# Object-oriented Programming in Java

## Session: 5

## File Handling in Java


# Objectives

- Define data streams
- Identify the need for streams
- Identify the purpose of the File class, its constructors and methods
- Describe the DataInput and DataOutput interfaces
- Describe the byte stream and character stream in the java.io.package
- Explain the InputStream and OutputStream classes
- Describe the BufferedInputStream and BufferedOutputStream classes
- Describe Character stream classes
- Describe the chaining of I/O systems
- Define Serialization and describe the need and purpose of Serialization

# Stream Classes

- Java works with streams of data.
- A stream is a sequence of data or logical entity that produces or consumes information.
- A data stream is a channel through which data travels from a source to a destination.
- This source or destination can be an `input` or `output` device, storage media or network computers.
- A physical file can be read using different types of streams, for example, `FileInputStream` or `FileReader`.
- Java uses such streams to perform various `input` and `output` operations.
- The standard `input/output` stream in Java is represented by three fields of the `System` class:
  - `in`: The standard input stream is used for reading characters of data.
  - `out`: The standard output stream is used to typically display the output on the screen or any other output medium.
  - `err`: This is the standard error stream.

# Need for Stream Classes

- In Java, streams are required to perform all the `input/output` (I/O) operations.
- Thus, `Stream` classes help in:

1. Reading input from a stream.
2. Writing output to a stream.
3. Managing disk files.
4. Share data with a network of computers.

# Steps for Using Stream Classes

- To read or write data using `Input/Output` streams, the following steps need to be performed. They are:

1. Open a stream that points at a specific data source: afile, a socket, URL, and so on.
2. Read or write data from/to this stream.
3. Close the stream.

- `Input` and `Output` streams are abstract classes and are used for reading and writing of unstructured sequence of bytes.
- The other input and output streams are subclasses of the basic `Input` and `Output` stream class and are used for reading and writing to a file.
- The different types of byte streams can be used interchangeably as they inherit the structure of `Input/Output` stream class.
- For reading or writing bytes, a subclass of the `InputStream` or `OutputStream` class has to be used respectively.

# File Class [1-2]

- `File` class directly works with files and the file system.
- The files are named using the file-naming conventions of the host operating system.
- These conventions are encapsulated using the `File` class constants.
- A pathname can be absolute or relative.
- In an absolute pathname, no other information is required in order to locate the required file as the pathname is complete.
- In a relative pathname, information is gathered from some other pathname.
- The classes in the `java.io` package resolve relative pathnames against the current user directory, which is named by the system property `user.dir`.

# File Class [2-2]

- The directory methods in the `File` class allow creating, deleting, renaming, and listing of directories.
- The interfaces and classes defined by the `java.nio.file` package helps the Java virtual machine to access files, file systems, and file attributes.
- The `toPath()` method helps to obtain a Path that uses the abstract path. A `File` object uses this path to locate a file.
- The constructors of the `File` class are as follows:
  - `File(String dirpath)`
  - `File(String parent, String child)`
  - `File(File fileobj, String filename)`
  - `File(URL urlobj)`

# Methods of File Class [1-4]

- The methods in `File` class help to manipulate the file on the file system.
- Some of the methods in the `File` class are:
  - `renameTo(File newname)`: Names the existing `File` object with the new name specified by the variable `newname`.
  - `delete()`: Deletes the file represented by the abstract path name.
  - `exists()`: Tests the existence of file or directory denoted by this abstract pathname.
  - `getPath()`: Converts the abstract pathname into a pathname string.
  - `isFile()`: Checks whether the file denoted by this abstract pathname is a normal file.
  - `createNewFile()`: Creates a new empty file whose name is the pathname for this file. It is only created when the file of similar name does not exist.
  - `mkdir()`: Creates the directory named by this abstract pathname.
  - `toPath()`: Returns a `java.nio.file.Path` object constructed from the abstract path.
  - `toURI()`: Constructs a file, URI. This file represents this abstract pathname.

# Methods of File Class [2-4]

- The following Code Snippet displays the use of methods of the `File` class:

**Code Snippet**

```
. . .
File fileObj = new File("C:/Java/Hello.txt");
System.out.println("Path is: " +fileObj.getPath());
System.out.println("Name is: " +fileObj.getName());
System.out.println("File exists is: " +fileObj.exists());
System.out.println("File is: " +fileObj.isFile());
...
```

- Displays the full path and the filename of the invoking `File` object.
- Checks for the existence of the file and returns true if the file exists, false if it does not.
- `isFile()` method returns true if called on a file and returns false if called on a directory.

# Methods of File Class [3-4]

The following Code Snippet displays the use of `FilenameFilter` class to filter files with a specific extension:

**Code Snippet**

```
import java.io.*;
class FileFilter implements FilenameFilter {
    String ext;
    public FileFilter(String ext) {
    this.ext = "." + ext;
    }
    public boolean accept (File dir, String fName) {
    return fName.endsWith(ext);
    }
}
public class DirList {
    public static void main (String [] args) {
    String dirName = "d:/resources";
```

# Methods of File Class [4-4]

```
    File fileObj = new File ("d:/resources");
    FilenameFilter filterObj = new FileFilter("java");
    String[] fileName = fileObj.list(filterObj);
    System.out.println("Number of files found : " +
fileName.length);
    System.out.println("" );
    System.out.println("Names of the files are : " );
    System.out.println("------------------------ " );
    for(int ctr=0; ctr < fileName.length; ctr++) {
    System.out.println(fileName[ctr]);
    }
    }
}
```

# FileDescriptor Class

- `FileDescriptor` class provides access to the file descriptors that are maintained by the OS when files and directories are being accessed.
- In practical use, a file descriptor is used to create a `FileInputStream` or `FileOutputStream` to contain it.
- File descriptors should not be created on their own by applications as they are tied to the operating system.
- The `FileDescriptor` class has the following public fields:
  - `static final FileDescriptor err`
  - `static final FileDescriptor in`
  - `static final FileDescriptor out`
- Following are the constructor and methods of `FileDescriptor`:
  - `FileDescriptor()`
  - `sync()`
  - `valid()`

# DataInput Interface and DataOutput Interface

- Data stream supports input/output of primitive data types and string values. The data streams implement `DataInput` or `DataOutput` interface.
- The `DataInput` interface has methods for:
  - Reading bytes from a binary stream and convert the data to any of the Java primitive types.
  - Converting data from Java modified Unicode Transmission Format (UTF)-8 format into string form.
- The `DataOutput` interface has methods for:
  - Converting data present in Java primitive type into a series of bytes and write them onto a binary stream.
  - Converting string data into Java-modified UTF-8 format and write it into a stream.

# Methods of DataInput Interface

- The methods in this interface are:
  - `readBoolean()`
  - `readByte()`
  - `readInt()`
  - `readDouble()`
  - `readChar()`
  - `readLine()`
  - `readUTF()`
- The following Code Snippet displays the use of `DataInput` interface:

**Code Snippet**

```
try
{
DataInputStream dis = new DataInputStream(System.in);
double d = dis.readDouble();
int num = dis.readInt();
}
catch(IOException e) {}
. . .
```

# Methods of DataOutput Interface

- The important methods in this interface are:
  - `writeBoolean(boolean b)`
  - `writeByte(int value)`
  - `writeInt(int value)`
  - `writeDouble(double value)`
  - `writeChar(int value)`
  - `writeChars(String value)`
  - `writeUTF(String value)`
- The following Code Snippet displays the use of `DataOutput` interface:

**Code Snippet**

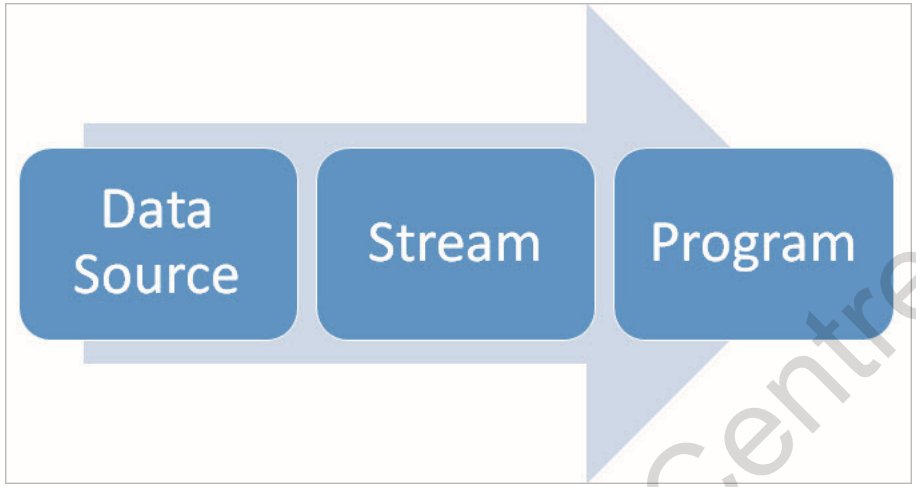
```
try
{
outStream.writeBoolean(true);
outStream.writeDouble(9.95);
. . .
}
catch (IOException e) {}
. . .
```

# java.io Package [1-7]

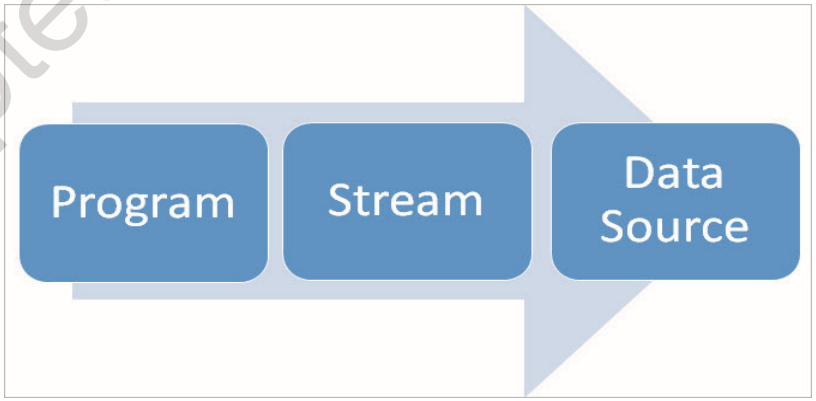
- A stream represents many sources and destinations, such as disk files and memory arrays.
- It is a sequence of data.
- An I/O Stream represents an input source or an output destination.
- Streams support many forms of data, such as simple bytes, primitive date type, localized characters and so on.
- Certain streams allow data to pass and certain streams transform the data in an useful way.
- However, all streams provide a simple model to programs to use them.
- A program uses an input stream to read data from a source. It reads one item at a time.

# java.io Package [2-7]

The following figure illustrates the input stream model:




The following figure illustrates that a program uses an output stream to write data to a destination:



# java.io Package [3-7]

The following Code Snippet displays the working of byte streams using the `FileInputStream` class and `FileOutputStream` class:

Code Snippet

```
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.IOException;
public class ByteStreamApp {
public static void main(String[] args) throws IOException {
   FileInputStream inObj = null;
   FileOutputStream outObj = null;
   try {
    inObj = new FileInputStream("c:/java/hello.txt");
    outObj = new FileOutputStream("outagain.txt");
    int ch;
    while ((ch = inObj.read()) != -1) {
     outObj.write(ch);
```

# java.io Package [4-7]

```
    }
   } finally {
     if (inObj != null) {
      inObj.close();
      }
      if (outObj != null) {
       outObj.close();
      }
     }
   }
  }
```

- In the Code Snippet, `read()` method:
  - Reads a character and returns an `int` value which indicates that the end of the stream is reached by returning a value of `-1`.

# java.io Package [5-7]

- A program that uses character streams adapts to the local character set and is ready for internationalization.
- All character stream classes are derived from the `Reader` and `Writer` class.
- There are character stream classes that specialize in file I/O operations such as `FileReader` and `FileWriter`.
- The following Code Snippet displays the reading and writing of character streams using the `FileReader` and `FileWriter` class:

**Code Snippet**

```
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;
public class CharStreamApp {
 public static void main(String[] args) throws IOException {
  FileReader inObjStream = null;
  FileWriter outObjStream = null;
```

# java.io Package [6-7]

```
 try {
  inObjStream = new FileReader("c:/java/hello.txt");
  outObjStream = new FileWriter("charoutputagain.txt");
  int ch;
  while ((ch = inObjStream.read()) != -1) {
   outObjStream.write(ch);
  }
 } finally {
   if (inObjStream != null) {
    inObjStream.close();
   }
  }
}
```

- Character streams act as wrappers for byte streams.
- The character stream manages translation between characters and bytes and uses the byte stream to perform the physical I/O operations.

# java.io Package [7-7]

- Character I/O typically occurs in bigger units than single characters, such as a line that includes a string of characters with a line terminator at the end.
- A line terminator can be any one of the following:
  - Carriage-return/line-feed sequence ("\r\n")
  - A single carriage-return ("\r")
  - A single line-feed ("\n").
- `BufferedReader.readLine()` and `PrintWriter.println()` methods:
  - The `readLine()` method returns a line of text with the line.
  - The `println()` method outputs each line on a new line as it appends the line terminator for the current operating system.

# Methods of InputStream Class [1-2]

**read()**:

- The `read()` method reads the next bytes of data from the input stream and returns an `int` value in the range of 0 to 255.
- The method returns -1 when end of file is reached.

```
public abstract int read() throws IOException
```

**available()**:

- The `available()` method returns the number of bytes that can be read without blocking.

```
public int available() throws IOException
```

**close()**:

- The `close()` method closes the input stream.
- It releases the system resources associated with the stream.

```
public void close() throws IOException
```

# Methods of InputStream Class [2-2]

**mark(int n)**:

- The `mark(int n)` method marks the current position in the stream and will remain valid until the number of bytes specified in the variable, `n`, is read.
- A call to the `reset()` method will position the pointer to the last marked position.

```
public void mark(int readlimit)
```

**skip(long n)**:

- The `skip(long n)` method skips `n` bytes of data while reading from an input stream.

```
public long skip(long n) throws IOException
```

**reset()**:

- The `reset()` method rests the reading pointer to the previously set mark in the stream.

```
public void reset() throws IOException
```

# FileInputStream Class [1-3]

- File stream objects can be created by either passing the name of the file or a `File` object or a `FileDescriptor` object respectively.
- `FileInputStream` class is used to read bytes from a file.
- When an object of `FileInputStream` class is created, it is also opened for reading.
- `FileInputStream` class overrides all the methods of the `InputStream` class except `mark()` and `reset()` methods.
- The `reset()` method will generate an `IOException`.
- Commonly used constructors of this class are as follows:
  - `FileInputStream(String sObj)`
  - `FileInputStream(File fObj)`
  - `FileInputStream(FileDescriptor fdObj)`

# FileInputStream Class [2-3]

The following Code Snippet displays the creation of `FileInputStream` object:

Code Snippet

```
. . .
FileInputStream fileName = new FileInputStream("Helloworld.txt");
File fName = new File("/command.doc");
FileInputStream fileObj = new FileInputStream(fName);
```

The following Code Snippet demonstrates how to create a `FileInputStream` object using different constructors:

Code Snippet

```
import java.io.FileInputStream;
import java.io.IOException;
public class FIStream {
public static void main(String argv[]){
try {
```

# FileInputStream Class [3-3]

```
    FileInputStream intest;
intest = new FileInputStream("D:/resources/Client.java");
    int ch;
    while ((ch = intest.read()) > -1) {
      StringBuffer buf = new StringBuffer();
       buf.append((char) ch);
     System.out.print(buf.toString());
    }
   } catch (IOException e) {
     System.out.println(e.getMessage());
   }
}
```

# ByteArrayInputStream Class [1-2]

- `ByteArrayInputStream` contains a buffer that stores the bytes that are read from the stream.
- `ByteArrayInputStream` class uses a byte array as the source.
- `ByteArrayInputStream` class has an internal counter, which keeps track of the next byte to be read.
- This class does not support any new methods.
- It only overrides the methods of the `InputStream` class such as `read()`, `skip()`, `available()`, and `reset()`.

**`protected byte[] buf`:**

This refers to an array of bytes that is provided by the creator of the stream.

**`protected int count`:**

This refers to the index greater than the last valid character in the input stream buffer.

**`protected int mark`:**

This refers to the currently marked position in the stream.

# ByteArrayInputStream Class [2-2]

**protected int pos:**

This refers to the index of the next character to be read from the input stream buffer.

The constructors of this class are as follows:

- `ByteArrayInputStream(byte[] b)`
- `ByteArrayInputStream(byte[] b, int start, int num)`

The following Code Snippet displays the use of the `ByteArrayInputStream` class:

Code Snippet

```
. . .
String content = "Hello World";
Byte [] bObj = content.getBytes();
ByteArrayInputStream inputByte = new ByteArrayInputStream(bObj);
. . .
```

# OutputStream Class and its Subclasses

- The `OutputStream` class is an abstract class that defines the method in which bytes or arrays of bytes are written to streams.
- `ByteArrayOutputStream` and `FileOutputStream` are the subclasses of `OutputStream` class.

# Methods in OutputStream Class

- `write(int b)`
- `write(byte[] b)`
- `write(byte[] b, int off, int len)`
- `flush()`
- `close()`

# FileOutputStream Class [1-2]

- `FileOutputStream` class creates an `OutputStream` that is used to write bytes to a file.
- `FileOutputStream` may or may not create the file before opening it for output and it depends on the underlying platform.
- Certain platforms allow only one file-writing object to open a file for writing.
- Therefore, if the file is already open, the constructors in the class fail.
- An `IOException` will be thrown only when a read-only file is opened.
- Some of the commonly used constructors of this class are as follows:
  - `FileOutputStream(String filename)`
  - `FileOutputStream(File name)`
  - `FileOutputStream(String filename, boolean flag)`
  - `FileOutputStream(File name, boolean flag)`

# FileOutputStream Class [2-2]

The following Code Snippet displays the use of `FileOutputStream` class:

**Code Snippet**

```
...
String temp = "One way to get the most out of life is to look
upon it as an adventure."
byte [] bufObj = temp.getBytes();
OutputStream fileObj = new FileOutputStream("Thought.txt");
fileObj.write(bufObj);
fileObj.close();
...
```

Code Snippet first stores the content of the `Stringvariable` in the byte array, `bufObj`, using the `getBytes()` method.

Then, the entire content of the byte array is written to the file, `Thought.txt`.

# ByteArrayOutputStream Class

- `ByteArrayOutputStream` class creates an output stream in which the data is written using a byte array.
- It allows the output array to grow in size so as to accommodate the new data that is written.
- `ByteArrayOutputStream` class defines two constructors which are as follows:
  - `ByteArrayOutputStream()`
  - `ByteArrayOutputStream(int size)`

# Methods in ByteArrayOutputStream Class [1-2]

- `reset()`
- `size()`
- `toByteArray()`
- `writeTo(OutputStream out)`
- `toString()`

# Methods in ByteArrayOutputStream Class [2-2]

- The following Code Snippet displays the use of the `ByteArrayOutputStream` class:

**Code Snippet**

```
. . .
String strObj = "Hello World";
byte[] buf = strObj.getBytes();
ByteArrayOutputStream byObj = new ByteArrayOutputStream();
byObj.write(buf);
System.out.println("The string is:" + byObj.toString());
. . .
```

- In the Code Snippet, a `ByteArrayOutputStream` object is created and then the content from the byte array is written to the `ByteArrayOutputStream` object.
- Finally, the content from the output stream is converted to a string using the `toString()` method and displayed.

# Filter Streams [1-8]

- The `FilterInputStream` class provides additional functionality by using an input stream as its basic source of data.
- The `FilterOutputStream` class streams are over existing output streams.
- They either transform the data along the way or provide additional functionality.

**`FilterInputStream`:**

- The `FilterInputStream` class overrides all the methods of the `InputStream` class that pass all requests to the contained input stream.
- The subclasses can also override certain methods and can provide additional methods and fields.
- Following are the fields and constructors for `java.io.FilterInputStream` class:
  - `protected InputStream in`
  - `protected FilterInputStream(InputStream in)`

# Filter Streams [2-8]

- Following are the methods of this class:
  - `mark(int readlimit)`
  - `markSupported()`
  - `read()`
  - `available()`
  - `close()`
  - `read(byte[] b)`
  - `reset()`
  - `skip(long n)`
  - `read(byte[] b, int off, int len)`
- The following Code Snippet demonstrates the use of `FilterInputStream` class:

Code Snippet

```
package javaioapplication;
import java.io.BufferedInputStream;
import java.io.FileInputStream;
import java.io.FilterInputStream;
```

# Filter Streams [3-8]

```
import java.io.IOException;
import java.io.InputStream;
public class FilterInputApplication {
 public static void main(String[] args) throws Exception {
  InputStream inputObj = null;
  FilterInputStream filterInputObj = null;
try {
     // creates input stream objects
    inputObj = new FileInputStream("C:/Java/Hello.txt");
    filterInputObj = new BufferedInputStream(inputObj);
    // reads and prints from filter input stream
    System.out.println((char) filterInputObj.read());
    System.out.println((char) filterInputObj.read());
    // invokes mark at this position
    filterInputObj.mark(0);
    System.out.println("mark() invoked");
    System.out.println((char) filterInputObj.read());
    System.out.println((char) filterInputObj.read());
} catch (IOException e) {
```

# Filter Streams [4-8]

```
    // prints if any I/O error occurs
    e.printStackTrace();
  } finally {
    // releases system resources associated with the stream
    if (inputObj != null) {
     inputObj.close();
    }
  if (filterInputObj != null) {
      filterInputObj.close();
      }
   }
  }
}
```

# Filter Streams [5-8]

**`FilterOutputStream` Class:**

- The `FilterOutputStream` class overrides all methods of `OutputStreamclass` that pass all requests to the underlying output stream.
- Subclasses of `FilterOutputStream` can also override certain methods and give additional methods and fields.
- The `java.io.FilterOutputStream` class includes the protected `OutputStreamout` field, which is the output stream to be filtered.
- `FilterOutputStream(OutputStream out)` is the constructor of this class.
- This creates an output stream filter that exist class over the defined output stream.

# Filter Streams [6-8]

The following Code Snippet demonstrates the use of `FilterOutputStream` class:

**Code Snippet**

```
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.FilterOutputStream;
import java.io.IOException;
import java.io.OutputStream;
public class FilterOutputApplication {
 public static void main(String[] args) throws Exception {
 OutputStream OutputStreamObj = null;
 FilterOutputStream filterOutputStreamObj = null;
 FileInputStream filterInputStreamObj = null;
 byte[] bufObj = {81, 82, 83, 84, 85};
 int i=0;
 char c;
```

# Filter Streams [7-8]

```
  //encloses the creation of stream objects within try-catch block
  try{
  // creates output stream objects
  OutputStreamObj = new FileOutputStream("C:/Java/test.txt");
  filterOutputStreamObj = new FilterOutputStream(OutputStreamObj);
// writes to the output stream from bufObj
   filterOutputStreamObj.write(bufObj);
   // forces the byte contents to be written to the stream
   filterOutputStreamObj.flush();
   // creates an input stream object
   filterInputStreamObj = new
FileInputStream("C:/Java/test.txt");
   while((i=filterInputStreamObj.read())!=-1)
   { // converts integer to character
    c = (char)i;
    // prints the character read
    System.out.println("Character read after conversion is: "+
c);
    }
```

# Filter Streams [8-8]

```
}catch(IOException e){
 // checks for any I/O errors
 System.out.print("Close() is invoked prior to write()");
 }finally{
  // releases system resources associated with the stream
  if(OutputStreamObj!=null)
   OutputStreamObj.close();
 if(filterOutputStreamObj!=null)
```

# Buffered Streams

- A buffer is a temporary storage area for data.
- By storing the data in a buffer, time is saved as data is immediately received from the buffer instead of going back to the original source of the data.
- Java uses buffered input and output to temporarily cache data read from or written to a stream.
- This helps programs to read or write small amounts of data without adversely affecting the performance of the system.
- Buffer allows skipping, marking, and resetting of the stream.
- Filters operate on the buffer, which is located between the program and the destination of the buffered stream.

# BufferedInputStream Class

- `BufferedInputStream` class allows the programmer to wrap any `InputStream` class into a buffered stream.
- The `BufferedInputStream` act as a cache for inputs.
- It does so by creating the array of bytes which are utilized for future reading.
- The simplest way to read data from an instance of `BufferedInputStream` class is to invoke its `read()` method.
- `BufferedInputStream` class also supports the `mark()` and `reset()` methods.
- The function `markSupported()` will return true if it is supported.
- `BufferedInputStream` class defines two constructors:
  - `BufferedInputStream(InputStream in)`
  - `BufferedInputStream(InputStream in, int size)`

# BufferedOutputStream Class

- `BufferedOutputStream` creates a buffer which is used for an output stream.
- It provides the same performance gain that is provided by the `BufferedInputStream` class.
- The main concept remains the same, that is, instead of going every time to the operating system to write a byte, it is cached in a buffer.
- It is the same as `OutputStream` except that the `flush()` method ensures that the data in the buffer is written to the actual physical output device.
- The constructors of this class are as follows:
  - `BufferedOutputStream(OutputStream os)`
  - `BufferedOutputStream(OutputStream os, int size)`

# Character Streams [1-4]

- Byte stream classes provide methods to handle any type of I/O operations except Unicode characters.
- Character streams provide functionalities to handle character oriented input/output operations.
- They support Unicode characters and can be internationalized.
- Reader and Writer are abstract classes at the top of the class hierarchy that supports reading and writing of Unicode character streams.
- All character stream class are derived from the `Reader` and `Writer` class.

**`Reader` Class**:

- `Reader` class is an abstract class used for reading character streams.
- The subclasses of this class override some of the methods present in this class to increase the efficiency and functionality of the methods.
- All the methods of this class throw an `IOException`.
- The `read()` method returns -1 when end of the file is encountered.
- The following are the two constructors for the `Reader` class:
  - `Reader()`
  - `Reader(Object lock)`

# Character Streams [2-4]

**`Writer` Class**:

- `Writer` class is an abstract class and supports writing characters into streams through methods that can be overridden by its subclasses.
- The methods of the `java.io.Writer` class are same as the methods of the `java.io.OutputStream` class.
- All the methods of this class throw an `IOException` in case of errors.
- The constructors for the `Writer` class are as follows:
  - `Writer()`
  - `Writer(Object lock)`

**`PrintWriter` Class**:

- The `PrintWriter` class is a character-based class that is useful for console output.
- It implements all the print methods of the `PrintStream` class.
- It does not have methods for writing raw bytes.
- In such a case, a program uses unencoded byte streams.

# Character Streams [3-4]

- The `PrintWriter` class differs from the `PrintStream` class as it can handle multiple bytes and other character sets properly.
- This class provides support for Unicode characters.
- The class overrides the `write()` method of the `Writer` class with the difference that none of them raise any `IOException`.
- The printed output is tested for errors using the `checkError()` method.
- The `PrintWriter` class also provides support for printing primitive data types, character arrays, strings and objects.
- It provides formatted output through its `print()` and `println()` methods.
- The `toString()` methods will enable the printing of values of objects.
- The constructors for `PrintWriter` class are as follows:
  - `PrintWriter(OutputStream out)`
  - `PrintWriter(OutputStream out, boolean autoFlush)`
  - `PrintWriter(Writer out)`
  - `PrintWriter(Writer out, boolean autoFlush)`

# Character Streams [4-4]

- The following Code Snippet displays the use of the `PrintWriter` class:

**Code Snippet**

```
. . .
InputStreamReader reader = new InputStreamReader (System.in);
OutputStreamWriter writer = new OutputStreamWriter (System.out);
PrintWriter pwObj = new PrintWriter (writer,true);
. . .
try
{
while (tmp != -1)
{
tmp = reader.read ();
ch = (char) tmp;
pw.println ("echo " + ch);
}
}
catch (IOException e)
{
System.out.println ("IO error:" + e );
}
. . .
```

# CharArrayReader Class

- `CharArrayReader` class is a subclass of `Reader` class.
- The class uses character array as the source of text to be read.
- `CharArrayReader` class has two constructors and reads stream of characters from an array of characters.
- The constructors of this class are as follows:
  - `CharArrayReader(char arr[])`
  - `CharArrayReader(char arr[], int start, int num)`
- The following Code Snippet displays the use of the `CharArrayReader` class:

**Code Snippet**

```
. . .
String temp = "Hello World";
int size = temp.length();
char [] ch = new char[size];
temp.getChars(0, size, ch, 0);
CharArrayReader readObj = new CharArrayReader(ch, 0, 5);
```

# CharArrayWriter Class [1-2]

- `CharArrayWriter` class is a subclass of `Writer` class.
- `CharArrayWriter` uses a character array into which characters are written.
- The size of the array expands as required.
- The methods to `CharArray()`, `toString()`, and `writeTo()` method can be used to retrieve the data.
- `CharArrayWriter` class inherits the methods provided by the `Writer` class.
- The constructors of this class are as follows:
  - `CharArrayWriter()`
  - `CharArrayWriter(int num)`

# CharArrayWriter Class [2-2]

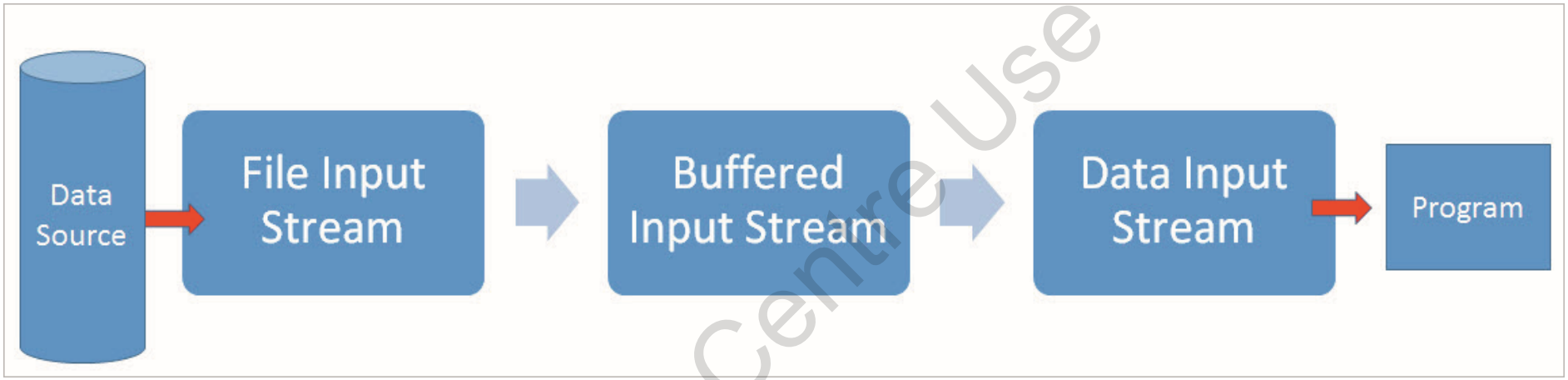
The following Code Snippet displays the use of the `CharArrayWriter` class:

**Code Snippet**

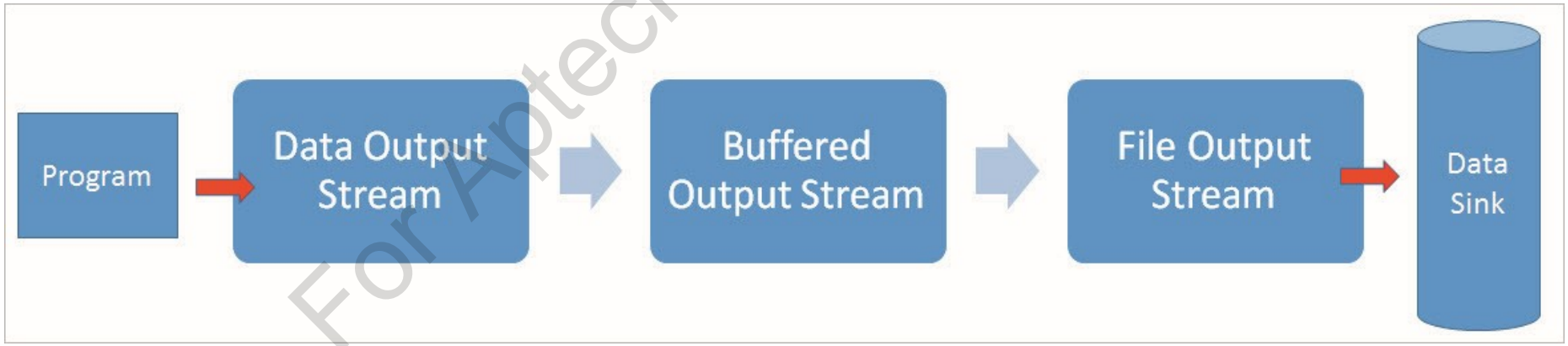
```
. . .
CharArrayWriter fObj = new CharArrayWriter();
. . .
String temp = "Hello World";
int size = temp.length();
char [] ch = new char[size];
temp.getChars(0, temp.length(), ch, 0);
fObj.write(ch);
char[] buffer = fObj.toCharArray();
System.out.println(buffer);
System.out.println(fObj.toString());
. . .
```

# Chaining I/O Systems

- A program, typically, uses a series of streams to process the data.
- The following figure illustrates this:




- The following figure displays the chaining of an output stream:



# Serialization

- Serialization is the process of reading and writing objects to a byte stream.
- An object that implements the `Serializable` interface will have its state saved and restored using serialization and deserialization facilities.
- When a Java object's class or superclass implements the `java.io.Serializable` interface or its subinterface, `java.io.Externalizable`, the Java object becomes serializable.
- The `java.io.Serializable` interface defines no methods.
- It indicates that the class should be considered for serialization.
- If a superclass is serializable, then its subclasses are also serializable.
- The only exception is if a variable is transient and static, its state cannot be saved by serialization facilities.
- When the serialized form of an object is converted back into a copy of the object, this process is called deserialization.

# ObjectOutputStream Class [1-2]

- `ObjectOutputStream` class extends the `OutputStream` class and implements the `ObjectOutput` interface.
- It writes primitive data types and object to the output stream.
- The constructors of this class are as follows:
  - `ObjectOutputStream()`
  - `ObjectOutputStream(OutputStreamout)`

**Methods in `ObjectOutputStream` Class:**

`writeFloat(float f)`

`writeObject(Object obj)`

`defaultWriteObject()`

# ObjectOutputStream Class [2-2]

The following Code Snippet displays the use of methods of `ObjectOutputStream` class:

**Code Snippet**

```
. . .
Point pointObj = new Point(50,75);
FileOutputStream fObj = new FileOutputStream("point");
ObjectOutputStream oos = new ObjectOutputStream(fObj);
oos.writeObject(pointObj);
oos.writeObject(new Date());
oos.close();
. . .
```

# ObjectInputStream Class [1-5]

- `ObjectInputStream` class extends the `InputStream` class and implements the `ObjectInput` interface.
- `ObjectInput` interface extends the `DataInput` interface and has methods that support object serialization.
- `ObjectInputStream` is responsible for reading object instances and primitive types from an underlying input stream.
- It has `readObject()` method to restore an object containing non-static and non-transient fields.
- The constructors of this class are as follows:
  - `ObjectInputStream()`
  - `ObjectInputStream(InputStream in)`

**Methods in `ObjectInputStream` Class:**

`readFloat()` `readBoolean()` `readByte()`
`readChar()` `readObject()`

# ObjectInputStream Class [2-5]

The following Code Snippet displays the creation of an instance of `ObjectInputStream` class:

**Code Snippet**

```
. . .
FileInputStream fObj = new FileInputStream("point");
ObjectInputStream ois = new ObjectInputStream(fObj);
Point obj = (Point) ois.readObject();
ois.close();
```

- In the Code Snippet, an instance of `FileInputStream` is created that refers to the file named point.
- An `ObjectInputStream` is created from that file stream.
- The `readObject()` method returns an object which deserialize the object.
- Finally, the object input stream is closed.

# ObjectInputStream Class [3-5]

- The `ObjectInputStream` class deserializes an object.
- The object to be deserialized must had already been created using the `ObjectOutputStream` class.
- The following Code Snippet demonstrates the `Serializable` interface:

**Code Snippet**

```
import java.io.Serializable;
public class Employee implements Serializable{
    String lastName;
    String firstName;
    double sal;
}
public class BranchEmpProcessor {
public static void main(String[] args) {
        FileInputStream fIn = null;
        FileOutputStream fOut = null;
ObjectInputStream oIn = null;
```

# ObjectInputStream Class [4-5]

```
        ObjectOutputStream oOut = null;
              try {
            fOut = new FileOutputStream("E:\\NewEmplyee.Ser");
            oOut = new ObjectOutputStream(fOut);
            Employee e = new Employee();
            e.lastName = "Smith";
            e.firstName = "John";
            e.sal = 5000.00;
            oOut.writeObject(e);
            oOut.close();
            fOut.close();
            fIn = new FileInputStream("E:\\NewEmplyee.Ser");
            oIn = new ObjectInputStream(fIn);
            //de-serializing employee
            Employee emp = (Employee) oIn.readObject();
          System.out.println("Deserialized  -  "  +
emp.firstName  +  "  "  +
          emp.lastName + " from NewEmployee.ser");
```

# ObjectInputStream Class [5-5]

```
        } catch (IOException e) {
            e.printStackTrace();
        } catch (ClassNotFoundException e) {
            e.printStackTrace();
        } finally {
            System.out.println("finally");
        }
    }
}
```

# Summary

- A stream is a logical entity that produces or consumes information.
- Data stream supports input/output of primitive data types and String values.
- InputStream is an abstract class that defines how data is received.
- The OutputStream class defines the way in which output is written to streams.
- File class directly works with files on the file system.
- A buffer is a temporary storage area for data.
- Serialization is the process of reading and writing objects to a byte stream.