**How to Take Input From User in Java?**

Java brings various Streams with its I/O package that helps the user to perform all the input-output operations. These streams support all the types of objects, data types, characters, files, etc to fully execute the I/O operations. There are **two ways** by which we can take input from the user or from a file

- BufferedReader Class
- Scanner Class

1. BufferedReader

It is a simple class that is used to read a sequence of characters. It has a simple function that reads a character another read which reads, an array of characters, and a readLine() function which reads a line.

InputStreamReader() is a function that converts the input stream of bytes into a stream of characters so that it can be read as BufferedReader expects a stream of characters.
BufferedReader can throw checked Exceptions

```
// Java Program for taking user
// input using BufferedReader Class
import java.io.*;

class brc {

    // Main Method
    public static void main(String[] args)
        throws IOException
    {
        // Creating BufferedReader Object
        // InputStreamReader converts bytes to
        // stream of character
        BufferedReader bfn = new BufferedReader(
            new InputStreamReader(System.in));

        // String reading internally
        String str = bfn.readLine();

        // Integer reading internally
        int it = Integer.parseInt(bfn.readLine());

        // Printing String
        System.out.println("Entered String : " + str);

        // Printing Integer
        System.out.println("Entered Integer : " + it);
    }
}
```

```
Miraj Trivedi
222
Entered String : Miraj Trivedi
Entered Integer : 222
```

2. Scanner

It is an advanced version of BufferedReader which was added in later versions of Java. The scanner can read formatted input. It has different functions for different types of data types.

- The scanner is much easier to read as we don't have to write throws as there is no exception thrown by it.
- It was added in later versions of Java
- It contains predefined functions to read an Integer, Character, and other data types as well.

**Syntax:** Scanner

```
Scanner scn = new Scanner(System.in);
```

**Syntax: Importing Scanner Class:** To use the Scanner we need to import the Scanner Class

```
import java.util.Scanner;
```

**Inbuilt Scanner functions are as follows:**

- Integer: nextInt()
- Float: nextFloat()
- String : next() and nextLine()

Hence, in the case of Integer and String in Scanner, we don't require parsing as we did require in BufferedReader.

```
// Java Program to show how to take
// input from user using Scanner Class

import java.util.*;

class GFG {

    public static void main(String[] args)
    {
        // Scanner definition
        Scanner scn = new Scanner(System.in);

        // input is a string ( one word )
        // read by next() function
        String str1 = scn.next();
```

```
        // print String
        System.out.println("Entered String str1 : " + str1);

        // input is a String ( complete Sentence )
        // read by nextLine()function
        String str2 = scn.nextLine();

        // print string
        System.out.println("Entered String str2 : " + str2);

        // input is an Integer
        // read by nextInt() function
        int x = scn.nextInt();

        // print integer
        System.out.println("Entered Integer : " + x);

        // input is a floatingValue
        // read by nextFloat() function
        float f = scn.nextFloat();

        // print floating value
        System.out.println("Entered FloatValue : " + f);
    }
}
```

**Output :**

```
Entered String str1 : Miraj Trivedi

Entered String str2 : Mirav rathi

Entered Integer : 123

Entered FloatValue : 123.004
```

Differences Between BufferedReader and Scanner

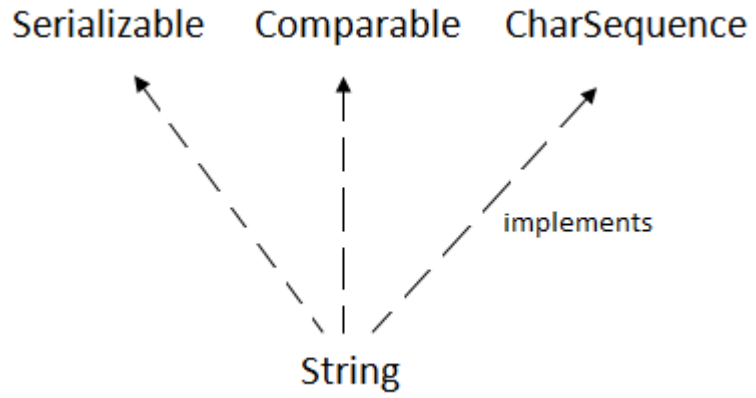
- BufferedReader is a very basic way to read the input generally used to read the stream of characters. It gives an edge over Scanner as it is faster than Scanner because Scanner does lots of post-processing for parsing the input; as seen in nextInt(), nextFloat()
- BufferedReader is more flexible as we can specify the size of stream input to be read. (In general, it is there that BufferedReader reads larger input than Scanner)
- These two factors come into play when we are reading larger input. In general, the Scanner Class serves the input.
- BufferedReader is preferred as it is synchronized. While dealing with multiple threads it is preferred.
- For decent input, easy readability. The Scanner is preferred over BufferedReader.

| No. | StringBuffer | StringBuilder |
|---|---|---|
| 1) | StringBuffer is *synchronized* i.e. thread safe. It means two threads can't call the methods of StringBuffer simultaneously. | StringBuilder is *non-synchronized* i.e. not thread safe. It means two threads can call the methods of StringBuilder simultaneously. |
| 2) | StringBuffer is *less efficient* than StringBuilder. | StringBuilder is *more efficient* than StringBuffer. |
| 3) | StringBuffer was introduced in Java 1.0 | StringBuilder was introduced in Java 1.5 |

# Java String

**Java String** class provides a lot of methods to perform operations on strings such as compare(), concat(), equals(), split(), length(), replace(), compareTo(), intern(), substring() etc.

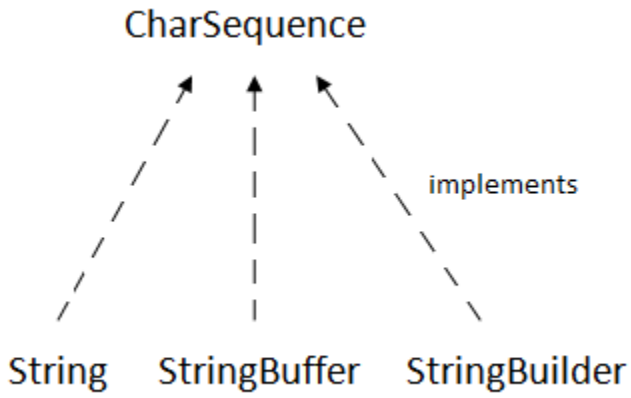
The java.lang.String class
implements *Serializable*, *Comparable* and *CharSequence* interfaces.




```
Object -> stream(serializable)

Stream -> object(deserializable)
```

# CharSequence Interface

The CharSequence interface is used to represent the sequence of characters. String, StringBuffer and StringBuilder classes implement it. It means, we can create strings in Java by using these three classes.




The Java String is immutable which means it cannot be changed. Whenever we change any string, a new instance is created. For mutable strings, you can use StringBuffer and StringBuilder classes.

- String objects are immutable whereas StringBuffer and StringBuilder objects are mutable.
- StringBuffer and StringBuilder are same only difference is that StringBuilder is not synchronized whereas StringBuffer is. As StringBuilder is not synchronized, it is not thread safe but faster than StringBuffer.
- **Use String**, for a string which will be constant through out the application.
  **Use StringBuffer**, for a string which can change in multi-threaded applications.
  **Use StringBuilder**, for a string which can change in single-threaded applications.

# What is String in Java?

Generally, String is a sequence of characters. But in Java, string is an object that represents a sequence of characters. The java.lang.String class is used to create a string object.

## How to create a string object?

There are two ways to create String object:

1. By string literal
2. By new keyword

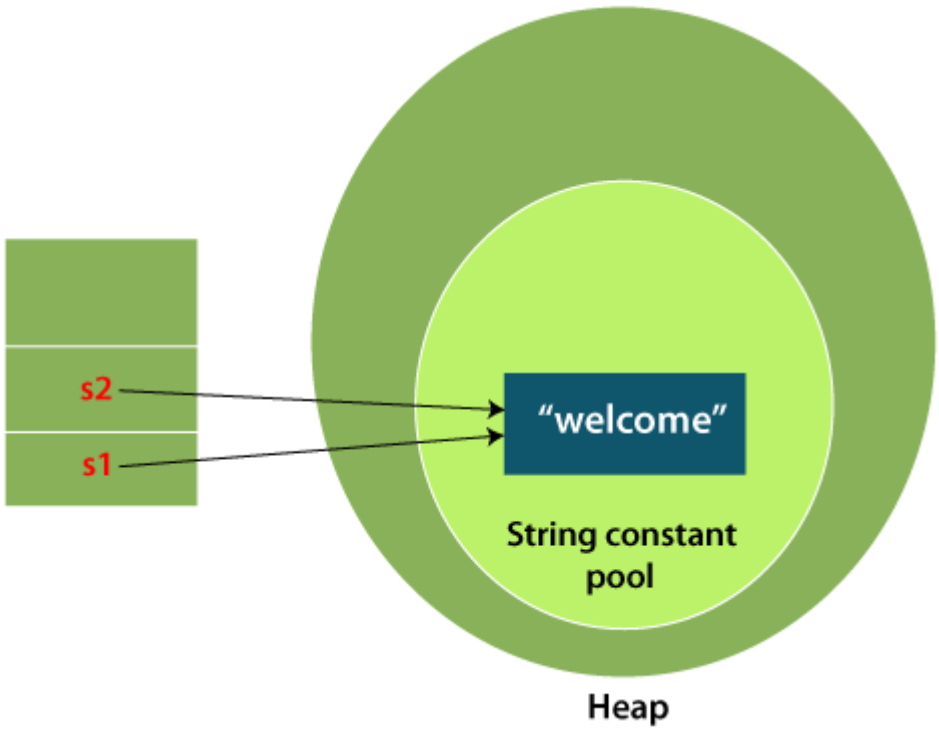
# 1) String Literal

Java String literal is created by using double quotes. For Example:

```
1. String s="welcome";
```

Each time you create a string literal, the JVM checks the "string constant pool" first. If the string already exists in the pool, a reference to the pooled instance is returned. If the string doesn't exist in the pool, a new string instance is created and placed in the pool. For example:

```
1. String s1="Welcome";
2. String s2="Welcome";//It doesn't create a new instance
```




In the above example, only one object will be created. Firstly, JVM will not find any string object with the value "Welcome" in string constant pool that is why it will

create a new object. After that it will find the string with the value "Welcome" in the pool, it will not create a new object but will return the reference to the same instance.

### Why Java uses the concept of String literal?

To make Java more memory efficient (because no new objects are created if it exists already in the string constant pool).

## 2) By new keyword

```
1. String s=new String("Welcome");//creates two objects and one reference variable
```

In such case, JVM will create a new string object in normal (non-pool) heap memory, and the literal "Welcome" will be placed in the string constant pool. The variable s will refer to the object in a heap (non-pool).

```
1. public class StringExample{
2. public static void main(String args[]){
3. String s1="java";//creating string by Java string literal
4. char ch[]={'s','t','r','i','n','g','s'};
5. String s2=new String(ch);//converting char array to string
6. String s3=new String("example");//creating Java string by new keyword
7. System.out.println(s1);
8. System.out.println(s2);
9. System.out.println(s3);
10. }}
```

**Output:**

```
java
strings
example
```

# Immutable String in Java

A String that can be modified or changed is known as mutable String. StringBuffer and StringBuilder classes are used for creating mutable strings.

A String is an unavoidable type of variable while writing any application program. String references are used to store various attributes like username, password, etc. In

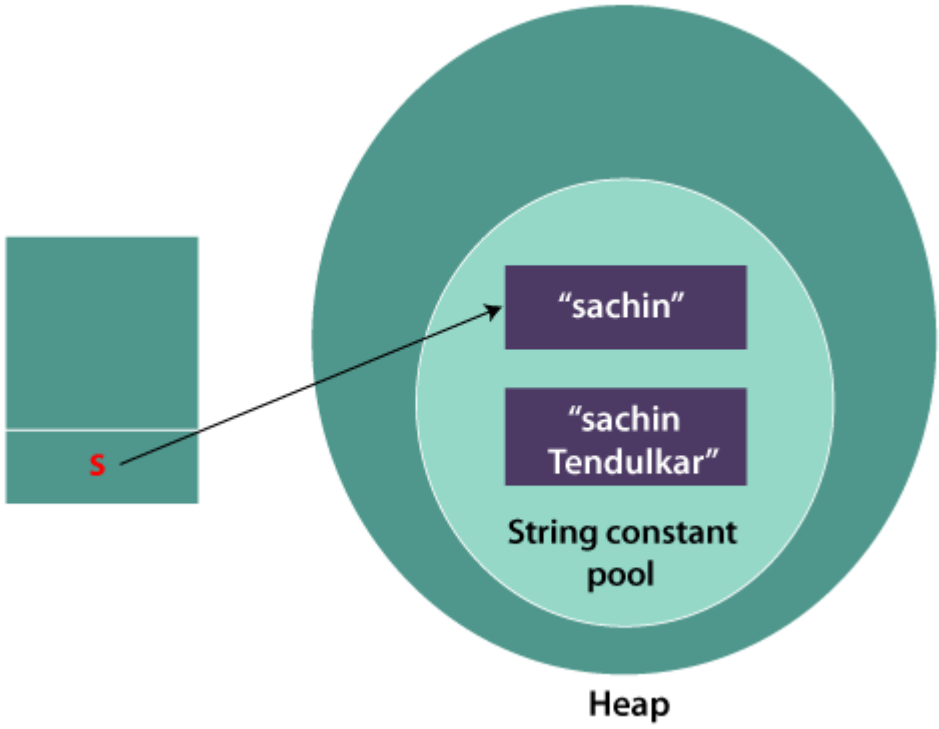
Java, **String objects are immutable**. Immutable simply means unmodifiable or unchangeable.

Once String object is created its data or state can't be changed but a new String object is created.

```
1. class Testimmutablestring{
2.  public static void main(String args[]){
3.    String s="Sachin";
4.    s.concat(" Tendulkar");//concat() method appends the string at the end
5.    System.out.println(s);//will print Sachin because strings are immutable objects
6.  }
7. }
```

**Output:**

```
Sachin
```




two objects are created but ***s*** reference variable still refers to "Sachin" not to "Sachin Tendulkar".

But if we explicitly assign it to the reference variable, it will refer to "Sachin Tendulkar" object.

```
1.  class Testimmutablestring1{
2.   public static void main(String args[]){
3.     String s="Sachin";
4.     s=s.concat(" Tendulkar");
5.     System.out.println(s);
6.   }
7.  }
```

**Output:**

```
Sachin Tendulkar
```

## Why String objects are immutable in Java?

As Java uses the concept of String literal. Suppose there are 5 reference variables, all refer to one object "Sachin". If one reference variable changes the value of the object, it will be affected by all the reference variables. That is why String objects are immutable in Java.

Following are some features of String which makes String objects immutable.

**1. ClassLoader:**

A ClassLoader in Java uses a String object as an argument. Consider, if the String object is modifiable, the value might be changed and the class that is supposed to be loaded might be different.

To avoid this kind of misinterpretation, String is immutable.

**2. Thread Safe:**

As the String object is immutable we don't have to take care of the synchronization that is required while sharing an object across multiple threads.

**3. Security:**

As we have seen in class loading, immutable String objects avoid further errors by loading the correct class. This leads to making the application program more secure. Consider an example of banking software. The username and password cannot be modified by any intruder because String objects are immutable. This can make the application program more secure.

**4. Heap Space:**

The immutability of String helps to minimize the usage in the heap memory. When we try to declare a new String object, the JVM checks whether the value already exists in the String pool or not. If it exists, the same value is assigned to the new object. This feature allows Java to use the heap space efficiently.

# Java String compare

We can compare String in Java on the basis of content and reference.

It is used in **authentication** (by equals() method), **sorting** (by compareTo() method), **reference matching** (by == operator) etc.

There are three ways to compare String in Java:

1. By Using equals() Method
2. By Using == Operator
3. By compareTo() Method

## 1) By Using equals() Method

The String class equals() method compares the original content of the string. It compares values of string for equality. String class provides the following two methods:

- **public boolean equals(Object another)** compares this string to the specified object.
- **public boolean equalsIgnoreCase(String another)** compares this string to another string, ignoring case.

**Teststringcomparison1.java**

```
1. class Teststringcomparison1{
2.  public static void main(String args[]){
3.    String s1="Sachin";
4.    String s2="Sachin";
5.    String s3=new String("Sachin");
6.    String s4="Saurav";
7.    System.out.println(s1.equals(s2));//true
8.    System.out.println(s1.equals(s3));//true
9.    System.out.println(s1.equals(s4));//false
```

```
10. }
11.}
```

**Output:**

```
true
true
false
```

In the above code, two strings are compared using **equals()** method of **String** class. And the result is printed as boolean values, **true** or **false**.

**Teststringcomparison2.java**

```
1.  class Teststringcomparison2{
2.   public static void main(String args[]){
3.     String s1="Sachin";
4.     String s2="SACHIN";
5.
6.     System.out.println(s1.equals(s2));//false
7.     System.out.println(s1.equalsIgnoreCase(s2));//true
8.   }
9.  }
```

**Output:**

```
false
true
```

# 2) By Using == operator

The == operator compares references not values.

```
1.  class Teststringcomparison3{
2.   public static void main(String args[]){
3.     String s1="Sachin";
4.     String s2="Sachin";
5.     String s3=new String("Sachin");
6.     System.out.println(s1==s2);//true (because both refer to same instance)
7.     System.out.println(s1==s3);//false(because s3 refers to instance created in n
    onpool)
8.   }
9.  }
```

**Output:**

```
true
false
```

# 3) By Using compareTo() method

The String class compareTo() method compares values lexicographically and returns an integer value that describes if first string is less than, equal to or greater than second string.

Suppose s1 and s2 are two String objects. If:

- **s1 == s2** : The method returns 0.
- **s1 > s2** : The method returns a positive value.
- **s1 < s2** : The method returns a negative value.

```
1. class Teststringcomparison4{
2.  public static void main(String args[]){
3.    String s1="Sachin";
4.    String s2="Sachin";
5.    String s3="Ratan";
6.    System.out.println(s1.compareTo(s2));//0
7.    System.out.println(s1.compareTo(s3));//1(because s1>s3)
8.    System.out.println(s3.compareTo(s1));//-1(because s3 < s1 )
9.   }
10. }
```

**Output:**

```
0
1
-1
```

# Java String charAt() Method Examples

```
1. public class CharAtExample{
2. public static void main(String args[]){
3. String name="Rotaract";
4. char ch=name.charAt(3);//returns the char value at the 4th index
```

```
5. System.out.println(ch);
6. }}
```

**Output:**

```
t
```

# Java String concat

The **Java String class concat()** method *combines specified string at the end of this string*. It returns a combined string. It is like appending another string.

```
1. public class ConcatExample{
2. public static void main(String args[]){
3. String s1="java string";
4. // The string s1 does not get changed, even though it is invoking the method

5. // concat(), as it is immutable. Therefore, the explicit assignment is required he
   re.
6. s1.concat("is immutable");
7. System.out.println(s1);
8. s1=s1.concat(" is immutable so assign it explicitly");
9. System.out.println(s1);
10. }}
```

**Output:**

```
java string
java string is immutable so assign it explicitly
```

```
1. public class ConcatExample2 {
2.     public static void main(String[] args) {
3.         String str1 = "Hello";
4.         String str2 = "world";
5.         String str3 = "good morning";
6.         // Concatenating one string
7.         String str4 = str1.concat(str2);
8.         System.out.println(str4);
9.         // Concatenating multiple strings
10.        String str5 = str1.concat(str2).concat(str3);
11.        System.out.println(str5);
```

```
    }
}
```

**Output:**

```
Helloworld
Helloworldgoodmorning
```

# Java String equals()

The **Java String class equals()** method compares the two given strings based on the content of the string. If any character is not matched, it returns false. If all characters are matched, it returns true.

```
public class EqualsExample{
public static void main(String args[]){
String s1="hello";
String s2="hello";
String s3="HELLO";
String s4="java";
System.out.println(s1.equals(s2));//true because content and case is same
System.out.println(s1.equals(s3));//false because case is not same
System.out.println(s1.equals(s4));//false because content is not same
}}
```

**Output:**

```
true
false
false
```

# Java String indexOf()

The **Java String class indexOf()** method returns the position of the first occurrence of the specified character or string in a specified string.

There are four overloaded indexOf() method in Java. The signature of indexOf() methods are given below:

| No. | Method | Description |
|---|---|---|
| 1 | int indexOf(int ch) | It returns the index position for the given char value |
| 2 | int indexOf(int ch, int fromIndex) | It returns the index position for the given char value and from index |
| 3 | int indexOf(String substring) | It returns the index position for the given substring |
| 4 | int indexOf(String substring, int fromIndex) | It returns the index position for the given substring and from index |

```
1. public class IndexOfExample{
2. public static void main(String args[]){
3. String s1="this is index of example";
4. //passing substring
5. int index1=s1.indexOf("is");//returns the index of is substring
6. int index2=s1.indexOf("index");//returns the index of index substring
7. System.out.println(index1+"  "+index2);//2 8
8.
9. //passing substring with from index
10. int index3=s1.indexOf("is",4);//returns the index of is substring after 4th index

11. System.out.println(index3);//5 i.e. the index of another is
12.
13. //passing char value
14. int index4=s1.indexOf('s');//returns the index of s char value
15. System.out.println(index4);//3
16. }}
```

**Output:**

```
2  8
5
3
```

# Java String isEmpty()

The **Java String class isEmpty()** method checks if the input string is empty or not. Note that here empty means the number of characters contained in a string is zero.

```
1. public class IsEmptyExample{
2. public static void main(String args[]){
3. String s1="";
4. String s2="helloworld";
5. 
6. System.out.println(s1.isEmpty());
7. System.out.println(s2.isEmpty());
8. }}
```

**Output:**

```
true
false
```

# Java String join()

The **Java String class join()** method returns a string joined with a given delimiter. In the String join() method, the delimiter is copied for each element. The join() method is included in the Java string since JDK 1.8.

```
1. public class StringJoinExample2 {
2.     public static void main(String[] args) {
3.         String date = String.join("/","25","06","2018");
4.         System.out.print(date);
5.         String time = String.join(":", "12","10","10");
6.         System.out.println(" "+time);
7.     }
8. }
```

**Output:**

```
25/06/2018 12:10:10
```

# Java String lastIndexOf()

The **Java String class lastIndexOf()** method returns the last index of the given character value or substring. If it is not found, it returns -1. The index counter starts from zero.

| No. | Method | Description |
|---|---|---|
| 1 | int lastIndexOf(int ch) | It returns last index position for the given char value |
| 2 | int lastIndexOf(int ch, int fromIndex) | It returns last index position for the given char value and from index |
| 3 | int lastIndexOf(String substring) | It returns last index position for the given substring |
| 4 | int lastIndexOf(String substring, int fromIndex) | It returns last index position for the given substring and from index |

```
1. public class LastIndexOfExample{
2. public static void main(String args[]){
3. String s1="this is index of example";//there are 2 's' characters in this sentence

4. int index1=s1.lastIndexOf('s');//returns last index of 's' char value
5. System.out.println(index1);//6
6. }}
```

**Output:**

```
6
```

# Java String length()

The **Java String class length()** method finds the length of a string. The length of the Java string is the same as the Unicode code units of the string.

```
1. public class LengthExample{
2. public static void main(String args[]){
```

```
3. String s1="helloworld";
4. String s2="morning";
5. System.out.println("string length is: "+s1.length());//10 is the length of javatpoi
   nt string
6. System.out.println("string length is: "+s2.length());//7 is the length of python st
   ring
7. }}
```

**Output:**

```
string length is: 10
string length is: 7
```

# Java String split()

The **java string split()** method splits this string against given regular expression and returns a char array.

```
1. public class SplitExample{
2. public static void main(String args[]){
3. String s1="java string split method by javatpoint";
4. String[] words=s1.split("\\s");//splits the string based on whitespace
5. //using java foreach loop to print elements of string array
6. for(String w:words){
7. System.out.println(w);
8. }
9. }}
```

Output

```
java
string
split
method
by
javatpoint
```

# Java String substring()

The **Java String class substring()** method returns a part of the string.

We pass beginIndex and endIndex number position in the Java substring method where beginIndex is inclusive, and endIndex is exclusive. In other words, the beginIndex starts from 0, whereas the endIndex starts from 1.

There are two types of substring methods in Java string.

1. **public** String substring(**int** startIndex)  // type - 1
2. and
3. **public** String substring(**int** startIndex, **int** endIndex)  // type - 2

## Exception Throws

**StringIndexOutOfBoundsException** is thrown when any one of the following conditions is met.

- if the start index is negative value
- end index is lower than starting index.
- Either starting or ending index is greater than the total number of characters present in the string.
- **public class** SubstringExample{
- **public static void** main(String args[]){
- String s1="javastrings";
- System.out.println(s1.substring(2,4));//returns va
- System.out.println(s1.substring(2));//returns vatpoint
- }}

**Output:**

```
va
vastrings
```

```
1. public class SubstringExample2 {
2.     public static void main(String[] args) {
3.         String s1=" javastrings ";
4.         String substr = s1.substring(0); // Starts with 0 and goes to end
5.         System.out.println(substr);
6.         String substr2 = s1.substring(5,10); // Starts from 5 and goes to 10
7.         System.out.println(substr2);
```

```
8.          String substr3 = s1.substring(5,15); // Returns Exception
9.      }
10. }
```

**Output:**

```
javastrings
tring
Exception in thread "main" java.lang.StringIndexOutOfBoundsException: begin
5, end 15, length 10
```

# Java String trim()

The **Java String class trim()** method eliminates leading and trailing spaces. The Unicode value of space character is '\u0020'. The trim() method in Java string checks this Unicode value before and after the string, if it exists then the method removes the spaces and returns the omitted string.

```
1. public class StringTrimExample{
2. public static void main(String args[]){
3. String s1="  hello string   ";
4. System.out.println(s1+"goodmorning");//without trim()
5. System.out.println(s1.trim()+"goodmorning ");//with trim()
6. }}
```

**Output**

```
hello string   goodmorning
hello stringgoodmorning
```

| No. | StringBuffer | StringBuilder |
|---|---|---|
| 1) | StringBuffer is *synchronized* i.e. thread safe. It means two threads can't call the methods of StringBuffer simultaneously. | StringBuilder is *non-synchronized* i.e. not thread safe. It means two threads can call the methods of StringBuilder simultaneously. |
| 2) | StringBuffer is *less efficient* than StringBuilder. | StringBuilder is *more efficient* than StringBuffer. |

| | | |
|---|---|---|
| 3) | StringBuffer was introduced in Java 1.0 | StringBuilder was introduced in Java 1.5 |

# Java StringBuffer Class

Java StringBuffer class is used to create mutable (modifiable) String objects. The StringBuffer class in Java is the same as String class except it is mutable i.e. it can be changed.

## Important Constructors of StringBuffer Class

| Constructor | Description |
|---|---|
| StringBuffer() | It creates an empty String buffer with the initial capacity of 16 characters. |
| StringBuffer(String str) | It creates a String buffer with the specified string. |
| StringBuffer(int capacity) | It creates an empty String buffer with the specified capacity as length. |

| Modifier and Type | Method | Description |
|---|---|---|
| public synchronized StringBuffer | append(String s) | It is used to append the specified string with this string. The append() method is overloaded like append(char), append(boolean), append(int), append(float), append(double) etc. |
| public synchronized StringBuffer | insert(int offset, String s) | It is used to insert the specified string with this string at the specified position. The insert() method is overloaded like insert(int, char), insert(int, boolean), insert(int, int), insert(int, float), insert(int, double) etc. |

| | | |
|---|---|---|
| public synchronized StringBuffer | replace(int startIndex, int endIndex, String str) | It is used to replace the string from specified startIndex and endIndex. |
| public synchronized StringBuffer | delete(int startIndex, int endIndex) | It is used to delete the string from specified startIndex and endIndex. |
| public synchronized StringBuffer | reverse() | is used to reverse the string. |
| public int | capacity() | It is used to return the current capacity. |
| public void | ensureCapacity(int minimumCapacity) | It is used to ensure the capacity at least equal to the given minimum. |
| public char | charAt(int index) | It is used to return the character at the specified position. |
| public int | length() | It is used to return the length of the string i.e. total number of characters. |
| public String | substring(int beginIndex) | It is used to return the substring from the specified beginIndex. |
| public String | substring(int beginIndex, int endIndex) | It is used to return the substring from the specified beginIndex and endIndex. |

# StringBuffer Methods

## 1) StringBuffer Class append() Method

The append() method concatenates the given argument with this String.

```
1. class StringBufferExample{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer("Hello ");
4. sb.append("Java");//now original string is changed
5. System.out.println(sb);//prints Hello Java
6. }
7. }
```

**Output:**

```
Hello Java
```

## 2) StringBuffer insert() Method

The insert() method inserts the given String with this string at the given position.

**StringBufferExample2.java**

```
1. class StringBufferExample2{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer("Hello ");
4. sb.insert(1,"Java");//now original string is changed
5. System.out.println(sb);//prints HJavaello
6. }
7. }
```

**Output:**

```
HJavaello
```

## 3) StringBuffer replace() Method

The replace() method replaces the given String from the specified beginIndex and endIndex.

**StringBufferExample3.java**

```
1. class StringBufferExample3{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer("Hello");
4. sb.replace(1,3,"Java");
5. System.out.println(sb);//prints HJavalo
6. }
7. }
```

**Output:**

```
HJavalo
```

## 4) StringBuffer delete() Method

The delete() method of the StringBuffer class deletes the String from the specified beginIndex to endIndex.

```
1. class StringBufferExample4{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer("Hello");
4. sb.delete(1,3);
5. System.out.println(sb);//prints Hlo
6. }
7. }
```

**Output:**

```
Hlo
```

## 5) StringBuffer reverse() Method

The reverse() method of the StringBuilder class reverses the current String.

**StringBufferExample5.java**

```
1. class StringBufferExample5{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer("Hello");
4. sb.reverse();
5. System.out.println(sb);//prints olleH
6. }
7. }
```

**Output:**

```
olleH
```

## 6) StringBuffer capacity() Method

The capacity() method of the StringBuffer class returns the current capacity of the buffer. The default capacity of the buffer is 16. If the number of character increases from its current capacity, it increases the capacity by (oldcapacity*2)+2. For example if your current capacity is 16, it will be (16*2)+2=34.

**StringBufferExample6.java**

```
1. class StringBufferExample6{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer();
4. System.out.println(sb.capacity());//default 16
5. sb.append("Hello");
6. System.out.println(sb.capacity());//now 16
7. sb.append("java is my favourite language");
8. System.out.println(sb.capacity());//now (16*2)+2=34 i.e (oldcapacity*2)+2
9. }
10. }
```

**Output:**

```
16
16
34
```

## 7) StringBuffer ensureCapacity() method

The ensureCapacity() method of the StringBuffer class ensures that the given capacity is the minimum to the current capacity. If it is greater than the current capacity, it increases the capacity by (oldcapacity*2)+2. For example if your current capacity is 16, it will be (16*2)+2=34.

**StringBufferExample7.java**

```
1. class StringBufferExample7{
2. public static void main(String args[]){
3. StringBuffer sb=new StringBuffer();
4. System.out.println(sb.capacity());//default 16
5. sb.append("Hello");
6. System.out.println(sb.capacity());//now 16
7. sb.append("java is my favourite language");
8. System.out.println(sb.capacity());//now (16*2)+2=34 i.e (oldcapacity*2)+2
9. sb.ensureCapacity(10);//now no change
10. System.out.println(sb.capacity());//now 34
11. sb.ensureCapacity(50);//now (34*2)+2
12. System.out.println(sb.capacity());//now 70
```

```
13. }
14. }
```

**Output:**

```
16
16
34
34
70
```

# Introduction to Exceptions:-

**Exception Handling** in Java is one of the effective means to handle the runtime errors so that the regular flow of the application can be preserved. Java Exception Handling is a mechanism to handle runtime errors such as ClassNotFoundException, IOException, SQLException, RemoteException, etc.

**Exception** is an unwanted or unexpected event, which occurs during the execution of a program, i.e. at run time, that disrupts the normal flow of the program's instructions. Exceptions can be caught and handled by the program. When an exception occurs within a method, it creates an object. This object is called the exception object. It contains information about the exception, such as the name and description of the exception and the state of the program when the exception occurred.

## Major reasons why an exception Occurs

- Invalid user input
- Device failure
- Loss of network connection
- Physical limitations (out of disk memory)
- Code errors
- Opening an unavailable file

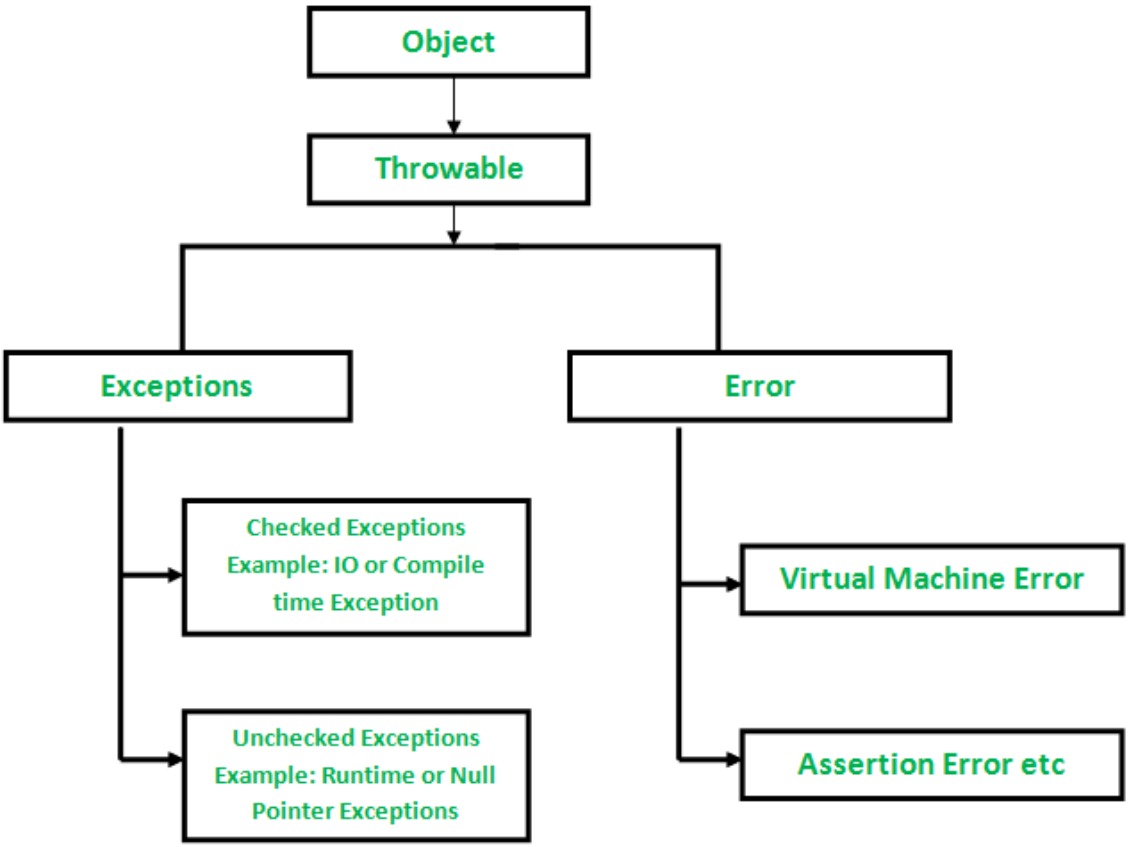
**Errors** represent irrecoverable conditions such as Java virtual machine (JVM) running out of memory, memory leaks, stack overflow errors, library incompatibility, infinite recursion, etc. Errors are usually beyond the control of the programmer, and we should not try to handle errors.

### differences between Error and Exception

- **Error:** An Error indicates a serious problem that a reasonable application should not try to catch.
- **Exception:** Exception indicates conditions that a reasonable application might try to catch.

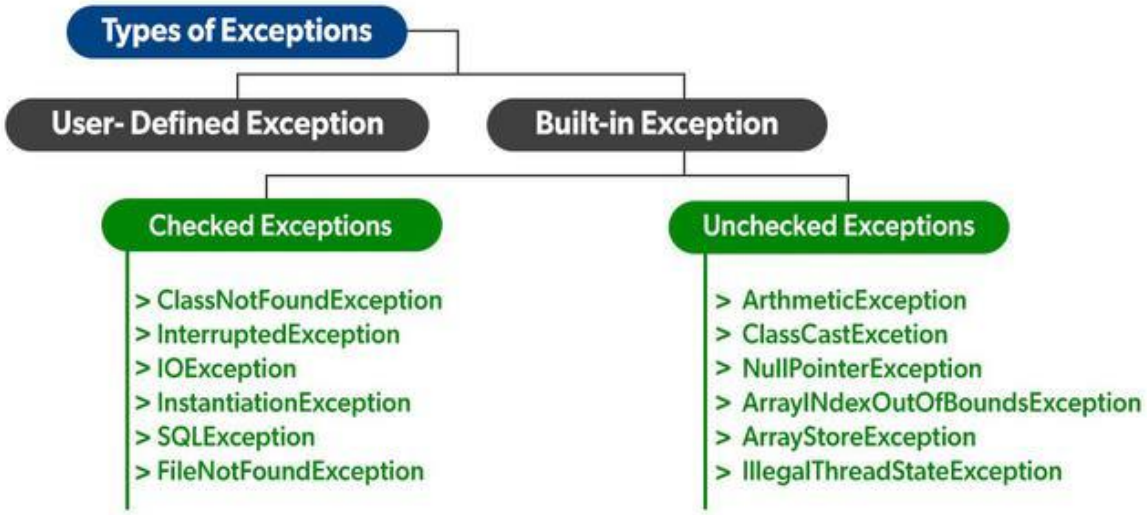
Exception Hierarchy

All exception and error types are subclasses of class **Throwable**, which is the base class of the hierarchy. One branch is headed by **Exception**. This class is used for exceptional conditions that user programs should catch. NullPointerException is an example of such an exception. Another branch, **Error** is used by the Java run-time system(JVM) to indicate errors having to do with the run-time environment itself(JRE). StackOverflowError is an example of such an error.




## Types of Exceptions

Java defines several types of exceptions that relate to its various class libraries. Java also allows users to define their own exceptions.




**Exceptions can be categorized in two ways:**

1. **Built-in Exceptions**
    - Checked Exception
    - Unchecked Exception
2. **User-Defined Exceptions**

## A. Built-in Exceptions:

Built-in exceptions are the exceptions that are available in Java libraries. These exceptions are suitable to explain certain error situations.

- **Checked Exceptions:** Checked exceptions are called compile-time exceptions because these exceptions are checked at compile-time by the compiler.

- **Unchecked Exceptions:** The unchecked exceptions are just opposite to the checked exceptions. The compiler will not check these exceptions at compile time. In simple words, if a program throws an unchecked exception, and even if we didn't handle or declare it, the program would not give a compilation error.

## B. User-Defined Exceptions:

Sometimes, the built-in exceptions in Java are not able to describe a certain situation. In such cases, users can also create exceptions, which are called 'user-defined Exceptions'.

The ***advantages of Exception Handling in Java*** are as follows:

1. Provision to Complete Program Execution
2. Easy Identification of Program Code and Error-Handling Code
3. Propagation of Errors
4. Meaningful Error Reporting
5. Identifying Error Types

**Methods to print the Exception information:**
**1.printStackTrace()**– This method prints exception information in the format of Name of the exception: description of the exception, stack trace.

```
//program to print the exception information using printStackTrace() method

import java.io.*;

class GFG {
    public static void main (String[] args) {
      int a=5;
      int b=0;
        try{
          System.out.println(a/b);
        }
      catch(ArithmeticException e){
        e.printStackTrace();
      }
    }
}
```

**Output:**

```
java.lang.ArithmeticException: / by zero

at GFG.main(File.java:10)
```

**2.toString() – This** method prints exception information in the format of Name of the exception: description of the exception.

```
//program to print the exception information using toString() method

import java.io.*;

class GFG1 {
    public static void main (String[] args) {
      int a=5;
      int b=0;
        try{
          System.out.println(a/b);
        }
      catch(ArithmeticException e){
        System.out.println(e.toString());
      }
    }
}
```

**Output:**

```
java.lang.ArithmeticException: / by zero
```

**3.getMessage()** -This method prints only the description of the exception.

```
//program to print the exception information using getMessage() method

import java.io.*;

class GFG1 {
    public static void main (String[] args) {
      int a=5;
      int b=0;
        try{
          System.out.println(a/b);
        }
      catch(ArithmeticException e){
        System.out.println(e.getMessage());
      }
    }
}
```

**Output:**

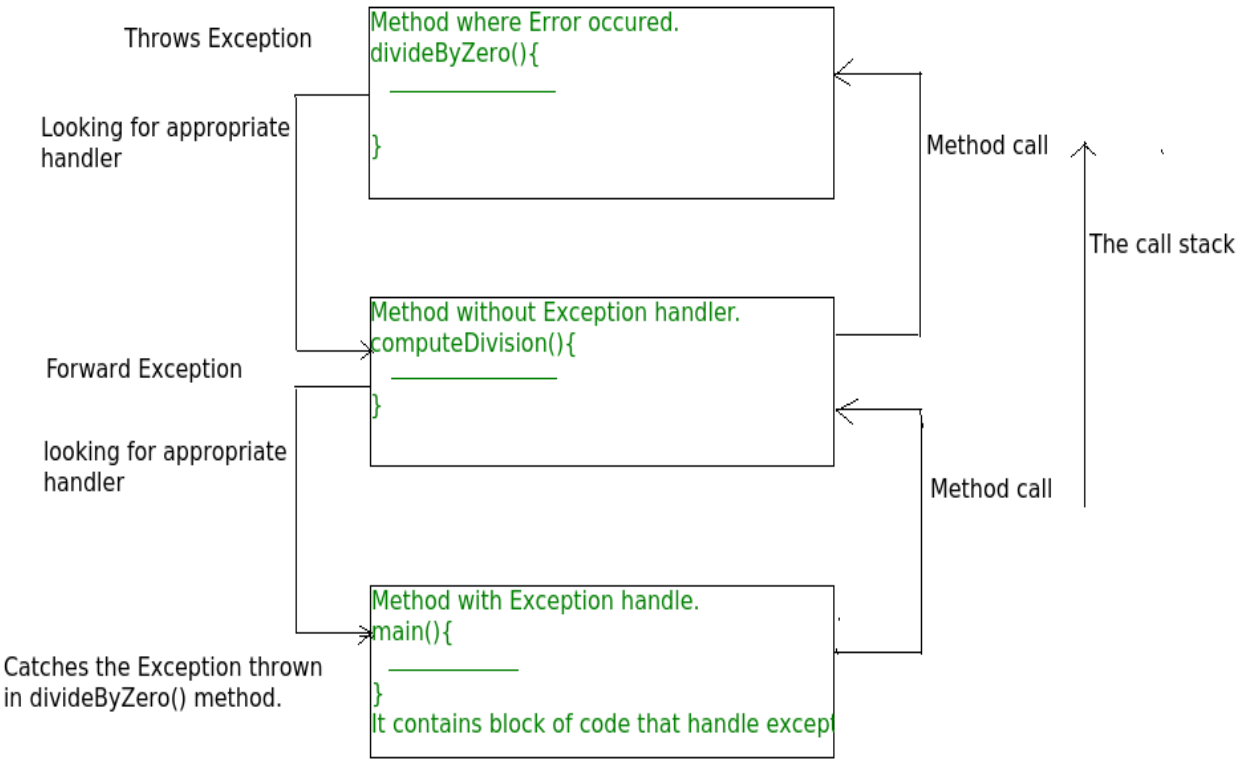
```
/ by zero
```

## How Does JVM handle an Exception?

**Default Exception Handling:** Whenever inside a method, if an exception has occurred, the method creates an Object known as an Exception Object and hands it off to the run-time system(JVM). The exception object contains the name and description of the exception and the current state of the program where the exception has occurred. Creating the Exception Object and handling it in the run-time system is called throwing an Exception. There might be a list of the methods that had been called to get to the method where an exception occurred. This ordered list of the methods is called **Call Stack**. Now the following procedure will happen.

- The run-time system searches the call stack to find the method that contains a block of code that can handle the occurred exception. The block of the code is called an **Exception handler**.
- The run-time system starts searching from the method in which the exception occurred, and proceeds through the call stack in the reverse order in which methods were called.
- If it finds an appropriate handler, then it passes the occurred exception to it. An appropriate handler means the type of the exception object thrown matches the type of the exception object it can handle.
- If the run-time system searches all the methods on the call stack and couldn't have found the appropriate handler, then the run-time system handover the Exception Object to the **default exception handler**, which is part of the run-time system. This handler prints the

exception information in the following format and terminates the program **abnormally**.

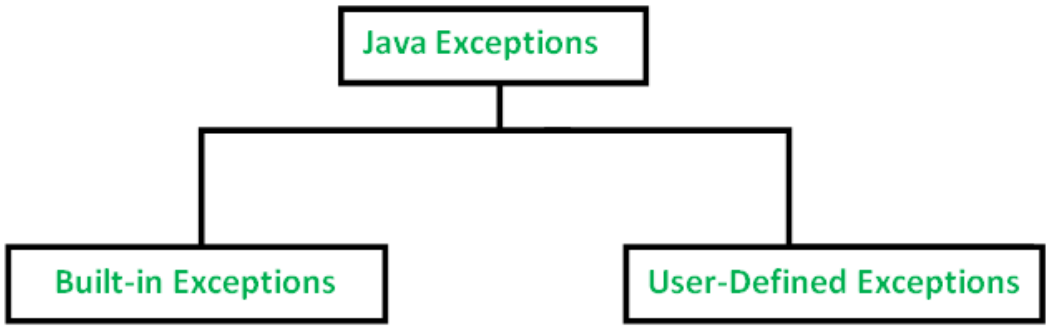



The call stack and searching the call stack for exception handler.

```
// Java Program to Demonstrate How Exception Is Thrown

// Class
// ThrowsExecp
class GFG {

    // Main driver method
    public static void main(String args[])
    {
        // Taking an empty string
        String str = null;
        // Getting length of a string
        System.out.println(str.length());
    }
}
```

```
Exception in thread "main" java.lang.NullPointerException: Cannot invoke
"String.length()" because "<local1>" is null
        at GFG.main(GFG.java:12)
```

# Types of Exception




Built-in Exception

### A. Arithmetic exception

```java
// Java program to demonstrate ArithmeticException
class ArithmeticException_Demo
{
    public static void main(String args[])
    {
        try {
            int a = 30, b = 0;
            int c = a/b;  // cannot divide by zero
            System.out.println ("Result = " + c);
        }
        catch(ArithmeticException e) {
            System.out.println ("Can't divide a number by 0");
        }
    }
}
```

### Output

```
Can't divide a number by 0
```

### B. NullPointer Exception

```
//Java program to demonstrate NullPointerException
class NullPointer_Demo
{
    public static void main(String args[])
    {
        try {
            String a = null; //null value
            System.out.println(a.charAt(0));
        } catch(NullPointerException e) {
            System.out.println("NullPointerException..");
        }
    }
}
```

**Output**

```
NullPointerException..
```

### C. StringIndexOutOfBound Exception

```
// Java program to demonstrate StringIndexOutOfBoundsException
class StringIndexOutOfBound_Demo
{
    public static void main(String args[])
    {
        try {
            String a = "This is like chipping "; // length is 22
            char c = a.charAt(24); // accessing 25th element
            System.out.println(c);
        }
        catch(StringIndexOutOfBoundsException e) {
            System.out.println("StringIndexOutOfBoundsException");
        }
    }
}
```

**Output**

```
StringIndexOutOfBoundsException
```

### D. FileNotFound Exception

```java
//Java program to demonstrate FileNotFoundException
import java.io.File;
import java.io.FileNotFoundException;
import java.io.FileReader;
 class File_notFound_Demo {

    public static void main(String args[])  {
        try {

            // Following file does not exist
            File file = new File("E://file.txt");

            FileReader fr = new FileReader(file);
        } catch (FileNotFoundException e) {
           System.out.println("File does not exist");
        }
    }
}
```

**Output:**

```
File does not exist
```

### E. NumberFormat Exception

```java
// Java program to demonstrate NumberFormatException
class  NumberFormat_Demo
{
    public static void main(String args[])
    {
        try {
            // "akki" is not a number
            int num = Integer.parseInt ("akki") ;

            System.out.println(num);
        } catch(NumberFormatException e) {
            System.out.println("Number format exception");
        }
    }
}
```

**Output**

```
Number format exception
```

### F. ArrayIndexOutOfBounds Exception

```java
// Java program to demonstrate ArrayIndexOutOfBoundException
class ArrayIndexOutOfBound_Demo
{
```

```
    public static void main(String args[])
    {
        try{
            int a[] = new int[5];
            a[6] = 9; // accessing 7th element in an array of
                      // size 5
        }
        catch(ArrayIndexOutOfBoundsException e){
            System.out.println ("Array Index is Out Of Bounds");
        }
    }
}
```

### Output

```
Array Index is Out Of Bounds
```

### G. IO Exception

```
// Java program to demonstrate IOException
class IOException_Demo {

    public static void main(String[] args)
    {

        // Create a new scanner with the specified String
        // Object
        Scanner scan = new Scanner("Hello Geek!");

        // Print the line
        System.out.println("" + scan.nextLine());

        // Check if there is an IO exception
        System.out.println("Exception Output: "
                           + scan.ioException());

        scan.close();
    }
}
```

### Output:

```
Hello Geek!

Exception Output: null
```

### H. NoSuchMethod Exception

**I. IllegalArgumentException:** This program, checks whether the person is eligible for voting or not. If the age is greater than or equal to 18 then it will

not throw any error. If the age is less than 18 then it will throw an error with the error statement.
Also, we can specify “throw new IllegalArgumentException()” without the error message. We can also specify Integer.toString(variable_name) inside the IllegalArgumentException() and It will print the argument name which is not satisfied the given condition.

```
/*package whatever //do not write package name here */

import java.io.*;

class GFG {
   public static void print(int a)
    {
         if(a>=18){
          System.out.println("Eligible for Voting");
          }
          else{

          throw new IllegalArgumentException("Not Eligible for Voting");

          }

    }
    public static void main(String[] args) {
         GFG.print(14);
    }
}
```

**Output :**

```
Exception in thread "main" java.lang.IllegalArgumentException: Not Eligible for Voting

at GFG.print(File.java:13)

at GFG.main(File.java:19)
```

**J. IllegalStateException:** This program, displays the addition of numbers only for Positive integers. If both the numbers are positive then only it will call the print method to print the result otherwise it will throw the IllegalStateException with an error statement. Here, the method is not accessible for non-positive integers.
Also, we can specify the “throw new IllegalStateException()” without the error statement.

```
/*package whatever //do not write package name here */

import java.io.*;
```

```
class GFG {
      public static void  print(int a,int b)
     {
         System.out.println("Addition of Positive Integers :"+(a+b));
     }

    public static void main(String[] args) {
    int n1=7;
    int n2=-3;
     if(n1>=0 && n2>=0)
     {
         GFG.print(n1,n2);
     }
     else
     {
         throw new IllegalStateException("Either one or two numbers are not
Positive Integer");
     }
    }
}
```

**Output :**

```
Exception in thread "main" java.lang.IllegalStateException: Either
one or two numbers are not Positive Integer

at GFG.main(File.java:20)
```

### k. ClassNotFound Exception :

```
// Java program to demonstrate ClassNotFoundException
public class ClassNotFoundException_Demo
{
    public static void main(String[] args) {
        try{
            Class.forName("Class1");   // Class1 is not defined
        }
        catch(ClassNotFoundException e){
            System.out.println(e);
            System.out.println("Class Not Found...");
        }
    }
}
```

**Output**

```
java.lang.ClassNotFoundException: Class1

Class Not Found...
```

## User-Defined Exceptions

Sometimes, the built-in exceptions in Java are not able to describe a certain situation. In such cases, the user can also create exceptions which are called ‘user-defined Exceptions’.

```
class SampleException{
public static void main(String args[]){
try{
throw new UserException(400);
}
catch(UserException e){
System.out.println(e) ;
}
}
}
class UserException extends Exception{
int num1;
UserException(int num2) {
num1=num2;
}
public String toString(){
return ("Status code = "+num1) ;
}
}
```

**Output:**

Keyword ‘throw’ is used to create a new Exception and throw it to catch block.

Status Code = 400

## Checked Exceptions

These are the exceptions that are checked at compile time. If some code within a method throws a checked exception, then the method must either handle the exception or it must specify the exception using the *throws* keyword.

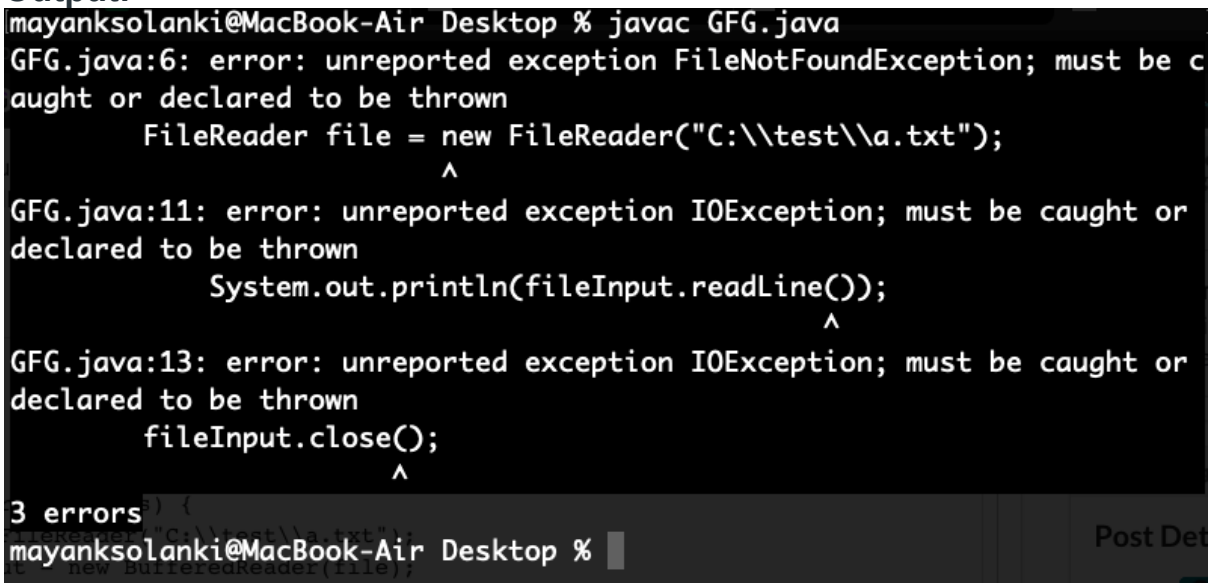
In checked exception, there are two types: fully checked and partially checked exceptions.
A fully checked exception is a checked exception where all its child classes are also checked, like IOException, InterruptedException.
A partially checked exception is a checked exception where some of its child classes are unchecked, like Exception.

For example, consider the following Java program that opens the file at location "C:\test\a.txt" and prints the first three lines of it. The program doesn't compile, because the function main() uses FileReader() and FileReader() throws a checked exception *FileNotFoundException*. It also uses readLine() and close() methods, and these methods also throw checked exception *IOException*

```
// Java Program to Illustrate Checked Exceptions
// Where FileNotFoundException occurred

// Importing I/O classes
import java.io.*;

// Main class
class GFG {

    // Main driver method
    public static void main(String[] args)
    {

        // Reading file from path in local directory
        FileReader file = new FileReader("C:\\test\\a.txt");

        // Creating object as one of ways of taking input
        BufferedReader fileInput = new BufferedReader(file);

        // Printing first 3 lines of file "C:\test\a.txt"
        for (int counter = 0; counter < 3; counter++)
            System.out.println(fileInput.readLine());

        // Closing file connections
        // using close() method
```

```
        fileInput.close();
    }
}
```

**Output:**




```java
// Java Program to Illustrate Checked Exceptions
// Where FileNotFoundException does not occur

// Importing I/O classes
import java.io.*;

// Main class
class GFG {

    // Main driver method
    public static void main(String[] args)
        throws IOException
    {

        // Creating a file and reading from local repository
        FileReader file = new FileReader("C:\\test\\a.txt");

        // Reading content inside a file
        BufferedReader fileInput = new BufferedReader(file);

        // Printing first 3 lines of file "C:\test\a.txt"
        for (int counter = 0; counter < 3; counter++)
            System.out.println(fileInput.readLine());

        // Closing all file connections
        // using close() method
```

```
        // Good practice to avoid any memory leakage
        fileInput.close();
    }
}
```

**Output:**

```
First three lines of file "C:\test\a.txt"
```

## Unchecked Exceptions

These are the exceptions that are not checked at compile time.
In C++, all exceptions are unchecked, so it is not forced by the compiler to either handle or specify the exception. It is up to the programmers to be civilized, and specify or catch the exceptions.

In Java, exceptions under *Error* and *RuntimeException* classes are unchecked exceptions, everything else under throwable is checked.
Consider the following Java program. It compiles fine, but it throws *ArithmeticException* when run. The compiler allows it to compile because *ArithmeticException* is an unchecked exception.

```
// Java Program to Illustrate Un-checked Exceptions

// Main class
class GFG {

    // Main driver method
    public static void main(String args[])
    {
        // Here we are dividing by 0
        // which will not be caught at compile time
        // as there is no mistake but caught at runtime
        // because it is mathematically incorrect
        int x = 0;
        int y = 10;
        int z = y / x;
    }
}
```

**Output:**

```
Exception in thread "main" java.lang.ArithmeticException: / by zero
    at Main.main(Main.java:5)
Java Result: 1
```

In short unchecked exceptions are runtime exceptions that are not required to be caught or declared in a throws clause. These exceptions are usually

caused by programming errors, such as attempting to access an index out of bounds in an array or attempting to divide by zero.

Unchecked exceptions include all subclasses of the RuntimeException class, as well as the Error class and its subclasses.

Here are some examples of unchecked exceptions in Java:

**throw**: The throw keyword is used to transfer control from the try block to the catch block.
**throws**: The throws keyword is used for exception handling without try & catch block. It specifies the exceptions that a method can throw to the caller and does not handle itself.
**finally**: It is executed after the catch block. We use it to put some common code (to be executed irrespective of whether an exception has occurred or not ) when there are multiple catch blocks.

## throw

The throw keyword in Java is used to explicitly throw an exception from a method or any block of code. We can throw either checked or unchecked exception. The throw keyword is mainly used to throw custom exceptions.

```
// Java program to demonstrate working of throws
class ThrowsExecp
{
    static void fun() throws IllegalAccessException
    {
        System.out.println("Inside fun(). ");
        throw new IllegalAccessException("demo");
    }
    public static void main(String args[])
    {
        try
        {
            fun();
        }
        catch(IllegalAccessException e)
        {
```

```
            System.out.println("caught in main.");
        }
    }
}
```

## throws

throws is a keyword in Java which is used in the signature of method to indicate that this method might throw one of the listed type exceptions. The caller to these methods has to handle the exception using a try-catch block.

In a program, if there is a chance of raising an exception then compiler always warn us about it and compulsorily we should handle that checked exception, Otherwise we will get compile time error saying **unreported exception XXX must be caught or declared to be thrown**. To prevent this compile time error we can handle the exception in two ways:

1. By using try catch
2. By using **throws** keyword

```
// Java program to demonstrate working of throws
class ThrowsExecp
{
    static void fun() throws IllegalAccessException
    {
        System.out.println("Inside fun(). ");
        throw new IllegalAccessException("demo");
    }
    public static void main(String args[])
    {
        try
        {
            fun();
        }
        catch(IllegalAccessException e)
        {
            System.out.println("caught in main.");
        }
    }
}
```

**Output:**

```
Inside fun().

caught in main.
```

**Important points to remember about throws keyword:**

- throws keyword is required only for checked exception and usage of throws keyword for unchecked exception is meaningless.

- throws keyword is required only to convince compiler and usage of throws keyword does not prevent abnormal termination of program.
- By the help of throws keyword we can provide information to the caller of the method about the exception.

| S. No. | Key Difference | throw | throws |
|---|---|---|---|
| 1. | Point of Usage | The throw keyword is used inside a function. It is used when it is required to throw an Exception logically. | The throws keyword is used in the function signature. It is used when the function has some statements that can lead to exceptions. |
| 2. | Exceptions Thrown | The throw keyword is used to throw an exception explicitly. It can throw only one exception at a time. | The throws keyword can be used to declare multiple exceptions, separated by a comma. Whichever exception occurs, if matched with the declared ones, is thrown automatically then. |
| 3. | Syntax | Syntax of throw keyword includes the instance of the Exception to be thrown. Syntax wise throw keyword is followed by the instance variable. | Syntax of throws keyword includes the class names of the Exceptions to be thrown. Syntax wise throws keyword is followed by exception class names. |

| | | | |
|---|---|---|---|
| 4. | Propagation of Exceptions | throw keyword cannot propagate checked exceptions. It is only used to propagate the unchecked Exceptions that are not checked using the throws keyword. | throws keyword is used to propagate the checked Exceptions only. |

## User-defined Exceptions:

You can create your own exceptions in Java by creating your own exception sub class simply by extending java Exception class.

You can define a constructor for your Exception sub class (not compulsory) and you can override the toString() function to display your customized message on catch.

User defined exceptions in java are also known as Custom exceptions. All exceptions must be a child of Throwable.

If you want to write a checked exception that is automatically enforced by the Handle or Declare Rule, you need to extend the Exception class.

If you want to write a runtime exception, you need to extend the RuntimeException class.
Program1:

```
class MyException extends Exception

{

String str1;

MyException(String str2)

 { str1=str2; }

public String toString()

{ return ("Output String = "+str1) ; }

}

 class CustomException{

public static void main(String args[]){

 try{ throw new MyException("Custom"); // I'm throwing user defined custom exception above } catch(MyException exp)
```

```
{ System.out.println("Hi this is my catch block") ;
 System.out.println(exp) ; } } }
```

Output: Hi this is my catch block

Output String = Custom