lightweight component that you use to create dialog windows. You can place dialog windows on a JFrame or JApplet. JDialog extends AWT's Dialog class.

JApplet

JApplet is a container that provides the basis for applets that run within web browsers. JApplet is a lightweight component that can contain other graphical user interface (GUI) components. JApplet extends AWT's Applet class.

All Swing components - including the JApplet and JDialog containers - need to be contained at some level inside a JWindow or JFrame.
Each top-level container depends on another intermediate container called the root, which provides a number of components to each.

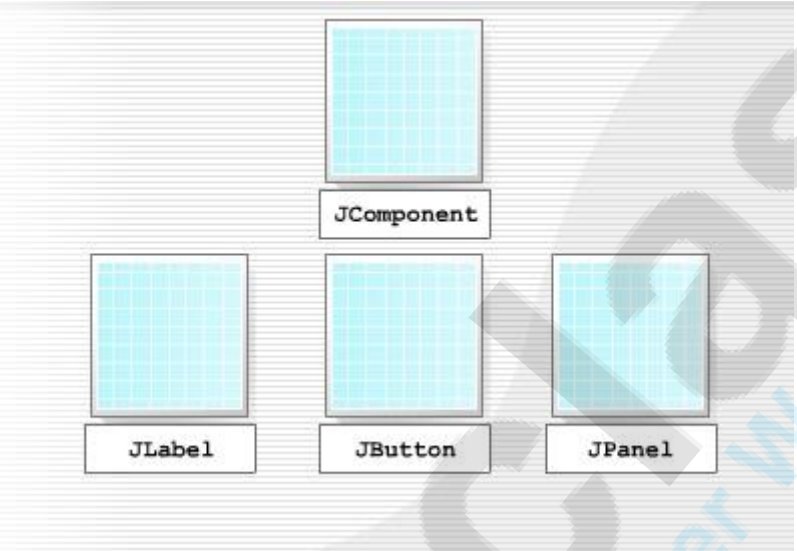


JApplet is the root container for Swing applets and JFrame is the root container for a standalone GUI application.

Once you've created a root container, you can add components and other containers to it

JComponent services

JComponent is the root class for all Swing components such as JPanel, JLabel, and JButton. This class inherits from the Container class and enables you to add containers and components to an application.



The JComponent class provides the following functionality features to its subclasses:

- Customizing component appearance
- Checking component states
- Adding event handling
- Painting components
- Modifying the containment hierarchy
- Arranging the layout of components
- Retrieving component size and position information
- TextComponent Printing

Customizing component appearance

You can change the appearance of a component by setting the border, foreground color, background color, font, and a cursor to display when moving over the component.

The most commonly used methods to change the appearance of a component include the setForeground and setBackground methods, which enable you to set the colors for a component.

The setForeground method sets the color for a component's text and the setBackground method sets the color for the background areas of a component.

You can also set a component to be opaque.

For example, consider the code used to change the background color of a JLabel - called label - to black.

The code to change the background color of a label is

label.setBackground(Color.black);

Checking component states

The JComponent class enables you to determine the state of components.

You can add tooltips and specify names for components, using the setToolTipText and setName methods, respectively.

You can also use the isEnabled method to check whether a component is enabled to generate events from user input.

You can set a component to be visible using the setVisible method.

You can also determine whether a component is visible onscreen by using the isShowing method.

Q.10) JApplet

Definition - What does *JApplet* mean?

JApplet is a java swing public class designed for developers usually written in Java. JApplet is generally in the form of Java bytecode that runs with the help of a Java virtual machine (JVM) or Applet viewer from Sun Microsystems. It was first introduced in 1995.

JApplet can also be written in other programming languages and can later be compiled to Java byte code.

Java applets can be executed on multiple platforms which include Microsoft Windows, UNIX, Mac OS and Linux. JApplet can also be run as an application, though this would require a little extra coding. The executable applet is made available on a domain from which it needs to be downloaded. The communication of the applet is restricted only to this particular domain.

JApplet extends the class in the form of java.applet.Applet. JApplets are executed in a tightly-controlled set of resources referred to as sandboxes. This prevents the JApplets from accessing local data like the clipboard or file system.

The first JApplet implementations were performed by downloading an applet class by class. Classes contain many small files and so applets were considered to be slow loading components. Since the introduction of the Java Archive (or simply JAR file), an applet is aggregated and sent as a single, but larger file.

Example of EventHandling in JApplet:

```
import java.applet.*;
import javax.swing.*;
import java.awt.event.*;
public class EventJApplet extends JApplet implements ActionListener{
JButton b;
JTextField tf;
public void init(){

tf=new JTextField();
tf.setBounds(30,40,150,20);

b=new JButton("Click");
b.setBounds(80,150,70,40);

add(b);add(tf);
b.addActionListener(this);

setLayout(null);
}

public void actionPerformed(ActionEvent e){
tf.setText("Welcome");
}
}
```

In the above example, we have created all the controls in init() method because it is invoked only once.

myapplet.html

```
<html>
<body>
<applet code="EventJApplet.class" width="300" height="300">
</applet>
</body>
</html>
```

Q.11) Layout managers

Introduction

Layout means the arrangement of components within the container. In other way we can say that placing the components at a particular position within the container. The task of layouting the controls is done automatically by the Layout Manager.

Layout Manager

The layout manager automatically positions all the components within the container. If we do not use layout manager then also the components are positioned by the default layout manager. It is possible to layout the controls by hand but it becomes very difficult because of the following two reasons.

- It is very tedious to handle a large number of controls within the container.
- Oftenly the width and height information of a component is not given when we need to arrange them.

Java provide us with various layout manager to position the controls. The properties like size,shape and arrangement varies from one layout manager to other layout manager. When the size of the applet or the application window changes the size, shape and arrangement of the components also changes in response i.e. the layout managers adapt to the dimensions of appletviewer or the application window.

The layout manager is associated with every Container object. Each layout manager is an object of the class that implements the LayoutManager interface.

Java LayoutManagers

The LayoutManagers are used to arrange components in a particular manner. LayoutManager is an interface that is implemented by all the classes of layout managers. There are following classes that represents the layout managers:

1. java.awt.BorderLayout
2. java.awt.FlowLayout
3. java.awt.GridLayout
4. java.awt.CardLayout
5. java.awt.GridBagLayout
6. javax.swing.BoxLayout
7. javax.swing.GroupLayout
8. javax.swing.ScrollPaneLayout
9. javax.swing.SpringLayout etc.

Java BorderLayout

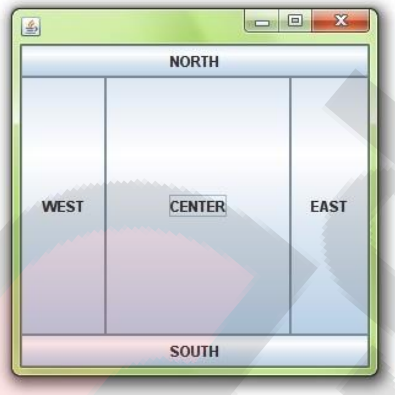
The BorderLayout is used to arrange the components in five regions: north, south, east, west and center. Each region (area) may contain one component only. It is the default layout of frame or window. The BorderLayout provides five constants for each region:

1. **public static final int NORTH**
2. **public static final int SOUTH**
3. **public static final int EAST**
4. **public static final int WEST**
5. **public static final int CENTER**

Constructors of BorderLayout class:

- **BorderLayout():** creates a border layout but with no gaps between the components.
- **JBorderLayout(inthgap, intvgap):** creates a border layout with the given horizontal and vertical gaps between the components.

Example of BorderLayout class:




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

public class Border {
JFrame f;
Border(){
f=new JFrame();

JButton b1=new JButton("NORTH");;
JButton b2=new JButton("SOUTH");;
JButton b3=new JButton("EAST");;
```

```
JButton b4=new JButton("WEST");;
JButton b5=new JButton("CENTER");;

f.add(b1,BorderLayout.NORTH);
f.add(b2,BorderLayout.SOUTH);
f.add(b3,BorderLayout.EAST);
f.add(b4,BorderLayout.WEST);
f.add(b5,BorderLayout.CENTER);

f.setSize(300,300);
f.setVisible(true);
}
public static void main(String[] args) {
new Border();
}
}
```

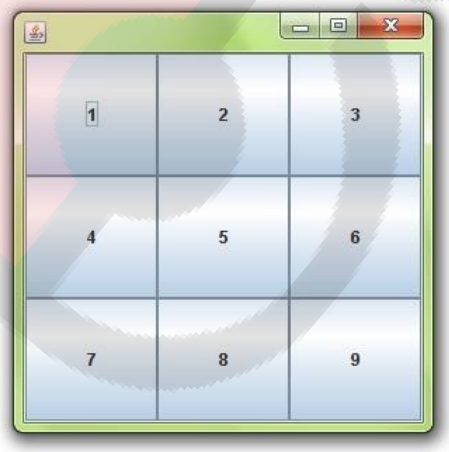
Java GridLayout

The GridLayout is used to arrange the components in rectangular grid. One component is displayed in each rectangle.

Constructors of GridLayout class

1. **GridLayout():** creates a grid layout with one column per component in a row.
2. **GridLayout(int rows, int columns):** creates a grid layout with the given rows and columns but no gaps between the components.
3. **GridLayout(int rows, int columns, inthgap, intvgap):** creates a grid layout with the given rows and columns alongwith given horizontal and vertical gaps.

Example of GridLayout class



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

public class MyGridLayout{
JFrame f;
MyGridLayout(){
f=new JFrame();

JButton b1=new JButton("1");
JButton b2=new JButton("2");
JButton b3=new JButton("3");
JButton b4=new JButton("4");
JButton b5=new JButton("5");
JButton b6=new JButton("6");
JButton b7=new JButton("7");
JButton b8=new JButton("8");
JButton b9=new JButton("9");

f.add(b1);f.add(b2);f.add(b3);f.add(b4);f.add(b5);
f.add(b6);f.add(b7);f.add(b8);f.add(b9);

f.setLayout(new GridLayout(3,3));
//setting grid layout of 3 rows and 3 columns

f.setSize(300,300);
f.setVisible(true);
}
public static void main(String[] args) {
new MyGridLayout();
}
}
```

Java FlowLayout

The FlowLayout is used to arrange the components in a line, one after another (in a flow). It is the default layout of applet or panel.

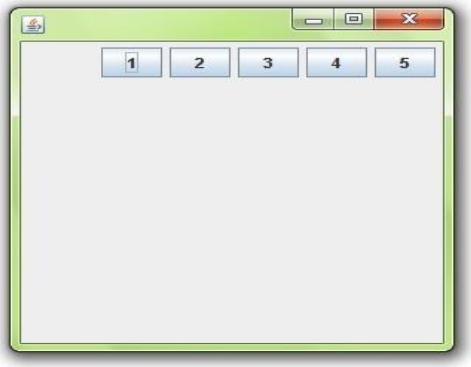
Fields of FlowLayout class

1. **public static final int LEFT**
2. **public static final int RIGHT**
3. **public static final int CENTER**
4. **public static final int LEADING**
5. **public static final int TRAILING**

Constructors of FlowLayout class

1. **FlowLayout():** creates a flow layout with centered alignment and a default 5 unit horizontal and vertical gap.
2. **FlowLayout(int align):** creates a flow layout with the given alignment and a default 5 unit horizontal and vertical gap.
3. **FlowLayout(int align, inthgap, intvgap):** creates a flow layout with the given alignment and the given horizontal and vertical gap.

Example of FlowLayout class




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

public class MyFlowLayout{
JFrame f;
MyFlowLayout(){
f=new JFrame();

JButton b1=new JButton("1");
JButton b2=new JButton("2");
JButton b3=new JButton("3");
JButton b4=new JButton("4");
JButton b5=new JButton("5");

f.add(b1);f.add(b2);f.add(b3);f.add(b4);f.add(b5);

f.setLayout(new FlowLayout(FlowLayout.RIGHT));
//setting flow layout of right alignment

f.setSize(300,300);
f.setVisible(true);
}
public static void main(String[] args) {
new MyFlowLayout();
}
```

}

Java BoxLayout

The BoxLayout is used to arrange the components either vertically or horizontally. For this purpose, BoxLayout provides four constants. They are as follows:

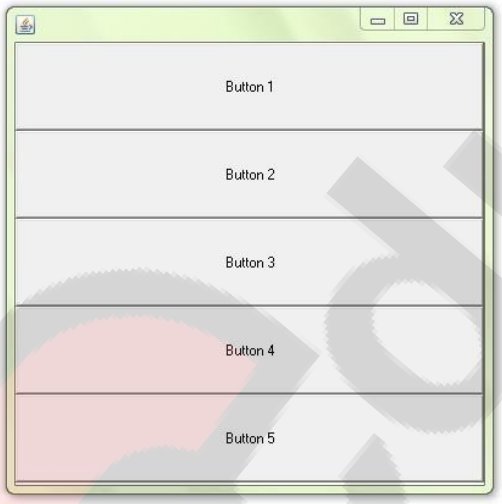
Fields of BoxLayout class

1. **public static final int X_AXIS**
2. **public static final int Y_AXIS**
3. **public static final int LINE_AXIS**
4. **public static final int PAGE_AXIS**

Constructor of BoxLayout class

1. **BoxLayout(Container c, int axis):** creates a box layout that arranges the components with the given axis.

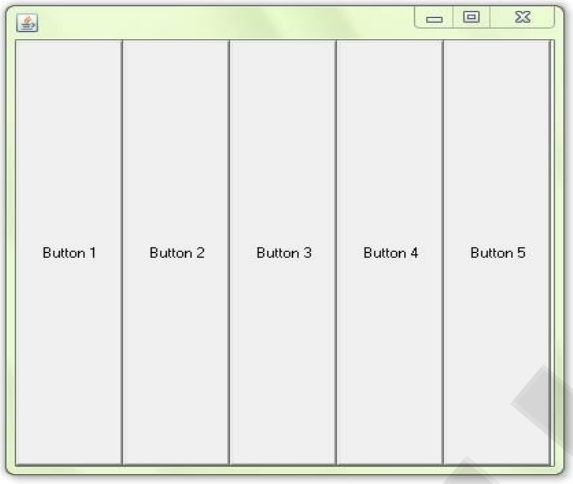
Example of BoxLayout class with Y-AXIS:




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

public class BoxLayoutExample1 extends Frame {
Button buttons[];

public BoxLayoutExample1 () {
buttons = new Button [5];

for (int i = 0;i<5;i++) {
buttons[i] = new Button ("Button " + (i + 1));
```

```
add (buttons[i]);
}

setLayout (new BoxLayout (this, BoxLayout.Y_AXIS));
setSize(400,400);
setVisible(true);
}

public static void main(String args[]){
BoxLayoutExample1 b=new BoxLayoutExample1();
}
}
```

Example of BoxLayout class with X-AXIS




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

public class BoxLayoutExample2 extends Frame {
Button buttons[];

public BoxLayoutExample2() {
buttons = new Button [5];

for (int i = 0;i<5;i++) {
buttons[i] = new Button ("Button " + (i + 1));
add (buttons[i]);
}

setLayout (new BoxLayout(this, BoxLayout.X_AXIS));
setSize(400,400);
setVisible(true);
}

public static void main(String args[]){
BoxLayoutExample2 b=new BoxLayoutExample2();
```

```
}
}
```

Java CardLayout

The CardLayout class manages the components in such a manner that only one component is visible at a time. It treats each component as a card that is why it is known as CardLayout.

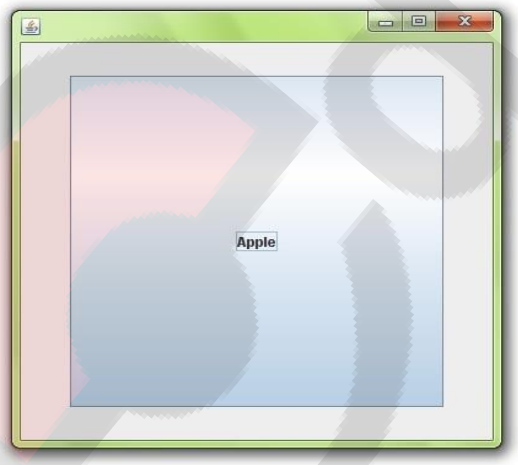
Constructors of CardLayout class

1. **CardLayout():** creates a card layout with zero horizontal and vertical gap.
2. **CardLayout(inthgap, intvgap):** creates a card layout with the given horizontal and vertical gap.

Commonly used methods of CardLayout class

1. **public void next(Container parent):** is used to flip to the next card of the given container.
2. **public void previous(Container parent):** is used to flip to the previous card of the given container.
3. **public void first(Container parent):** is used to flip to the first card of the given container.
4. **public void last(Container parent):** is used to flip to the last card of the given container.
5. **public void show(Container parent, String name):** is used to flip to the specified card with the given name.

Example of CardLayout class




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

import javax.swing.*;

public class CardLayoutExample extends JFrame implements ActionListener{
```

```
CardLayout card;
JButton b1,b2,b3;
Container c;
CardLayoutExample(){

c=getContentPane();
card=new CardLayout(40,30);
//create CardLayout object with 40 hor space and 30 ver space
c.setLayout(card);

b1=new JButton("Apple");
b2=new JButton("Boy");
b3=new JButton("Cat");
b1.addActionListener(this);
b2.addActionListener(this);
b3.addActionListener(this);

c.add("a",b1);c.add("b",b2);c.add("c",b3);

}
public void actionPerformed(ActionEvent e) {
card.next(c);
}

public static void main(String[] args) {
CardLayoutExample cl=new CardLayoutExample();
cl.setSize(400,400);
cl.setVisible(true);
cl.setDefaultCloseOperation(EXIT_ON_CLOSE);
}
}
```

Q.12) Java Adapter Classes

Adapter class	Listener interface
WindowAdapter	WindowListener
KeyAdapter	KeyListener
MouseAdapter	MouseListener
MouseMotionAdapter	MouseMotionListener
FocusAdapter	FocusListener

ComponentAdapter	ComponentListener
ContainerAdapter	ContainerListener
HierarchyBoundsAdapter	HierarchyBoundsListener

java.awt.event Adapter classes

Java adapter classes *provide the default implementation of listener interfaces*. If you inherit the adapter class, you will not be forced to provide the implementation of all the methods of listener interfaces. So it *saves code*.

The adapter classes are found in **java.awt.event**, **java.awt.dnd** and **javax.swing.event** packages. The Adapter classes with their corresponding listener interfaces are given below.

java.awt.dnd Adapter classes

Adapter class	Listener interface
DragSourceAdapter	DragSourceListener
DragTargetAdapter	DragTargetListener

javax.swing.event Adapter classes

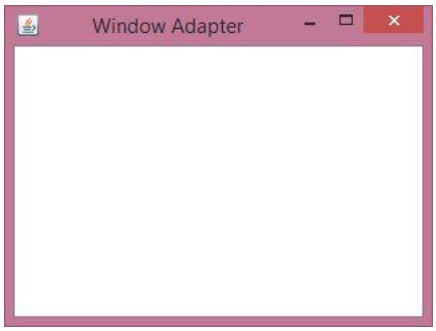
Adapter class	Listener interface
MouseInputAdapter	MouseInputListener
InternalFrameAdapter	InternalFrameListener

Java WindowAdapter Example

```
import java.awt.*;
import java.awt.event.*;
public class AdapterExample{
Frame f;
AdapterExample(){
f=new Frame("Window Adapter");
f.addWindowListener(new WindowAdapter(){
public void windowClosing(WindowEvent e) {
f.dispose();
}
});

f.setSize(400,400);
```

```
f.setLayout(null);
f.setVisible(true);
}
public static void main(String[] args) {
new AdapterExample();
}
}
```

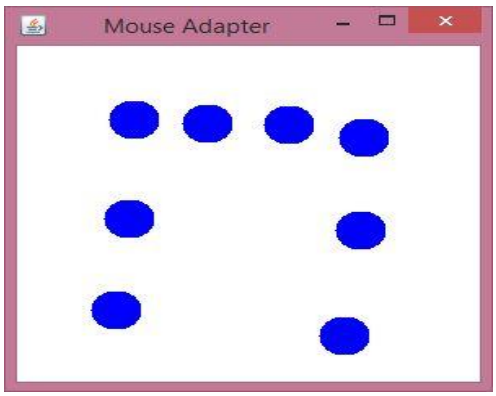
Output:



Java MouseAdapter Example

```
import java.awt.*;
import java.awt.event.*;
public class MouseAdapterExample extends MouseAdapter{
Frame f;
MouseAdapterExample(){
f=new Frame("Mouse Adapter");
f.addMouseListener(this);

f.setSize(300,300);
f.setLayout(null);
f.setVisible(true);
}
public void mouseClicked(MouseEvent e) {
Graphics g=f.getGraphics();
g.setColor(Color.BLUE);
g.fillOval(e.getX(),e.getY(),30,30);
}

public static void main(String[] args) {
new MouseAdapterExample();
}
}
```

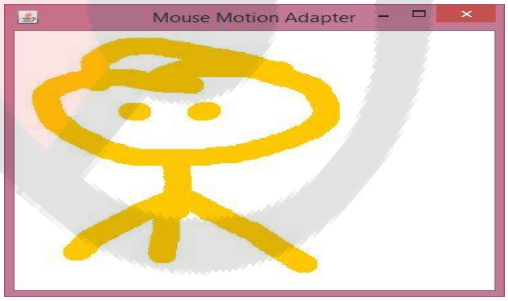
Output:



Java MouseMotionAdapter Example

```
import java.awt.*;
import java.awt.event.*;
public class MouseMotionAdapterExample extends MouseMotionAdapter{
Frame f;
MouseMotionAdapterExample(){
f=new Frame("Mouse Motion Adapter");
f.addMouseMotionListener(this);

f.setSize(300,300);
f.setLayout(null);
f.setVisible(true);
}
public void mouseDragged(MouseEvent e) {
Graphics g=f.getGraphics();
g.setColor(Color.ORANGE);
g.fillOval(e.getX(),e.getY(),20,20);
}
public static void main(String[] args) {
new MouseMotionAdapterExample();
}
}
```

Output:

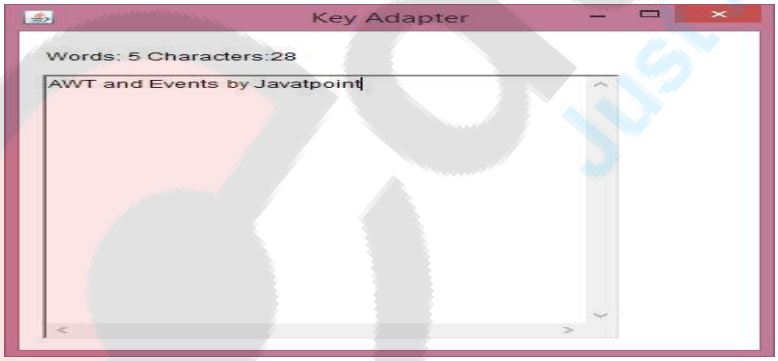


Java KeyAdapter Example

```
import java.awt.*;
```

```
import java.awt.event.*;
public class KeyAdapterExample extends KeyAdapter{
Label l;
TextArea area;
Frame f;
KeyAdapterExample(){
f=new Frame("Key Adapter");
l=new Label();
l.setBounds(20,50,200,20);
area=new TextArea();
area.setBounds(20,80,300, 300);
area.addKeyListener(this);

f.add(l);f.add(area);
f.setSize(400,400);
f.setLayout(null);
f.setVisible(true);
}
public void keyReleased(KeyEvent e) {
String text=area.getText();
String words[]=text.split("\\s");
l.setText("Words: "+words.length+" Characters:"+text.length());
}

public static void main(String[] args) {
new KeyAdapterExample();
}
}
```

Output:



Q) Inner class.

Nested Classes

In Java, just like methods, variables of a class too can have another class as its member. Writing a class within another is allowed in Java. The class written within is called the **nested class**, and the class that holds the inner class is called the **outer class**.

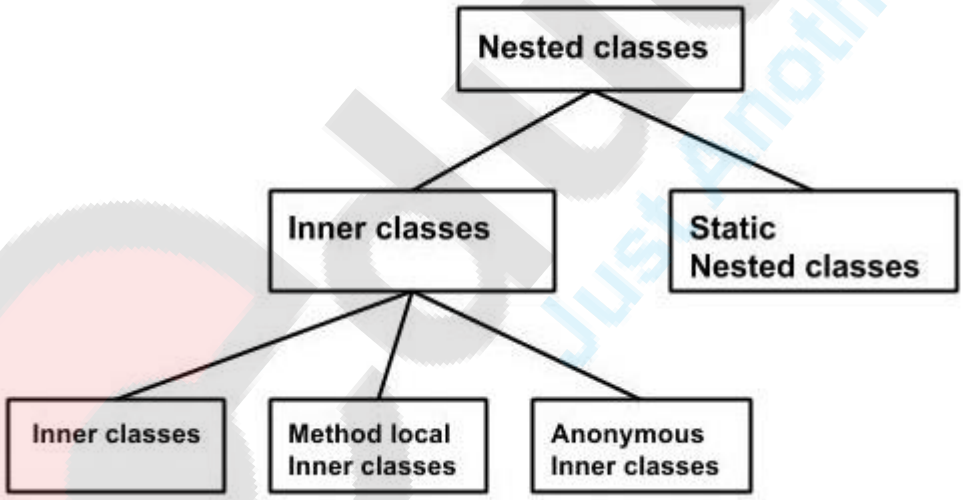
Syntax

Following is the syntax to write a nested class. Here, the class **Outer_Demo**is the outer class and the class **Inner_Demo** is the nested class.

```
classOuter_Demo {
classNested_Demo {
  }
}
```

Nested classes are divided into two types −

- **Non-static nested classes** − These are the non-static members of a class.
- **Static nested classes** − These are the static members of a class.



Inner Classes (Non-static Nested Classes)

Inner classes are a security mechanism in Java. We know a class cannot be associated with the access modifier **private**, but if we have the class as a member of other class, then the inner class can be made private. And this is also used to access the private members of a class.

Inner classes are of three types depending on how and where you define them. They are −

- Inner Class
- Method-local Inner Class
- Anonymous Inner Class

Inner Class

Creating an inner class is quite simple. You just need to write a class within a class. Unlike a class, an inner class can be private and once you declare an inner class private, it cannot be accessed from an object outside the class.

Following is the program to create an inner class and access it. In the given example, we make the inner class private and access the class through a method.

Example

```
classOuter_Demo{
intnum;

// inner class
privateclassInner_Demo{
publicvoidprint(){
System.out.println("This is an inner class");
}
}

// Accessing he inner class from the method within
voiddisplay_Inner(){
Inner_Demo inner =newInner_Demo();
inner.print();
}
}

publicclassMy_class{

publicstaticvoid main(Stringargs[]){
// Instantiating the outer class
Outer_Demo outer =newOuter_Demo();

// Accessing the display_Inner() method.
outer.display_Inner();
}
}
```

Here you can observe that **Outer_Demo** is the outer class, **Inner_Demo** is the inner class, **display_Inner()** is the method inside which we are instantiating the inner class, and this method is invoked from the **main**method.

If you compile and execute the above program, you will get the following result −

Output

```
This is an inner class.
```

Static Nested Class

A static inner class is a nested class which is a static member of the outer class. It can be accessed without instantiating the outer class, using other static members. Just like static members, a static nested class does not have access to the instance variables and methods of the outer class. The syntax of static nested class is as follows −

Syntax

```
classMyOuter {
static class Nested_Demo {
  }
}
```

Instantiating a static nested class is a bit different from instantiating an inner class. The following program shows how to use a static nested class.

Example

```
publicclassOuter{
staticclassNested_Demo{
publicvoidmy_method(){
System.out.println("This is my nested class");
}
}

publicstaticvoid main(Stringargs[]){
Outer.Nested_Demo nested =newOuter.Nested_Demo();
nested.my_method();
}
}
```

If you compile and execute the above program, you will get the following result −

Output

```
This is my nested class
```

UNIT - 9

DATABASE PROGRAMMING

Q.1) JDBC Architecture

The JDBC API supports both two-tier and three-tier processing models for database access but in general, JDBC Architecture consists of two layers

JDBC API: This provides the application-to-JDBC Manager connection.

JDBC Driver API: This supports the JDBC Manager-to-Driver Connection.

The JDBC API uses a driver manager and database-specific drivers to provide transparent connectivity to heterogeneous databases.

The JDBC driver manager ensures that the correct driver is used to access each data source. The driver manager is capable of supporting multiple concurrent drivers connected to multiple heterogeneous databases.

Following is the architectural diagram, which shows the location of the driver manager with respect to the JDBC drivers and the Java application −

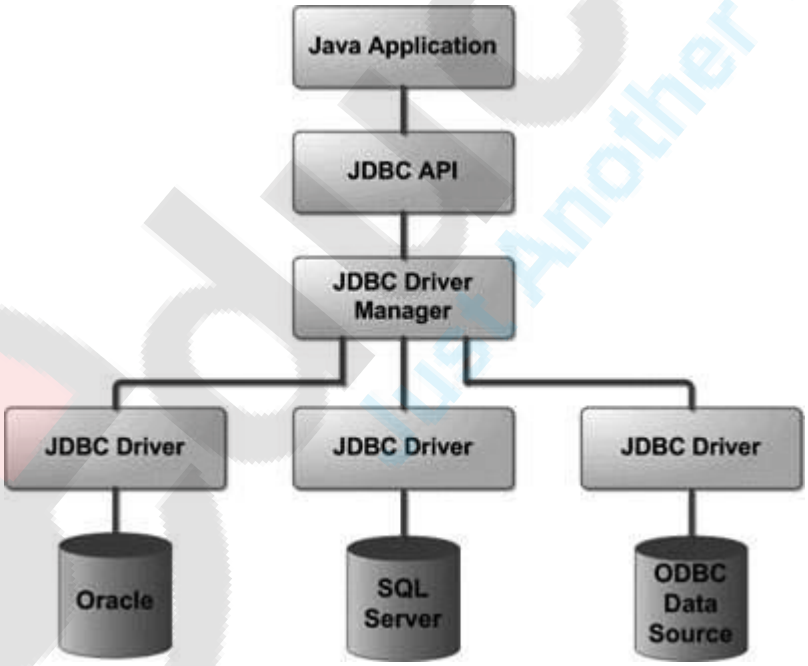
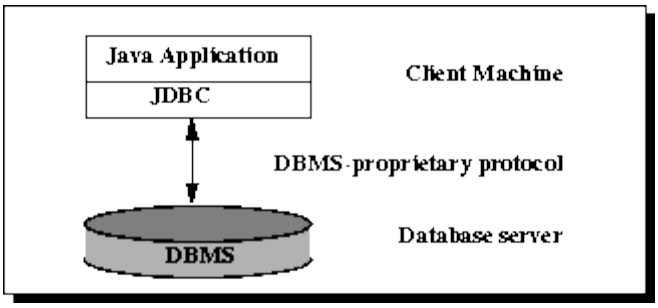


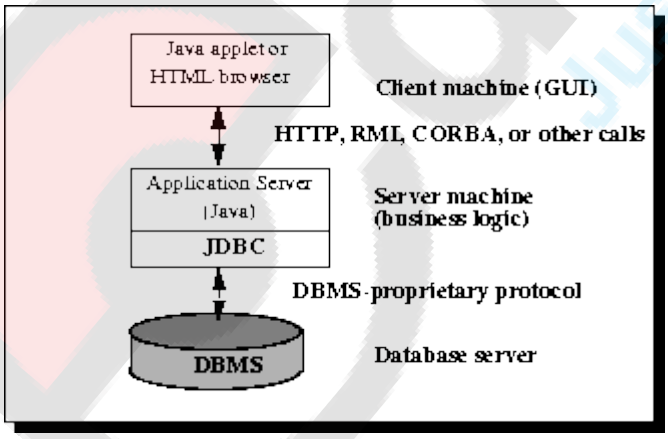
Figure 1: Two-tier Architecture for Data Access.



In the two-tier model, a Java application talks directly to the data source. This requires a JDBC driver that can communicate with the particular data source being accessed. A user's commands are delivered to the database or other data source, and the results of those statements are sent back to the user. The data source may be located on another machine to which the user is connected via a network. This is referred to as a client/server configuration, with the user's machine as the client, and the machine housing the data source as the server. The network can be an intranet, which, for example, connects employees within a corporation, or it can be the Internet.

In the three-tier model, commands are sent to a "middle tier" of services, which then sends the commands to the data source. The data source processes the commands and sends the results back to the middle tier, which then sends them to the user. MIS directors find the three-tier model very attractive because the middle tier makes it possible to maintain control over access and the kinds of updates that can be made to corporate data. Another advantage is that it simplifies the deployment of applications. Finally, in many cases, the three-tier architecture can provide performance advantages.

Figure 2: Three-tier Architecture for Data Access.



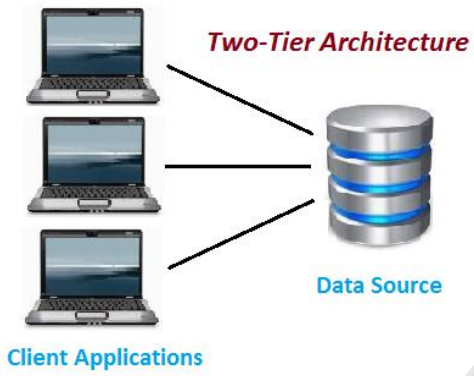
Until recently, the middle tier has often been written in languages such as C or C++, which offer fast performance. However, with the introduction of optimizing compilers that translate Java bytecode into efficient machine-specific code and technologies such as Enterprise

JavaBeans™, the Java platform is fast becoming the standard platform for middle-tier development. This is a big plus, making it possible to take advantage of Java's robustness, multithreading, and security features.

With enterprises increasingly using the Java programming language for writing server code, the JDBC API is being used more and more in the middle tier of a three-tier architecture. Some of the features that make JDBC a server technology are its support for connection pooling, distributed transactions, and disconnected rowsets. The JDBC API is also what allows access to a data source from a Java middle tier.

Two-Tier Architecture:

The two-tier is based on Client Server architecture. The two-tier architecture is like client server application. The direct communication takes place between client and server. There is no intermediate between client and server. Because of tight coupling a 2 tiered application will run faster.



Two-Tier Architecture

The above figure shows the architecture of two-tier. Here the direct communication between client and server, there is no intermediate between client and server.

Let’s take a look of real life example of Railway Reservation two-tier architecture:

Let’s consider that first Person is making Railway Reservation for Mumbai to Delhi by Mumbai Express at Counter No. 1 and at same time second Person is also try to make Railway reservation of Mumbai to Delhi from Counter No. 2

If staff from Counter No. 1 is searching for availability into system & at the same staff from Counter No. 2 is also looking for availability of ticket for same day then in this case there is might be good change of confusion and chaos occurs. There might be chance of lock the Railway reservation that reserves the first.

But reservations can be making anywhere from the India, then how it is handled?

So here if there is difference of micro seconds for making reservation by staff from Counter No. 1 & 2 then second request is added into queue. So in this case the Staff is entering data to

Client Application and reservation request is sent to the database. The database sends back the information/data to the client.

In this application the Staff user is an end user who is using Railway reservation application software. He gives inputs to the application software and it sends requests to Server. So here both Database and Server are incorporated with each other, so this technology is called as "***Client-Server Technology***".

The Two-tier architecture is divided into two parts:

1) Client Application (Client Tier)
2) Database (Data Tier)

On client application side the code is written for saving the data in the SQL server database. Client sends the request to server and it process the request & send back with data. The main problem of two tier architecture is the server cannot respond multiple request same time, as a result it cause a data integrity issue.

Advantages:

- Easy to maintain and modification is bit easy
- Communication is faster

Disadvantages:

- In two tier architecture application performance will be degrade upon increasing the users.
- Cost-ineffective

Three-Tier Architecture:

Three-tier architecture typically comprise a presentation tier, a business or data access tier, and a data tier. Three layers in the three tier architecture are as follows:

1) Client layer
2) Business layer
3) Data layer

1) Client layer:

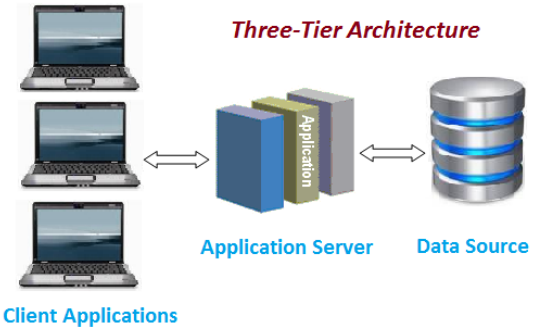
It is also called as *Presentation layer* which contains UI part of our application. This layer is used for the design purpose where data is presented to the user or input is taken from the user. For example designing registration form which contains text box, label, button etc.

2) Business layer:

In this layer all business logic written like validation of data, calculations, data insertion etc. This acts as a interface between Client layer and Data Access Layer. This layer is also called the intermediary layer helps to make communication faster between client and data layer.

3) Data layer:

In this layer actual database is comes in the picture. Data Access Layer contains methods to connect with database and to perform insert, update, delete, get data from database based on our input data.



Three-tier Architecture

Advantages

- High performance, lightweight persistent objects
- Scalability – Each tier can scale horizontally
- Performance – Because the Presentation tier can cache requests, network utilization is minimized, and the load is reduced on the Application and Data tiers.
- High degree of flexibility in deployment platform and configuration
- Better Re-use
- Improve Data Integrity
- Improved Security – Client is not direct access to database.
- Easy to maintain and modification is bit easy, won't affect other modules
- In three tier architecture application performance is good.

Disadvantages

- Increase Complexity/Effort

Q2) **What is a driver and JDBC Driver Types?**

Driver is a software which connects two dissimilar software components or software and hardware. Dissimilar (or heterogeneous) means, they differ in each and every respect. For example, load an **operating system** and connect a **mouse**. You will not see a mouse cursor on the monitor as mouse is not recognised by the OS. Now you require a driver as mouse and OS are heterogenous – mouse is hardware having weight and appearance and OS is a software without shape and weight. With the mouse, the manufacturer supplies a driver CD. Connect the mouse and just run the CD, now the mouse is recognized by the OS.

Similarly, **Java** and **database** (say, Oracle) are two dissimilar software components. **Java** is a programming language used to develop software and **Oracle** is a database used to store data. Even the companies who developed them are different (Sun Microsystems and Oracle

corporation; by the time JDBC was introduced, Java is not acquired by Oracle corporation). Now you feel the necessity of a driver. **The driver here is called as JDBC driver.**

Coming to JDBC drivers, Sun Microsystems identified **4 types** of drivers. Each of these types meets a different application need and also differ in their performance.

All the JDBC Driver Types are discussed here under with diagrams.

Type 1: JDBC-ODBC Bridge, plus ODBC driver

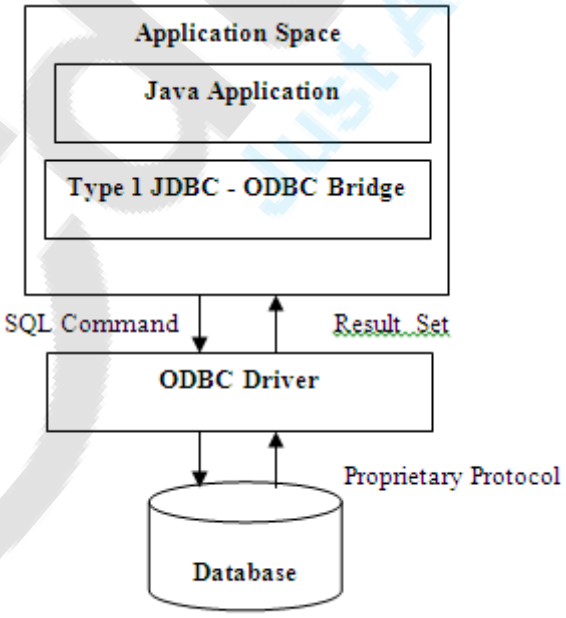
Type 2: Native-API, partly-Java driver

Type 3: JDBC-net, pure Java driver

Type 4: Native-protocol, pure Java driver

Type 1: JDBC-ODBC Bridge, plus ODBC Driver

This first type of bridge driver is supported by the JDBC through JdbcOdbcDriver class from sun.jdbc.odbc package. This driver bridges with another driver (ODBC driver) to connect to a database. The disadvantage with this driver is the database client code and ODBC driver must be installed on every client in an office. This is quiet easy where systems are confined to a limited area but difficult when the systems are spread apart. By performance it is the poorestof all four types as it requires many translations between the JDBC call and finally the SQL statement executed on the database.



Type 1 JDBC-ODBC Bridge

By performance it is very very slow. This is mostly used in colleges while learning JDBC but not in realtime (in realtime, Type 4 driver is used). This driver is used with DSN.

Advantage

The JDBC-ODBC Bridge allows access to almost any database, since the database's
Disadvantages

1. Since the Bridge driver is not written fully in Java, Type 1 drivers are not portable.
2. A performance issue is seen as a JDBC call goes through the bridge to the ODBC driver, then to the database, and this applies even in the reverse process. They are the slowest of all driver types.
3. The client system requires the ODBC Installation to use the driver.
4. Not good for the Web.

ODBC drivers are already available.

Type 2: Native-API Driver, partly- Java driver

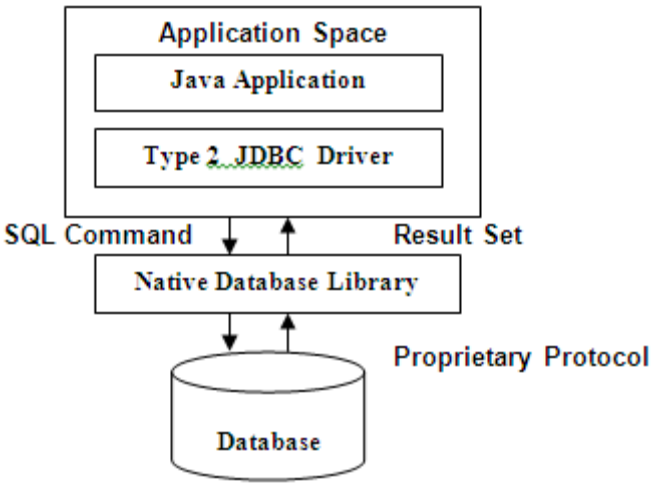
The native-API driver converts JDBC commands into DBMS-specific native calls. This is much like the restriction of Type 1 drivers. The client must have some binary code loaded on its machine. These drivers have an advantage over type 1 drivers, because they interface directly with the database.

Advantage

The distinctive characteristic of type 2 jdbc drivers are that they are typically offer better performance than the JDBC-ODBC Bridge as the layers of communication (tiers) are less than that of Type
1 and also it uses Native api which is Database specific.

Disadvantage

1. Native API must be installed in the Client System and hence type 2 drivers cannot be used for the Internet.
2. Like Type 1 drivers, it’s not written in Java Language which forms a portability issue.
3. If we change the Database we have to change the native api as it is specific to a database
4. Mostly obsolete now
5. Usually not thread safe.



Type 2 Native-API JDBC driver

Type 3: JDBC – Net, pure Java Driver

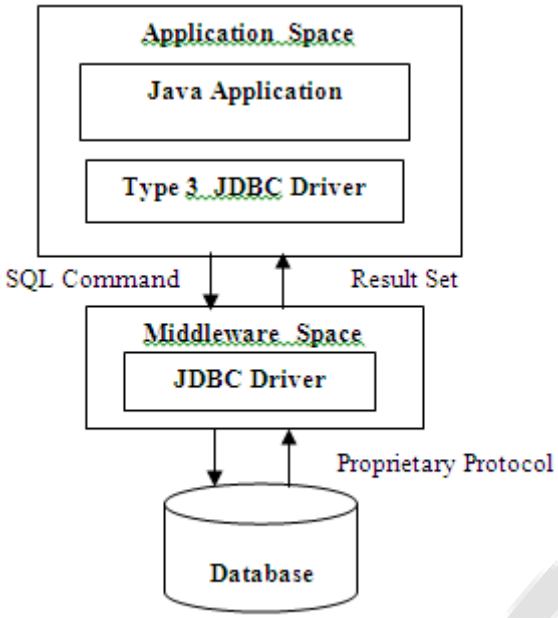
The JDBC-Net drivers are a three-tier solution. This type of driver translates JDBC calls into a database-independent network protocol that is sent to a middleware server. This server, then translates this DBMS-specific protocol, which is sent to a particular database. The results are routed back through the middleware server and sent back to the client. This type of solution makes it possible to implement a pure Java client. It also makes it possible to swap databases without affecting the client. This is by far the most flexible JDBC solution. The following figure shows this three-tier solution.

Advantage

1. This driver is server-based, so there is no need for any vendor database library to be present on client machines.
2. This driver is fully written in Java and hence Portable. It is suitable for the web.
3. There are many opportunities to optimize portability, performance, and scalability.
4. The net protocol can be designed to make the client JDBC driver very small and fast to load.
5. The type 3 driver typically provides support for features such as caching (connections, query results, and so on), load balancing, and advanced system administration such as logging and auditing.
6. This driver is very flexible allows access to multiple databases using one driver.
7. They are the most efficient amongst all driver types.

Disadvantage

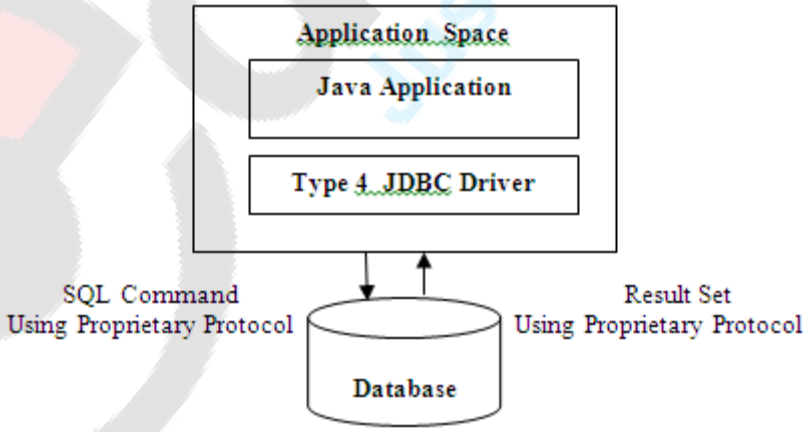
It requires another server application to install and maintain. Traversing the recordset may take longer, since the data comes through the backend server.



Type 3 JDBC-Net driver

Type 4: Native-Protocol, pure Java Driver (known as thin driver)

By performance-wise it is the most preferred and is the one used in real time. Performance is due to the direct conversion of JDBC queries into the database-specific network protocol and additional transformation of middle layers is eliminated. With this driver, the client (in 3-tier, the client for a database server is an application server) can connect to the database directly and is the ideal choice in Intranets. This native-protocol driver is database dependent and is generally supplied by the database vendors itself (many times, free of cost). This driver is written entirely using Java language and is commonly known as "thin driver" as less code is executed and less translations exists (directly translates Java calls to SQL statements). The following diagrams communications of a Type 4 driver.



Type 4 native-protocol JDBC driver

This driver is very fast as it executes less code to communicate. For this reason, it is known asthin driver. It can be used with connection pooling.

Advantage

1. The major benefit of using a type 4 jdbc drivers are that they are completely written in Java to achieve platform independence and eliminate deployment administration issues. It is most suitable for the web.
2. Number of translation layers is very less i.e. type 4 JDBC drivers don't have to translate database requests to ODBC or a native connectivity interface or to pass the request on to another server, performance is typically quite good.
3. You don't need to install special software on the client or server. Further, these drivers can be downloaded dynamically.

Disadvantage

With type 4 drivers, the user needs a different driver for each database.

Q.3) The java.sql Package

The java.sql package contains the entire JDBC API that sends SQL (Structured Query Language) statements to relational databases and retrieves the results of executing those SQL statements. Figure 18-1 shows the class hierarchy of this package. The JDBC 1.0 API became part of the core Java API in Java 1.1. The JDBC 2.0 API supports a variety of new features and is part of the Java 2 platform.

The Driver interface represents a specific JDBC implementation for a particular database system. Connection represents a connection to a database. The Statement, PreparedStatement, and CallableStatement interfaces support the execution of various kinds of SQL statements. ResultSet is a set of results returned by the database in response to a SQL query. The ResultSetMetaData interface provides metadata about a result set, while DatabaseMetaData provides metadata about the database as a whole.

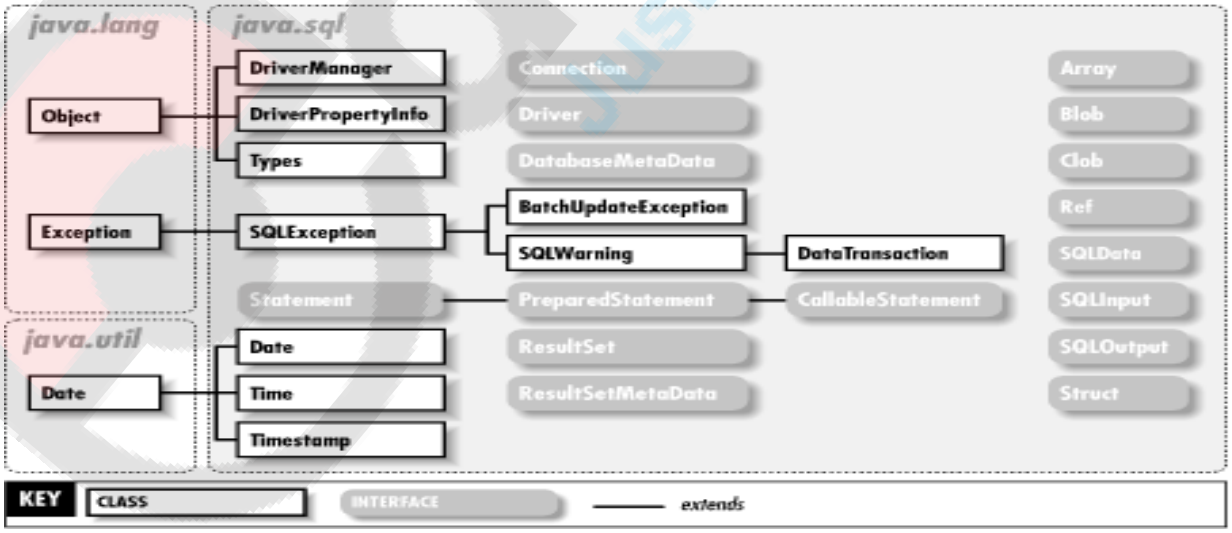


Figure 18-1. The java.sql Package

Q.4) Establishing connectivity and working with connection interface

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5 Steps to connect to the database in java

There are 5 steps to connect any java application with the database in java using JDBC. They are as follows:

1. Register the driver class
2. Creating connection
3. Creating statement
4. Executing queries
5. Closing connection

1) Register the driver class

The forName() method of Class class is used to register the driver class. This method is used to dynamically load the driver class.

Syntax of forName() method

```
public static void forName(String className)throws ClassNotFoundException
```

Example to register the OracleDriver class

```
Class.forName("oracle.jdbc.driver.OracleDriver");
```

---

2) Create the connection object

The getConnection() method of DriverManager class is used to establish connection with the database.

Syntax of getConnection() method

```
1) public static Connection getConnection(String url)throws SQLException
2) public static Connection getConnection(String url,String name,String password)
throws SQLException
```

Example to establish connection with the Oracle database

```
Connection con=DriverManager.getConnection(
"jdbc:oracle:thin:@localhost:1521:xe","system","password");
```

---

3) Create the Statement object

The createStatement() method of Connection interface is used to create statement. The object of statement is responsible to execute queries with the database.

Syntax of createStatement() method

```
public Statement createStatement()throws SQLException
```

Example to create the statement object

```
Statement stmt=con.createStatement();
```

---

4) Execute the query

The executeQuery() method of Statement interface is used to execute queries to the database. This method returns the object of ResultSet that can be used to get all the records of a table.

Syntax of executeQuery() method

```
public ResultSet executeQuery(String sql)throws SQLException
```

Example to execute query

```
ResultSet rs=stmt.executeQuery("select * from emp");

while(rs.next()){
System.out.println(rs.getInt(1)+" "+rs.getString(2));
}
```

---

5) Close the connection object

By closing connection object statement and ResultSet will be closed automatically. The close() method of Connection interface is used to close the connection.

Syntax of close() method

```
public void close()throws SQLException
```

Example to close connection

```
con.close();
```

Q.5) Working with statement interface

Statement interface

The Statement interface provides methods to execute queries with the database. The statement interface is a factory of ResultSet i.e. it provides factory method to get the object of ResultSet.

Commonly used methods of Statement interface:

The important methods of Statement interface are as follows:

1) publicResultSetexecuteQuery(String sql): is used to execute SELECT query. It returns the object of ResultSet.

2) public intexecuteUpdate(String sql): is used to execute specified query, it may be create, drop, insert, update, delete etc.

3) publicboolean execute(String sql): is used to execute queries that may return multiple results.

4) publicint[] executeBatch(): is used to execute batch of commands.

Example of Statement interface

Let's see the simple example of Statement interface to insert, update and delete the record.

```
import java.sql.*;
class FetchRecord{
public static void main(String args[])throws Exception{
Class.forName("oracle.jdbc.driver.OracleDriver");
Connection con=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:xe","syst
em","oracle");
Statement stmt=con.createStatement();

//stmt.executeUpdate("insert into emp765 values(33,'Irfan',50000)");
//int result=stmt.executeUpdate("update emp765 set name='Vimal',salary=10000 where
id=33");
int result=stmt.executeUpdate("delete from emp765 where id=33");
System.out.println(result+" records affected");
con.close();
}}
```

Q.6) Working withPreparedStatement interface

PreparedStatement interface

The PreparedStatement interface is a subinterface of Statement. It is used to execute parameterized query.

Let's see the example of parameterized query:

String sql="insert into emp values(?,?,?)";

As you can see, we are passing parameter (?) for the values. Its value will be set by calling the setter methods of PreparedStatement.

Why use PreparedStatement?

Improves performance: The performance of the application will be faster if you use PreparedStatement interface because query is compiled only once.

How to get the instance of PreparedStatement?

The prepareStatement() method of Connection interface is used to return the object of PreparedStatement.

Syntax:

public PreparedStatement prepareStatement(String query)throws SQLException{}

Method	Description
public void setInt(intparamIndex, int value)	sets the integer value to the given parameter index.
public void setString(intparamIndex, String value)	sets the String value to the given parameter index.
public void setFloat(intparamIndex, float value)	sets the float value to the given parameter index.
public void setDouble(intparamIndex, double value)	sets the double value to the given parameter index.
public intexecuteUpdate()	executes the query. It is used for create, drop, insert, update, delete etc.
public ResultSetexecuteQuery()	executes the select query. It returns an instance of ResultSet.

Methods of PreparedStatement interface

The important methods of PreparedStatement interface are given below:

Example of PreparedStatement interface that inserts the record

First of all create table as given below:

create table emp(id number(10),name varchar2(50));

Now insert records in this table by the code given below:

```
import java.sql.*;
class InsertPrepared{
public static void main(String args[]){
try
{
Class.forName("oracle.jdbc.driver.OracleDriver");

Connection con=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:xe","system",
"oracle");

PreparedStatement stmt=con.prepareStatement("insert into Emp values(?,?)");
stmt.setInt(1,101);//1 specifies the first parameter in the query
stmt.setString(2,"Ratan");

int i=stmt.executeUpdate();
System.out.println(i+" records inserted");

con.close();

}
catch(Exception e)
{
System.out.println(e);
}
}
}
```

Q.6) Working with ResultSet interface

JDBC - Result Sets

The SQL statements that read data from a database query, return the data in a result set. The SELECT statement is the standard way to select rows from a database and view them in a result set. The *java.sql.ResultSet* interface represents the result set of a database query.

A ResultSet object maintains a cursor that points to the current row in the result set. The term "result set" refers to the row and column data contained in a ResultSet object.

The methods of the ResultSet interface can be broken down into three categories −

- Navigational methods: Used to move the cursor around.
- Get methods: Used to view the data in the columns of the current row being pointed by the cursor.
- Update methods: Used to update the data in the columns of the current row. The updates can then be updated in the underlying database as well.

The cursor is movable based on the properties of the ResultSet. These properties are designated when the corresponding Statement that generates the ResultSet is created.

JDBC provides the following connection methods to create statements with desired ResultSet −

createStatement(intRSType, intRSConcurrency);

prepareStatement(String SQL, intRSType, intRSConcurrency);

prepareCall(String sql, intRSType, intRSConcurrency);

The first argument indicates the type of a ResultSet object and the second argument is one of two ResultSet constants for specifying whether a result set is read-only or updatable.

Type of ResultSet

The possible RSType are given below. If you do not specify any ResultSet type, you will automatically get one that is TYPE_FORWARD_ONLY.

Type	Description
ResultSet.TYPE_FORWARD_ONLY	The cursor can only move forward in the result set.
ResultSet.TYPE_SCROLL_INSENSITIVE	The cursor can scroll forward and backward, and the result set is not sensitive to changes made by others to the database that occur after the result set was created.
ResultSet.TYPE_SCROLL_SENSITIVE.	The cursor can scroll forward and backward, and the result set is sensitive to changes made by others to the database that occur after the result set was created.

Q.7) Working with ResultSetMetaData interface.

Java ResultSetMetaData Interface

The metadata means data about data i.e. we can get further information from the data.

If you have to get metadata of a table like total number of column, column name, column type etc. ,ResultSetMetaData interface is useful because it provides methods to get metadata from the ResultSet object.

Commonly used methods of ResultSetMetaData interface

Method	Description
public intgetColumnCount()throws SQLException	it returns the total number of columns in theResultSet object.
public String getColumnName(int index)throws SQLException	it returns the column name of the specified column index.
public String getColumnTypeName(int index)throws SQLException	it returns the column type name for the specified index.
public String getTableName(int index)throws SQLException	it returns the table name for the specified column index.

How to get the object of ResultSetMetaData:

The getMetaData() method of ResultSet interface returns the object of ResultSetMetaData.
Syntax:

```
public ResultSetMetaData getMetaData()throws SQLException
```

Example of ResultSetMetaDatainterface :

```
import java.sql.*;
class Rsmd{
public static void main(String args[]){
try{
Class.forName("oracle.jdbc.driver.OracleDriver");
Connection con=DriverManager.getConnection(
"jdbc:oracle:thin:@localhost:1521:xe","system","oracle");

PreparedStatement ps=con.prepareStatement("select * from emp");
ResultSet rs=ps.executeQuery();
ResultSetMetaData rsmd=rs.getMetaData();

System.out.println("Total columns: "+rsmd.getColumnCount());
System.out.println("Column Name of 1st column: "+rsmd.getColumnName(1));
System.out.println("Column Type Name of 1st column: "+rsmd.getColumnTypeName(1);

con.close();
}catch(Exception e){ System.out.println(e);}
}
```

```
}
```

Output:

```
Total columns: 2
Column Name of 1st column: ID
Column Type Name of 1st column: NUMBER
```

Q) Introduction to Servlet

What are Servlets?

Java Servlets are programs that run on a Web or Application server and act as a middle layer between a requests coming from a Web browser or other HTTP client and databases or applications on the HTTP server.

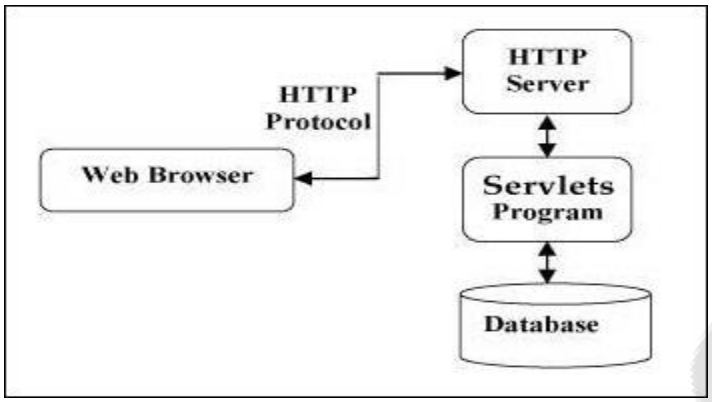
Using Servlets, you can collect input from users through web page forms, present records from a database or another source, and create web pages dynamically.

Java Servlets often serve the same purpose as programs implemented using the Common Gateway Interface (CGI). But Servlets offer several advantages in comparison with the CGI.

- Performance is significantly better.
- Servlets execute within the address space of a Web server. It is not necessary to create a separate process to handle each client request.
- Servlets are platform-independent because they are written in Java.
- Java security manager on the server enforces a set of restrictions to protect the resources on a server machine. So servlets are trusted.
- The full functionality of the Java class libraries is available to a servlet. It can communicate with applets, databases, or other software via the sockets and RMI mechanisms that you have seen already.

Servlets Architecture

The following diagram shows the position of Servlets in a Web Application.



Servlets Tasks

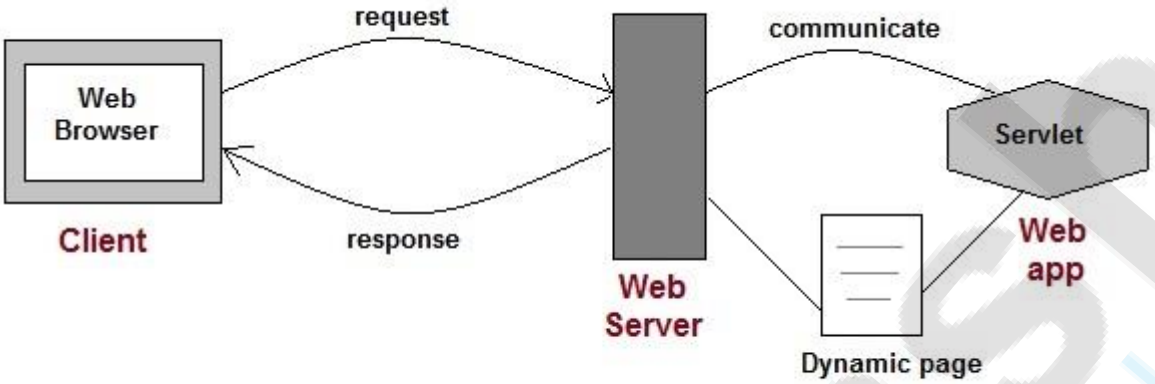
Servlets perform the following major tasks −

- Read the explicit data sent by the clients (browsers). This includes an HTML form on a Web page or it could also come from an applet or a custom HTTP client program.
- Read the implicit HTTP request data sent by the clients (browsers). This includes cookies, media types and compression schemes the browser understands, and so forth.
- Process the data and generate the results. This process may require talking to a database, executing an RMI or CORBA call, invoking a Web service, or computing the response directly.
- Send the explicit data (i.e., the document) to the clients (browsers). This document can be sent in a variety of formats, including text (HTML or XML), binary (GIF images), Excel, etc.
- Send the implicit HTTP response to the clients (browsers). This includes telling the browsers or other clients what type of document is being returned (e.g., HTML), setting cookies and caching parameters, and other such tasks.

====Servlet====

Servlet Technology is used to create web applications. **Servlet** technology uses Java language to create web applications.

Web applications are helper applications that resides at web server and build dynamic web pages. A dynamic page could be anything like a page that randomly chooses picture to display or even a page that displays the current time.

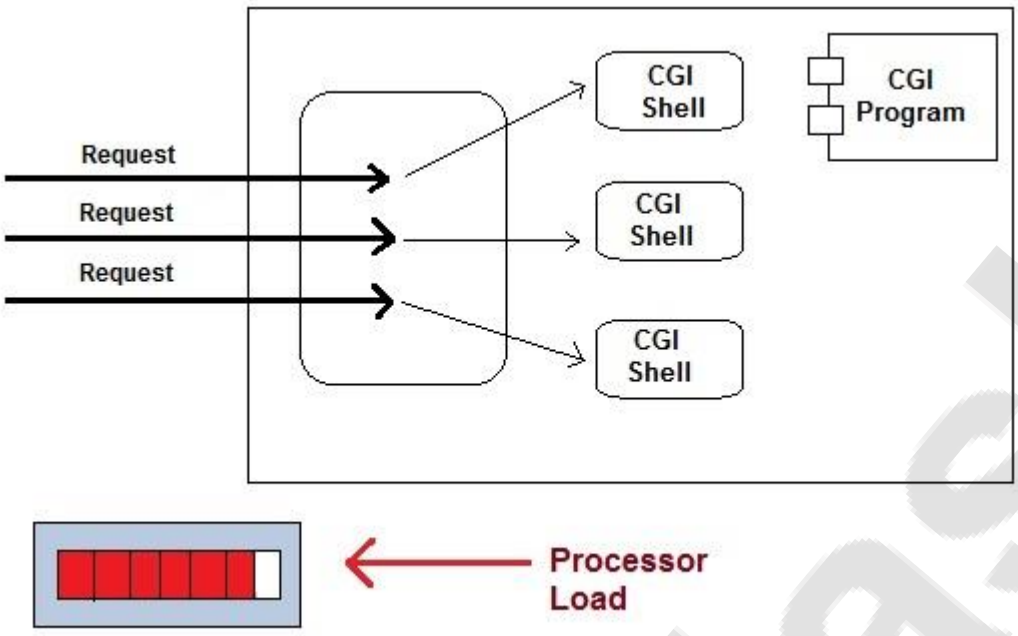


As Servlet Technology uses Java, web applications made using Servlet are **Secured**, **Scalable** and **Robust**.

CGI (Common Gateway Interface)

Before Servlets, CGI(Common Gateway Interface) programming was used to create web applications. Here's how a CGI program works :

- User clicks a link that has URL to a dynamic page instead of a static page.
- The URL decides which CGI program to execute.
- Web Servers run the CGI program in seperate OS shell. The shell includes OS enviroment and the process to execute code of the CGI program.
- The CGI response is sent back to the Web Server, which wraps the response in an HTTP response and send it back to the web browser.



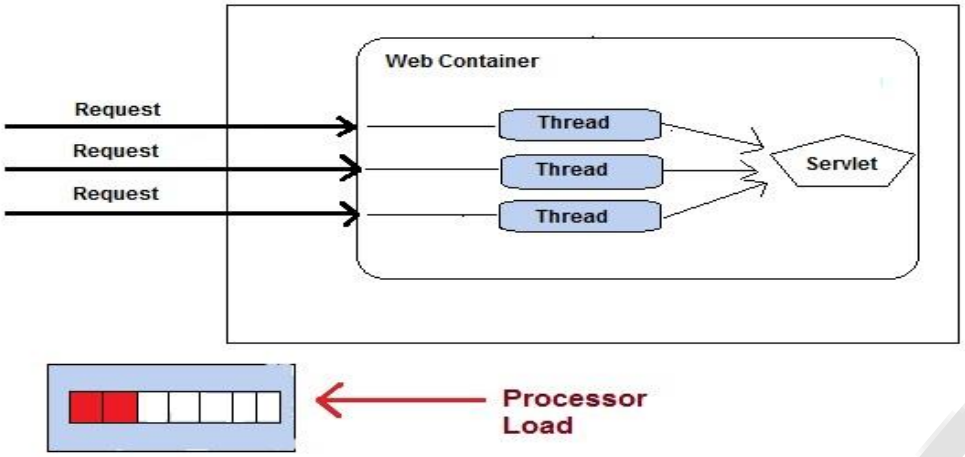
Drawbacks of CGI programs

- High resposne time because CGI programs execute in their own OS shell.
- CGI is not scalable.
- CGI programs are not always secure or object-oriented.
- It is Platform dependent.

Because of these disadvantages, developers started looking for better CGI solutions. And then Sun Microsystems developed **Servlet** as a solution over traditional CGI technology.

Advantages of using Servlets

- Less response time because each request runs in a separate thread.
- Servlets are scalable.
- Servlets are robust and object oriented.
- Servlets are platform independent.

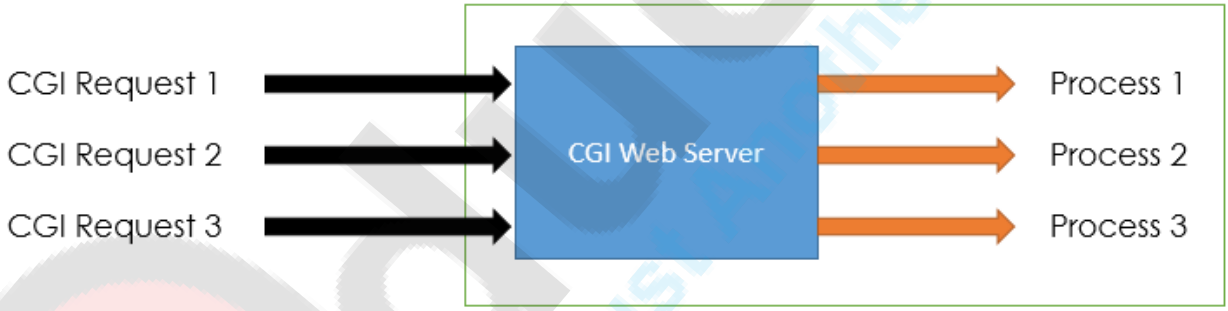


Q) Difference between servlet and CGI

CGI (Commmon Gateway Interface) :

1. CGI (Common Gateway Interface) is used to provide dynamic content to the user.
2. CGI is used to execute a program that resides in the server to process data or access databases to produce the relevant dynamic content.
3. Programs that resides in server can be written in native operating system such as C++.

Diagrammatic Representation :



We have listed some problems in CGI technology –

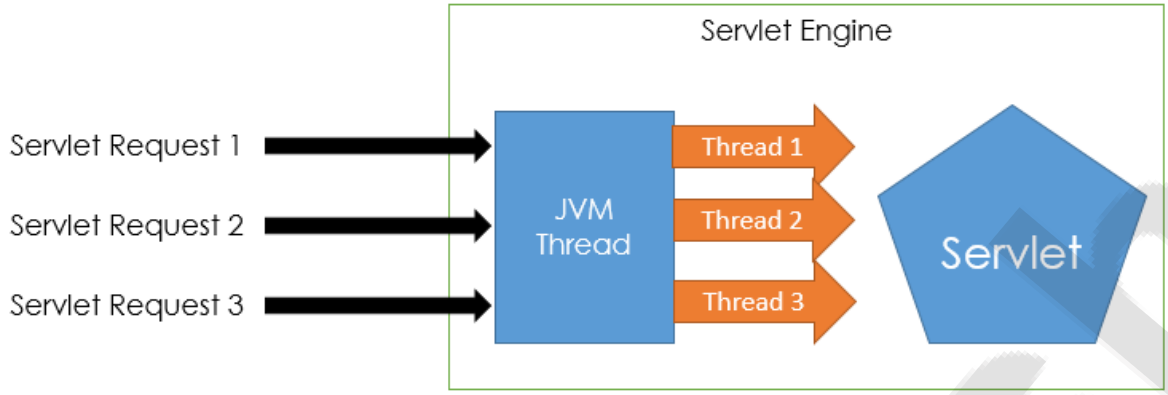
Disadvantages of CGI :

1. For each request CGI Server receives, It creates new Operating System Process.
2. If the number of requests from the client increases then more time it will take to respond to the request.
3. As programs executed by CGI Script are written in the native languages such as C, C++, perl which are platform independent.

Servlet :

CGI programs are used to execute programs written inside the native language. But in Servlet all the programs are compiled into the Java bytecode which is then run in the Java virtual

machine.



In Servlet, All the requests coming from the Client are processed with the threads instead of the OS process.

Servlet Vs CGI :

Let's differentiate Servlet and CGI –

Servlet	**CGI (Common Gateway Interface)**
Servlets are portable	CGI is not portable.
In Servlets each request is handled by lightweight Java Thread	IN CGI each request is handled by heavy weight OS process
In Servlets, Data sharing is possible	In CGI, data sharing is not available.
Servlets can link directly to the Web server	CGI cannot directly link to Web server.
Session tracking and caching of previous computations can be performed	Session tracking and caching of previous computations cannot be performed
Automatic parsing and decoding of HTML form data can be performed.	Automatic parsing and decoding of HTML form data cannot be performed.
Servlets can read and Set HTTP Headers	CGI cannot read and Set HTTP Headers
Servlets can handle cookies	CGI cannot handle cookies
Servlets can track sessions	CGI cannot track sessions
Servlets is inexpensive than CGI	CGI is more expensive than Servlets

Q) Servlet API overview?

- The javax.servlet and javax.servlet.http packages represent interfaces and classes for servlet api.
- The **javax.servlet** package contains many interfaces and classes that are used by the servlet or web container. These are not specific to any protocol.
- The **javax.servlet.http** package contains interfaces and classes that are responsible for http requests only.

Let's see what are the interfaces of javax.servlet package.

Interfaces in javax.servlet package

There are many interfaces in javax.servlet package. They are as follows:

1. Servlet
2. ServletRequest
3. ServletResponse
4. RequestDispatcher
5. ServletConfig
6. ServletContext
7. SingleThreadModel
8. Filter
9. FilterConfig
10. FilterChain
11. ServletRequestListener
12. ServletRequestAttributeListener
13. ServletContextListener
14. ServletContextAttributeListener

Classes in javax.servlet package

There are many classes in javax.servlet package. They are as follows:

1. GenericServlet
2. ServletInputStream
3. ServletOutputStream
4. ServletRequestWrapper
5. ServletResponseWrapper
6. ServletRequestEvent
7. ServletContextEvent
8. ServletRequestAttributeEvent
9. ServletContextAttributeEvent
10. ServletException
11. UnavailableException

Interfaces in javax.servlet.http package

There are many interfaces in javax.servlet.http package. They are as follows:

1. HttpServletRequest
2. HttpServletResponse
3. HttpSession
4. HttpSessionListener
5. HttpSessionAttributeListener
6. HttpSessionBindingListener
7. HttpSessionActivationListener
8. HttpSessionContext (deprecated now)

Classes in javax.servlet.http package

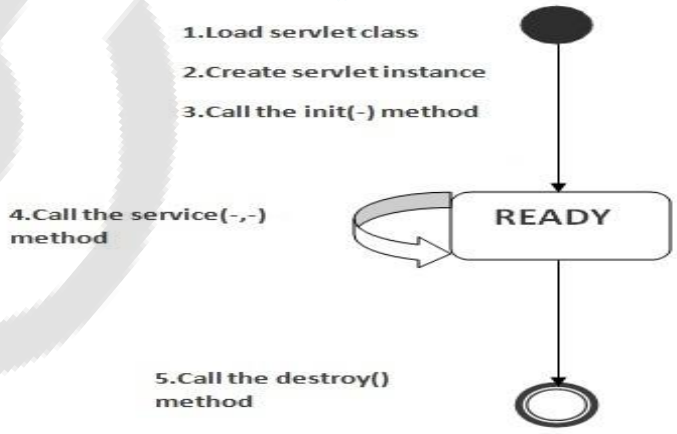
There are many classes in javax.servlet.http package. They are as follows:

1. HttpServlet
2. Cookie
3. HttpServletRequestWrapper
4. HttpServletResponseWrapper
5. HttpSessionEvent
6. HttpSessionBindingEvent
7. HttpUtils (deprecated now)

Q)Servlets - Life Cycle

The web container maintains the life cycle of a servlet instance. Let's see the life cycle of the servlet:

1. Servlet class is loaded.
2. Servlet instance is created.
3. init method is invoked.
4. service method is invoked.
5. destroy method is invoked.



As displayed in the above diagram, there are three states of a servlet: new, ready and end. The servlet is in new state if servlet instance is created. After invoking the init() method, Servlet comes in the ready state. In the ready state, servlet performs all the tasks. When the web container invokes the destroy() method, it shifts to the end state.

1) Servlet class is loaded

The classloader is responsible to load the servlet class. The servlet class is loaded when the first request for the servlet is received by the web container.

2) Servlet instance is created

The web container creates the instance of a servlet after loading the servlet class. The servlet instance is created only once in the servlet life cycle.

3) init method is invoked

The web container calls the init method only once after creating the servlet instance. The init method is used to initialize the servlet. It is the life cycle method of the javax.servlet.Servlet interface. Syntax of the init method is given below:

The init() Method

- The init method is called only once. It is called only when the servlet is created, and not called for any user requests afterwards. So, it is used for one-time initializations, just as with the init method of applets.
- The servlet is normally created when a user first invokes a URL corresponding to the servlet, but you can also specify that the servlet be loaded when the server is first started.
- When a user invokes a servlet, a single instance of each servlet gets created, with each user request resulting in a new thread that is handed off to doGet or doPost as appropriate. The init() method simply creates or loads some data that will be used throughout the life of the servlet.

The init method definition looks like this −

```
publicvoidinit()throwsServletException{
// Initialization code...
}
```

4) service method is invoked

The service() Method

The service() method is the main method to perform the actual task. The servlet container (i.e. web server) calls the service() method to handle requests coming from the client(browsers) and to write the formatted response back to the client.

Each time the server receives a request for a servlet, the server spawns a new thread and calls service. The service() method checks the HTTP request type (GET, POST, PUT, DELETE, etc.) and calls doGet, doPost, doPut, doDelete, etc. methods as appropriate.

Here is the signature of this method −

```
publicvoid service(ServletRequest request,ServletResponse response)
throwsServletException,IOException{
}
```

The service () method is called by the container and service method invokes doGe, doPost, doPut, doDelete, etc. methods as appropriate. So you have nothing to do with service() method but you override either doGet() or doPost() depending on what type of request you receive from the client.

The doGet() and doPost() are most frequently used methods with in each service request. Here is the signature of these two methods.

The doGet() Method

A GET request results from a normal request for a URL or from an HTML form that has no METHOD specified and it should be handled by doGet() method.

```
publicvoiddoGet(HttpServletRequest request,HttpServletResponse response)
throwsServletException,IOException{
// Servlet code
}
```

The doPost() Method

A POST request results from an HTML form that specifically lists POST as the METHOD and it should be handled by doPost() method.

```
publicvoiddoPost(HttpServletRequest request,HttpServletResponse response)
throwsServletException,IOException{
// Servlet code
}
```

5) destroy method is invoked

The destroy() Method

The destroy() method is called only once at the end of the life cycle of a servlet. This method gives your servlet a chance to close database connections, halt background threads, write cookie lists or hit counts to disk, and perform other such cleanup activities.

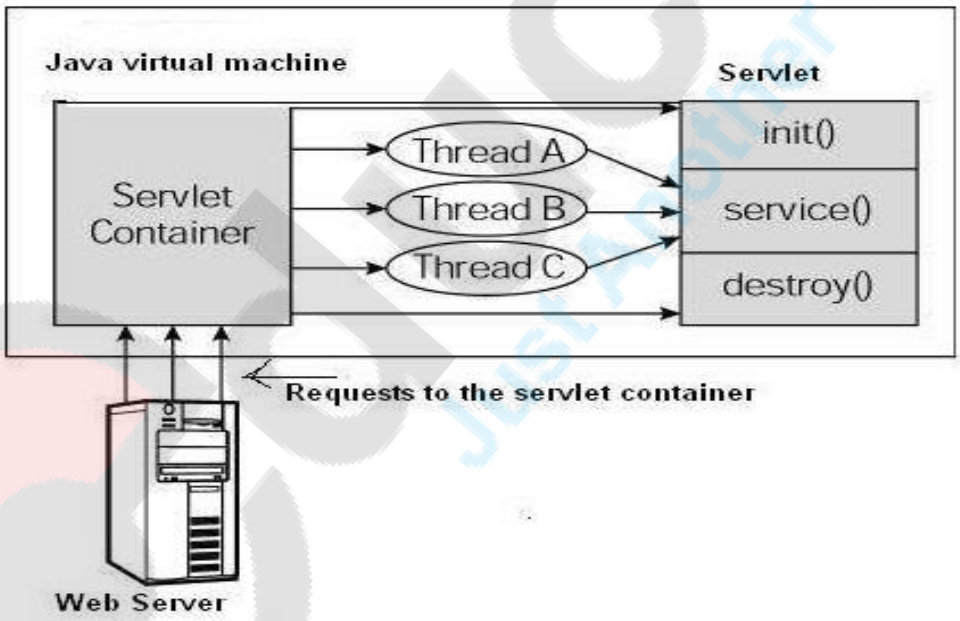
After the destroy() method is called, the servlet object is marked for garbage collection. The destroy method definition looks like this −

```
publicvoid destroy(){
// Finalization code...
}
```

Architecture Diagram

The following figure depicts a typical servlet life-cycle scenario.

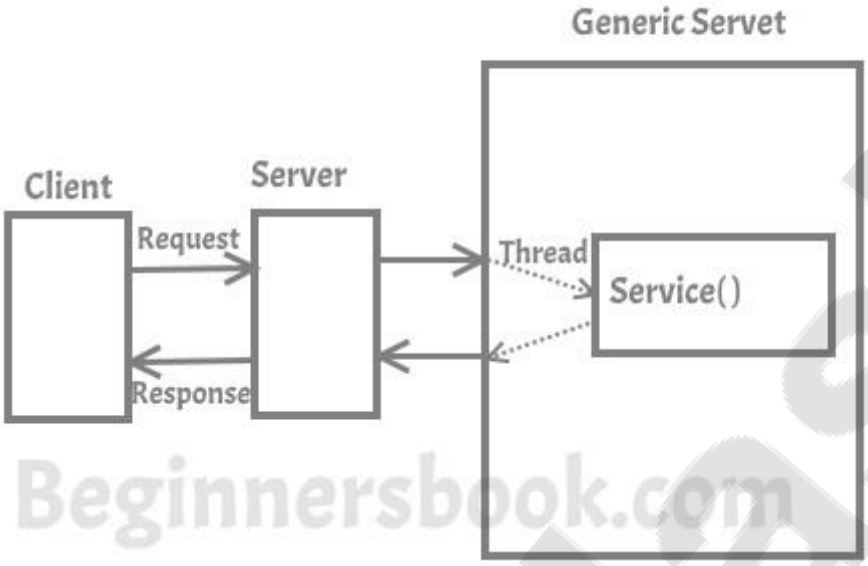
- First the HTTP requests coming to the server are delegated to the servlet container.
- The servlet container loads the servlet before invoking the service() method.
- Then the servlet container handles multiple requests by spawning multiple threads, each thread executing the service() method of a single instance of the servlet.



Q) GenericServlet

A generic servlet is a protocol independent Servlet that should always override the service() method to handle the client request. The service() method accepts two arguments ServletRequest object and ServletResponse object. The request object tells the servlet about the request made by client while the response object is used to return a response back to the client.

How Generic Servlet works?



Hierarchy of Generic Servlet

java.lang.Object
|_extended byjavax.servlet.GenericServlet

GenericServlet is an abstract class and it has only one abstract method, which is service(). That's why when we create Generic Servlet by extending GenericServlet class, we must override service() method.

Pros of using Generic Servlet:
1. Generic Servlet is easier to write
2. Has simple lifecycle methods
3. To write Generic Servlet you just need to extend javax.servlet.GenericServlet and override the service() method (check the example below).

Cons of using Generic Servlet:
Working with Generic Servlet is not that easy because we don't have convenience methods such as doGet(), doPost(), doHead() etc in Generic Servlet that we can use in Http Servlet. In Http Servlet we need to override particular convenience method for particular request, for example if you need to get information then override doGet(), if you want to send information to server override doPost(). However in Generic Servlet we only override service() method for each type of request which is cumbersome.

I would always recommend you to use HttpServlet instead of the GenericServlet. HttpServlet is easier to work with, and has more methods to work with than GenericServlet.

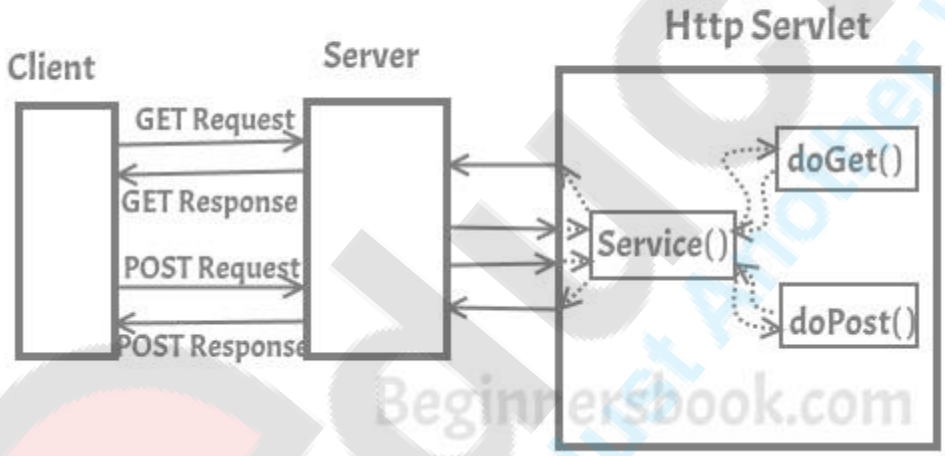
Q)HttpServlet

Unlike Generic Servlet, the HTTP Servlet doesn't override the service() method. Instead it overrides the doGet() method or doPost() method or both. The doGet() method is used for getting the information from server while the doPost() method is used for sending information to the server.

In Http Servlet there is no need to override the service() method because this method dispatches the Http Requests to the correct method handler, for example if it receives HTTP GET Request it dispatches the request to the doGet() method.

How Http Servlet works?

As you can see in the diagram below that client (user's browser) make requests. These requests can be of any type, for example – Get Request, Post Request, Head Request etc. Server dispatches these requests to the servlet's service() method, this method dispatches these requests to the correct handler for example if it receives Get requests it dispatches it to the doGet() method.



Hierarchy of Http Servlet

```
java.lang.Object
        |_extended byjavax.servlet.GenericServlet
        |_extended byjavax.servlet.http.HttpServlet
```

I have already discussed in the Generic Servlet article that you should always use HttpServlet instead of the GenericServlet. HttpServlet is easier to work with, and has more methods to work with than GenericServlet.

Q) diff between GenericServlet and HttpServlet

GENERICSERVLET	HTTPSERVLET
Can be used with any protocol (means, can handle any protocol). Protocol independent.	Should be used with HTTP protocol only (can handle HTTP specific protocols) . Protocol dependent.
All methods are concrete except service() method. service() method is abstract method.	All methods are concrete (non-abstract). service() is non-abstract method.
service() should be overridden being abstract in super interface.	service() method need not be overridden.
It is a must to use service() method as it is a callback method.	Being service() is non-abstract, it can be replaced by doGet() or doPost() methods.
Extends Object and implements interfaces Servlet, ServletConfig and Serializable.	Extends GenericServlet and implements interface Serializable
Direct subclass of Servet interface.	Direct subclass of GenericServlet.
Defined javax.servlet package.	Defined javax.servlet.http package.
All the classes and interfaces belonging to javax.servlet package are protocol independent.	All the classes and interfaces present in javax.servlet.http package are protocol dependent (specific to HTTP).
Not used now-a-days.	Used always.

Difference between ServletContext vs ServletConfig

Now let's see difference between ServletContext and ServletConfig in Servlets JSP in tabular format

Servlet Config	Servlet Context
Servlet config object represent single servlet	It represent whole web application running on particular JVM and common for all the servlet
Its like local parameter associated with particular servlet	Its like global parameter associated with whole application
It's a name value pair defined inside the servlet section of web.xml file so it has servlet wide scope	ServletContext has application wide scope so define outside of servlet tag in web.xml file.
getServletConfig() method is used to get the config object	getServletContext() method is used to get the context object.
for example shopping cart of a user is a specific to particular user so here we can use servlet config	To get the MIME type of a file or application session related information is stored using servlet context object.

ServletConfig

- ServletConfig available in javax.servlet.*; package
- ServletConfig object is one per servlet class
- Object of ServletConfig will be created during initialization process of the servlet
- This Config object is public to a particular servlet only
- *Scope*: As long as a servlet is executing, ServletConfig object will be available, it will be destroyed once the servlet execution is completed.
- We should give request explicitly, in order to create ServletConfig object for the first time
- In web.xml – <*init-param*> tag will be appear under <*servlet-class*> tag

ServletContext

- ServletContext available in javax.servlet.*; package
- ServletContext object is global to entire web application
- Object of ServletContext will be created at the time of web application deployment
- *Scope*: As long as web application is executing, ServletContext object will be available, and it will be destroyed once the application is removed from the server.
- ServletContext object will be available even before giving the first request
- In web.xml – <*context-param*> tag will be appear under <*web-app*> tag

ServletConfig Interface

An object of ServletConfig is created by the web container for each servlet. This object can be used to get configuration information from web.xml file.

If the configuration information is modified from the web.xml file, we don't need to change the servlet. So it is easier to manage the web application if any specific content is modified from time to time.

Advantage of ServletConfig

The core advantage of ServletConfig is that you don't need to edit the servlet file if information is modified from the web.xml file.

Methods of ServletConfig interface

1. **public String getInitParameter(String name):**Returns the parameter value for the specified parameter name.
2. **public Enumeration getInitParameterNames():**Returns an enumeration of all the initialization parameter names.
3. **public String getServletName():**Returns the name of the servlet.
4. **publicServletContextgetServletContext():**Returns an object of ServletContext.

How to get the object of ServletConfig

1. **getServletConfig() method** of Servlet interface returns the object of ServletConfig.

Syntax of getServletConfig() method

```
public ServletConfig getServletConfig();
```

Example of getServletConfig() method

```
ServletConfig config=getServletConfig();

//Now we can call the methods of ServletConfig interface
```

Example:

In this example, we will use two methods getInitParameter() and getInitParameterNames() to get all the parameters from web.xml along with their values.
The getInitParameterNames() method returns an enumeration of all parameters names and by passing those names during the call of getInitParameter() method, we can get the corresponding parameter value from web.xml.

DemoServlet.java

```
import java.io.*;
importjavax.servlet.*;
```

```
importjavax.servlet.http.*;
importjava.util.Enumeration;

publicclassDemoServletextendsHttpServlet{

protectedvoiddoGet(HttpServletRequest request,
HttpServletResponse response)
throwsServletException,IOException
{

response.setContentType("text/html;charset=UTF-8");
PrintWriterpwriter=response.getWriter();
ServletConfigsc=getServletConfig();

Enumeration<String> e=sc.getInitParameterNames();
Stringstr;
while(e.hasMoreElements()){
str=e.nextElement();
pwriter.println("<br>Param Name: "+str);
pwriter.println(" value: "+sc.getInitParameter(str));
}
}
}
```

web.xml

```
<web-app>
<display-name>BeginnersBookDemo</display-name>
<welcome-file-list>
<welcome-file>index.html</welcome-file>
</welcome-file-list>
<servlet>
<servlet-name>MyServlet</servlet-name>
<servlet-class>DemoServlet</servlet-class>
<init-param>
<param-name>MyName</param-name>
<param-value>Chaitanya</param-value>

</init-param>
<init-param>
<param-name>MyWebsite</param-name>
<param-value>Beginnersbook.com</param-value>
</init-param>
</servlet>
<servlet-mapping>
<servlet-name>MyServlet</servlet-name>
<url-pattern>/scdemo</url-pattern>
</servlet-mapping>
</web-app>
```

ServletContext Interface

An object of ServletContext is created by the web container at time of deploying the project. This object can be used to get configuration information from web.xml file. There is only one ServletContext object per web application.

If any information is shared to many servlet, it is better to provide it from the web.xml file using the **<context-param>** element.

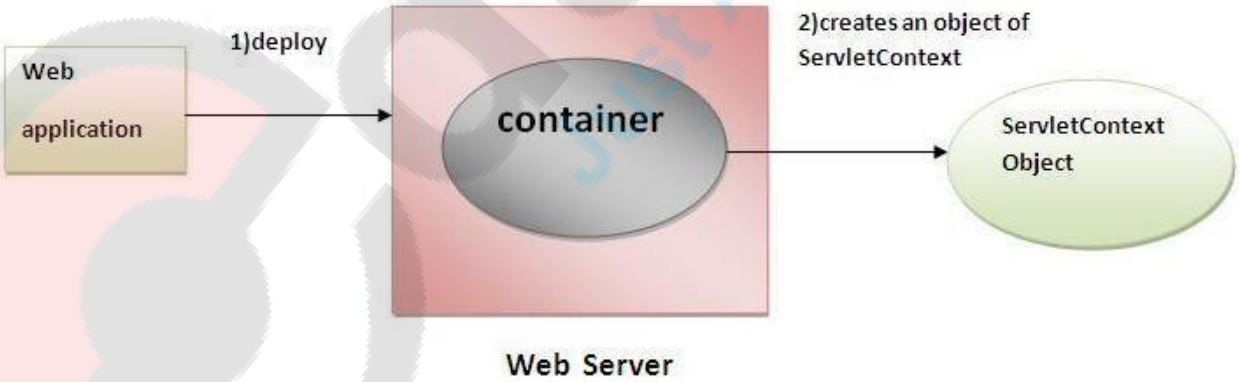
Advantage of ServletContext

Easy to maintain if any information is shared to all the servlet, it is better to make it available for all the servlet. We provide this information from the web.xml file, so if the information is changed, we don't need to modify the servlet. Thus it removes maintenance problem.

Usage of ServletContext Interface

There can be a lot of usage of ServletContext object. Some of them are as follows:

1. The object of ServletContext provides an interface between the container and servlet.
2. The ServletContext object can be used to get configuration information from the web.xml file.
3. The ServletContext object can be used to set, get or remove attribute from the web.xml file.
4. The ServletContext object can be used to provide inter-application communication.



Commonly used methods of ServletContext interface

There is given some commonly used methods of ServletContext interface.

1. **public String getInitParameter(String name):**Returns the parameter value for the specified parameter name.
2. **public Enumeration getInitParameterNames():**Returns the names of the context's initialization parameters.
3. **public void setAttribute(String name,Object object):**sets the given object in the application scope.
4. **public Object getAttribute(String name):**Returns the attribute for the specified name.
5. **public Enumeration getInitParameterNames():**Returns the names of the context's initialization parameters as an Enumeration of String objects.
6. **public void removeAttribute(String name):**Removes the attribute with the given name from the servlet context.

How to get the object of ServletContext interface

1. **getServletContext() method** of ServletConfig interface returns the object of ServletContext.
2. **getServletContext() method** of GenericServlet class returns the object of ServletContext.

Syntax of getServletContext() method

```
public ServletContext getServletContext()
```

Example of getServletContext() method

```
//We can get the ServletContext object from ServletConfig object
ServletContext application=getServletConfig().getServletContext();

//Another convenient way to get the ServletContext object
ServletContext application=getServletContext();
```

ServletContext complete example: To get the initialization parameters

In this example we have two context initialization parameters (user name and user email) in web.xml file and we are getting the value in Servlet using getInitParameter() method that returns the value of given parameter.

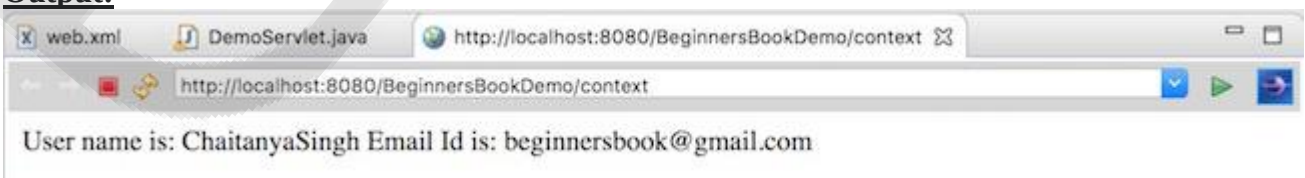
DemoServlet.java

```
import java.io.*;
importjavax.servlet.*;
importjavax.servlet.http.*;
publicclassDemoServletextendsHttpServlet{
publicvoiddoGet(HttpServletRequestrequest,HttpServletResponse response)
throwsServletException,IOException
{
response.setContentType("text/html");
PrintWriterpwriter=response.getWriter();

//ServletContext object creation
ServletContextscontext=getServletContext();

//fetching values of initialization parameters and printing it
StringuserName=scontext.getInitParameter("uname");
pwriter.println("User name is="+userName);
StringuserEmail=scontext.getInitParameter("email");
pwriter.println("Email Id is="+userEmail);
pwriter.close();
}
}
```

web.xml

```
<web-app>
<servlet>
<servlet-name>BeginnersBook</servlet-name>
<servlet-class>DemoServlet</servlet-class>
</servlet>
<context-param>
<param-name>uname</param-name>
<param-value>ChaitanyaSingh</param-value>
</context-param>
<context-param>
<param-name>email</param-name>
<param-value>beginnersbook@gmail.com</param-value>
</context-param>
<servlet-mapping>
<servlet-name>BeginnersBook</servlet-name>
<url-pattern>/context</url-pattern>
</servlet-mapping>
</web-app>
```

Output:



Q)Handling HTTP Request and response –GET /

POST method.

Handling GET and POST Requests

To handle HTTP requests in a servlet, extend the HttpServlet class and override the servlet methods that handle the HTTP requests that your servlet supports. This lesson illustrates the handling of GET and POST requests. The methods that handle these requests are doGet and doPost.

Handling GET requests

Handling GET requests involves overriding the doGet method. The following example shows the BookDetailServlet doing this. The methods discussed in the Requests and Responses section are shown in **bold**.

```
public class BookDetailServlet extends HttpServlet {

public void doGet (HttpServletRequest request,
HttpServletResponse response)
throwsServletException, IOException
{
...
// set content-type header before accessing the Writer
response.setContentType("text/html");
PrintWriter out = response.getWriter();

// then write the response
out.println("<html>" +
"<head><title>Book Description</title></head>" +
...);

//Get the identifier of the book to display
String bookId = request.getParameter("bookId");
if (bookId != null) {
// and the information about the book and print it
...
}
out.println("</body></html>");
out.close();
}
...
}
```

The servlet extends the HttpServlet class and overrides the doGet method.

Within the doGet method, the getParameter method gets the servlet's expected argument.

To respond to the client, the example doGet method uses a Writer from the HttpServletResponse object to return text data to the client. Before accessing the writer, the example sets the content-type header. At the end of the doGetmethod, after the response has been sent, the Writer is closed.

Handling POST Requests

Handling POST requests involves overriding the doPost method. The following example shows the ReceiptServlet doing this. Again, the methods discussed in the Requests and Responses section are shown in **bold**.

```
public class ReceiptServlet extends HttpServlet {

public void doPost(HttpServletRequest request,
HttpServletResponse response)
throwsServletException, IOException
{
...
// set content type header before accessing the Writer
response.setContentType("text/html");
PrintWriter out = response.getWriter();

// then write the response
out.println("<html>" +
"<head><title> Receipt </title>" +
...);

out.println("<h3>Thank you for purchasing your books from us " +
request.getParameter("cardname") +
...);
out.close();
}
...
}
```

The servlet extends the HttpServlet class and overrides the doPost method.

Within the doPost method, the getParameter method gets the servlet's expected argument.

To respond to the client, the example doPost method uses a Writer from the HttpServletResponse object to return text data to the client. Before accessing the writer the example sets the content-type header. At the end of the doPostmethod, after the response has been set, the Writer is closed.

Q)RequestDispatcher in Servlet

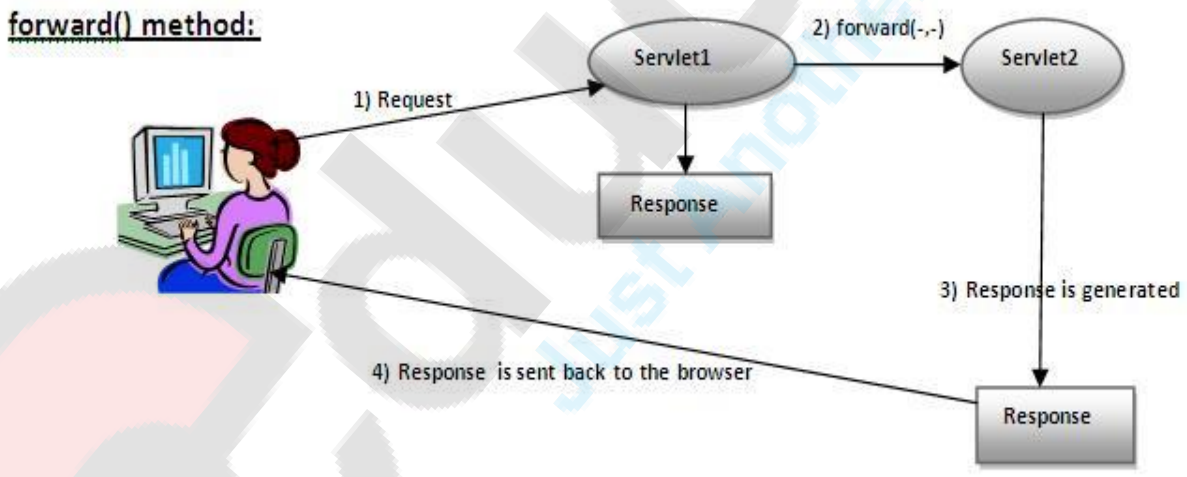
The RequestDispatcher interface provides the facility of dispatching the request to another resource it may be html, servlet or jsp. This interface can also be used to include the content of another resource also. It is one of the way of servlet collaboration.

There are two methods defined in the RequestDispatcher interface.

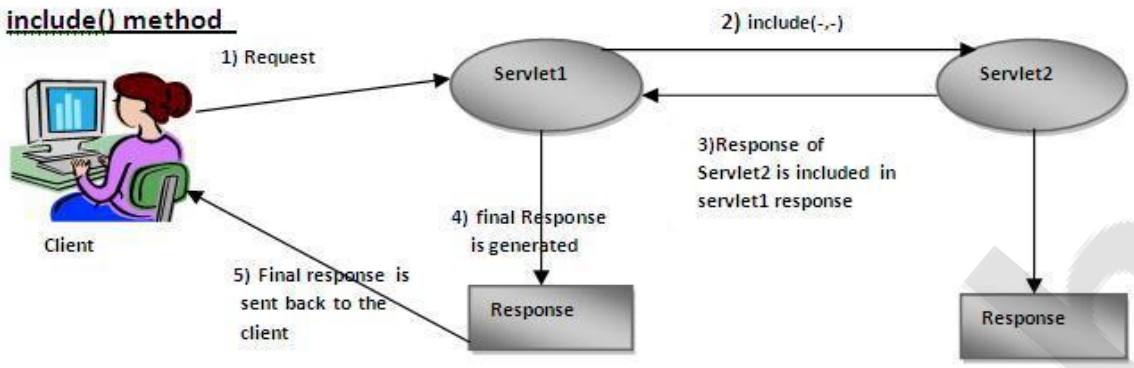
Methods of RequestDispatcher interface

The RequestDispatcher interface provides two methods. They are:

1. **public void forward(ServletRequestrequest,ServletResponse response)throws ServletException,java.io.IOException:**Forwards a request from a servlet to another resource (servlet, JSP file, or HTML file) on the server.
2. **public void include(ServletRequestrequest,ServletResponse response)throws ServletException,java.io.IOException:**Includes the content of a resource (servlet, JSP page, or HTML file) in the response.



As you see in the above figure, response of second servlet is sent to the client. Response of the first servlet is not displayed to the user.



As you can see in the above figure, response of second servlet is included in the response of the first servlet that is being sent to the client.

How to get the object of RequestDispatcher

The getRequestDispatcher() method of ServletRequest interface returns the object of RequestDispatcher. Syntax:

Syntax of getRequestDispatcher method

```
public RequestDispatcher getRequestDispatcher(String resource);
```

Example of using getRequestDispatcher method

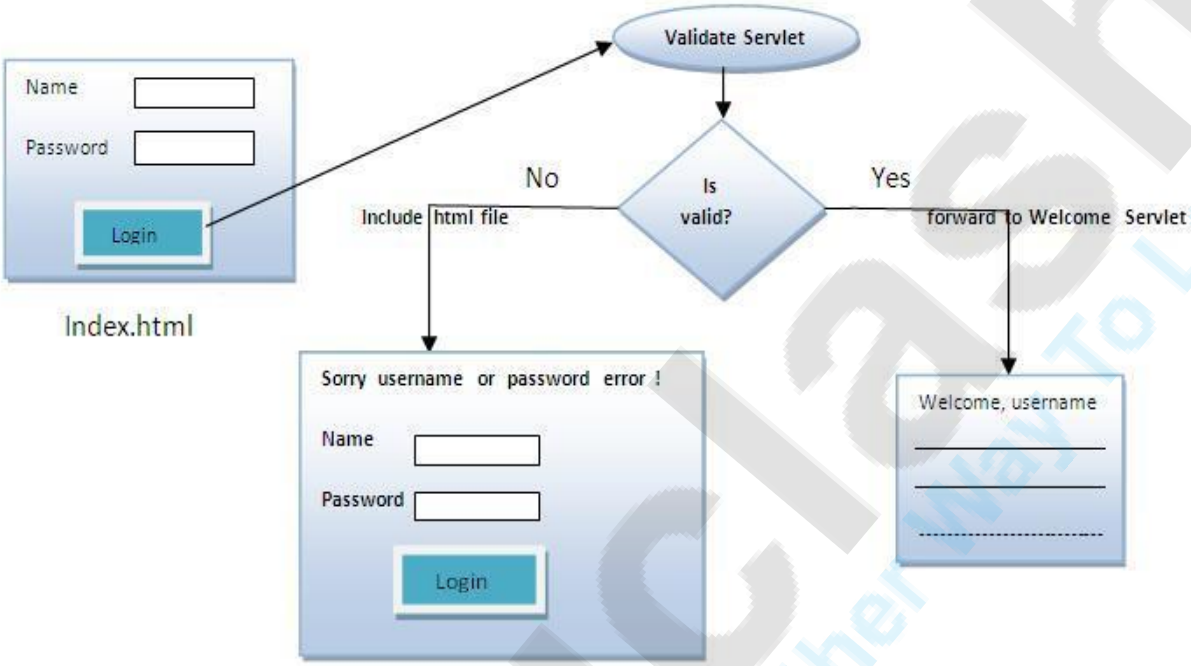
```
RequestDispatcher rd=request.getRequestDispatcher("servlet2");
//servlet2 is the url-pattern of the second servlet
  rd.forward(request, response);//method may be include or forward
```

Example of RequestDispatcher interface

In this example, we are validating the password entered by the user. If password is servlet, it will forward the request to the WelcomeServlet, otherwise will show an error message: sorry username or password error!. In this program, we are cheking for hardcoded information. But you can check it to the database also that we will see in the development chapter. In this example, we have created following files:

- **index.html file:** for getting input from the user.

- **Login.java file:** a servlet class for processing the response. If password is servet, it will forward the request to the welcome servlet.
- **WelcomeServlet.java file:** a servlet class for displaying the welcome message.
- **web.xml file:** a deployment descriptor file that contains the information about the servlet.



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index.html

```
<form action="servlet1" method="post">
Name:<input type="text" name="userName"/><br/>
Password:<input type="password" name="userPass"/><br/>
<input type="submit" value="login"/>
</form>
```

Login.java

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;


public class Login extends HttpServlet {

public void doPost(HttpServletRequest request, HttpServletResponse response)
throws ServletException, IOException {
```

```
response.setContentType("text/html");
PrintWriter out = response.getWriter();

String n=request.getParameter("userName");
String p=request.getParameter("userPass");

if(p.equals("servlet"){
RequestDispatcher rd=request.getRequestDispatcher("servlet2");
rd.forward(request, response);
}
else{
out.print("Sorry UserName or Password Error!");
RequestDispatcher rd=request.getRequestDispatcher("/index.html");
rd.include(request, response);

}
}

}
```

WelcomeServlet.java

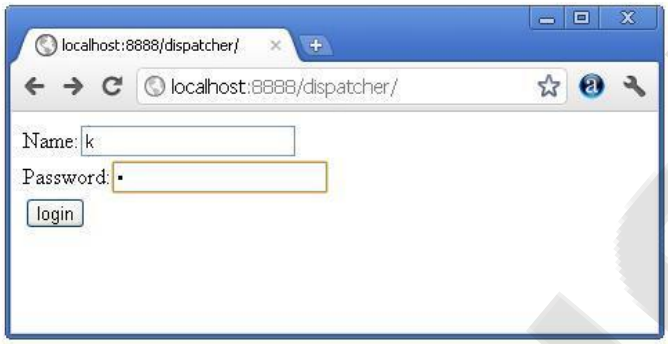
```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class WelcomeServlet extends HttpServlet {

  public void doPost(HttpServletRequest request, HttpServletResponse response)
    throws ServletException, IOException {

  response.setContentType("text/html");
  PrintWriter out = response.getWriter();

  String n=request.getParameter("userName");
  out.print("Welcome "+n);
  }

}
```

---

web.xml

```
<web-app>
<servlet>
<servlet-name>Login</servlet-name>
<servlet-class>Login</servlet-class>
</servlet>
<servlet>
<servlet-name>WelcomeServlet</servlet-name>
```

```
<servlet-class>WelcomeServlet</servlet-class>
</servlet>


<servlet-mapping>
<servlet-name>Login</servlet-name>
<url-pattern>/servlet1</url-pattern>
</servlet-mapping>
<servlet-mapping>
<servlet-name>WelcomeServlet</servlet-name>
<url-pattern>/servlet2</url-pattern>
</servlet-mapping>

<welcome-file-list>
<welcome-file>index.html</welcome-file>
</welcome-file-list>
</web-app>
```

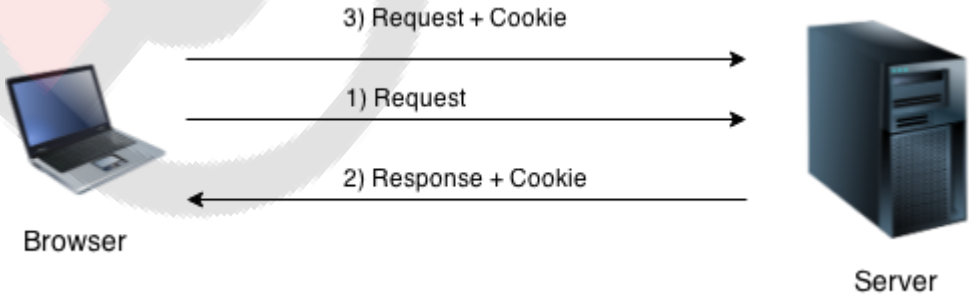


Q)Cookies in Servlet

- A **cookie** is a small piece of information that is persisted between the multiple client requests.
- A cookie has a name, a single value, and optional attributes such as a comment, path and domain qualifiers, a maximum age, and a version number.

How Cookie works

By default, each request is considered as a new request. In cookies technique, we add cookie with response from the servlet. So cookie is stored in the cache of the browser. After that if request is sent by the user, cookie is added with request by default. Thus, we recognize the user as the old user.



Types of Cookie

There are 2 types of cookies in servlets.

1. Non-persistent cookie
2. Persistent cookie

Non-persistent cookie

It is **valid for single session** only. It is removed each time when user closes the browser.

Persistent cookie

It is **valid for multiple session** . It is not removed each time when user closes the browser. It is removed only if user logout or signout.

Advantage of Cookies

1. Simplest technique of maintaining the state.
2. Cookies are maintained at client side.

Disadvantage of Cookies

1. It will not work if cookie is disabled from the browser.
2. Only textual information can be set in Cookie object.

> **Note: Gmail uses cookie technique for login. If you disable the cookie, gmail won't work.**

Cookie class

javax.servlet.http.Cookie class provides the functionality of using cookies. It provides a lot of useful methods for cookies.

Constructor of Cookie class

Constructor	Description
Cookie()	constructs a cookie.
Cookie(String name, String value)	constructs a cookie with a specified name and value.

Useful Methods of Cookie class

There are given some commonly used methods of the Cookie class.

Method	Description
public void setMaxAge(int expiry)	Sets the maximum age of the cookie in seconds.
public String getName()	Returns the name of the cookie. The name cannot be changed after creation.
public String getValue()	Returns the value of the cookie.
public void setName(String name)	changes the name of the cookie.
public void setValue(String value)	changes the value of the cookie.

Other methods required for using Cookies

For adding cookie or getting the value from the cookie, we need some methods provided by other interfaces. They are:

1. **public void addCookie(Cookie ck):**method of HttpServletResponse interface is used to add cookie in response object.
2. **public Cookie[] getCookies():**method of HttpServletRequest interface is used to return all the cookies from the browser.

How to create Cookie?

Let's see the simple code to create cookie.

```
1. Cookie ck=new Cookie("user","sonoo jaiswal");//creating cookie object
2. response.addCookie(ck);//adding cookie in the response
```

How to delete Cookie?

Let's see the simple code to delete cookie. It is mainly used to logout or signout the user.

```
1. Cookie ck=new Cookie("user","");//deleting value of cookie
2. ck.setMaxAge(0);//changing the maximum age to 0 seconds
3. response.addCookie(ck);//adding cookie in the response
```

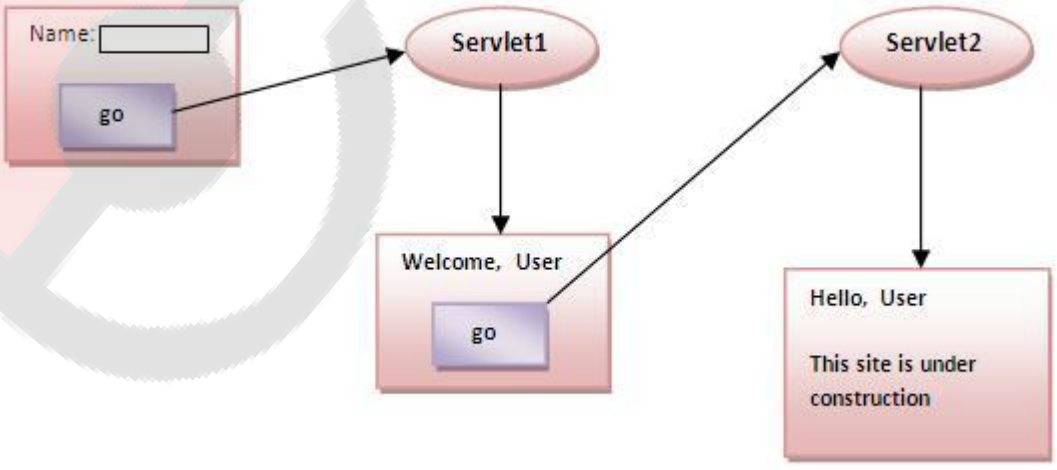
How to get Cookies?

Let's see the simple code to get all the cookies.

```
1. Cookie ck[]=request.getCookies();
2. for(int i=0;i<ck.length;i++){
3.  out.print("<br>"+ck[i].getName()+" "+ck[i].getValue());//printing name and value of cookie

4. }
```

Simple example of Servlet Cookies

In this example, we are storing the name of the user in the cookie object and accessing it in another servlet. As we know well that session corresponds to the particular user. So if you access it from too many browsers with different values, you will get the different value.



index.html

```
<form action="servlet1" method="post">
Name:<input type="text" name="userName"/><br/>
<input type="submit" value="go"/>
</form>
```

FirstServlet.java

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;


public class FirstServlet extends HttpServlet {

public void doPost(HttpServletRequest request, HttpServletResponse response){
try{

response.setContentType("text/html");
PrintWriter out = response.getWriter();

String n=request.getParameter("userName");
out.print("Welcome "+n);

Cookie ck=new Cookie("uname",n);//creating cookie object
response.addCookie(ck);//adding cookie in the response

//creating submit button
out.print("<form action='servlet2'>");
out.print("<input type='submit' value='go'>");
out.print("</form>");

out.close();

}catch(Exception e){System.out.println(e);}
}
}
```

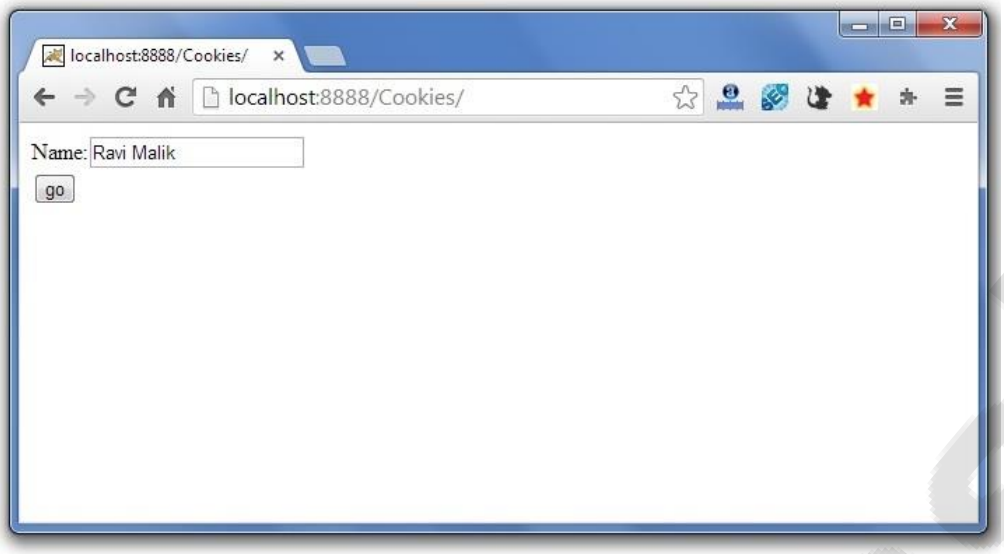
SecondServlet.java

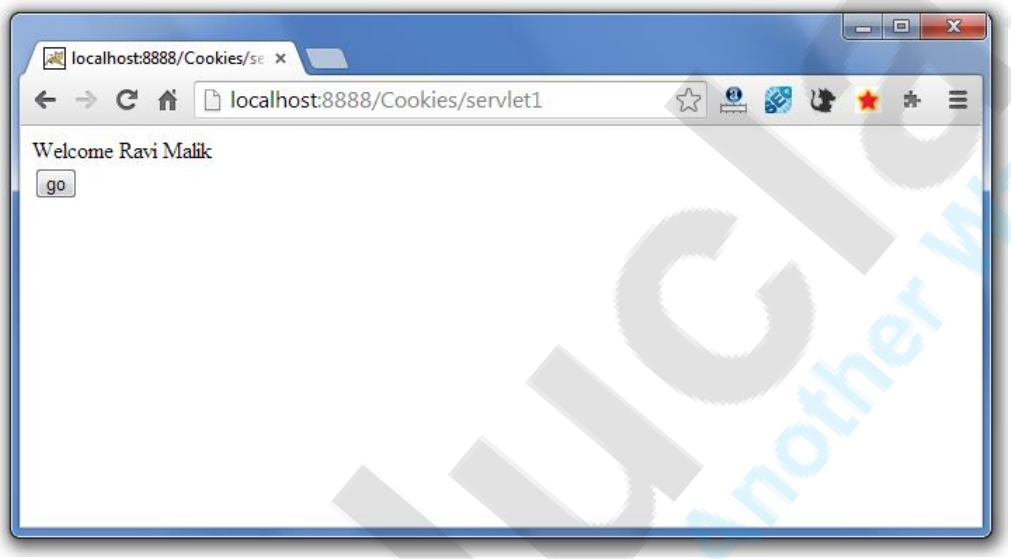
```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class SecondServlet extends HttpServlet {

public void doPost(HttpServletRequest request, HttpServletResponse response){
  try{

  response.setContentType("text/html");
```

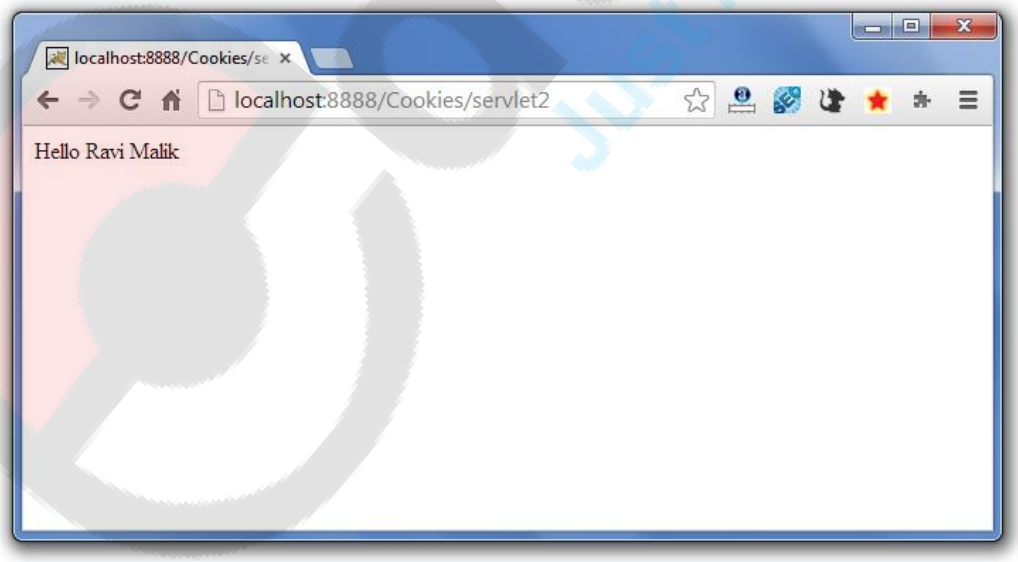
```
    PrintWriter out = response.getWriter();

    Cookie ck[]=request.getCookies();
    out.print("Hello "+ck[0].getValue());

    out.close();

        }catch(Exception e){System.out.println(e);}
    }


}
```

web.xml

```
<web-app>

<servlet>
<servlet-name>s1</servlet-name>
<servlet-class>FirstServlet</servlet-class>
</servlet>

<servlet-mapping>
<servlet-name>s1</servlet-name>
<url-pattern>/servlet1</url-pattern>
</servlet-mapping>

<servlet>
<servlet-name>s2</servlet-name>
<servlet-class>SecondServlet</servlet-class>
</servlet>

<servlet-mapping>
<servlet-name>s2</servlet-name>
<url-pattern>/servlet2</url-pattern>
</servlet-mapping>

</web-app>
```


localhost:8888/Cookies/
localhost:8888/Cookies/
Name: Ravi Malik
go


localhost:8888/Cookies/se
localhost:8888/Cookies/servlet1
Welcome Ravi Malik
go


localhost:8888/Cookies/se
localhost:8888/Cookies/servlet2
Hello Ravi Malik

Q)Servlets - Session Tracking

HTTP is a "stateless" protocol which means each time a client retrieves a Web page, the client opens a separate connection to the Web server and the server automatically does not keep any record of previous client request.

Still there are following three ways to maintain session between web client and web server −

There are four techniques used in Session tracking:

1. **Cookies**
2. **Hidden Form Field**
3. **URL Rewriting**
4. **HttpSession**

Cookies

A webserver can assign a unique session ID as a cookie to each web client and for subsequent requests from the client they can be recognized using the recieved cookie.

This may not be an effective way because many time browser does not support a cookie, so I would not recommend to use this procedure to maintain the sessions.

Hidden Form Fields

A web server can send a hidden HTML form field along with a unique session ID as follows −

```
<input type = "hidden" name = "sessionid" value = "12345">
```

This entry means that, when the form is submitted, the specified name and value are automatically included in the GET or POST data. Each time when web browser sends request back, then session_id value can be used to keep the track of different web browsers.

This could be an effective way of keeping track of the session but clicking on a regular (<A HREF...>) hypertext link does not result in a form submission, so hidden form fields also cannot support general session tracking.

URL Rewriting

You can append some extra data on the end of each URL that identifies the session, and the server can associate that session identifier with data it has stored about that session.

For example, with http://tutorialspoint.com/file.htm;sessionid = 12345, the session identifier is attached as sessionid = 12345 which can be accessed at the web server to identify the client.

URL rewriting is a better way to maintain sessions and it works even when browsers don't support cookies. The drawback of URL re-writing is that you would have to generate every URL dynamically to assign a session ID, even in case of a simple static HTML page.

The HttpSession Object

Apart from the above mentioned three ways, servlet provides HttpSession Interface which provides a way to identify a user across more than one page request or visit to a Web site and to store information about that user.

The servlet container uses this interface to create a session between an HTTP client and an HTTP server. The session persists for a specified time period, across more than one connection or page request from the user.

You would get HttpSession object by calling the public method **getSession()**of HttpServletRequest, as below −

```
HttpSession session =request.getSession();
```

You need to call *request.getSession()* before you send any document content to the client. Here is a summary of the important methods available through HttpSession object −

Sr.No.	Method & Description
1	public Object getAttribute(String name) This method returns the object bound with the specified name in this session, or null if no object is bound under the name.
2	public Enumeration getAttributeNames() This method returns an Enumeration of String objects containing the names of all the objects bound to this session.
3	public long getCreationTime() This method returns the time when this session was created, measured in milliseconds since midnight January 1, 1970 GMT.
4	public String getId() This method returns a string containing the unique identifier assigned to this session.
5	public long getLastAccessedTime() This method returns the last accessed time of the session, in the format of milliseconds since midnight January 1, 1970 GMT

6	public intgetMaxInactiveInterval() This method returns the maximum time interval (seconds), that the servlet container will keep the session open between client accesses.
7	public void invalidate() This method invalidates this session and unbinds any objects bound to it.
8	public booleanisNew(This method returns true if the client does not yet know about the session or if the client chooses not to join the session.
9	public void removeAttribute(String name) This method removes the object bound with the specified name from this session.
10	public void setAttribute(String name, Object value) This method binds an object to this session, using the name specified.
11	public void setMaxInactiveInterval(int interval) This method specifies the time, in seconds, between client requests before the servlet container will invalidate this session.

Q)Diff betn Servlet and JSP

	Servlet	JSP
1	Servlet is faster than jsp	JSP is slower than Servlet because it first translate into java code then compile.
2	In Servlet, if we modify the code then we need recompilation, reloading, restarting the server> It means it is time consuming process.	In JSP, if we do any modifications then just we need to click on refresh button and recompilation, reloading, restart the server is not required.
3	Servlet is a java code.	JSP is tag based approach.
4	In Servlet, there is no such method for running JavaScript at client side.	In JSP, we can use the client side validations using running the JavaScript at client side.
5	To run a Servlet you have to make an entry of Servlet mapping into the deployment descriptor file i.e. web.xml file externally.	For running a JSP there is no need to make an entry of Servlet mapping into the web.xml file externally, you may or not make an entry for JSP file as welcome file list.
6	Coding of Servlet is harden than jsp.	Coding of jsp is easier than Servlet because it is tag based.
7	In MVC pattern, Servlet plays a controller role.	In MVC pattern, JSP is used for showing output data i.e. in MVC it is a view.
8	Servlet accept all protocol request.	JSP will accept only http protocol request.
9	In Servlet, aervice() method need to override.	In JSP no need to override service() method.

10	In Servlet, by default session management is not enabled we need to enable explicitly.	In JSP, session management is automatically enabled.
11	In Servlet we do not have implicit object. It means if we want to use an object then we need to get object explicitly form the servlet.	In JSP, we have implicit object support.
12	In Servlet, we need to implement business logic, presentation logic combined.	In JSP, we can separate the business logic from the presentation logic by uses javaBean technology.
13	In Servlet, all package must be imported on top of the servlet.	In JSP, package imported anywhere top, middle and bottom.

Q) Difference Between GET and POST

	GET	POST
History	Parameters remain in browser history because they are part of the URL	Parameters are not saved in browser history.
Bookmarked	Can be bookmarked.	Can not be bookmarked.
BACK button/re-submit behaviour	GET requests are re-executed but may not be re-submitted to server if the HTML is stored in the browser cache.	The browser usually alerts the user that data will need to be re-submitted.
Encoding type (enctype attribute)	application/x-www-form-urlencoded	multipart/form-data or application/x-www-form-urlencoded Use multipart encoding for binary data.
Parameters	can send but the parameter data is limited to what we can stuff into the request line (URL). Safest to use less than 2K of parameters, some servers handle up to 64K	Can send parameters, including uploading files, to the server.
Hacked	Easier to hack for script kiddies	More difficult to hack
Restrictions on form data type	Yes, only ASCII characters allowed.	No restrictions. Binary data is also allowed.
Security	GET is less secure compared to POST because data sent is part of the URL. So it's saved in browser history and server logs in plaintext.	POST is a little safer than GET because the parameters are not stored in browser history or in web server logs.
Restrictions on form data length	Yes, since form data is in the URL and URL length is restricted. A safe URL length limit is often 2048 characters but varies by browser and web server.	No restrictions

Usability	GET method should not be used when sending passwords or other sensitive information.	POST method used when sending passwords or other sensitive information.
Visibility	GET method is visible to everyone (it will be displayed in the browser's address bar) and has limits on the amount of information to send.	POST method variables are not displayed in the URL.

UNIT 11

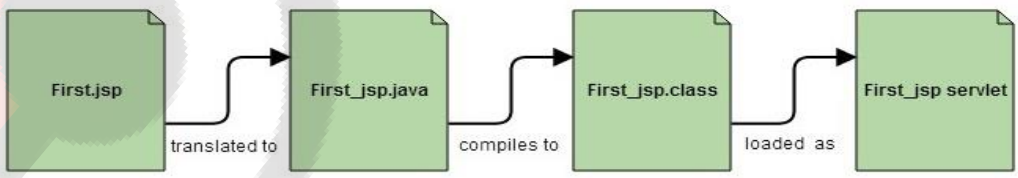
WEB DEVELOPMENT USING JSP : -

Q.1) Introduction to JSP

- JavaServer Pages (JSP) is a technology for developing Webpages that supports dynamic content. This helps developers insert java code in HTML pages by making use of special JSP tags, most of which start with <% and end with %>.
- A JavaServer Pages component is a type of Java servlet that is designed to fulfill the role of a user interface for a Java web application. Web developers write JSPs as text files that combine HTML or XHTML code, XML elements, and embedded JSP actions and commands.
- Using JSP, you can collect input from users through Webpage forms, present records from a database or another source, and create Webpages dynamically.
- JSP tags can be used for a variety of purposes, such as retrieving information from a database or registering user preferences, accessing JavaBeans components, passing control between pages, and sharing information between requests, pages etc.
- **JSP** technology is used to create dynamic web applications. **JSP** pages are easier to maintain then a **Servlet**. JSP pages are opposite of Servlets as a servlet adds HTML code inside Java code, while JSP adds Java code inside HTML using JSP tags. Everything a Servlet can do, a JSP page can also do it.
- JSP enables us to write HTML pages containing tags, inside which we can include powerful Java programs. **Using JSP, one can easily separate Presentation and Business logic** as a web designer can design and update JSP pages creating the presentation layer and java developer can write server side complex computational code without concerning the web design. And both the layers can easily interact over HTTP requests.

In the end a JSP becomes a Servlet

JSP pages are converted into **Servlet** by the Web Container. The Container translates a JSP page into servlet **class source(.java)** file and then compiles into a Java Servlet class.



Why JSP is preffered over servlets?

- JSP provides an easier way to code dynamic web pages.
- JSP does not require additional files like, java class files, web.xml etc
- Any change in the JSP code is handled by Web Container(Application server like tomcat), and doesn't require re-compilation.
- JSP pages can be directly accessed, and web.xml mapping is not required like in servlets.

There are five different types of scripting elements

Scripting Element	Example
Comment	<%-- comment --%>
Directive	<%@ directive %>
Declaration	<%! declarations %>
Scriptlet	<% scriplets %>
Expression	<%= expression %>

Why Use JSP?

JavaServer Pages often serve the same purpose as programs implemented using the **Common Gateway Interface (CGI)**. But JSP offers several advantages in comparison with the CGI.

- Performance is significantly better because JSP allows embedding Dynamic Elements in HTML Pages itself instead of having separate CGI files.
- JSP are always compiled before they are processed by the server unlike CGI/Perl which requires the server to load an interpreter and the target script each time the page is requested.

- JavaServer Pages are built on top of the Java Servlets API, so like Servlets, JSP also has access to all the powerful Enterprise Java APIs, including **JDBC, JNDI, EJB, JAXP,** etc.
- JSP pages can be used in combination with servlets that handle the business logic, the model supported by Java servlet template engines.

Finally, JSP is an integral part of Java EE, a complete platform for enterprise class applications. This means that JSP can play a part in the simplest applications to the most complex and demanding.

Advantages of JSP

Following table lists out the other advantages of using JSP over other technologies −

vs. Active Server Pages (ASP)

The advantages of JSP are twofold. First, the dynamic part is written in Java, not Visual Basic or other MS specific language, so it is more powerful and easier to use. Second, it is portable to other operating systems and non-Microsoft Web servers.

vs. Pure Servlets

It is more convenient to write (and to modify!) regular HTML than to have plenty of println statements that generate the HTML.

vs. Server-Side Includes (SSI)

SSI is really only intended for simple inclusions, not for "real" programs that use form data, make database connections, and the like.

vs. JavaScript

JavaScript can generate HTML dynamically on the client but can hardly interact with the web server to perform complex tasks like database access and image processing etc.

vs. Static HTML

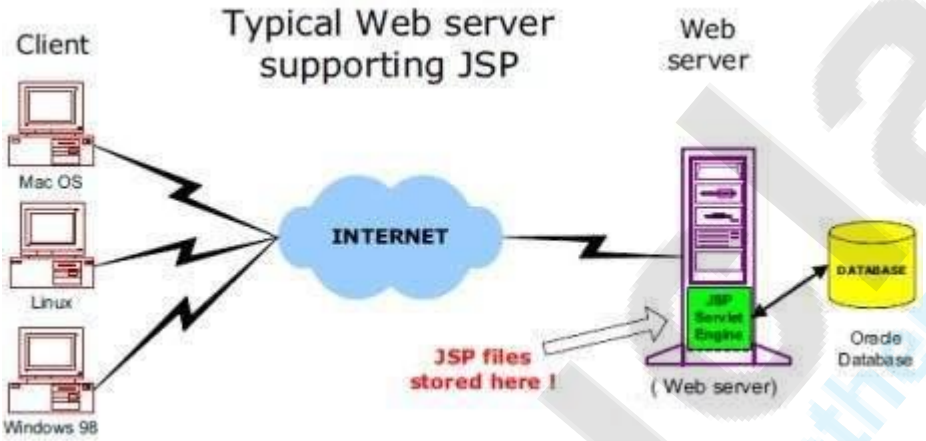
Regular HTML, of course, cannot contain dynamic information.

Q.2) what is JSP Architecture?

The web server needs a JSP engine, i.e, a container to process JSP pages. The JSP container is responsible for intercepting requests for JSP pages. This tutorial makes use of Apache which has built-in JSP container to support JSP pages development.

A JSP container works with the Web server to provide the runtime environment and other services a JSP needs. It knows how to understand the special elements that are part of JSPs.

Following diagram shows the position of JSP container and JSP files in a Web application.



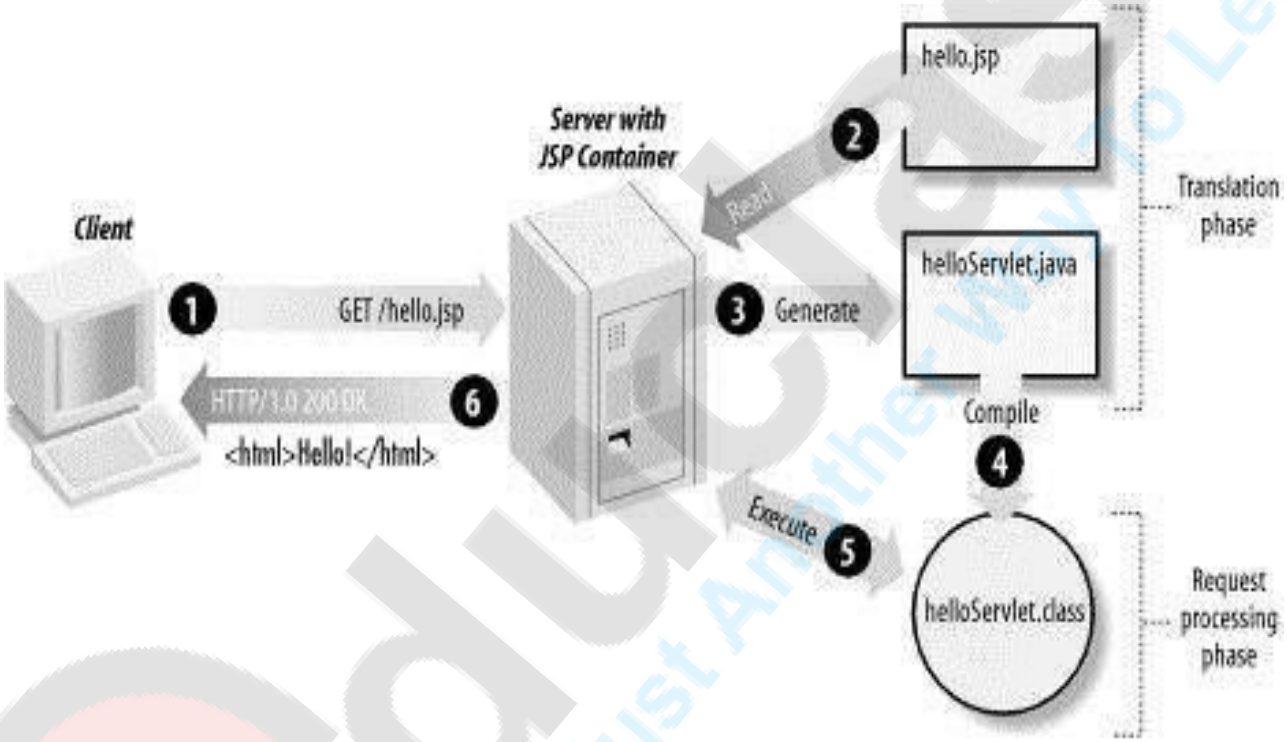
JSP Processing

The following steps explain how the web server creates the Webpage using JSP −

- As with a normal page, your browser sends an HTTP request to the web server.
- The web server recognizes that the HTTP request is for a JSP page and forwards it to a JSP engine. This is done by using the URL or JSP page which ends with **.jsp** instead of **.html**.
- The JSP engine loads the JSP page from disk and converts it into a servlet content. This conversion is very simple in which all template text is converted to println( ) statements and all JSP elements are converted to Java code. This code implements the corresponding dynamic behavior of the page.
- The JSP engine compiles the servlet into an executable class and forwards the original request to a servlet engine.

- A part of the web server called the servlet engine loads the Servlet class and executes it. During execution, the servlet produces an output in HTML format. The output is furthur passed on to the web server by the servlet engine inside an HTTP response.
- The web server forwards the HTTP response to your browser in terms of static HTML content.
- Finally, the web browser handles the dynamically-generated HTML page inside the HTTP response exactly as if it were a static page.

All the above mentioned steps can be seen in the following diagram −



Typically, the JSP engine checks to see whether a servlet for a JSP file already exists and whether the modification date on the JSP is older than the servlet. If the JSP is older than its generated servlet, the JSP container assumes that the JSP hasn't changed and that the generated servlet still matches the JSP's contents. This makes the process more efficient than with the other scripting languages (such as PHP) and therefore faster.

So in a way, a JSP page is really just another way to write a servlet without having to be a Java programming wiz. Except for the translation phase, a JSP page is handled exactly like a regular servlet.

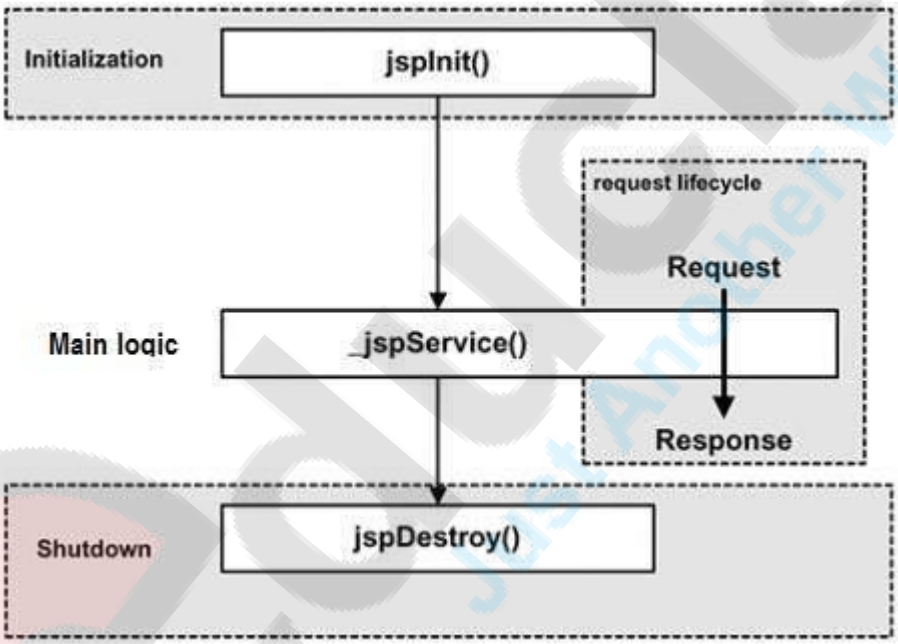
Q.3) JSP - Lifecycle

A JSP life cycle is defined as the process from its creation till the destruction. This is similar to a servlet life cycle with an additional step which is required to compile a JSP into servlet.

Paths Followed By JSP

The following are the paths followed by a JSP −

- Compilation
- Initialization
- Execution
- Cleanup
- The four major phases of a JSP life cycle are very similar to the Servlet Life Cycle. The four phases have been described below −



JSP Compilation

When a browser asks for a JSP, the JSP engine first checks to see whether it needs to compile the page. If the page has never been compiled, or if the JSP has been modified since it was last compiled, the JSP engine compiles the page.

The compilation process involves three steps −

- Parsing the JSP.

- Turning the JSP into a servlet.
- Compiling the servlet.

JSP Initialization

When a container loads a JSP it invokes the **jspInit()** method before servicing any requests. If you need to perform JSP-specific initialization, override the **jspInit()** method −

```
publicvoid jspInit(){
// Initialization code...
}
```

Typically, initialization is performed only once and as with the servlet init method, you generally initialize database connections, open files, and create lookup tables in the jspInit method.

JSP Execution

This phase of the JSP life cycle represents all interactions with requests until the JSP is destroyed.

Whenever a browser requests a JSP and the page has been loaded and initialized, the JSP engine invokes the **_jspService()** method in the JSP.

The _jspService() method takes an **HttpServletRequest** and an **HttpServletResponse** as its parameters as follows −

```
void _jspService(HttpServletRequest request,HttpServletResponse response){
// Service handling code...
}
```

The **_jspService()** method of a JSP is invoked on request basis. This is responsible for generating the response for that request and this method is also responsible for generating responses to all seven of the HTTP methods, i.e, **GET, POST, DELETE**, etc.

JSP Cleanup

The destruction phase of the JSP life cycle represents when a JSP is being removed from use by a container.

The **jspDestroy()** method is the JSP equivalent of the destroy method for servlets. Override jspDestroy when you need to perform any cleanup, such as releasing database connections or closing open files.

The jspDestroy() method has the following form −

```
publicvoid jspDestroy(){
// Your cleanup code goes here.
```

Q.4) JSP – Directives

A JSP directive affects the overall structure of the servlet class. It usually has the following form −

```
<%@ directive attribute = "value" %>
```

Directives can have a number of attributes which you can list down as key-value pairs and separated by commas.

The blanks between the @ symbol and the directive name, and between the last attribute and the closing %>, are optional.

There are three types of directive tag –

S.No.	Directive & Description
1	<%@ page ... %> Defines page-dependent attributes, such as scripting language, error page, and buffering requirements.
2	<%@ include ... %> Includes a file during the translation phase.
3	<%@ taglib ... %> Declares a tag library, containing custom actions, used in the page

JSP - The page Directive

The **page** directive is used to provide instructions to the container. These instructions pertain to the current JSP page. You may code page directives anywhere in your JSP page. By convention, page directives are coded at the top of the JSP page.

Following is the basic syntax of the page directive −

```
<%@ page attribute = "value" %>
```

You can write the XML equivalent of the above syntax as follows −

```
<jsp:directive.page attribute = "value" />
```

Attributes

Following table lists out the attributes associated with the page directive −

S.No.	Attribute & Purpose
1	buffer Specifies a buffering model for the output stream.
2	autoFlush Controls the behavior of the servlet output buffer.
3	contentType Defines the character encoding scheme.
4	errorPage Defines the URL of another JSP that reports on Java unchecked runtime exceptions.
5	isErrorPage Indicates if this JSP page is a URL specified by another JSP page's errorPage attribute.
6	extends Specifies a superclass that the generated servlet must extend.
7	import Specifies a list of packages or classes for use in the JSP as the Java import statement does for Java classes.
8	info Defines a string that can be accessed with the servlet's getServletInfo() method.
9	isThreadSafe Defines the threading model for the generated servlet.
10	language Defines the programming language used in the JSP page.
11	session Specifies whether or not the JSP page participates in HTTP sessions
12	isELIgnored Specifies whether or not the EL expression within the JSP page will be ignored.
13	isScriptingEnabled Determines if the scripting elements are allowed for use.

The include Directive

The **include** directive is used to include a file during the translation phase. This directive tells the container to merge the content of other external files with the current JSP during the translation phase. You may code the ***include***directives anywhere in your JSP page.

The general usage form of this directive is as follows −

```
<%@ include file = "relative url" >
```

The filename in the include directive is actually a relative URL. If you just specify a filename with no associated path, the JSP compiler assumes that the file is in the same directory as your JSP.

You can write the XML equivalent of the above syntax as follows −

```
<jsp:directive.include file = "relative url" />
```

The taglib Directive

The JavaServer Pages API allow you to define custom JSP tags that look like HTML or XML tags and a tag library is a set of user-defined tags that implement custom behavior.

The **taglib** directive declares that your JSP page uses a set of custom tags, identifies the location of the library, and provides means for identifying the custom tags in your JSP page.

The taglib directive follows the syntax given below −

```
<%@ taglib uri="uri" prefix = "prefixOfTag" >
```

Here, the **uri** attribute value resolves to a location the container understands and the **prefix** attribute informs a container what bits of markup are custom actions.

You can write the XML equivalent of the above syntax as follows −

```
<jsp:directive.taglib uri = "uri" prefix = "prefixOfTag" />
```

Q) What are JSP scripting elements?

JSP scripting elements enable you insert Java code into the servlet that will be generated from the current JSP page. There are three forms:

- Expressions of the form <%= expression%> that are evaluated and inserted into output,
- Scriptlets of the form <% code %> that are inserted into the servlets service method, and

- Declarations of the form <%! code %> that are inserted into the body of the servlet class, outside of any existing methods.

Expression

The Expression element contains a Java expression that returns a value. This value is then written to the HTML page. The Expression tag can contain any expression that is valid according to the Java Language Specification. This includes variables, method calls than return values or any object that contains a toString() method.

Syntax

<%= Java expression %>

The Java expression is evaluated, converted to a string, and inserted in the page. This evaluation is performed at run-time (when the page is requested), and thus has full access to information about the request. For example, the following shows the client host name and the date/time that the page was requested:

```
<html>
...
<body>
Your hostname : <%=request.getRemoteHost()%><br>
Current time  : <%= new java.util.Date() %>
...
</body>
</html>
```

Finally, note that XML authors can use an alternative syntax for JSP expressions:

```
<jsp:expression>
Java Expression
</jsp:expression>
```

Remember that XML elements, unlike HTML ones, are case sensitive. So be sure to use lowercase.

Scriptlet

The scriptlet can contain any number of language statements, variable or method declarations, or expressions that are valid in the page scripting language.

Within a scriptlet, you can do any of the following:

- Declare variables or methods to use later in the JSP page.
- Write expressions valid in the page scripting language.

- Use any of the implicit objects or any object declared with a <jsp:useBean> element.
- Write any other statement valid in the scripting language used in the JSP page.

Any text, HTML tags, or JSP elements you write must be outside the scriptlet. For example,

```
<HTML>
<BODY>
<%
   // This scriptlet declares and initializes "date"
   java.util.Date date = new java.util.Date();
%>
Hello!  The time is now
<%
   out.println( date );
   out.println( "<BR>Your machine's address is " );
   out.println( request.getRemoteHost());
%>
</BODY>
</HTML>
```

Scriptlets are executed at request time, when the JSP container processes the request. If the scriptlet produces output, the output is stored in the out object.

If you want to use the characters "%>" inside a scriptlet, enter "%\>" instead. Finally, note that the XML equivalent of <% Code %> is

```
<jsp:scriptlet>
Code
</jsp:scriptlet>
```

Declaration

A declaration can consist of either methods or variables, static constants are a good example of what to put in a declaration.

The JSP you write turns into a class definition. All the scriptlets you write are placed inside a single method of this class. You can also add variable and method declarations to this class. You can then use these variables and methods from your scriptlets and expressions.

You can use declarations to declare one or more variables and methods at the class level of the compiled servlet. The fact that they are declared at class level rather than in the body of the page is significant. The class members (variables and methods) can then be used by Java code in the rest of the page.

Syntax

<%! declaration; [declaration;]+...%>

When you write a declaration in a JSP page, remember these rules:

- You must end the declaration with a semicolon (the same rule as for a Scriptlet, but the opposite of an Expression).
  <% int i = 0;%>
- You can already use variables or methods that are declared in packages imported by the page directive, without declaring them in a declaration element.
- You can declare any number of variables or methods within one declaration element, as long as you end each declaration with a semicolon. The declaration must be valid in the Java programming language.

<% int i = 0; long l = 5L; %>

For example,

```
<%@ page import="java.util.*" %>
<HTML>
<BODY>
<%!
   Date getDate()
   {
      System.out.println( "In getDate() method" );
      return new Date();
   }
%>
Hello!  The time is now <%= getDate() %>
</BODY>
</HTML>
```

A declaration has translation unit scope, so it is valid in the JSP page and any of its static include files. A static include file becomes part of the source of the JSP page and is any file included with an include directive or a static resouce included with a <jsp:include> element. The scope of a declaration does not include dynamic resources included with <jsp:include>.

As with scriptlets, if you want to use the characters "%>", enter "%\>" instead. Finally, note that the XML equivalent of <%! Code %> is

```
<jsp:declaration>
Code
</jsp:declaration>
```

Q) Default objects in JSP

Note:
Default obj ko he implicit obj bolte hai..

In this chapter, we will discuss the Implicit Objects in JSP. These Objects are the Java objects that the JSP Container makes available to the developers in each page and the

developer can call them directly without being explicitly declared. JSP Implicit Objects are also called **pre-defined variables**.

Following table lists out the nine Implicit Objects that JSP supports −

S.No.	Object & Description
1	request This is the HttpServletRequest object associated with the request.
2	response This is the HttpServletResponse object associated with the response to the client.
3	out This is the PrintWriter object used to send output to the client.
4	session This is the HttpSession object associated with the request.
5	application This is the ServletContext object associated with the application context.
6	config This is the ServletConfig object associated with the page.
7	pageContext This encapsulates use of server-specific features like higher performance JspWriters.
8	page This is simply a synonym for this, and is used to call the methods defined by the translated servlet class.
9	Exception The Exception object allows the exception data to be accessed by designated JSP.

The request Object

The request object is an instance of a **javax.servlet.http.HttpServletRequest** object. Each time a client requests a page the JSP engine creates a new object to represent that request.

The request object provides methods to get the HTTP header information including form data, cookies, HTTP methods etc.

We can cover a complete set of methods associated with the request object in a subsequent chapter − JSP - Client Request.

The response Object

The response object is an instance of a **javax.servlet.http.HttpServletResponse** object. Just as the server creates the request object, it also creates an object to represent the response to the client.

The response object also defines the interfaces that deal with creating new HTTP headers. Through this object the JSP programmer can add new cookies or date stamps, HTTP status codes, etc.

We will cover a complete set of methods associated with the response object in a subsequent chapter − JSP - Server Response.

The out Object

The out implicit object is an instance of a **javax.servlet.jsp.JspWriter** object and is used to send content in a response.

The initial JspWriter object is instantiated differently depending on whether the page is buffered or not. Buffering can be easily turned off by using the **buffered = 'false'** attribute of the page directive.

The JspWriter object contains most of the same methods as the **java.io.PrintWriter** class. However, JspWriter has some additional methods designed to deal with buffering. Unlike the PrintWriter object, JspWriter throws **IOExceptions**.

Following table lists out the important methods that we will use to write **boolean char, int, double, object, String**, etc.

S.No.	Method & Description
1	out.print(dataType dt) Print a data type value
2	out.println(dataType dt) Print a data type value then terminate the line with new line character.
3	out.flush() Flush the stream.

The session Object

The session object is an instance of **javax.servlet.http.HttpSession** and behaves exactly the same way that session objects behave under Java Servlets.

The session object is used to track client session between client requests. We will cover the complete usage of session object in a subsequent chapter − JSP - Session Tracking.

The application Object

The application object is direct wrapper around the **ServletContext** object for the generated Servlet and in reality an instance of a **javax.servlet.ServletContext** object.

This object is a representation of the JSP page through its entire lifecycle. This object is created when the JSP page is initialized and will be removed when the JSP page is removed by the **jspDestroy()** method.

By adding an attribute to application, you can ensure that all JSP files that make up your web application have access to it.

We will check the use of Application Object in JSP - Hits Counter chapter.

The config Object

The config object is an instantiation of **javax.servlet.ServletConfig** and is a direct wrapper around the **ServletConfig** object for the generated servlet.

This object allows the JSP programmer access to the Servlet or JSP engine initialization parameters such as the paths or file locations etc.

The following **config** method is the only one you might ever use, and its usage is trivial −

```
config.getServletName();
```

This returns the servlet name, which is the string contained in the **<servlet-name>** element defined in the **WEB-INF\web.xml** file.

The pageContext Object

The pageContext object is an instance of a **javax.servlet.jsp.PageContext**object. The pageContext object is used to represent the entire JSP page.

This object is intended as a means to access information about the page while avoiding most of the implementation details.

This object stores references to the request and response objects for each request. The **application, config, session**, and out objects are derived by accessing attributes of this object.

The pageContext object also contains information about the directives issued to the JSP page, including the buffering information, the errorPageURL, and page scope.

The PageContext class defines several fields, including **PAGE_SCOPE, REQUEST_SCOPE, SESSION_SCOPE,** and **APPLICATION_SCOPE**, which identify the four scopes. It also supports more than 40 methods, about half of which are inherited from the **javax.servlet.jsp.JspContext class**.

One of the important methods is **removeAttribute**. This method accepts either one or two arguments. For example, **pageContext.removeAttribute ("attrName")** removes the attribute from all scopes, while the following code only removes it from the page scope −

```
pageContext.removeAttribute("attrName", PAGE_SCOPE);
```

The use of pageContext can be checked in JSP - File Uploading chapter.

The page Object

This object is an actual reference to the instance of the page. It can be thought of as an object that represents the entire JSP page.

The page object is really a direct synonym for the **this** object.

The exception Object

The exception object is a wrapper containing the exception thrown from the previous page. It is typically used to generate an appropriate response to the error condition.

Q) JSP Actions

In this chapter, we will discuss Actions in JSP. These actions use constructs in XML syntax to control the behavior of the servlet engine. You can dynamically insert a file, reuse JavaBeans components, forward the user to another page, or generate HTML for the Java plugin.

There is only one syntax for the Action element, as it conforms to the XML standard −

```
<jsp:action_name attribute = "value" />
```

Action elements are basically predefined functions. The following table lists out the available JSP actions −

S.No.	Syntax & Purpose
1	jsp:include Includes a file at the time the page is requested.
2	jsp:useBean Finds or instantiates a JavaBean.

3	jsp:setProperty Sets the property of a JavaBean.
4	jsp:getProperty Inserts the property of a JavaBean into the output.
5	jsp:forward Forwards the requester to a new page.
6	jsp:plugin Generates browser-specific code that makes an OBJECT or EMBED tag for the Java plugin.
7	jsp:element Defines XML elements dynamically.
8	jsp:attribute Defines dynamically-defined XML element's attribute.
9	jsp:body Defines dynamically-defined XML element's body.
10	jsp:text Used to write template text in JSP pages and documents.

Common Attributes

There are two attributes that are common to all Action elements: the **id**attribute and the **scope** attribute.

Id attribute

The id attribute uniquely identifies the Action element, and allows the action to be referenced inside the JSP page. If the Action creates an instance of an object, the id value can be used to reference it through the implicit object PageContext.

Scope attribute

This attribute identifies the lifecycle of the Action element. The id attribute and the scope attribute are directly related, as the scope attribute determines the lifespan of the object associated with the id. The scope attribute has four possible values: **(a) page, (b)request, (c)session**, and **(d) application**.

The <jsp:include> Action

This action lets you insert files into the page being generated. The syntax looks like this −

```
<jsp:include page = "relative URL" flush = "true" />
```

Unlike the **include** directive, which inserts the file at the time the JSP page is translated into a servlet, this action inserts the file at the time the page is requested.

Following table lists out the attributes associated with the include action −

S.No.	Attribute & Description
1	page The relative URL of the page to be included.
2	flush The boolean attribute determines whether the included resource has its buffer flushed before it is included.

Example

Let us define the following two files **(a)date.jsp** and **(b) main.jsp** as follows −

Following is the content of the **date.jsp** file −

```
<p>Today's date: <%=(new java.util.Date()).toLocaleString()%></p>
```

Following is the content of the **main.jsp** file −

```
<html>
<head>
<title>The include Action Example</title>
</head>

<body>
<center>
<h2>The include action Example</h2>
<jsp:includepage="date.jsp"flush="true"/>
</center>
</body>
</html>
```

Let us now keep all these files in the root directory and try to access **main.jsp**. You will receive the following output −

The include action Example

Today's date: 12-Sep-2010 14:54:22

The <jsp:useBean> Action

The **useBean** action is quite versatile. It first searches for an existing object utilizing the id and scope variables. If an object is not found, it then tries to create the specified object.

The simplest way to load a bean is as follows −

```
<jsp:useBean id = "name" class = "package.class" />
```

Once a bean class is loaded, you can use **jsp:setProperty** and **jsp:getProperty** actions to modify and retrieve the bean properties.

Following table lists out the attributes associated with the useBean action −

S.No.	Attribute & Description
1	class Designates the full package name of the bean.
2	type Specifies the type of the variable that will refer to the object.
3	beanName Gives the name of the bean as specified by the instantiate () method of the java.beans.Beans class.

Let us now discuss the **jsp:setProperty** and the **jsp:getProperty** actions before giving a valid example related to these actions.

The <jsp:setProperty> Action

The **setProperty** action sets the properties of a Bean. The Bean must have been previously defined before this action. There are two basic ways to use the setProperty action −

You can use **jsp:setProperty** after, but outside of a **jsp:useBean** element, as given below −

```
<jsp:useBean id = "myName" ... />
...
<jsp:setProperty name = "myName" property = "someProperty" .../>
```

In this case, the **jsp:setProperty** is executed regardless of whether a new bean was instantiated or an existing bean was found.

A second context in which jsp:setProperty can appear is inside the body of a **jsp:useBean** element, as given below −

```
<jsp:useBeanid="myName" ... >
  ...
```

```
<jsp:setPropertyname="myName"property="someProperty" .../>
</jsp:useBean>
```

Here, the jsp:setProperty is executed only if a new object was instantiated, not if an existing one was found.

Following table lists out the attributes associated with the **setProperty** action −

S.No.	Attribute & Description
1	name Designates the bean the property of which will be set. The Bean must have been previously defined.
2	property Indicates the property you want to set. A value of "*" means that all request parameters whose names match bean property names will be passed to the appropriate setter methods.
3	value The value that is to be assigned to the given property. The the parameter's value is null, or the parameter does not exist, the setProperty action is ignored.
4	param The param attribute is the name of the request parameter whose value the property is to receive. You can't use both value and param, but it is permissible to use neither.

The <jsp:getProperty> Action

The **getProperty** action is used to retrieve the value of a given property and converts it to a string, and finally inserts it into the output.

The getProperty action has only two attributes, both of which are required. The syntax of the getProperty action is as follows −

```
<jsp:useBeanid="myName" ... />
...
<jsp:getPropertyname="myName"property="someProperty" .../>
```

Following table lists out the required attributes associated with the **getProperty** action −

S.No.	Attribute & Description
1	name The name of the Bean that has a property to be retrieved. The Bean must have been previously defined.
2	property The property attribute is the name of the Bean property to be retrieved.

Example

Let us define a test bean that will further be used in our example −

```
/* File: TestBean.java */
package action;

publicclassTestBean{
privateString message ="No message specified";

publicString getMessage(){
return(message);
}
publicvoid setMessage(String message){
this.message = message;
}
}
```

Compile the above code to the generated **TestBean.class** file and make sure that you copied the TestBean.class in **C:\apache-tomcat-7.0.2\webapps\WEB-INF\classes\action** folder and the **CLASSPATH**variable should also be set to this folder −

Now use the following code in **main.jsp** file. This loads the bean and sets/gets a simple String parameter −

```
<html>

<head>
<title>Using JavaBeans in JSP</title>
</head>

<body>
<center>
<h2>Using JavaBeans in JSP</h2>
<jsp:useBeanid="test"class="action.TestBean"/>
<jsp:setPropertyname="test"property="message"
value="Hello JSP..."/>

<p>Got message....</p>
```

```
<jsp:getPropertyname="test"property="message"/>
</center>
</body>
</html>
```

Let us now try to access **main.jsp**, it would display the following result −

Using JavaBeans in JSP

Got message....
Hello JSP...

The <jsp:forward> Action

The **forward** action terminates the action of the current page and forwards the request to another resource such as a static page, another JSP page, or a Java Servlet.

Following is the syntax of the **forward** action −

```
<jsp:forward page = "Relative URL" />
```

Following table lists out the required attributes associated with the forward action −

S.No.	Attribute & Description
1	page Should consist of a relative URL of another resource such as a static page, another JSP page, or a Java Servlet.

Example

Let us reuse the following two files **(a) date.jsp** and **(b) main.jsp** as follows −

Following is the content of the **date.jsp** file −

```
<p>Today's date: <%=(new java.util.Date()).toLocaleString()%></p>
```

Following is the content of the **main.jsp** file −

```
<html>
<head>
<title>The include Action Example</title>
</head>

<body>
<center>
<h2>The include action Example</h2>
```

```
<jsp:forwardpage="date.jsp"/>
</center>
</body>
</html>
```

Let us now keep all these files in the root directory and try to access **main.jsp**. This would display result something like as below.

Here it discarded the content from the main page and displayed the content from forwarded page only.

Today's date: 12-Sep-2010 14:54:22

The <jsp:plugin> Action

The **plugin** action is used to insert Java components into a JSP page. It determines the type of browser and inserts the **<object>** or **<embed>** tags as needed.

If the needed plugin is not present, it downloads the plugin and then executes the Java component. The Java component can be either an Applet or a JavaBean.

The plugin action has several attributes that correspond to common HTML tags used to format Java components. The **<param>** element can also be used to send parameters to the Applet or Bean.

Following is the typical syntax of using the plugin action −

```
<jsp:plugintype="applet"codebase="dirname"code="MyApplet.class"
width="60"height="80">
<jsp:paramname="fontcolor"value="red"/>
<jsp:paramname="background"value="black"/>

<jsp:fallback>
    Unable to initialize Java Plugin
</jsp:fallback>

</jsp:plugin>
```

You can try this action using some applet if you are interested. A new element, the **<fallback>** element, can be used to specify an error string to be sent to the user in case the component fails.

The <jsp:element> Action

The <jsp:attribute> Action

The <jsp:body> Action

The **<jsp:element>, <jsp:attribute>** and **<jsp:body>** actions are used to define XML elements dynamically. The word dynamically is important, because it means that the XML elements can be generated at request time rather than statically at compile time.

Following is a simple example to define XML elements dynamically −

```
<%@page language ="java" contentType ="text/html"%>
<htmlxmlns="http://www.w3c.org/1999/xhtml"
xmlns:jsp="http://java.sun.com/JSP/Page">

<head><title>Generate XML Element</title></head>

<body>
<jsp:elementname="xmlElement">
<jsp:attributename="xmlElementAttr">
Value for the attribute
</jsp:attribute>

<jsp:body>
Body for XML element
</jsp:body>

</jsp:element>
</body>
</html>
```

This would produce the following HTML code at run time −

```
<htmlxmlns="http://www.w3c.org/1999/xhtml"xmlns:jsp="http://java.sun.com/JSP/Page">
<head><title>Generate XML Element</title></head>

<body>
<xmlElementxmlElementAttr="Value for the attribute">
Body for XML element
</xmlElement>
</body>
</html>
```

The <jsp:text> Action

The **<jsp:text>** action can be used to write the template text in JSP pages and documents. Following is the simple syntax for this action −

```
<jsp:text>Template data</jsp:text>
```

The body of the template cannot contain other elements; it can only contain text and EL expressions (Note − EL expressions are explained in a subsequent chapter). Note that in XML files, you cannot use expressions such as **${whatever > 0}**, because the greater than signs are illegal. Instead, use the **gt** form, such as **${whatever gt 0}** or an alternative is to embed the value in a **CDATA** section.

```
<jsp:text><![CDATA[<br>]]></jsp:text>
```

If you need to include a **DOCTYPE** declaration, for instance for **XHTML**, you must also use the **<jsp:text>** element as follows −

```
<jsp:text><![CDATA[<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0
Strict//EN"
"DTD/xhtml1-strict.dtd">]]></jsp:text>

<head><title>jsp:text action</title></head>

<body>
<books><book><jsp:text>
Welcome to JSP Programming
</jsp:text></book></books>
</body>
</html>
```

Q) JSP with beans

A JavaBean is a specially constructed Java class written in the Java and coded according to the JavaBeans API specifications.

Following are the unique characteristics that distinguish a JavaBean from other Java classes –

- It provides a default, no-argument constructor.
- It should be serializable and that which can implement the **Serializable** interface.
- It may have a number of properties which can be read or written.
- It may have a number of "**getter**" and "**setter**" methods for the properties.

JavaBeans Properties

A JavaBean property is a named attribute that can be accessed by the user of the object. The attribute can be of any Java data type, including the classes that you define.

A JavaBean property may be **read, write, read only**, or **write only**. JavaBean properties are accessed through two methods in the JavaBean's implementation class −

S.No.	Method & Description
1	getPropertyName() For example, if property name is *firstName*, your method name would be getFirstName() to read that property. This method is called accessor.
2	setPropertyName() For example, if property name is *firstName*, your method name would be setFirstName() to write that property. This method is called mutator.

A read-only attribute will have only a **getPropertyName()** method, and a write-only attribute will have only a **setPropertyName()** method.

JavaBeans Example

Consider a student class with few properties −

```
package com.tutorialspoint;

publicclassStudentsBeanimplements java.io.Serializable{
privateString firstName =null;
privateString lastName =null;
privateint age =0;

publicStudentsBean(){
}
publicString getFirstName(){
return firstName;
}
publicString getLastName(){
return lastName;
}
publicint getAge(){
return age;
}
publicvoid setFirstName(String firstName){
this.firstName = firstName;
}
publicvoid setLastName(String lastName){
this.lastName = lastName;
}
publicvoid setAge(Integer age){
this.age = age;
}
}
```

Accessing JavaBeans

The **useBean** action declares a JavaBean for use in a JSP. Once declared, the bean becomes a scripting variable that can be accessed by both scripting elements and other custom tags used in the JSP. The full syntax for the useBean tag is as follows −

```
<jsp:useBean id = "bean's name" scope = "bean's scope" typeSpec/>
```

Here values for the scope attribute can be a **page, request, session** or **application based** on your requirement. The value of the **id** attribute may be any value as a long as it is a unique name among other **useBean declarations** in the same JSP.

Following example shows how to use the useBean action −

```
<html>
<head>
<title>useBean Example</title>
</head>

<body>
<jsp:useBeanid="date"class="java.util.Date"/>
<p>The date/time is <%= date %>
</body>
</html>
```

You will receive the following result − −

```
The date/time is Thu Sep 30 11:18:11 GST 2010
```

Accessing JavaBeans Properties

Along with **<jsp:useBean...>** action, you can use the **<jsp:getProperty/>**action to access the get methods and the **<jsp:setProperty/>** action to access the set methods. Here is the full syntax −

```
<jsp:useBeanid="id"class="bean's class"scope="bean's scope">
<jsp:setPropertyname="bean's id"property="property name"
value="value"/>
<jsp:getPropertyname="bean's id"property="property name"/>
  .....
</jsp:useBean>
```

The name attribute references the id of a JavaBean previously introduced to the JSP by the useBean action. The property attribute is the name of the **get**or the **set** methods that should be invoked. Following example shows how to access the data using the above syntax −

```
<html>
<head>
<title>get and set properties Example</title>
</head>
```

```
<body>
<jsp:useBeanid="students"class="com.tutorialspoint.StudentsBean">
<jsp:setPropertyname="students"property="firstName"value="Zara"/>
<jsp:setPropertyname="students"property="lastName"value="Ali"/>
<jsp:setPropertyname="students"property="age"value="10"/>
</jsp:useBean>

<p>Student First Name:
<jsp:getPropertyname="students"property="firstName"/>
</p>

<p>Student Last Name:
<jsp:getPropertyname="students"property="lastName"/>
</p>

<p>Student Age:
<jsp:getPropertyname="students"property="age"/>
</p>

</body>
</html>
```

Let us make the **StudentsBean.class** available in CLASSPATH. Access the above JSP. the following result will be displayed −

```
Student First Name: Zara

Student Last Name: Ali

Student Age: 10
```

Q) JSP - Exception Handling

When you are writing a JSP code, you might make coding errors which can occur at any part of the code. There may occur the following type of errors in your JSP code −

Checked exceptions

A checked exception is an exception that is typically a user error or a problem that cannot be foreseen by the programmer. For example, if a file is to be opened, but the file cannot be found, an exception occurs. These exceptions cannot simply be ignored at the time of compilation.

Runtime exceptions

A runtime exception is an exception that probably could have been avoided by the programmer. As opposed to the checked exceptions, runtime exceptions are ignored at the time of compliation.

Errors

These are not exceptions at all, but problems that arise beyond the control of the user or the programmer. Errors are typically ignored in your code because you can rarely do anything about an error. For example, if a stack overflow occurs, an error will arise. They are also ignored at the time of compilation.

Exception Handling

Exception Handling is a process of handling exceptional condition that might occur in your application. Exception Handling in JSP is much easier than Java Technology exception handling. Although JSP Technology also uses the same exception class objects.

It is quite obvious that you dont want to show error stack trace to any random user surfing your website. You can't prevent all errors in your application but you can atleast give a user friendly error response page.

Ways to perform Exception Handling in JSP

JSP provide 3 different ways to perform exception handling:

1. Using **isErrorPage** and **errorPage** attribute of page directive.
2. Using **<error-page>** tag in **Deployment Descriptor**.
3. Using simple try...catch block.

Example of isErrorPage and errorPage attribute

isErrorPage attribute in page directive officially appoints a JSP page as an error page.

error.jsp

```
<%@ page isErrorPage="true" %>

<html>
<body>

<strong>You are here because we are not able to
find the page you have asked for.</stong>

<img src="userFriendlyImage.jpg" />

</body>
</html>
```

This attribute officially designate this page as an error page.

errorPage attribute in a page directive informs the Web Container that if an exception occurs in the current page, forward the request to the specified error page.

sum.jsp

```
<%@ page errorPage="error.jsp" %>

<html>
<body>

<% int x=10/0; %>

The sum is <%= x %>

</body>
</html>
```

Tells the Web Container that if some exception occurs here, forward the request to **error.jsp**

Whenever an exception occurs in sum.jsp page the user is redirected to the error.jsp page, where either you can display a nice message, or you can also print the exception trace into a file/database in the background, to check later what caused the error.

Declaring error page in Deployment Descriptor

You can also declare error pages in the DD for the entire Web Apllication. Using <error-page> tag in the **Deployment Descriptor**. You can even configure different error pages for different exception types, or HTTP error code type(503, 500 etc).

Declaring an error page for all type of exception

```
<error-page>

<exception-type>java.lang.Throwable</exception-type>

<location>/error.jsp</location>

</error-page>
```

Declaring an error page for more detailed exception

```
<error-page>

<exception-type>java.lang.ArithmeticException</exception-type>

<location>/error.jsp</location>

</error-page>
```

Declaring an error page based on HTTP Status code

<error-page>

<error-code>404</error-code>

<location>/error.jsp</location>

</error-page>

Using the try...catch block

Using try...catch block is just like how it is used in Core Java.

```
<html>
<head>
<title>Try...Catch Example</title>
</head>
<body>
<%
try{
    int i = 100;
    i = i / 0;
    out.println("The answer is " + i);
  }
catch (Exception e){
    out.println("An exception occurred: " + e.getMessage());
  }
%>
</body>
</html>
```

Q) Session Tracking Techniques

14.1 Overview of JSP Session tracking

In a web application, server may be responding to several clients at a time so session tracking is a way by which a server can identify the client. As we know HTTP protocol is stateless which means client needs to open a separate connection every time it interacts with server and server treats each request as a new request.

Now to identify the client ,server needs to maintain the state and to do so , there are several session tracking techniques.

14.2 Session Tracking Techniques

There are four techniques which can be used to identify a user session.

a) Cookies

b) Hidden Fields

c) URL Rewriting

d) Session Object

With Cookies , Hidden Fields and URL rewriting approaches, client always sends a unique identifier with each request and server determines the user session based on that unique identifier where as session tracking approach using Session Object uses the other three techniques internally.

14.2.1 Cookie

Cookie is a key value pair of information, sent by the server to the browser and then browser sends back this identifier to the server with every request there on.

There are two types of cookies:

· **Session cookies** - are temporary cookies and are deleted as soon as user closes the browser. The next time user visits the same website, server will treat it as a new client as cookies are already deleted.

· **Persistent cookies** - remains on hard drive until we delete them or they expire.

If cookie is associated with the client request, server will associate it with corresponding user session otherwise will create a new unique cookie and send back with response.

We will discuss Cookie in detail in one of the upcoming chapters .

Cookie object can be created using a name value pair. For example we can create a cookie with name sessionId with a unique value for each client and then can add it in a resposne so that it will be sent to client:

```
1    Cookie cookie = newCookie("sessionID", "some unique value");

2    response.addCookie(cookie);
```

The major disadvantage of cookies is browser provides a way to disable the cookies and in that case server will not be able to identify the user.If our application uses cookies for session management and our users disable the cookie , then we will be in a big trouble.

14.2.2 Hidden Field

Hidden fields are similar to other input fields with the only difference is that these fields are not displayed on the page but its value is sent as other input fields. For example

<input type="hidden" name="sessionId" value="unique value"/>

is a hidden form field which will not displayed to the user but its value will be send to the server and can be retrieved using request.getParameter("sessionId") .

With this approach ,we have to have a logic to generate unique value and HTML does not allow us to pass a dynamic value which means we cannot use this approach for static pages. In short with this approach, HTML pages cannot participate in session tracking.

14.2.3 URL Rewriting

URL Rewriting is the approach in which a session (unique) identifier gets appended with each request URL so server can identify the user session. For example if we apply URL rewriting on **http://localhost:8080/jsp-tutorial/home.jsp** , it will become something like

?jSessionId=XYZ where jSessionId=XYZ is the attached session identifier and value XYZ will be used by server to identify the user session.

There are several advantages of URL rewriting over above discussed approaches like it is browser independent and even if user's browser does not support cookie or in case user has disabled cookies, this approach will work.

Another advantage is , we need not to submit extra hidden parameter.

As other approaches, this approach also has some disadvantages like we need to regenerate every url to append session identifier and this need to keep track of this identifier until the conversation completes.

14.2.4 Session Object

Session object is representation of a user session. User Session starts when a user opens a browser and sends the first request to server. Session object is available in all the request (in entire user session) so attributes stored in Http session in will be available in any servlet or in a jsp.

When session is created, server generates a unique ID and attach that ID with the session. Server sends back this Id to the client and there on , browser sends back this ID with every request of that user to server with which server identifies the user

How to get a Session Object – By calling getSession() API on HttpServletRequest object (remember this is an implicit object)

a) HttpSession session = request.getSession()

b) HttpSession session = request.getSession(Boolean)

Destroy or Invalidate Session –

This is used to kill user session and specifically used when user logs off. To invalidate the session use -

session.invalidate();

Other important methods

· **Object getAttribute(String attributeName)** – this method is used to get the attribute stored in a session scope by attribute name. Remember the return type is Object.

· **void setAttribute(String attributeName, Object value)**- this method is used to store an attribute in session scope. This method takes two arguments- one is attribute name and another is value.

· **void removeAttribute(String attributeName)**- this method is used to remove the attribute from session.

· **public boolean isNew()**- This method returns true if server does not found any state of the client.

Browser session and server sessions are different. Browser session is client session which starts when you opens browser and destroy on closing of browser where as server session are maintained at server end.

Let's discuss Session Tracking using Session Object with the help of examples.

14.3 JSP Session Tracking Examples

14.3.1 Printing session info

Write an example to print session Id , session creation time and last accessed time and a welcome message if client has visited again.

Solution- HttpSession API provides a method getId() which returns the associated session Id , getCreationTime() to get the session creation time and getLastAccessedTime() to get session last accessed time. Similarly isNew() method can be used to identify the new users

getLastAccessedTime() and getCreationTime() returns the time as long data type so to convert it to display format, create a date object passing long value in it.

a) Write sessionInformation.jsp with the below content in WebContent directory which will get the session object and displays its attributes

```
<html>
<head>
  <title> Display Session Information </title></head>
<%@page import="java.util.Date"%>
<body>
   <%
      long creationTime = session.getCreationTime();
      StringsessionId = session.getId();
      long lastAccessedTime = session.getLastAccessedTime();
      DatecreateDate= newDate(creationTime);
      DatelastAccessedDate= newDate(lastAccessedTime);
      StringBuffer buffer = newStringBuffer();
      if(session.isNew())
      {
        buffer.append("<h3>Welcome </h3>");
      }
      else
      {
        buffer.append("<h3>Welcome Back!! </h3>");
      }
  buffer.append("<STRONG> Session ID : </STRONG>"+ sessionId);
 buffer.append(" <BR/> ");
  buffer.append("<STRONG> Session Creation Time </STRONG>: "+ createDate);
  buffer.append(" <BR/> ");
buffer.append("<STRONG> Last Accessed Time : </STRONG>"+
lastAccessedDate);
  buffer.append(" <BR/> ");
    %>
    <%=       buffer.toString()     %>
  </body>
</html>
```

Q) Introduction to custom tags

Creating a Custom Tag

To create a Custom Tag the following components are required :

1. The **Tag Handler** class which should extend SimpleTagSupport.
2. The **Tag Library Descriptor(TLD)** file
3. Use the Custom Tag in your JSP file

Tag Handler Class

You can create a Tag Handler class in two different ways:

- By implementing one of three interfaces : SimpleTag, Tag or BodyTag, which define methods that are invoked during the life cycle of the tag.
- By extending an abstract base class that implements the SimpleTag, Tag, or BodyTag interfaces. The **SimpleTagSupport**, **TagSupport**, and **BodyTagSupport** classes implement the SimpleTag, Tag andBodyTag interfaces . Extending these classes relieves the tag handler class from having to implement all methods in the interfaces and also provides other convenient functionality.

Tag Library Descriptor

A Tag Library Descriptor is an XML document that contains information about a library as a whole and about each tag contained in the library. TLDs are used by the web container to validate the tags and also by JSP page development tools.

Tag library descriptor file must have the extension .tld and must be packaged in the **/WEB-INF/**directory or subdirectory of the WAR file or in the **/META-INF/** directory or subdirectory of a tag library packaged in a JAR.

Example of Custom Tag

In our example, we will be creating a Tag Handler class that extends the **TagSupport** class. When we extend this class, we have to override the method doStartTag(). There are two other methods of this class namely doEndTag() and release(), that we can decide to override or not depending on our requirement.

CountMatches.java

```
package com.studytonight.taghandler;

import java.io.IOException;
import javax.servlet.jsp.*;
import org.apache.commons.lang.StringUtils;

public class CountMatches extends TagSupport {
```

```
 private String inputstring;
 private String lookupstring;

 public String getInputstring() {
  return inputstring;
 }

 public void setInputstring(String inputstring) {
  this.inputstring = inputstring;
 }

 public String getLookupstring() {
  return lookupstring;
 }

 public void setLookupstring(String lookupstring) {
  this.lookupstring = lookupstring;
 }

 @Override
 public int doStartTag() throws JspException {
  try {
   JspWriter out = pageContext.getOut();
   out.println(StringUtils.countMatches(inputstring, lookupstring));
  }
  catch (IOException e) {
   e.printStackTrace();
  }
  return SKIP_BODY;
 }
}
```

In the above code, we have an implementation of the doStartTag() method which is must if we are extending **TagSupport** class. We have declared two variables inputstring and lookupstring. These variables represents the **attributes** of the custom tag. We must provide getter and setter for these variables in order to set the values into these variables that will be provided at the time of using this custom tag. We can also specify whether these attributes are required or not.

Q) JSP - Standard Tag Library (JSTL)

The JavaServer Pages Standard Tag Library (JSTL) is a collection of useful JSP tags which encapsulates the core functionality common to many JSP applications.

JSTL has support for common, structural tasks such as iteration and conditionals, tags for manipulating XML documents, internationalization tags, and SQL tags. It also provides a framework for integrating the existing custom tags with the JSTL tags.

Classification of The JSTL Tags

The JSTL tags can be classified, according to their functions, into the following JSTL tag library groups that can be used when creating a JSP page −

- **Core Tags**
- **Formatting tags**
- **SQL tags**
- **XML tags**
- **JSTL Functions**

Core Tags

The core group of tags are the most commonly used JSTL tags. Following is the syntax to include the JSTL Core library in your JSP −

<%@ taglib prefix = "c" uri = "http://java.sun.com/jsp/jstl/core" %>

Following table lists out the core JSTL Tags −

S.No.	Tag & Description
1	**<c:out>** Like <%= ... >, but for expressions.
2	**<c:set >** Sets the result of an expression evaluation in a 'scope'
3	**<c:remove >** Removes a scoped variable (from a particular scope, if specified).
4	**<c:catch>** Catches any Throwable that occurs in its body and optionally exposes it.
5	**<c:if>** Simple conditional tag which evalutes its body if the supplied condition is true.
6	**<c:choose>** Simple conditional tag that establishes a context for mutually exclusive conditional operations, marked by <when> and <otherwise>.
7	**<c:when>** Subtag of <choose> that includes its body if its condition evalutes to 'true'.
8	**<c:otherwise >**

	Subtag of <choose> that follows the <when> tags and runs only if all of the prior conditions evaluated to 'false'.
9	**<c:import>** Retrieves an absolute or relative URL and exposes its contents to either the page, a String in 'var', or a Reader in 'varReader'.
10	**<c:forEach >** The basic iteration tag, accepting many different collection types and supporting subsetting and other functionality .
11	**<c:forTokens>** Iterates over tokens, separated by the supplied delimeters.
12	**<c:param>** Adds a parameter to a containing 'import' tag's URL.
13	**<c:redirect >** Redirects to a new URL.
14	**<c:url>** Creates a URL with optional query parameters

Formatting Tags

The JSTL formatting tags are used to format and display text, the date, the time, and numbers for internationalized Websites. Following is the syntax to include Formatting library in your JSP −

```
<%@ taglib prefix = "fmt" uri = "http://java.sun.com/jsp/jstl/fmt" %>
```

Following table lists out the Formatting JSTL Tags −

S.No.	Tag & Description
1	**<fmt:formatNumber>** To render numerical value with specific precision or format.
2	**<fmt:parseNumber>** Parses the string representation of a number, currency, or percentage.
3	**<fmt:formatDate>** Formats a date and/or time using the supplied styles and pattern.
4	**<fmt:parseDate>** Parses the string representation of a date and/or time
5	**<fmt:bundle>**

	Loads a resource bundle to be used by its tag body.
6	**<fmt:setLocale>** Stores the given locale in the locale configuration variable.
7	**<fmt:setBundle>** Loads a resource bundle and stores it in the named scoped variable or the bundle configuration variable.
8	**<fmt:timeZone>** Specifies the time zone for any time formatting or parsing actions nested in its body.
9	**<fmt:setTimeZone>** Stores the given time zone in the time zone configuration variable
10	**<fmt:message>** Displays an internationalized message.
11	**<fmt:requestEncoding>** Sets the request character encoding

SQL Tags

The JSTL SQL tag library provides tags for interacting with relational databases (RDBMSs) such as **Oracle, mySQL**, or **Microsoft SQL Server**.

Following is the syntax to include JSTL SQL library in your JSP −

```
<%@ taglib prefix = "sql" uri = "http://java.sun.com/jsp/jstl/sql" %>
```

Following table lists out the SQL JSTL Tags −

S.No.	Tag & Description
1	**<sql:setDataSource>** Creates a simple DataSource suitable only for prototyping
2	**<sql:query>** Executes the SQL query defined in its body or through the sql attribute.
3	**<sql:update>** Executes the SQL update defined in its body or through the sql attribute.
4	**<sql:param>** Sets a parameter in an SQL statement to the specified value.
5	**<sql:dateParam>** Sets a parameter in an SQL statement to the specified java.util.Date value.
6	**<sql:transaction >**

	Provides nested database action elements with a shared Connection, set up to execute all statements as one transaction.

XML tags

The JSTL XML tags provide a JSP-centric way of creating and manipulating the XML documents. Following is the syntax to include the JSTL XML library in your JSP.

The JSTL XML tag library has custom tags for interacting with the XML data. This includes parsing the XML, transforming the XML data, and the flow control based on the XPath expressions.

```
<%@ taglib prefix = "x"
  uri = "http://java.sun.com/jsp/jstl/xml" %>
```

Before you proceed with the examples, you will need to copy the following two XML and XPath related libraries into your **<Tomcat Installation Directory>\lib** −

- **XercesImpl.jar** − Download it from https://www.apache.org/dist/xerces/j/
- **xalan.jar** − Download it from https://xml.apache.org/xalan-j/index.html

Following is the list of XML JSTL Tags −

S.No.	Tag & Description
1	**<x:out>** Like <%= ... >, but for XPath expressions.
2	**<x:parse>** Used to parse the XML data specified either via an attribute or in the tag body.
3	**<x:set >** Sets a variable to the value of an XPath expression.
4	**<x:if >** Evaluates a test XPath expression and if it is true, it processes its body. If the test condition is false, the body is ignored.
5	**<x:forEach>** To loop over nodes in an XML document.
6	**<x:choose>** Simple conditional tag that establishes a context for mutually exclusive conditional operations, marked by <when> and <otherwise> tags.
7	**<x:when >** Subtag of <choose> that includes its body if its expression evalutes to 'true'.

8	**<x:otherwise >** Subtag of <choose> that follows the <when> tags and runs only if all of the prior conditions evaluates to 'false'.
9	**<x:transform >** Applies an XSL transformation on a XML document
10	**<x:param >** Used along with the transform tag to set a parameter in the XSLT stylesheet

JSTL Functions

JSTL includes a number of standard functions, most of which are common string manipulation functions. Following is the syntax to include JSTL Functions library in your JSP –

```
<%@ taglib prefix = "fn"
   uri = "http://java.sun.com/jsp/jstl/functions" %>
```

Following table lists out the various JSTL Functions –

S.No.	Function & Description
1	**fn:contains()** Tests if an input string contains the specified substring.
2	**fn:containsIgnoreCase()** Tests if an input string contains the specified substring in a case insensitive way.
3	**fn:endsWith()** Tests if an input string ends with the specified suffix.
4	**fn:escapeXml()** Escapes characters that can be interpreted as XML markup.
5	**fn:indexOf()** Returns the index withing a string of the first occurrence of a specified substring.
6	**fn:join()** Joins all elements of an array into a string.
7	**fn:length()** Returns the number of items in a collection, or the number of characters in a string.
8	**fn:replace()** Returns a string resulting from replacing in an input string all occurrences with a given string.

9	**fn:split()** Splits a string into an array of substrings.
10	**fn:startsWith()** Tests if an input string starts with the specified prefix.
11	**fn:substring()** Returns a subset of a string.
12	**fn:substringAfter()** Returns a subset of a string following a specific substring.
13	**fn:substringBefore()** Returns a subset of a string before a specific substring.
14	**fn:toLowerCase()** Converts all of the characters of a string to lower case.
15	**fn:toUpperCase()** Converts all of the characters of a string to upper case.
16	**fn:trim()** Removes white spaces from both ends of a string.

UNIT 12

INTRODUCTION TO SPRING FRAMEWORKS

12.1 INTRODUCTION TO SPRING FRAMEWORK

- Spring Framework is a Java platform that provides comprehensive infrastructure support for developing Java applications. Spring handles the infrastructure so you can focus on your application.
- Spring enables you to build applications from "plain old Java objects" (POJOs) and to apply enterprise services non-invasively to POJOs. This capability applies to the Java SE programming model and to full and partial Java EE.
- Spring is the most popular application development framework for enterprise Java. Millions of developers around the world use Spring Framework to create high performing, easily testable, and reusable code.
- Spring framework is an open source Java platform. It was initially written by Rod Johnson and was first released under the Apache 2.0 license in June 2003.
- Spring is lightweight when it comes to size and transparency. The basic version of spring framework is around 2MB.
- The core features of the Spring Framework can be used in developing any Java application, but there are extensions for building web applications on top of the Java EE platform. Spring framework targets to make J2EE development easier to use and promotes good programming practices by enabling a POJO-based programming model.

Benefits of Using the Spring Framework

Following is the list of few of the great benefits of using Spring Framework −

- Spring enables developers to develop enterprise-class applications using POJOs. The benefit of using only POJOs is that you do not need an EJB container product such as an application server but you have the option of using only a robust servlet container such as Tomcat or some commercial product.
- Spring is organized in a modular fashion. Even though the number of packages and classes are substantial, you have to worry only about the ones you need and ignore the rest.
- Spring does not reinvent the wheel, instead it truly makes use of some of the existing technologies like several ORM frameworks, logging frameworks, JEE, Quartz and JDK timers, and other view technologies.
- Testing an application written with Spring is simple because environment-dependent code is moved into this framework. Furthermore, by using JavaBean style POJOs, it becomes easier to use dependency injection for injecting test data.

- Spring's web framework is a well-designed web MVC framework, which provides a great alternative to web frameworks such as Struts or other over-engineered or less popular web frameworks.
- Spring provides a convenient API to translate technology-specific exceptions (thrown by JDBC, Hibernate, or JDO, for example) into consistent, unchecked exceptions.
- Lightweight IoC containers tend to be lightweight, especially when compared to EJB containers, for example. This is beneficial for developing and deploying applications on computers with limited memory and CPU resources.
- Spring provides a consistent transaction management interface that can scale down to a local transaction (using a single database, for example) and scale up to global transactions (using JTA, for example).

12.1.2 Dependency Injection (DI)

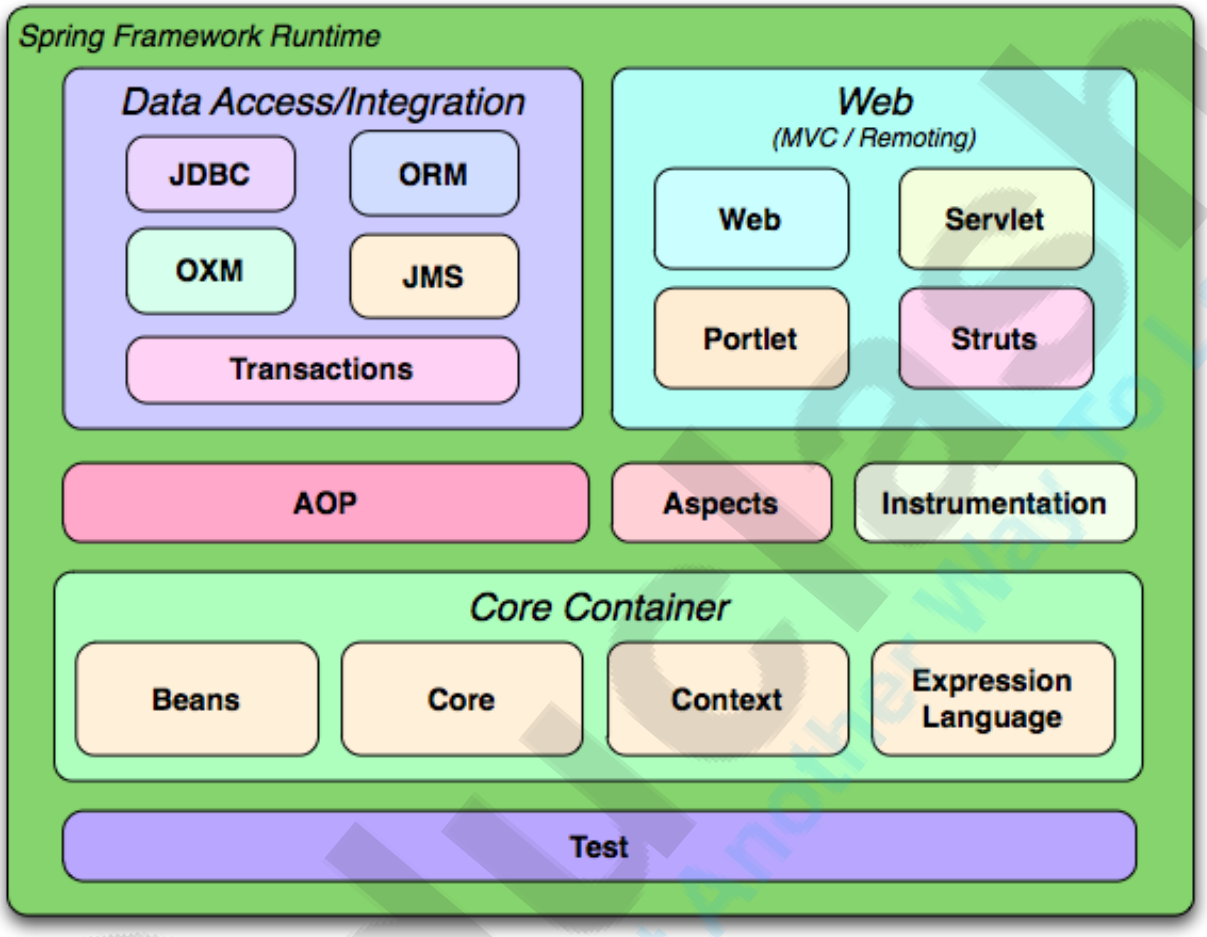
- The technology that Spring is most identified with is the **Dependency Injection (DI)** flavor of Inversion of Control. The **Inversion of Control (IoC)** is a general concept, and it can be expressed in many different ways. Dependency Injection is merely one concrete example of Inversion of Control.
- When writing a complex Java application, application classes should be as independent as possible of other Java classes to increase the possibility to reuse these classes and to test them independently of other classes while unit testing. Dependency Injection helps in gluing these classes together and at the same time keeping them independent.
- What is dependency injection exactly? Let's look at these two words separately. Here the dependency part translates into an association between two classes. For example, class A is dependent of class B. Now, let's look at the second part, injection. All this means is, class B will get injected into class A by the IoC.
- Dependency injection can happen in the way of passing parameters to the constructor or by post-construction using setter methods.

12.2 SPRING ARCHITECTURE

- Spring could potentially be a one-stop shop for all your enterprise applications. However, Spring is modular, allowing you to pick and choose which modules are applicable to you, without having to bring in the rest. The following section provides details about all the modules available in Spring Framework.
- The Spring Framework provides about 20 modules which can be used based on an application requirement.

These modules are grouped into **Core Container, Data Access/Integration, Web, AOP (Aspect Oriented Programming),** as shown in the following diagram:-

Overview of the Spring Framework



MODULES:-

1) Core Container:-

The Core Container consists of the Core, Beans, Context, and Expression Language modules the details of which are as follows −

- The **Core** module provides the fundamental parts of the framework, including the IoC and Dependency Injection features.
- The **Bean** module provides BeanFactory, which is a sophisticated implementation of the factory pattern.
- The **Context** module builds on the solid base provided by the Core and Beans modules and it is a medium to access any objects defined and configured. The ApplicationContext interface is the focal point of the Context module.
- The **EL** module provides a powerful expression language for querying and manipulating an object graph at runtime.

2) Data Access/Integration:-

The Data Access/Integration layer consists of the JDBC, ORM, OXM, JMS and Transaction modules whose detail is as follows −

- The **JDBC** module provides a JDBC-abstraction layer that removes the need for tedious JDBC related coding.
- The **ORM** module provides integration layers for popular object-relational mapping APIs, including JPA, JDO, Hibernate, and iBatis.
- The **OXM** module provides an abstraction layer that supports Object/XML mapping implementations for JAXB, Castor, XMLBeans, JiBX and XStream.
- The Java Messaging Service **JMS** module contains features for producing and consuming messages.
- The **Transaction** module supports programmatic and declarative transaction management for classes that implement special interfaces and for all your POJOs.

3) Web:-

The Web layer consists of the Web, Web-MVC, Web-Socket, and Web-Portlet modules the details of which are as follows −

- The **Web** module provides basic web-oriented integration features such as multipart file-upload functionality and the initialization of the IoC container using servlet listeners and a web-oriented application context.
- The **Web-MVC** module contains Spring's Model-View-Controller (MVC) implementation for web applications.
- The **Web-Socket** module provides support for WebSocket-based, two-way communication between the client and the server in web applications.
- The **Web-Portlet** module provides the MVC implementation to be used in a portlet environment and mirrors the functionality of Web-Servlet module.

4) Aspect Oriented Programming (AOP):-

- One of the key components of Spring is the **Aspect Oriented Programming (AOP)** framework. The functions that span multiple points of an application are called **cross-cutting concerns** and these cross-cutting concerns are conceptually separate from the application's business logic.
- There are various common good examples of aspects including logging, declarative transactions, security, caching, etc.
- The key unit of modularity in OOP is the class, whereas in AOP the unit of modularity is the aspect.
- DI helps you decouple your application objects from each other, while AOP helps you decouple cross-cutting concerns from the objects that they affect.
- The AOP module of Spring Framework provides an aspect-oriented programming implementation allowing you to define method-interceptors and point cuts to cleanly decouple code that implements functionality that should be separated.

5) Miscellaneous (Other Modules):-

There are few other important modules like Aspects, Instrumentation, Web and Test modules the details of which are as follows –

- The **Aspects** module provides integration with AspectJ, which is again a powerful and mature AOP framework.
- The **Instrumentation** module provides class instrumentation support and class loader implementations to be used in certain application servers.
- The **Messaging** module provides support for STOMP as the WebSocket sub-protocol to use in applications. It also supports an annotation programming model for routing and processing STOMP messages from WebSocket clients.
- The **Test** module supports the testing of Spring components with JUnit or TestNG frameworks.

12.3 SPRING ASPECT OF OBJECT ORIENTED CONCEPTS

- One of the key components of Spring Framework is the **Aspect oriented programming (AOP)** framework. Aspect-Oriented Programming entails breaking down program logic into distinct parts called so-called concerns.
- The functions that span multiple points of an application are called **cross-cutting concerns** and these cross-cutting concerns are conceptually separate from the application's business logic.
- There are various common good examples of aspects like logging, auditing, declarative transactions, security, caching, etc.
- The key unit of modularity in OOP is the class, whereas in AOP the unit of modularity is the aspect.
- Dependency Injection helps you decouple your application objects from each other and AOP helps you decouple cross-cutting concerns from the objects that they affect. AOP is like triggers in programming languages such as Perl, .NET, Java, and others.
- Spring AOP module provides interceptors to intercept an application. For example, when a method is executed, you can add extra functionality before or after the method execution.

12.3.1 AOP Terminologies

Before we start working with AOP, let us become familiar with the AOP concepts and terminology. These terms are not specific to Spring, rather they are related to AOP.

Sr.No	Terms & Description
1	Aspect This is a module which has a set of APIs providing cross-cutting requirements. For example, a logging module would be called AOP aspect for logging. An application can have any number of aspects depending on the requirement.
2	Join point This represents a point in your application where you can plug-in the AOP aspect. You can also say, it is the actual place in the application

	where an action will be taken using Spring AOP framework.
3	Advice This is the actual action to be taken either before or after the method execution. This is an actual piece of code that is invoked during the program execution by Spring AOP framework.
4	Pointcut This is a set of one or more join points where an advice should be executed. You can specify pointcuts using expressions or patterns as we will see in our AOP examples.
5	Introduction An introduction allows you to add new methods or attributes to the existing classes.
6	Target object The object being advised by one or more aspects. This object will always be a proxied object, also referred to as the advised object.
7	Weaving Weaving is the process of linking aspects with other application types or objects to create an advised object. This can be done at compile time, load time, or at runtime.

12.3.2 Types of Advice

Spring aspects can work with five kinds of advice mentioned as follows −

Sr.No	Advice & Description
1	before Run advice before the a method execution.
2	after Run advice after the method execution, regardless of its outcome.
3	after-returning Run advice after the a method execution only if method completes successfully.
4	after-throwing Run advice after the a method execution only if method exits by throwing an exception.
5	around Run advice before and after the advised method is invoked.

12.3.3 Custom Aspects Implementation

Spring supports the **@AspectJ annotation style** approach and the **schema-based** approach to implement custom aspects. These two approaches have been explained in detail in the following sections.

Sr.No	Approach & Description
1	**XML Schema based** Aspects are implemented using the regular classes along with XML based configuration.
2	**@AspectJ based** @AspectJ refers to a style of declaring aspects as regular Java classes annotated with Java 5 annotations.

WHY SHOULD WE USE AOP ?

It provides the pluggable way to dynamically add the additional concern before, after or around the actual logic. Suppose there are 10 methods in a class as given below:

```
class A{
public void m1(){...}
public void m2(){...}
public void m3(){...}
public void m4(){...}
public void m5(){...}
public void n1(){...}
public void n2(){...}
public void p1(){...}
public void p2(){...}
public void p3(){...}
}
```

- There are 5 methods that starts from m, 2 methods that starts from n and 3 methods that starts from p.
- **Understanding Scenario** We have to maintain log and send notification after calling methods that starts from m.
- **Problem without AOP** We can call methods (that maintains log and sends notification) from the methods starting with m. In such scenario, we need to write the code in all the 5 methods.

- But, if client says in future, that he don't have to send notification, you need to change all the methods. It leads to the maintenance problem.
- **Solution with AOP** We don't have to call methods from the method. Now we can define the additional concern like maintaining log, sending notification etc. in the method of a class. Its entry is given in the xml file.
- In future, if client says to remove the notifier functionality, we need to change only in the xml file. So, maintenance is easy in AOP.

WHERE TO USE AOP ?

AOP is mostly used in following cases:

- to provide declarative enterprise services such as declarative transaction management.
- It allows users to implement custom aspects.

12.3.4AOP CONCEPTS

AOP concepts are as follows:

1) **Join Point**
2) **Point Cuts**

1) JOIN POINT:-

- A JoinPoint represents a point in your application where you can plug-in AOP aspect. You can also say, it is the actual place in the application where an action will be taken using Spring AOP framework.

- While creating the business logic of the method the additional services are needed to be injected (which we saw already) at different places or points, we call such points as **Join point**. At a join point a new services will be added into the normal flow of a business method.

- While executing the business method, the services are required at the following **3** places (generally), we call them as **Join Point.**

- Before business logic of the method starts
- After business logic of the method got completed

- If business logic throws an exception at run time

Consider the following examples −

- All methods classes contained in a package(s).
- A particular methods of a class.

2) POINT CUTS:-

PointCut is a set of one or more JoinPoint where an advice should be executed. You can specify PointCuts using expressions or patterns as we will see in our AOP examples. In Spring, PointCut helps to use specific JoinPoints to apply the advice.

Consider the following examples −

- @PointCut("execution(* com.examplexyz.*.*(..))")
- @PointCut("execution(* com.examplexyz.Student.getName(..))")

Syntax for Point Cut:-

```
@Aspect
publicclassLogging{

@PointCut("execution(* com.examplexyz.*.*(..))")
privatevoidselectAll(){}

}
```

Where,

- **@Aspect** − Mark a class as a class containing advice methods.
- **@PointCut** − Mark a function as a PointCut
- **execution(expression)** − Expression covering methods on which advice is to be applied.