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3140705

Unit – 6

Exception Handling, I/O, Abstract Classes and Interfaces

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KNOWLEDGE IS THE CURRENCY FOR THE 21st CENTURY

Introduction

- Exception handling enables a program to deal with exceptional situations and continue its normal execution.

- Ex. You divide a number with ‘0’. Division by 0 exception will occur and program will be terminated.
- If you can handle this kind of exceptions then your program will continue its normal execution.

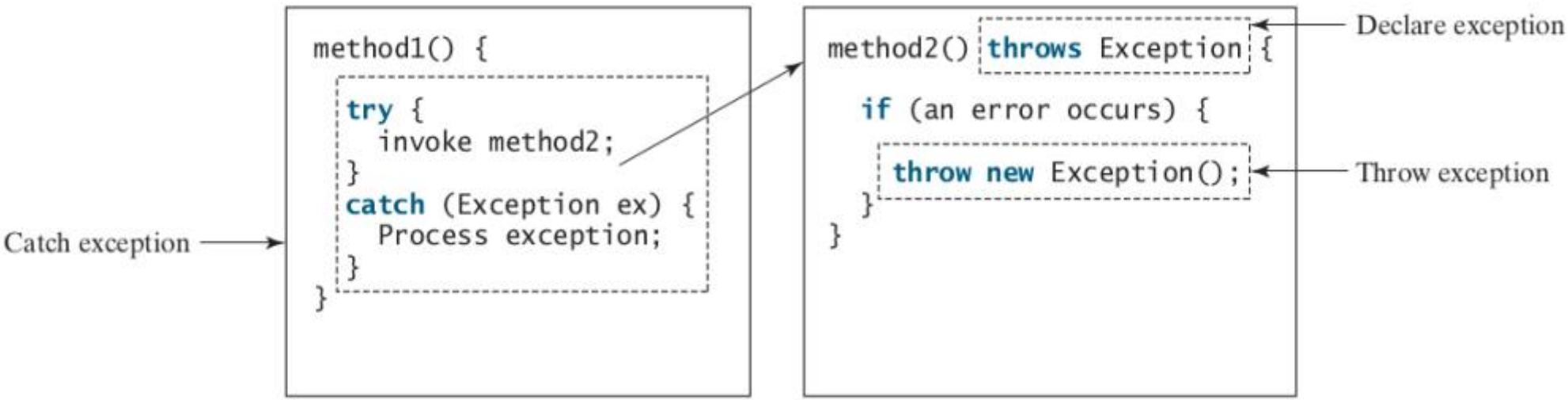
Exception-Handling Overview

Java's exception-handling model is based on three operations:

1. Declaring an exception,
2. Throwing an exception, and
3. Catching an exception.

Exceptions are thrown from a method. The caller of the method can catch and handle the exception.

Exception-Handling Overview



Exception Types

Three types,

1. Checked Exception (Compile time)

These exceptions checked by the code itself. Using try-catch or throws i.e compiler will check these exceptions. From java.lang.Exception class.

Ex: IOException

2. Unchecked Exception (Run time)

These exceptions are not checked by compiler. JVM will check these exceptions. From java.lang.RuntimeException class.

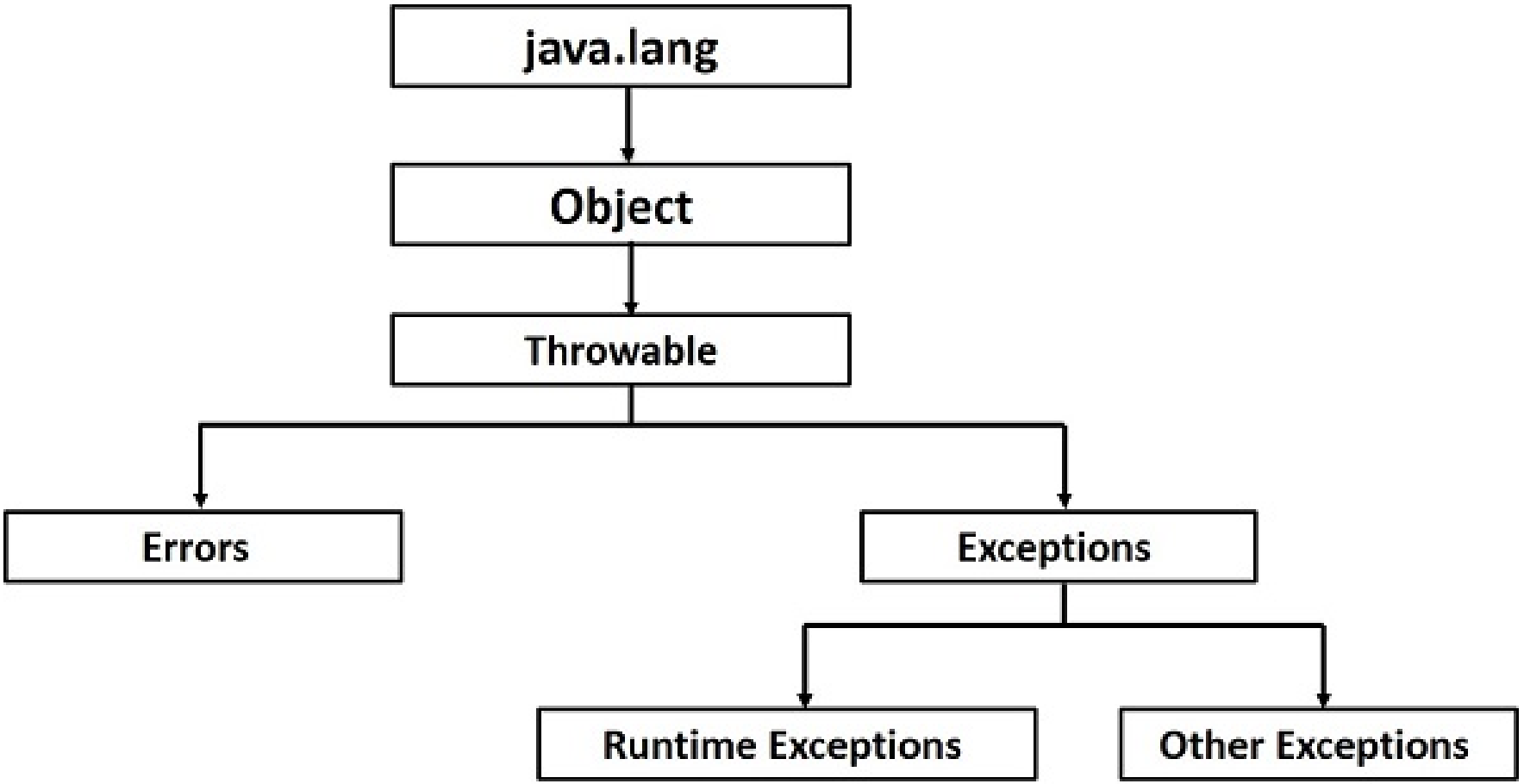
Ex: ArrayIndexOutOfBounds, RunTimeException.

3. System Errors

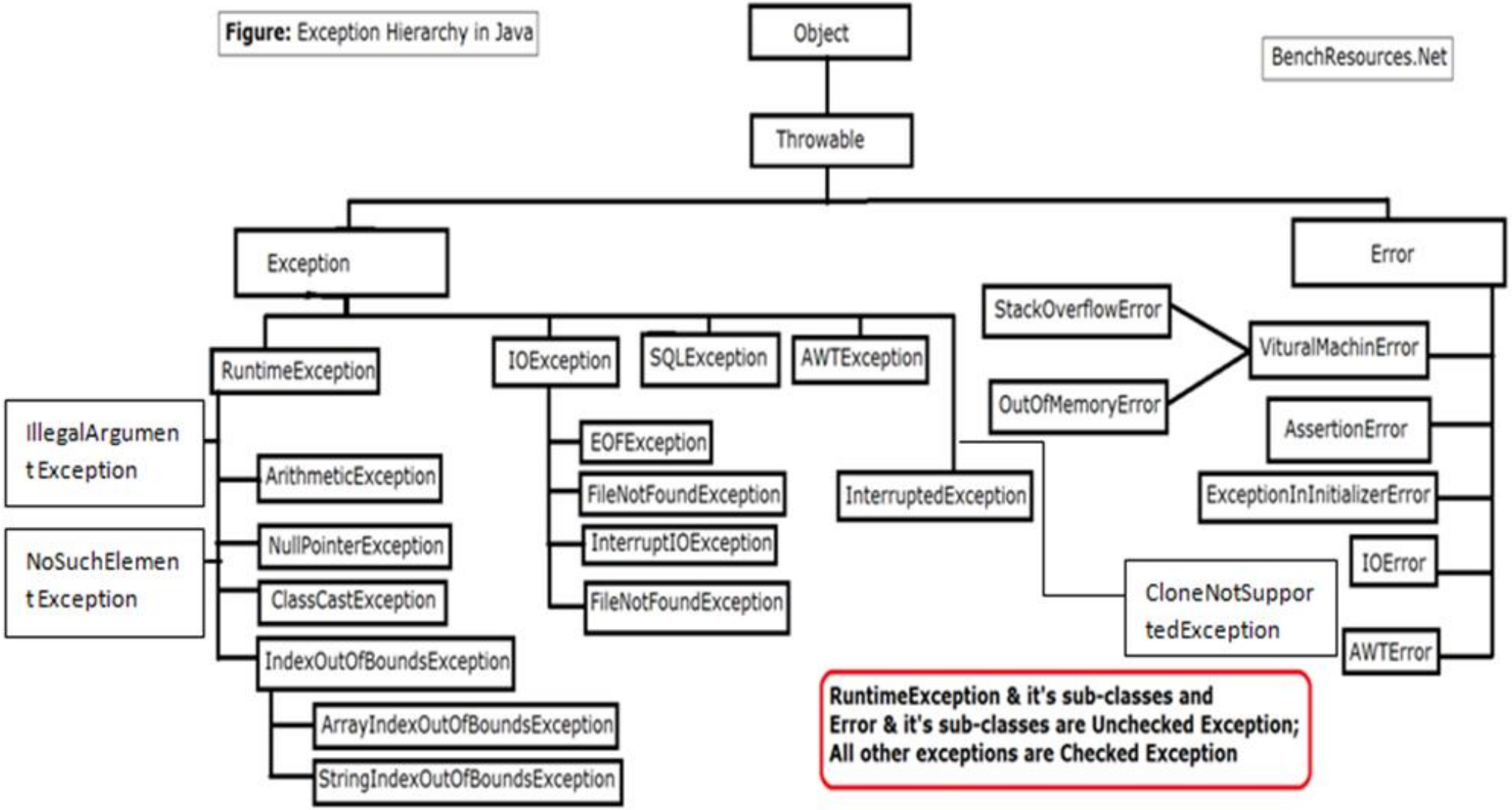
System errors are thrown by the JVM and are represented in the Error class. The Error class describes **internal** system errors, though such errors rarely occur.

Ex: LinkageError, VirtualMachineError

Exception Types



Exception Types



The finally Clause

- The finally clause is always executed regardless whether an exception occurred or not.
- You may want some code to be executed regardless of whether an
- exception occurs or is caught.
- Java has a finally clause that can be used to accomplish this objective.

› Syntax:

```
try {
  statements;
} catch (TheException ex) {
  handling ex;
} finally {
  finalStatements;
}
```

Throwing and Catching Exceptions

Five keywords to handle exception,

1. Try – to monitor exception | to try critical block
2. Catch – handles specific exception with try block
3. Finally – code executed even exception may or may not occur. Denotes end of the program. | optional to use
4. Throw – used to throw specific exception
5. Throws - used to throw specific exception by a particular method.

Throwing and Catching Exceptions

Using Multiple Catch Clauses

To catch different types of exceptions multiple catch clause can be used.

Example:

```
public class TestMultipleCatchBlock{
public static void main(String args[]){
                try{
                        int a[]=new int[5];
                        a[5]=30/0;
                   }
                catch(ArithmeticException e){
                        System.out.println("task1 is completed");}
                catch(ArrayIndexOutOfBoundsException e){
                        System.out.println("task 2 completed");}
                 catch(Exception e){
                        System.out.println("common task completed");}
                System.out.println("rest of the code...");
} }
```

Output:task1 completed
rest of the code...

Throwing and Catching Exceptions

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Try block can be nested

A try, catch or finally block can contain another set of try catch and finally sequence.

```
class Excep6{
    public static void main(String args[]){
     try{
                    try{
                                System.out.println("going to divide");
                                 int b =39/0;
                    }catch(ArithmeticException e)    {System.out.println(e);}

                     try{
                                 int a[]=new int[5];
                                a[5]=4;
                    }catch(ArrayIndexOutOfBoundsException e) {System.out.println(e);}
                    System.out.println("other statement");
     }catch(Exception e)
{System.out.println("handeled");}  System.out.println("normal flow..");      }
```

Output:

```
going to divide
Java.lang. ArithmeticException: /by zero
Java.lang. ArrayIndexOutOfBoundsException: 5
Other statement
Normal flow..
```

Throwing and Catching Exceptions

try-catch-finally keyword

```
class myExeption
{       public static void main(String s[]){
                int i=5, j=0;
                System.out.println("Try started");
                try
                {
                        int temp = i/j;
                        System.out.println("Inside try");
                }
                catch(Exception e)
                {
                        System.out.println("Inside catch");
                        System.out.println("Divide by 0");
                }
                finally
                {
                        System.out.println("Finally block");
                }       }   }
```

Output:
```
try started
Inside catch
Divide by 0
Finally block
```

Throwing and Catching Exceptions

Using throw #UserDefined Exception **#Explicit**

```
public class Main
{
  void checkAge(int age)
          {  if(age<18)
              throw new ArithmeticException("Not Eligible for voting");  //inside Method UserDefined
          else
                    System.out.println("Eligible for voting");
          }
  public static void main(String args[])
          {
           Main obj = new Main();
          obj.checkAge(13);
          System.out.println("End Of Program");
          }
}
```

Output:

```
Exception in thread "main"
java.lang.ArithmeticException:
Not Eligible for voting
at Example1.checkAge(Example1.java:4)
at Example1.main(Example1.java:10)
```

Throwing and Catching Exceptions

Example using throws

```
public class Example1
{
  int division(int a, int b) throws ArithmeticException  //Method signature, Supports Multiple Exception
            {  int t = a/b;
                return t;
            }
  public static void main(String args[])
            {
            Example1 obj = new Example1();
                        try{
                                    System.out.println(obj.division(15,0));
                           }
                        catch(ArithmeticException e)
                           {
                                    System.out.println("You shouldn't divide number by zero");
                           }
            }
}
```

Output:

```
You shouldn't divide number by zero
```

Rethrowing Exception

- Sometimes we may need to rethrow an exception in Java. If a catch block cannot handle the particular exception it has caught, we can rethrow the exception. The rethrow expression causes the originally thrown object to be rethrown.
- Java allows an exception handler to rethrow the exception if the handler cannot process the exception or simply wants to let its caller be notified of the exception.

- The syntax for rethrowing an exception may look like this:

```
try {
 statements;
} catch (TheException ex) {
 perform operations before exits;
 throw ex;
}
```

Rethrowing Exception

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```
public class RethrowingExceptions
 {   static void divide() {
        int x,y,z;
        try  {
          x = 6 ;
          y = 0 ;
          z = x/y ;
       System.out.println(x + "/"+ y +" = " + z);
        }
        catch(ArithmeticException e)
        {
         System.out.println("Exception Caught
in Divide()");
         System.out.println("Cannot Divide by
Zero in Integer Division");
         throw e; // Rethrows an exception
        }
    }
```

```
    public static void main(String[] args)
    {
         System.out.println("Start of main()");
         try
         {
             divide();
         }
         catch(ArithmeticException e)
         {
            System.out.println("Rethrown
Exception Caught in Main()");
            System.out.println(e);
         }
     }
}
```

```
F:\Java>javac RethrowingExceptions.java

F:\Java>java RethrowingExceptions
Start of main()
Exception Caught in Divide()
Cannot Divide by Zero in Integer Division
Rethrown Exception Caught in Main()
java.lang.ArithmeticException: / by zero
```

Chained Exception

Throwing an exception along with another exception forms a chained exception.

Example

```
// the catch block of method1
catch (Exception ex) { ex.printStackTrace(); }

// the catch block of method2
catch (Exception ex) {
        throw new Exception("New info from method1", ex);
}
```

Chained Exception

The Throwable class has methods which support exception chaining –

Method	Description
getCause()	Returns the original cause of the exception
initCause(Throwable cause)	Sets the cause for invoking the exception

```
public class Example {
   public static void main(String[] args) {
      try {
         // creating an exception
         ArithmeticException e = new ArithmeticException("Apparent cause");
         // set the cause of an exception
         e.initCause(new NullPointerException("Actual cause"));
         // throwing the exception
         throw e;
      } catch(ArithmeticException e) {
         // Getting the actual cause of the exception
         System.out.println(e.getCause());       }    } }
```

Defining Custom Exception Classes

- You can define a custom exception class by extending the java.lang.Exception class.

- You can use exception classes provided by Java, whenever it is appropriate.
- If you run into a problem that cannot be adequately described by the predefined exception classes, you can create your own exception class.
- Custom Exception Class must be derived from Exception or from a subclass of Exception, such as IOException.

Defining Custom Exception Classes


```
class CustomException extends Exception {
  String message;
  CustomException(String str) {
    message = str;
  }
  public String toString() {
    return ("Custom Exception Occurred : " + message);
  }
}
public class MainException {
  public static void main(String args[]) {
    try {
      throw new CustomException("This is a custom message");
    } catch(CustomException e) {
      System.out.println(e);      }   } }
```

File Handling

- A file is a **sequence of records stored in binary format**. A disk drive is formatted into several blocks that can store records. File records are mapped onto those disk blocks.
- A file is an object on a computer that stores data, information, settings, or commands used with a computer program.

- To obtain properties of file/directory.
- To delete file/directory.
- To rename file/directory.
- To create directory.
- To read File.
- To write File.
- Absolute vs. Relative File Name

Absolute vs Relative File Name

- An absolute file name (or full name) contains a file name with its complete path.
- Absolute file names are machine dependent.
- For example,
- Windows: D:\MEFGI\Oop1.java
- directory path: D:\MEFGI, file name: Oop1.java
- UNIX: /home/tejas/MEFGI/Oop1.java
- directory path: /home/tejas/MEFGI, file name: Oop1.java

- A relative file name is in relation to the current working directory.
- The complete directory path for a relative file name is omitted.
- For example, Oop1.java is a relative file name.

Absolute vs Relative File Name

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File Handling

- Use the **File class** to obtain file/directory properties, to delete and rename files/directories, and to create directories.
- Use the **Scanner class** for reading text data from a file.
- Use the **PrintWriter class** for writing text data to a file.

File Class

- File class is in java.io package.
- The File class is intended to provide an abstraction that deals with most of the machine-dependent complexities of files and path names in a machine-independent fashion.
- The File class contains the methods for obtaining the properties of a file/directory and for renaming and deleting a file/directory.
- However, the File class does not contain the methods for reading and writing file contents.

The File Class

- File Constructors
- exists() method
- canRead() method
- isDirectory() method
- isFile() mthod
- isAbsolute() method
- isHidden() method
- getAbsolutePath() method
- getName() method
- getPath() method
- getParent() method
- lastModified() method
- length() method
- listFile() method
- delete() method
- renameTo() method
- mkdir() method

The Scanner Class

› Scanner(source: File) // Creates a Scanner that scans tokens from the specified file.

› Scanner(source: String) // Creates a Scanner that scans tokens from the specified string.

› close() // Closes this scanner.

› hasNext(): boolean // Returns true if this scanner has more data to be read.

› next(): String // Returns next token as a string from this scanner.

› nextLine(): String // Returns a line ending with the line separator from this scanner.

The Scanner Class

› nextByte(): byte // Returns next token as a byte from this scanner.

› nextShort(): short // Returns next token as a short from this scanner.

› nextInt(): int // Returns next token as an int from this scanner.

› nextLong(): long // Returns next token as a long from this scanner.

› nextFloat(): float // Returns next token as a float from this scanner.

› nextDouble(): double // Returns next token as a double from this scanner

The Scanner Class

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› nextShort(): short // Returns next token as a short from this scanner.

› nextInt(): int // Returns next token as an int from this scanner.

› nextLong(): long // Returns next token as a long from this scanner.

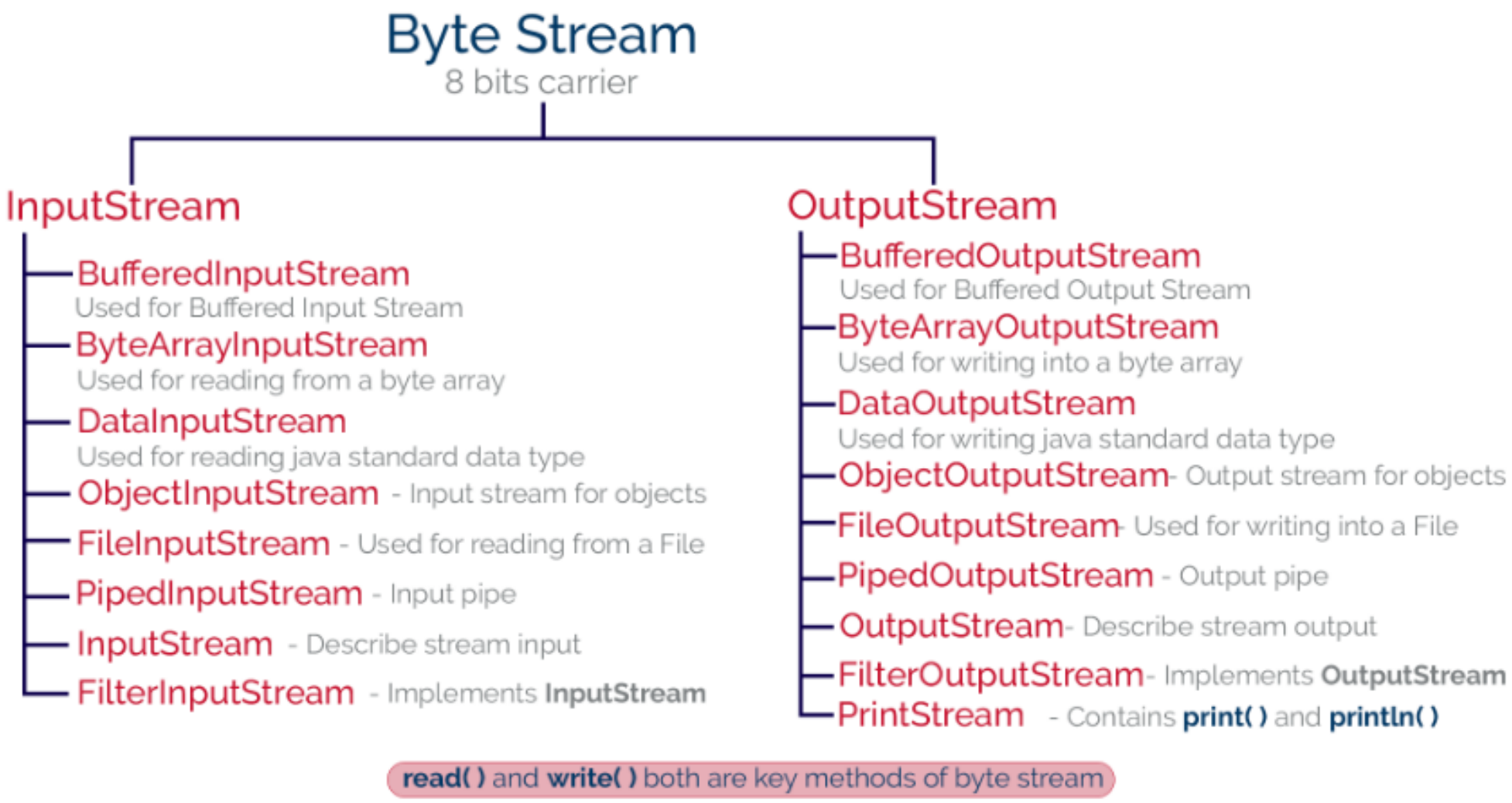
› nextFloat(): float // Returns next token as a float from this scanner.

› nextDouble(): double // Returns next token as a double from this scanner

Byte streams and character streams

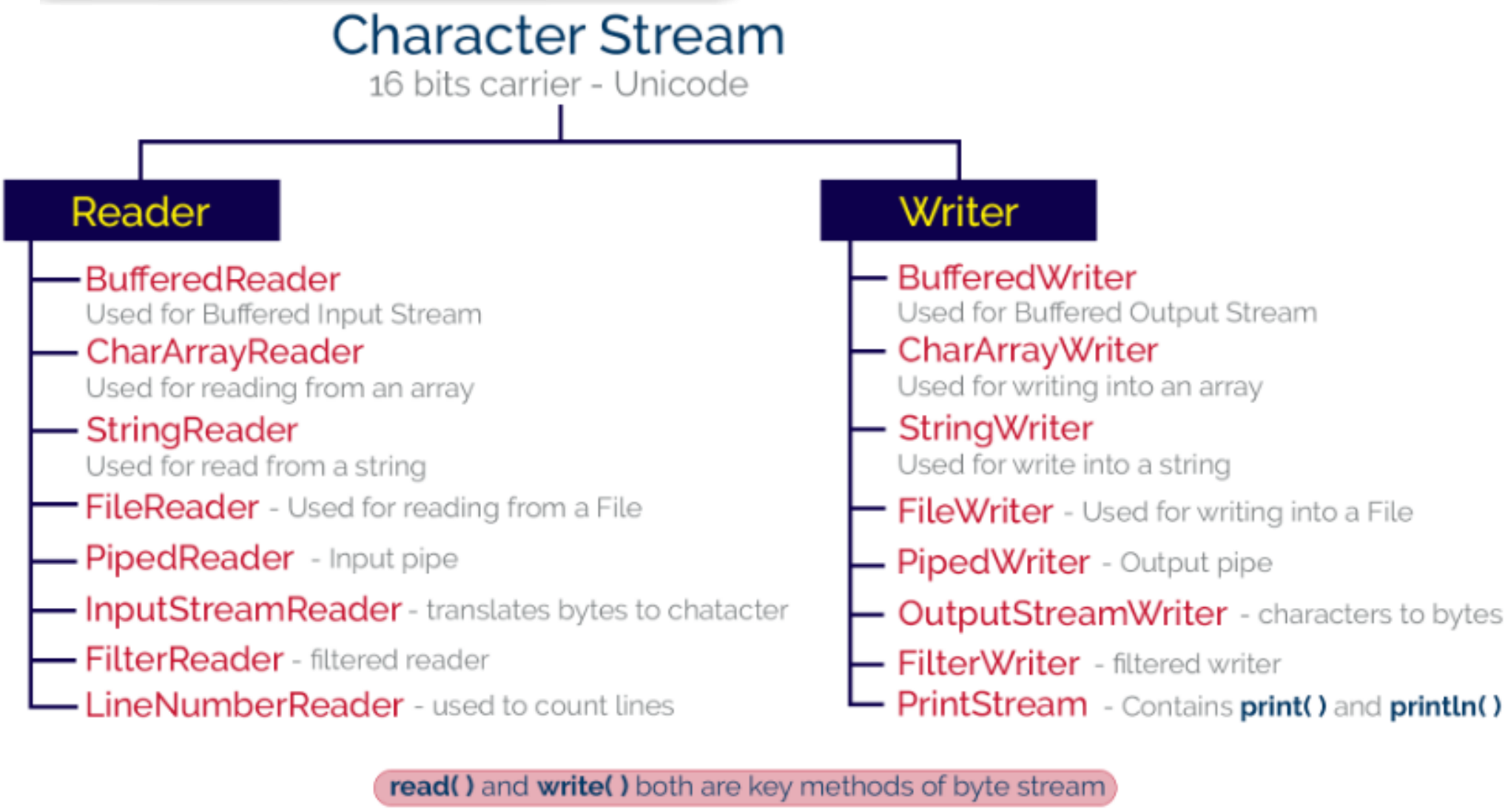
- Stream is a channel in which data flow from sender to receiver.
- Sequence of objects and methods pipelined together to produce results.
- An input object reads the stream of data from a file is called input stream.
- The output object writes the stream of data to a file is called output stream.
- These classes are found in java.IO package.

Byte Stream



read( ) and **write( )** both are key methods of byte stream

Character Stream



read( ) and **write( )** both are key methods of byte stream

Read and write operations on file using InputStream and OutputStream


```
//To write into a file using byte stream
import java.io.*;
class output
{public static void main(String args[])
{           String s ="This is my file";
int a=5;
Double d=5.35;
try
{
FileOutputStream fos= new FileOutputStream("abcd.txt");
DataOutputStream dos = new DataOutputStream(fos);
dos.writeBytes(s);
dos.writeInt(a);
dos.writeDouble(d);
dos.close();
}
catch(IOException ex)
{ex.printStackTrace();}
}}
```

Read and write operations on file using InputStream and OutputStream


```
//To read from a file using byte stream
import java.io.*;
class input
{public static void main(String args[])
{
try
{          FileInputStream fin= new FileInputStream("abcd.txt"); //to read data from a file in
bytes
           DataInputStream din = new DataInputStream(fin); // read primitive Java data types
                      String line=null;
                      while((line =din.readLine())!=null)
                      {
                                 System.out.println(line);
                      }
           din.close();
}
catch(Exception ex)
{ex.printStackTrace();}
}}
```

FileWriter and FileReader


```
//To write into a file using character stream
import java.io.*;
class writerDemo
{
public static void main(String[] args)
{
try
{
FileWriter fw = new FileWriter("abc.txt");
fw.write("Hello, Good Morning");  // fw.write("123");
fw.close();
}
catch(IOException ex)
{ex.printStackTrace();}
}}
```

```
//To read from a file using character stream
import java.io.*;
class readerDemo
{
public static void main(String[] args)
{
try
{
File f1= new File("abc.txt");
FileReader fr = new FileReader(f1);

BufferedReader br=new BufferedReader(fr);
//chaining
String line=null;
while((line=br.readLine()) !=null)
{
System.out.println(line);
}
br.close();
}
catch(Exception ex)
{ex.printStackTrace();} }}
```

For Reference

Example 2

PrintWriter and Reader


```
import java.io.PrintWriter;

class Main {
  public static void main(String[] args) {

    String data = "This is a text inside the file.";

    try {
      PrintWriter output = new PrintWriter(“PQR.txt");

      output.print(data);
      output.close();
    }
    catch(Exception e) {
      e.getStackTrace();
    }
  }
}
```

```
import java.io.*;
public class ReaderExample {
    public static void main(String[] args) {
        try {
            Reader reader = new FileReader(“PQR.txt");
            int data = reader.read();
            while (data != -1) {
                System.out.print((char) data);
                data = reader.read();
            }
            reader.close();
        } catch (Exception ex) {
            System.out.println(ex.getMessage());
        }
    }
}
```

ByteStream VS CharacterStream

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Character streams

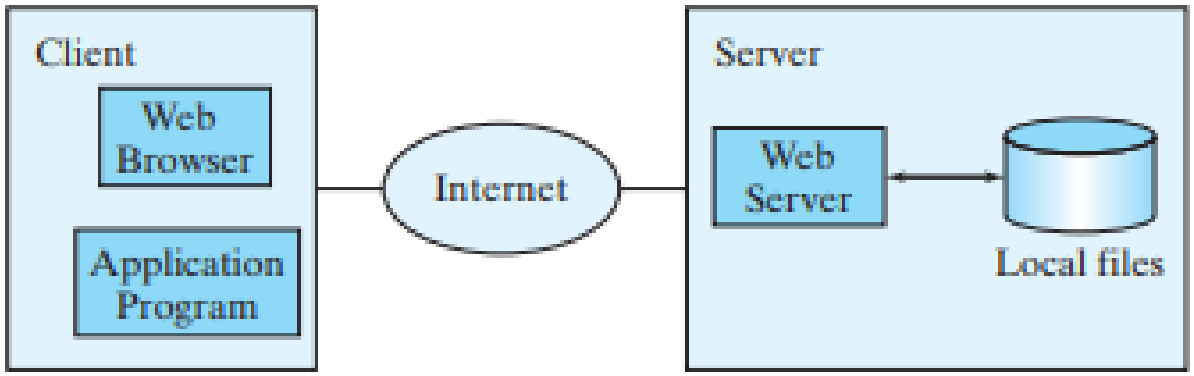
1. Meant for reading or writing to character- or text-based I/O such as text files, text documents, XML, and HTML files.
2. Data dealt with is 16-bit Unicode characters.
3. Input and output character streams are called readers and writers, respectively.
4. The abstract classes of Reader and Writer and their derived classes in the java.io package provide support for character streams.

Byte streams

1. Meant for reading or writing to binary data I/O such as executable files, image files, and files in low-level file formats such as .zip, .class, .obj and .exe.
2. Data dealt with is bytes (i.e., units of 8-bit data).
3. Input and output byte streams are simply called input streams and output streams, respectively.
4. The abstract classes of Input Stream and Output Stream and their derived classes in the java.io package provide support for byte streams.

Reading Data from the Web

- **Just like you can read data from a file on your computer, you can read data from a file on the Web.**
- You can also access data from a file that is on the Web if you know the file's URL (Uniform Resource Locator—the unique address for a file on the Web).
- For example, **www.google.com/index.html** is the URL for the file index.html located on the Google Web server.



The client retrieves files from a Web server.

Reading Data from the Web

- For an application program to read data from a URL, you first need to create a URL object using the java.net.URL class with this constructor:
- public URL(String spec) throws MalformedURLException

```
try {
URL url = new URL("http://www.google.com/index.html");
}
catch (MalformedURLException ex)
{ ex.printStackTrace();
}
```

Reading Data from the Web

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```
try {
URL url = new URL("http://www.google.com/index.html");
}
catch (MalformedURLException ex)
{ ex.printStackTrace();
}
```

Reading Data from the Web


```
import java.net.*;
import java.io.*;

public class ReadURL {
   public static void main(String[] args) throws Exception {

      URL url = new URL("http://www.google.com/index.html");
      BufferedReader read = new BufferedReader(
      new InputStreamReader(url.openStream()));

      String i;
      while ((i = read.readLine()) != null)
         System.out.println(i);
      read.close();
   }}
```

Abstract Class VS Interface

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Refer previous unit for examples.

Parameters	Interface	Abstract class
Speed	Slow	Fast
Multiple Inheritances	Implement several Interfaces	Only one abstract class
Structure	Abstract methods	Abstract & concrete methods
When to use	Future enhancement	To avoid independence
Inheritance/ Implementation	A Class can implement multiple interfaces	The class can inherit only one Abstract Class
Data fields	the interface cannot contain data fields.	the class can have data fields.
Abstract keyword	In an abstract interface keyword, is optional for declaring a method as an abstract.	In an abstract class, the abstract keyword is compulsory for declaring a method as an abstract.

Abstract Class Example

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Ex.: Shape (superclass), Circle and Rectangle (subclass)

Shape Class

```
public abstract class Shape {
    ...
    ...

    /** Abstract method getArea */
    public abstract double getArea();

    /** Abstract method getPerimeter */
    public abstract double getPerimeter();

}
```

Circle Class

```
public class Circle extends Shape {
    ...
    ...

    public double getArea(){
        //Implementation
    }
    public double getPerimeter(){
        //Implementation
    }
}
```

Rectangle Class

```
public class Rectangle extends Shape {
    ...
    ...

    public double getArea(){
        //Implementation
    }
    public double getPerimeter(){
        //Implementation
    }
}
```

Main Class
Class main{
Circle c = new circle();
Rectangle r = new Rectangle(); }

Interface

- Since abstract class allows concrete methods as well, it does not provide 100% abstraction.
- You can say that it provides partial abstraction.
- Interfaces are used for 100% abstraction (full abstraction)

Syntax:

```
modifier interface InterfaceName {

/** Constant declarations */
/** Abstract method signatures */
}
```

The Comparable Interface

- Suppose you want to design a generic method to find the larger of two objects of the same type, such as two students / dates / circles / rectangles / etc.
- In order to accomplish this, the two objects must be comparable, so the common behavior for the objects must be comparable.
- Java provides the Comparable interface for this purpose.

- **The Comparable interface defines the compareTo method for comparing objects.**

The interface is defined as follows:

```
package java.lang;
public interface Comparable<E> {
public int compareTo(E o);
}
```

The Comparable Interface

- The Comparable interface is a generic interface.
- The generic type E [Comparable<E>] is replaced by a concrete type when implementing this interface.

```
class circle implements Comparable<Circle> {
 public int compareTo(Circle o){
 ...
 }
}
```

The Comparable Interface
SortComparableObjects


```
import java.math.*;
public class Main {
public static void main(String[] args) {
String[] cities = {"Savannah", "Boston", "Atlanta", "Tampa"};
java.util.Arrays.sort(cities);
for (String city: cities)
System.out.print(city + " ");
System.out.println();
```

Output:
Atlanta Boston Savannah Tampa
54623239292 432232323239292 2323231092923992

```
BigInteger[] hugeNumbers = {new BigInteger("2323231092923992"),
new BigInteger("432232323239292"),
new BigInteger("54623239292")};
java.util.Arrays.sort(hugeNumbers);
for (BigInteger number: hugeNumbers)
System.out.print(number + " ");
} }
```

The Comparable Interface


```
class Student implements Comparable<Student>{
int rollno;
String name;
int age;
Student(int rollno,String name,int age){
this.rollno=rollno;
this.name=name;
this.age=age;
}

public int compareTo(Student st){
if(age==st.age)
return 0;
else if(age>st.age)
return 1;
else
return -1;
}
}
```

```
import java.util.*;
public class TestSort2{
public static void main(String args[]){
ArrayList<Student> al=new ArrayList<Student>();
al.add(new Student(101,"Vijay",23));
al.add(new Student(106,"Ajay",27));
al.add(new Student(105,"Jai",21));

Collections.sort(al);
for(Student st:al){
System.out.println(st.rollno+" "+st.name+" "+st.age)
;
}
}
}
```

The Cloneable Interface

- Often it is desirable to create a copy of an object. To do this, you need to use the clone method and understand the Cloneable interface.
- The Cloneable interface specifies that an object can be cloned.

- An interface contains constants and abstract methods, but the Cloneable interface is a special case. The Cloneable interface in the java.lang package is defined as follows:

```
package java.lang;
public interface Cloneable {
}
```

This interface is empty. An interface with an empty body is referred to as a marker interface. A marker interface does not contain constants or methods. It is used to denote that a class possesses certain desirable properties. A class that implements the Cloneable interface is marked cloneable, and its objects can be cloned using the clone() method defined in the Object class.

The Cloneable Interface


```
package java.lang;
public interface Cloneable {
}
```

- This interface is empty. An interface with an empty body is referred to as a marker interface.
- A marker interface does not contain constants or methods. It is used to denote that a class possesses certain desirable properties.
- A class that implements the Cloneable interface is marked cloneable, and its objects can be cloned using the clone() method defined in the Object class.
- Many classes in the Java library (e.g., Date, Calendar, ArrayList etc.) implement Cloneable. Thus, the instances of these classes can be cloned.

The Cloneable Interface

- Creating Copy of Java Object
- We can create a replica or copy of java object by

- Creating a copy of object in a different memory location. This is called a Deep copy.

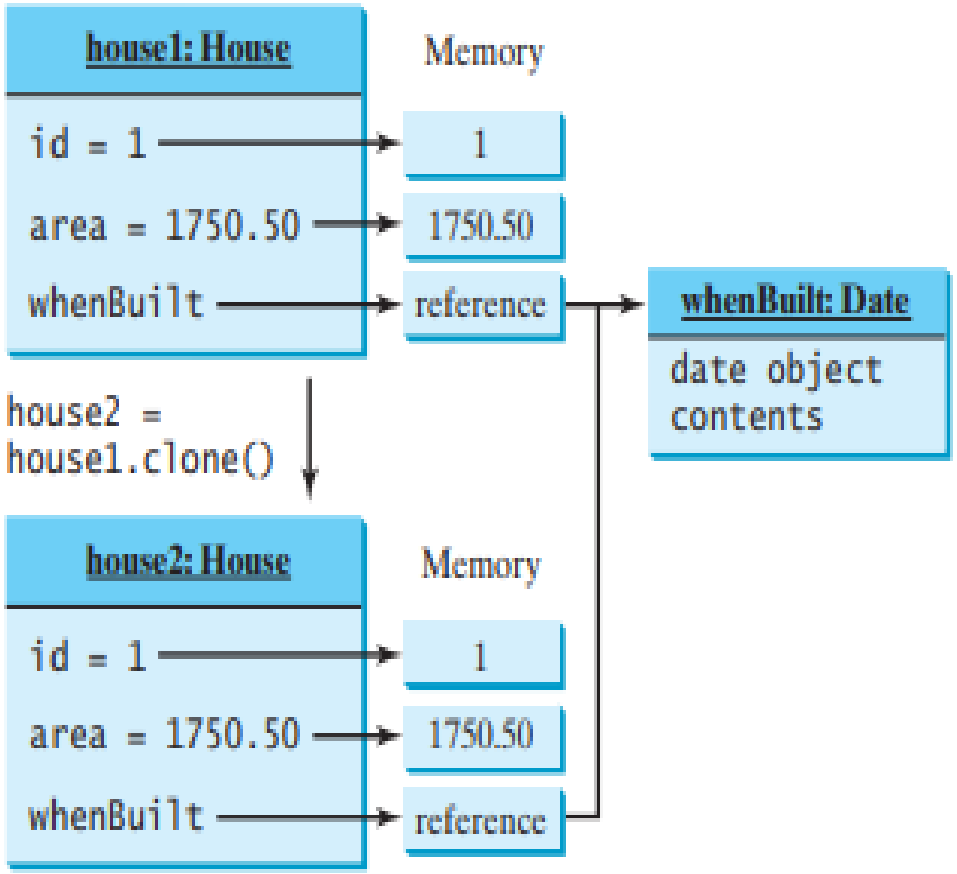
- Creating a new reference that points to the same memory location. This is also called a Shallow copy.

The Cloneable Interface

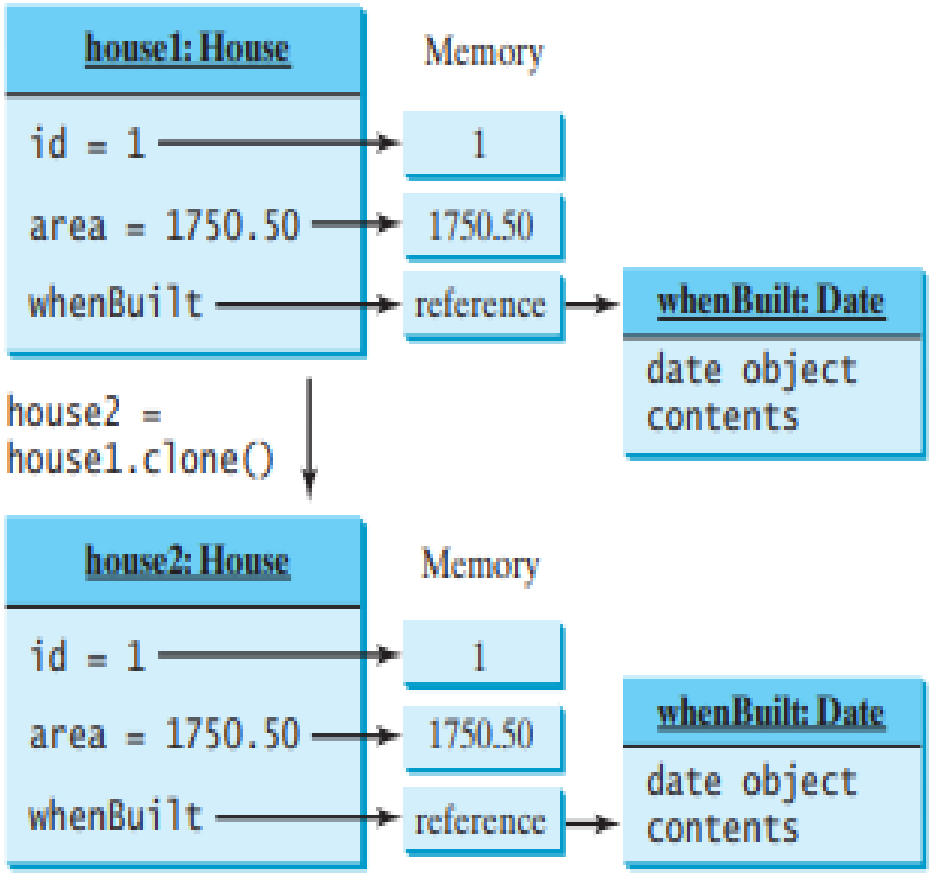

```
//ShallowCopy
class Main
{
int x = 30;

public static void main(String args[])
{
Main obj1 = new Main();

// it will copy the reference, not value
Main obj2 = obj1;

obj2.x = 6;
System.out.println("The value of x is: " + obj1.x);
} }
```

```
//DeepCopy
class Main implements Cloneable
{
public int x = 30;

public static void main(String args[])
{
Main obj1 = new Main();

// it will copy the reference, not value
//SCopy obj2 = obj1;
try{
Main obj2 = (Main)obj1.clone();
obj2.x = 6;
System.out.println("The value of x is: " + obj1.x);
System.out.println("The value of x is: " + obj2.x);
}
catch(Exception e){System.out.println(e);}

} }
```

The Cloneable Interface



Shallow Copy



Deep Copy

Reference Programs

Reading Data from the Web


```
import java.util.Scanner;

 public class ReadFileFromURL {
 public static void main(String[] args) {
 System.out.print("Enter a URL: ");
 String URLString = new Scanner(System.in).next();

 try {
 java.net.URL url = new java.net.URL(URLString);
int count = 0;
Scanner input = new Scanner(url.openStream());
while (input.hasNext()) {
String line = input.nextLine();
count += line.length();
}

System.out.println("The file size is " + count + " characters");
}
catch (java.net.MalformedURLException ex) {
System.out.println("Invalid URL");
}
catch (java.io.IOException ex) {
System.out.println("I/O Errors: no such file");
}
}
}
```

ByteStream VS CharacterStream

```
import java.io.*;
class CopyFile
{
        public static void main(String args[])
        {
                try
                {
                        FileInputStream fr = new  FileInputStream("photo.jpg");
                        FileOutputStream fw = new FileOutputStream("Copy.jpg");
                        int i =0;
                        while ((i=fr.read())!=-1){
                                fw.write(i);
                        }
                        fw.flush();
                        fw.close();
                        fr.close();
                        System.out.println("File copied successfully.....");
                }
                catch(Exception e)
                {
                        System.out.println(e);
                }
        }
}
```

ByteStream VS CharacterStream

```
import java.io.*;
class CopyFile
{
        public static void main(String args[])
        {
                try
                {
                        FileReader fr = new  FileReader("Data.txt");
                        FileWriter fw = new  FileWriter("Copy.txt");
                        int i =0;
                        while ((i=fr.read())!=-1){
                                fw.write(i);
                        }
                        fw.flush();
                        fw.close();
                        fr.close();
                        System.out.println("File copied successfully.....");
                }
                catch(Exception e)
                {
                        System.out.println(e);                  }       } }
```

END OF UNIT - 6