

# Notes of JAVA Programming



## Don't Repeat Yourself

TARAK RAHMAN

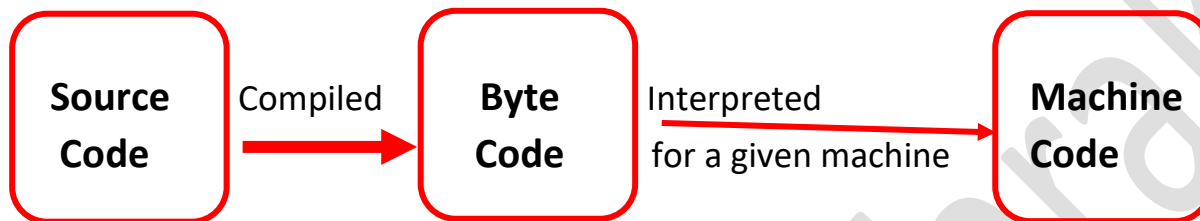
# Introduction

Java is an Object Oriented programming language developed by Sun Microsystems of USA in 1991. It was originally called Oak by James Goslin (One of the inventors Java!).

**JAVA = Purely object oriented**

## How JAVA Works?

Java is compiled into the bytecode and then it is interpreted to machine code



## JAVA Installation:

- ❖ Go to Google & type "Install JDK" => Installs JAVA JDK
- ❖ Go to Google & type "Install IntelliJ Idea" => Installs JAVA IDE

JDK → JAVA Development Kit = Collection of tools used for developing and running Java programs

JRE → JAVA Runtime Environment = Helps in executing programs developed in JAVA

## Basic Structure of a Java Program

```
1 package com.company;
2
3 public class Main {
4     public static void main(String[] args) {
5         System.out.println("Hello Tarak");
6     }
7 }
```

The screenshot shows a code editor window titled 'undefined - Main.java'. It contains the following Java code:

Groups Class

Entrypoint into a application

## Naming Conventions:

- for classes, we use Pascal Convention. First and Subsequent Characters from a word are Capital letters (uppercase) Example: Main, My Scanner, My Employee, TarakRahman
- For functions and variables, we use Camel Case Convention. Here first character is lowercase and the subsequent characters are uppercase like below: main, my scanner, my Marks, developerTarak

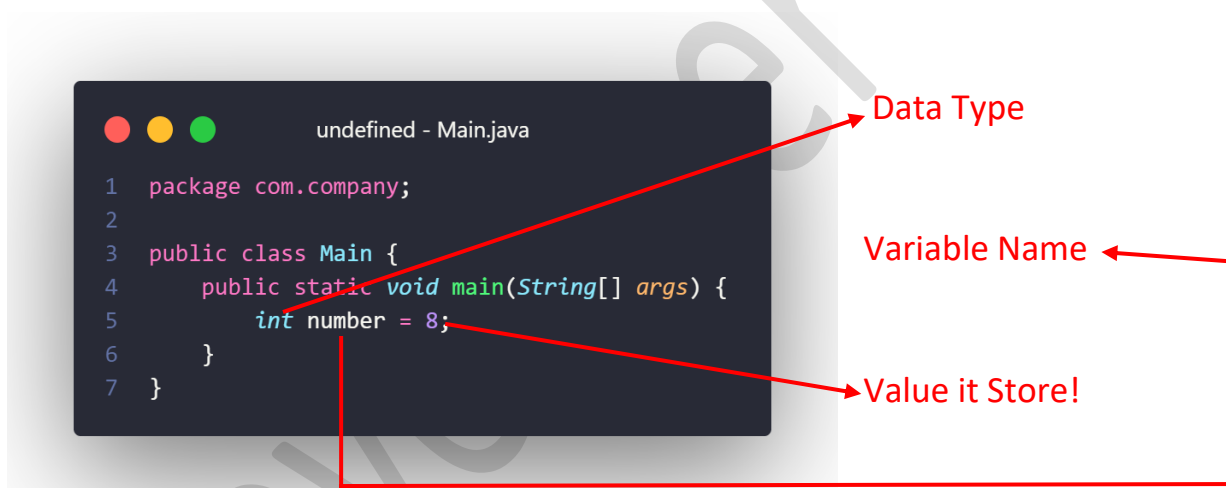
# Chapter 1

## Variables and datatypes.

---

Just like we have some rules that we follow to speak English (the grammar), we have some rules to follow while writing a Java program. The set of these rules is called syntax (Vocabulary & Grammar of Java).

Example:



### Rules for declaring a variable name:

- ❖ We can choose a name while declaring a Java variable if the following rules are followed:
- ❖ Must not begin with a digit → `int 1tarak;` > is invalid!
- ❖ Name is Case sensitive → `tarak` and `Tarak` are different!
- ❖ Should not be a keyword (like Void).
- ❖ White Space not allowed. → `int Your Tarak;` > is invalid.
- ❖ Can contain alphabets, \$character, \_character and digits if the other conditions are met.

### Data Types:

Data types in Java fall under the following Categories -

- Primitive Data Types (Intrinsic).
- Non-Primitive Data Types (Derived)

## Primitive Data Types:

Java is statically typed .→ **Variables must be declared before use!**

There are **8 primitive** data types supported by Java:

### 1. byte→

- Value ranges from **-128 to 127**.
- Takes 1 byte
- Default value is 0

### 2. Short →

- Value ranges from-  **$(2^{16})/2$  to  $(2^{16})/2-1$**
- Takes 2 Bytes
- Default value is 0

### 3. Int →

- Value ranges from-  **$(2^{32})/2$  to  $(2^{32})/2-1$**
- Takes 4 bytes
- Default value is 0.

### 4. Float →

- Value ranges from **(See Docs)**
- Takes 4 bytes
- Default value is 0.0f

### 5. long →

- Value ranges from- **$(2^{64})/2$  to  $(2^{64})/2-1$**
- Takes 8 bytes
- Default value is 0

### 6. double →

- Value ranges from **(see docs)**
- Takes 8 bytes
- Default value is 0.0d

### 7. char→

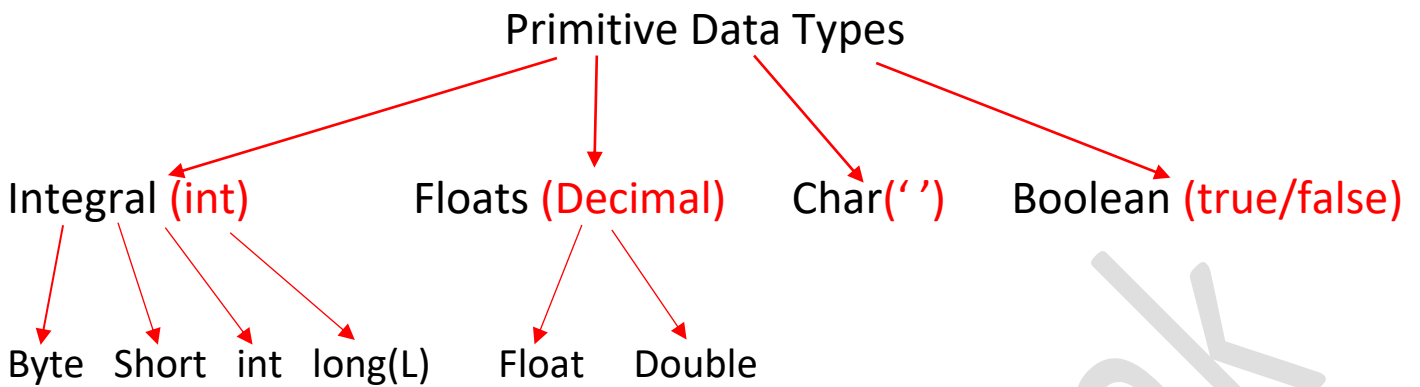
- Value ranges from **0 to 65535( $2^{16}-1$ )**
- Takes 2 bytes → **because it supports Unicode**
- Default value is 'u0000"

### 8. Boolean →

- Value can be true or false
- Size depends on JVM
- Default value is false

**Quick Quiz:** Write a Java program to add three numbers.

## How to choose data types for our Variables:



In order to choose the data type we first need to find the type of data we want to store. After that we need to analyze the Min & Max value we might use.

### Literals:

A Constant value which can be assigned to the variable is Called as a literal

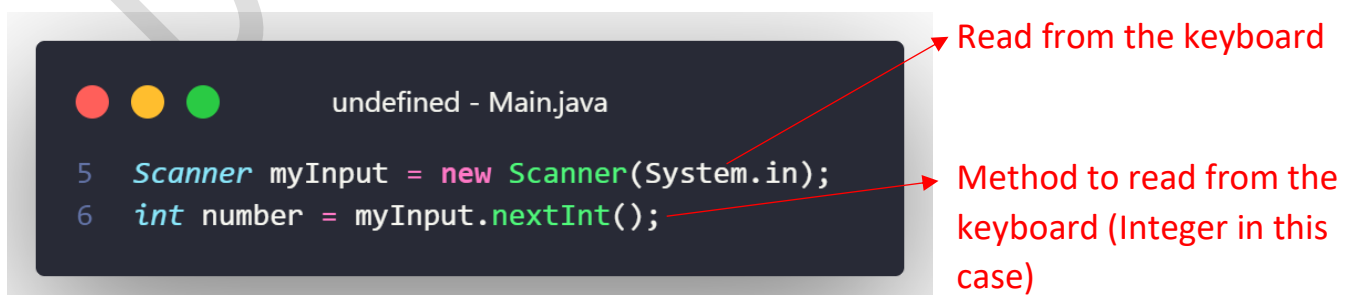
- ❖ 101 → Integer literal
- ❖ 10.1 f → Float Literal
- ❖ 10.1 → double Literal (default type for decimals)
- ❖ 'A' → Character literal
- ❖ true → Boolean Literal
- ❖ "Tarak" String Literal

### Keywords:

Words which are reserved and used by the Java Compiler. They cannot be used (Go to [docs.oracle.com for a comprehensive list!](https://docs.oracle.com/javase/7/docs/keywords.html)) as an Identifier

### Reading data from the Keyboard:

In order to read data from the keyboard, Java has a Scanner class! Scanner class has a lot of methods to read the data from the keyboard.





**Exercise 1.1:** Write a Program to Calculate percentage of a given student in CBSE board exam. His marks from 5 Subjects must be taken as input from the keyboard. (Marks are out of 100).

## Chapter 1 - Practice Set

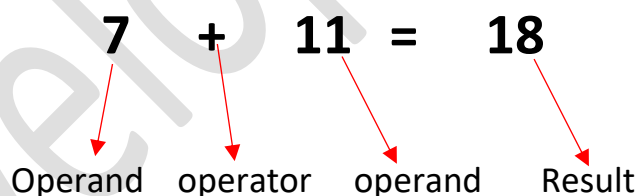
- Write a program to sum three numbers in Java
- Write a program to calculate CGPA using marks of three subjects (out of 100).
- Write a Java program which asks the user to enter his/her name and greets them with "Hello <name>, have a good day" text.
- Write a Java program to convert Kilometers to miles
- Write a Java program to detect whether a number entered by the user is integer or not?

## Chapter 2

### Operators and Expressions

---

Operators are used to perform operations on variable and values.



#### Types of operators:

- ❖ Arithmetic operators → +, -, \*, /, %, ++, --
- ❖ Assignment operators → =, +=
- ❖ Comparison operators → ==, <=, >=
- ❖ Logical operators → ||, &&, !
- ❖ Bitwise Operators → &, | (Coperates bitwise)

Arithmetic operators cannot work with Booleans % operator can work on floats & doubles

#### Precedence of operators:

The operators are applied and evaluated based on precedence. For example (+, -) has less precedence compared to (\*, /). Hence \* & / are evaluated first. In case we like to change this order, we use parenthesis.

## Associativity:

Associativity tells the direction of execution of operators It can either be left to Right or Right to left.

- $*, / \rightarrow$  L to R
- $+, - \rightarrow$  L to R
- $++, = \rightarrow$  R to L

**Quick Quiz:** How will you write the following expressions in Java ?

$$\frac{X - Y}{2}, \quad \frac{b^2 - 4ac}{2a}, \quad v^2 - u^2, \quad a \times b - d$$

## Resulting data type after arithmetic operation:

following table summarizes the resulting data types after arithmetic operation on them

$R = b + s \rightarrow$ int	$b \rightarrow$ byte
$R = s + i \rightarrow$ int	$f \rightarrow$ float
$R = l + f \rightarrow$ float	$s \rightarrow$ short
$R = i + f \rightarrow$ float	$i \rightarrow$ integer
$R = c + i \rightarrow$ int	$d \rightarrow$ double
$R = c + s \rightarrow$ int	$c \rightarrow$ character
$R = l + d \rightarrow$ double	$l \rightarrow$ long
$R = f + d \rightarrow$ double	

## Increment and Decrement operators:

- $a++, ++a \rightarrow$  Increment operators  $\rightarrow$  Data type
- $-, --a \rightarrow$  Decrement operators  $\rightarrow$  remains Same

These will operate on all data types except Booleans.

**Quick Quiz:** Ty increment and decrement operators on a Java Variable.

$a++ \rightarrow$  first use the value and then increment

$++a \rightarrow$  first increment the value then use it

**Quick Quiz:** What will be the value of the following expression (x).

`int y = 7;`

`int x = ++y*8;`

Value of X

`Char a ='B';`

`a++;`  $\rightarrow$  a is now 'C'

## Chapter 2 - Practice Set

- What will be the result of the following expression: **float a = 7/4 \* 9/2**
- Write a java program to encrypt a grade by adding 8 to it. Decrypt it to show the correct grade.
- Use Comparison operators to find out whether a given number is greater than the user entered number or not.
- Write the following expression in a java program :
$$\frac{v^2 - u^2}{2as}$$
- find the value of the following expression:  
int x = 7;  
int a = 7\*49/7 + 35/7;  
value of a?

## Chapter 3

### String

---

A string is a sequence of Characters

A string is instantiated as follows :

```
5 String Name;  
6 Name = new String("Tarak Rahman")
```

String is a class but can be used like a data type (strings are immutable and cannot be changed) :

String Name = "Tarak";  
          ↓          ↓  
Reference  Object

### Different ways to print in Java:

We can use the following ways to print in Java:

- System.out.print () → No newline at the end!
- System.out.println() → Prints a new line at the End
- System.out.printf()
- System.out.format()

```
5 System.out.printf("%C",Ch);  
6 //%d for int  
7 //%f for float  
8 //%C for Character  
9 //%S for String
```



## String methods:

String methods operate on Java Strings. They Can be used find length of the string, Convert to lowercase, etc.

Some of the commonly used String methods:

1. `name.length ()` → Returns length of String name. (5 in this case)
2. `name.toLowerCase()` → Returns a new String which has all the lower case characters from the String name.
3. `name.toUpperCase ()` → Returns a new String which has all the lowercase characters from the string name.
4. `name.trim()` → Returns a new String after removing all the leading and trailing spaces from the original String.
5. `name.Substring(int start)` → Returns a substring from start to the end bushing (3) returns "ry"  
[ Note that index starts from 0 ]
6. `name.substring (int start, int end)` → Returns a substring from Start index to the end. index. Start index is included and end is excluded
7. `name.replace('r', 'p')` → Returns a new string after replacing 'r' with 'p'. Happy is returned in this case .
8. `name.startsWith("Ta")` → returns true if name starts with string "Ha". true in this case!
9. `name.endsWith("ak")` → returns true if name ends -> with string "ry". true in this case.
10. `name.charAt(2)` → returns character at a given index position r in this case!
11. `name.indexOf(5)` → returns the index of the given string. For ex: `name.indexOf("ar")` returns 1 which is the first occurrence of ar in string "Tarak", -1 otherwise.
12. `name.indexOf("s", 3)` → returns the index of the given String starting from the index 3 (int). -1 is returned in this case!
13. `name.lastIndexOf ("r")` → returns the last index of the given string 3 in this case!
14. `name.lastIndexOf ("r", 2)` → returns the last index of the given string before index 2.
15. `name.equals("Tarak")` → returns true if the given. String is equal to "Tarak" false otherwise [ case sensitive]
16. `name.equalsIgnoreCase("Tarak")` → returns true if two Strings are equal ignoring the case of characters.

## Escape Sequence Characters:

Sequence of characters after backslash '\'

= Escape sequence Characters

Escape sequence characters Consist of more than One characters but represents one character when used within the Strings.

Examples: `\n`, `\t`, `\'`, `\\`, etc.

Newline Tab SingleQuote Backslash

## Chapter 3 - Practice Set

- Write a Java program to convert a string to lower case
- Write a Java program to replace spaces with underscores.
- Write a Java program to fill in a letter template which looks like bellow:  
Letter = "Dear <|Name|>, Thanks a lot"  
Replace <|name|> with a string (Some name)
- Write a Java program to detect double and triple spaces in a string
- Write a program to format the following letter using escape sequence Characters.  
letter = "Dear Tarak, This Java Note is nice. Thanks"

## Chapter 4

### Conditionals in Java

---

Sometimes we want to watch comedy videos on You Tube if the day is Sunday.

Sometimes, we order junk food if it is our friend's birthday in the hostel.

You might want to buy an Umbrella if its raining and you have the money. You order the meal if Allow or your favorite Dados is listed on the menu.

All these are decisions which depends on Certain Condition being met.

In Java, we can execute instructions on Condition being met.

#### Decision making Instructions in Java:

- If- Else Statement
- Switch statements!

#### If else Statements:

The syntax of an If-Else statement in C looks like that of C++ and JavaScript. Java has a similar Syntax too. It looks like:

```
undefined - Main.java
4  if (Condition To be checked){
5      //Statements if Condition True
6  }
7  else{
8      //statements if condition False
9  }
```

## Code Example:

```
undefined - Main.java
1 //package com.tarak;
2 public class Main{
3     public static void main(String[] args) {
4         int a=5;
5         if (if a>2){
6             System.out.println("A is bigger then 2");
7         }
8         else{
9             System.out.println("A is smaller then 2");
10        }
11    }
12 }
```

Note that the else block is optional

## Relational Operators in Java:

Relational operators are used to evaluate conditions (true or false) inside the if statements. Some examples of relational operators are:

**==, >=, >, <, <=, !=**

Note : '=' is used for assignment where as "==" is used for equality check

The condition can be either true or false.

## Logical Operators:

&& , || and ! are most commonly used logical operators in Java

These are read as:-

&& →AND

|| →OR

! →NOT

Used to provide logic to our JAVA programs

### AND operator:

Evaluates to true if both the conditions are true

Y && Y = Y

Y = True

Y && N = N

N = False

N && Y = N

N && N = N

### OR Operator:

Evaluates to true when at least one of the conditions

$Y \ || \ Y = Y$

$Y = \text{True}$

$Y \ || \ N = Y$

$N = \text{False}$

$N \ || \ Y = Y$

$N \ || \ N = N$

### NOT Operator:

Negates the given logic (true becomes false and false becomes true)

$!Y = N$

$Y = \text{True}$

$!N = Y$

$N = \text{False}$

### else if clause:

Instead of using multiple if statements, we can also use else if along with if thus forming an if-else- if-else ladder

Using such kind of logic reduces indents. last else is executed only if all the conditions fail.



```
undefined - Main.java
4  if (Condition){
5      //Statement
6  }else if(Condition){
7      //statement
8  }
9  else{
10     //statement
11 }
```

### Switch Case Control Instruction:

Switch -Case is used when we have to make a choice between number of alternatives for a given Variable

```
undefined - Main.java

4  Switch(Var){
5      case c1:
6          //Code;
7          break;
8      case c2:
9          //Code;
10         break;
11     case c3:
12         //Code;
13         break;
14     case c4:
15         //Code;
16         break;
17     case c5:
18         //Code;
19         break;
20     default:
21         //code;
22 }
```

Var can be an integer, character or string in Java.

A switch can occur within another but in practice this is rarely done

## Chapter 4 - Practice Set

- What will be the output of this program:

```
undefined - Main.java

4  int a =10;
5  if (a==1){
6      System.out.println("I'm 11 now");
7  }else{
8      System.out.println("I'm Not 11");
9  }
```

- Write a program to find out whether a student is pass or fail; if it requires total 40% and at least 33% in each subject to pass. Assume 3 Subjects and take marks as an input from the user.

- Calculate income tax paid by an employee to the government as per the slabs mentioned below:

Income Salary	Tax
2.5L – 5.0L	5%
5.0L – 10.0L	20%
Above 10.0L	30%

Note that there is no tax below 2.5L. Take input amount as an input from the user.

- Write a Java program to find out the day of the week given the number [ 1 for Monday, 2 for Tuesday and so on! ]
- Write a Java program to find whether a year user is a leap year or not.
- Write a program to find out the type of website from the Url:  
.com → Commercial website  
.org → organization website  
.in → Indian website

## Chapter 5

### Loop Control Instruction

---

Sometimes we want our programs to execute a few set of instructions over and over again for example -- print 1 to 1000, print multiplication table of 7, etc.

Loops make it easy for us to tell the Computer that a given set of instructions need to be executed repeatedly.

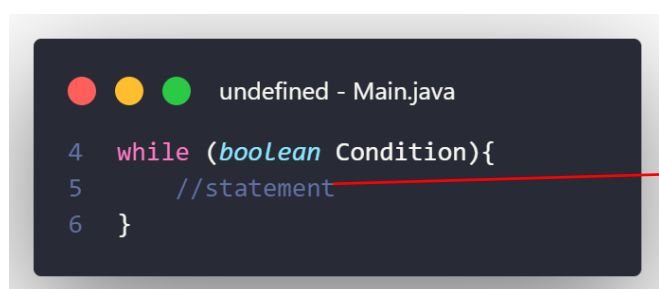
#### Types of Loops:

Primarily, there are three types of loops in Java :

- While loop
- do while loop
- for loop

We will look into these one by one.

#### While loops:



→ This keeps executing as long true. as the Condition is True



If the condition never becomes false, the while loop keeps getting executed. Such a loop is known as an infinite loop.

**Quick Quiz:** Write a program to print natural numbers from 100 to 200

**do while loop:**

This loop is similar to a while loop except the fact that it is guaranteed to execute at least once.

A code editor window titled 'undefined - Main.java' with a dark background. It contains three lines of code: line 4 is 'do{', line 5 is '//code', and line 6 is '}while(Condition);'. A red arrow points from the text 'Note This Semicolon' to the semicolon at the end of line 6.

```
4 do{
5     //code
6 }while(Condition);
```

Note This Semicolon

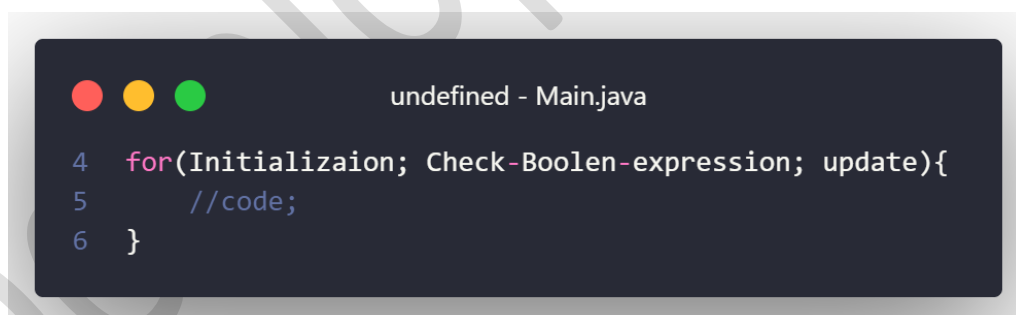
While → checks the condition & executes the code

do while → Executes the code & then checks the condition

**Quick Quiz:** Write a program to print first n natural numbers using do-while loop.

**for Loop:**

The syntax of a for loop looks like this:

A code editor window titled 'undefined - Main.java' with a dark background. It contains three lines of code: line 4 is 'for(Initializaion; Check-Boolean-expression; update){', line 5 is '//code;', and line 6 is '}'.

```
4 for(Initializaion; Check-Boolean-expression; update){
5     //code;
6 }
```

A for loop is usually used to execute a piece of Code for specific number of times.

**Quick Quiz:** Write a program to print first n odd numbers using a for loop.

## Decrementing for loop:

```
undefined - Main.java
4  for(int i =7; i!=0; i--){
5      System.out.println(i);
6  }
```

This for loop keeps running until i becomes 0

**Quick Quiz:** Write a program to print first n natural numbers in reverse order.

### break statement:

The break statement is used to exit the loop irrespective of whether the condition is true or false.

Whenever a "break" is encountered inside the loop, the control is sent outside the loop.

### Continue statement :

The continue statement is used to immediately move to the next iteration of the loop. The control is taken to the next iteration thus skipping everything below "Continue" inside the loop for that iteration.

### In a Nut shell....

- break statement Completely exits the loop
- Continue statement skips the particular iteration of the loop.

## Chapter 5 - Practice Set

- Write a program to print the following pattern:

```
undefined - Main.java
9  ****
10 ***
11 **
12 *
```

- Write a program to sum first n even numbers using while loop.
- Write a program to print multiplication table of a given number n.
- Write a program to print multiplication table of 10 in reverse order.
- Write a program to find factorial of a given number using for Loops.

- Repeat 5 using while loop
- Repeat 1 using for/while loop
- What can be done using one type of loop can also be done using the other two types of loops → True or False.
- Write a program to calculate the sum of the numbers accruing in the multiplication table of 8.
- A do while loop is executed :
  - I. At least once
  - II. At least twice
  - III. At most once
- Repeat 2 using for loop.

## Chapter 6

### Arrays

---

Array is a collection of similar types of data.

Use Case: Storing marks of 5 Students

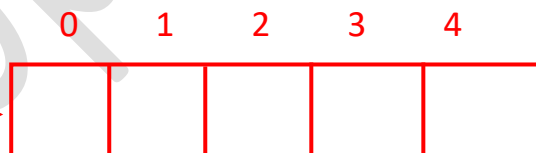
`int [] marks = new int [5]` => [data Type Array Name;]

reference

Object



Marks



Object

→ 5 x 4 = 20bytes

### Accessing Array Elements:

Array elements can be accessed as follows

`marks [0]= 100;`

`marks [1]= 70;`

- 
- 
- 

➔ Note That index Starts from 0.

`marks [4] = 98;`

So in a nut shell, this is how array works:

- `int [] marks;` → Declaration
- `marks = new int[5];!` → Memory Allocation!
- `int [] marks = new int [5];` → Declaration + Memory Allocation!
- `int [] marks = { 100, 70, 80, 71, 98}` → Declare + Initialize!

Array index starts from 0 and goes till (n-1) where n is the size of the array

## Array length:

Arrays have a length property which gives the length of the array.

`marks.length` → gives 5 if marks is a reference to array with 5 elements

## Displaying an Array :

An array can be displayed using a for loop:



```

4  for(int i =0; i<marks.length; i++){
5      System.out.println(marks[i]);
6  }

```

Array Traversal

**Quick Quiz:** Write a Java program to print the elements of an array in reverse order.

## for each loop in Java:

Array elements can also be traversed as follows:



```

4  for(int element: Array1){
5      System.out.println(element);
6  }

```

Prints all the elements

## Multidimensional Arrays:

Multidimensional Arrays are Array of Arrays Each element of a M-D array is an array itself marks in the previous example was a 1-D array .

## Multidimensional 2-D Array:

A 2-D array can be created as follows:

undefined - Main.java

```
4 int [] [] flats = new int [2][3];
```

→ A 2-D array of 2 rows + 3 Columns

We can add elements to this array as follows:

undefined - Main.java

```
5 flats [0][1] = 100;  
6 flats [0][2] = 101;  
7 flats [0][3] = 102;  
8 /*  
9 -  
10 -  
11 and So On  
12 */
```

This 2-D array can be visualized as follows:

	[0]	[1]	[2]
	Col1	Col2	Col3
[0] Row1	(0,0)	(0,1)	(0,2)
[1] Row2	(1,0)	(1,1)	(1,2)

Similarly a 3-D array can be treated as follows:

**String [][][] arr = new String [2] [3] [4] [5]**

## Chapter 6 - Practice Set

- Create an array of 5 floats and calculate their Sum
- Write a program to find out whether a given integer is present in an array or not.
- Calculate the average marks from an array Containing marks of All students in Physics using for each loop
- Create a Java program to add two matrices of Size 2x3.
- Write a Java program to reverse an array
- Write a Java program to find the maximum element in an array.
- Write a Java program to find the minimum element in a Java array!
- Write a Java program to find whether an array is sorted or not.

# Chapter 7

## Methods in Java

---

Sometimes our program grows in size and we want to separate the logic of main method to other methods

for instance- If we are calculating average of a number pair 5 times, we can use methods to avoid repeating the logic. (DRY = Don't Repeat Yourself)

### Syntax of a Method:

A method is a function written inside a class. Since Java is an Object Oriented language, we need to write the method inside some class.

```
undefined - Main.java  
4  dataType name(){  
5      //method Body  
6  }
```

Following method returns sum of two numbers

```
undefined - Main.java  
4  int mySum(int a, int b){  
5      int c = a+b;  
6      return c;  
7  }
```

Return Type

Return Value

### Calling a Method:

A method can be called by creating an object of the class in which the method exists followed by the method call:

```
undefined - Main.java  
4  Cal obj =new Cal();  
5  obj.mySum(a,b);
```

Object Creation

Method Call Upon an Object



The values from the method call (a and b) are copied to the a and b of the function mySum. Thus even if we modify the values a and b inside the method, the values in the main method will not change.

### Void return type:

When we don't want our method to return anything, We use Void as the return type

### Static keyword :

static keyword is used to associate a method of a given class with the class rather than the object. static method in a class is shared by all the objects.

### Process of method invocation in Java

Consider the method Sum:

```
undefined - Main.java
4  int Sum(int a, int b){
5      return a+b;
6  }
```

The method is called like this:

```
undefined - Main.java
4  Calc obj = new Calc();
5  c = obj.Sum(2,3);
```

The values 2 and 3 are copied to a and b and then  $a + b = 2 + 3 = 5$  is returned in C which is an integer.

**Note:** In Case of Arrays, the reference is passed. Same is the case for object passing to methods.

### Method Overloading :

Two or more methods can have same name but different parameters. Such methods are called Overloaded methods.

undefined - Main.java

```
4 void foo();  
5 void foo(int a);  
6 int foo(int a, int b);
```

Overloaded function for

Method overloading cannot be performed by changing the return type of methods

## Variable Arguments (Varargs):

A function with Variable Argument can be created in Java using the following Syntax:

undefined - Main.java

```
6 public static void foo(int ...arr){  
7     //arr is available here as int[] arr  
8 }
```

foo can be called with Zero or more arguments like this:

undefined - Main.java

```
9 foo(7);  
10 foo(7,8,9);  
11 foo(1,2,7,8,9)
```

We can also create a function bare like this

undefined - Main.java

```
9 public static void bar(int a, int ...arr){  
10     //code  
11 }
```

At least one integer is required now

bar can be called as bar (1), bar (1, 2), bar (1,7,9,11) etc.

## Recursion:

A function in Java can call itself. Such calling of function by itself is called recursion.

**Example:** factorial of a number

undefined - Main.java

```
4 factorial(n) = n * factorial(n-1);
```

**Quick Quiz:** Write a program to calculate (recursion must be used) factorial of a number in Java?

## Chapter 7 - Practice Set

- Write a Java method to print multiplication table of a number n.
- Write a program using functions to print the following pattern:  
\*  
\*  
\* \*  
\* \* \*
- Write a recursive function to calculate sum of first n natural numbers.
- Write a function to print the following pattern:  
\* \* \* \*  
\* \* \*  
\* \*  
\*
- Write a function to print n<sup>th</sup> term of Fibonacci series using recursion.
- Write a function to find average of a set of numbers passed as arguments
- Repeat 4 using Recursion.
- Repeat 2 using Recursion
- Write a function to convert Celsius temperature into Fahrenheit.
- Repeat 3 using iterative approach.

## *Chapter 8*

### **Introduction to OOPs**

.....

Object Oriented programming tries to map Code instructions with real world making the code Short and easier to understand

**What is Object Oriented Programming:**

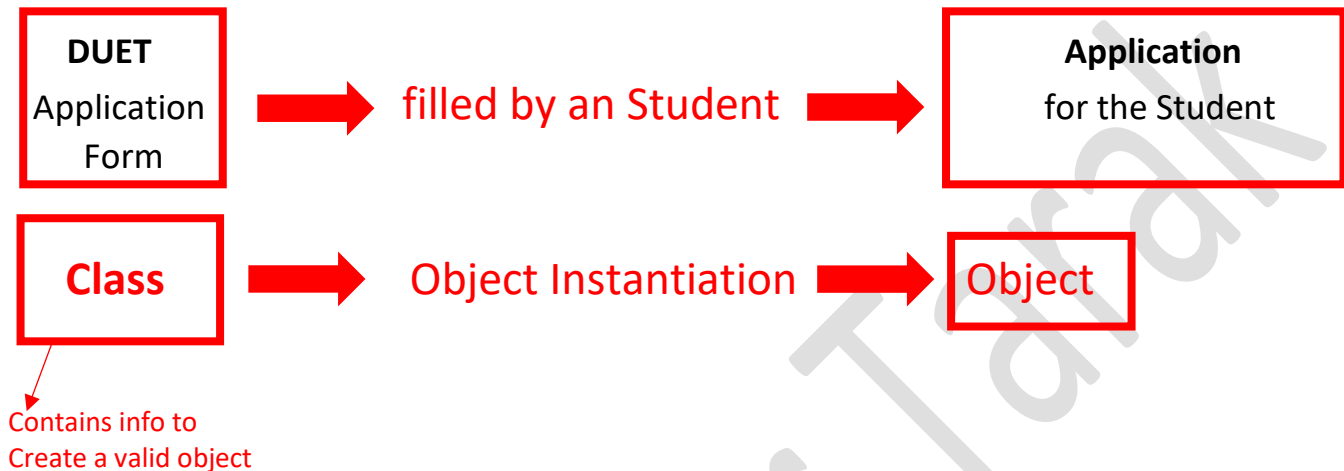
Solving a problem by creating objects is one of the most popular approaches in programming. This is called Object Oriented Programming.

## What is DRY?

DRY stands for - Do not Repeat Yourself → (focuses on code reusability)

## Class

A class is a blueprint for creating objects.



## Object :

An Object is an instantiation of a class. When a class is defined, a template (info) is defined. Memory is allocated only after object instantiation.

## How to model a problem in OOPs

We identify the following:

Noun → Class → Employee

Adjective → Attributes → name, age, Salary

Verb → Methods → getSalary(), increment()

## OOPS Terminology:

A. **Abstraction** → Hiding internal details [show only essential info!]



→ Use This Phone Without bothering about how it was made

B. **Encapsulation** → The act of putting various components together (in a capsule).



→ Laptop is a single entity with wifi + Speaker + Storage in a Single box!

In Java, encapsulation simply means that the Sensitive data can be hidden from the users

C. **Inheritance** → The act of deriving new things from existing things.

Rickshaw → E-Rickshaw  
Phone → Smart Phone

D. **Polymorphism** → One entity many forms

Smartphone → Phone      Smartphone → Calculator

## Writing a Custom Class:

We can write a custom class as follows:

```
Java Custom - tarak.java  
2  class Employ{  
3      int id;  
4      String name;  
5  }
```

Any real world Object = Properties + Behavior  
Object in OOPs = Attributes + Methods.

## A class with Methods:

We can add methods to our class Employe as follows:

```
Java Custom - tarak.java  
2  class Employ{  
3      public int id;  
4      public String name;  
5      public int getSalary(){  
6          //code  
7      }  
8      public void getDetails(){  
9          //code  
10     }  
11 }
```

## Chapter 8 - Practice Set

- Create class Employee with following properties and methods:
  - Salary (property) (int)
  - get Salary (method returning int)
  - name ( properly) (String)"
  - get Name (method returning string)
  - setName (method changing name)
- Create a class CellPhone with methods to print "ringing...", "Vibrating.." etc.
- Create a class Square with a method to initialize its side, calculating area, perimeter etc.
- Create a class Rectangle & repeat 3
- Create a class TommyVecetti for Rockstar Games capable of hitting (print hitting..), running, firing etc.
- Repeat 4 for a Circle.

## *Chapter 9*

### **Access Modifiers & Constructor**

---

#### **Access Modifiers:**

Specifier where a property / method is accessible There are **four types** of access modifiers in Java:

- ❖ **Private**
- ❖ **Default**
- ❖ **Protected**
- ❖ **Public**

#### **Getters and Setters :**

Getter → Returns the value [accessors]

Setter → Sets/updates the value [ mutators ]



### Example:

```
Java Custom - tarak.java

2  class Employ{
3      private int id;
4      private String name;
5      public String getName(){
6          return name;
7      }
8      public void setName(){
9          this.name = "Tarak"
10     }
11     public void setName(String n){
12         this.name = n;
13     }
14 }
```

**Quick Quiz:** Use these getters and setters from the main method.

### Constructors in Java :

A member function used to initialize an object While creating it.

```
Java Custom - tarak.java

17  Employ Em = new Employ();
18  Em.setName("Tarak");
```

In order to write our own constructor, we define a method with name Same as class name.

```
Java Custom - tarak.java

5  public Employ(){
6      name = "Your-name";
7  }
```

### Constructor Overloading in Java:

Constructors can be overloaded just like other methods in Java. We can overload the Employ Constructor like below:

```

Java Custom - tarak.java

8  public Employ(String n){
9      this.name = n;
10 }

```

#### Note :

- Constructors can take parameters without being overloaded.
- There can be more than two overloaded Constructors

**Quick Quiz:** Overload the Employee constructor to initialize the Salary to Rs 10,000

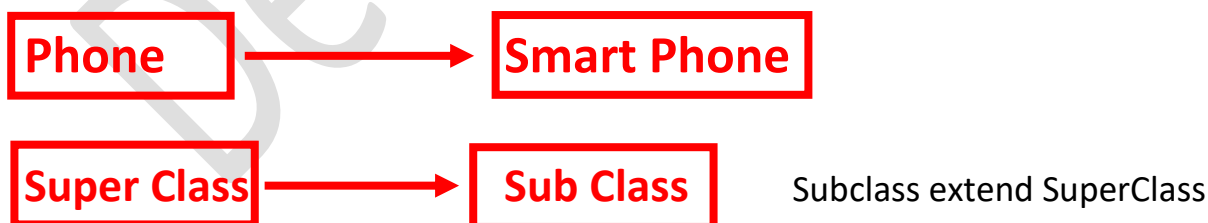
### Chapter 9 - Practice Set

- Create a class Cylinder and use getters and Setters to set it's radius and height.
- Use 1 to calculate surface area and Volume of the Cylinder.
- Use a constructor and repeat 1
- Overload a constructor used to initialize a rectangle of length 4 and width 5 for using Custom parameters
- Repeat 1 for a sphere

## Chapter 10

### Inheritance

Inheritance is used to borrow properties & methods from an existing class



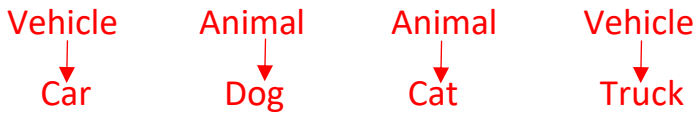
#### Declaring Inheritance in Java:

Inheritance in Java is declared using extends Keyword

Superclass  
↓  
Subclass

Subclass extends the superclass

## More Examples:



When a class inherits from a superclass, it inherits parts of superclass methods and fields. Java doesn't support multiple inheritance. Two classes cannot be super classes for a subclass.

## Code Example:

Inheritance in Java is declared using extends keyword



**Quick Quiz:** Create a Class Animal and Derive another class Dag from it.

## Constructors in Inheritance:

When a Derived class is extended from the Base class the constructor of the Base class is executed first followed by the constructor of the derived class.

for the following Inheritance hierarchy, the constructors are executed in the order:

1 → 2 → 3

C<sub>1</sub> → Parent

C<sub>1</sub> → Child

C<sub>1</sub> → Grand child

Constructors execute in top to bottom order!

## Constructors during Constructor Overloading :

When there are multiple constructors in the parent class, the constructor without any parameters is Called from the child class.

If we want to call the constructor with parameters from the parent class, we can use super keyword

Super (a, b); → Calls the constructor from the parent class which takes 2 Variables

## this keyword:

this is a way for us to reference an object of the class which is being created /referenced.

this.area = 2 → this is a reference to current object

## Super keyword:

A reference variable used to refer immediate parent class object

- Can be used to refer immediate parent class instance variable
- Can be used to invoke parent class methods.
- Can be used to invoke parent class constructors.

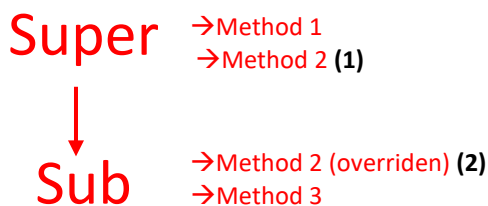
## Method Overriding:

If the child class implements the same method present in the parent class again, it is known as method overriding. → Redefining method of super class! (in sub class)

When an object of subclass is created and the overridden method is called, the method which has been implemented in the subclass is called & its code is executed.

## Dynamic method dispatch:

Consider the following inheritance hierarchy



### Scenario 1 →

- ❖ Super obj = new Sub() → Allowed
- ❖ obj.meth2() → (2) is called (Method of object)
- ❖ obj.meth3() → Not Allowed

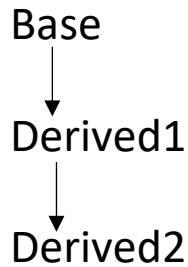
### Scenario 2 →

- ❖ Sub obj = new Super() → Not Allowed

This is known as Dynamic method dispatch and is used to Achieve run time polymorphism in Java.

## Chapter 10 - Practice Set

- Create a class Circle and use inheritance to create Another class Cylinder from it.
- Create a class Rectangle and use inheritance to create another class Cuboid. Try to keep it as close to real world Scenario as possible.
- Create methods for area and Volume in (1).
- Create methods for area & volume in (2) Also create getters and setters
- What is the order of Constructor execution for the following inheritance hierarchy:



Derived2 obj = new Derived2();

Which constructor(s) will be executed & in what order?

## Chapter 11

### Abstract Classes & Interfaces

---

#### What does Abstract (class) mean?

Abstract in English means → existing in thought or as an idea without concrete existence.

#### Abstract method

A method that is declared without an implementation

`abstract void moveTo(double x, double Y)`

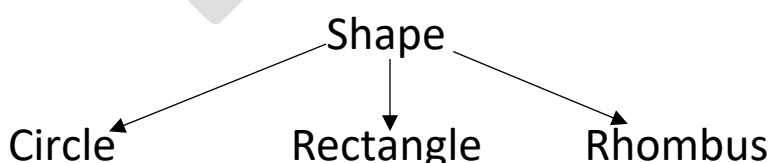
#### Abstract Class

If a class includes abstract methods, then the class. itself must be declared abstract, as in:

```
Java Custom - tarak.java  
2  abstract class PhoneModel{  
3      abstract void switchOff();  
4      //more code  
5  }
```

When an abstract class is subclassed, the subclass usually provides implementations for all of the methods in parent class. If it doesn't, it must be declared abstract

#### An Example

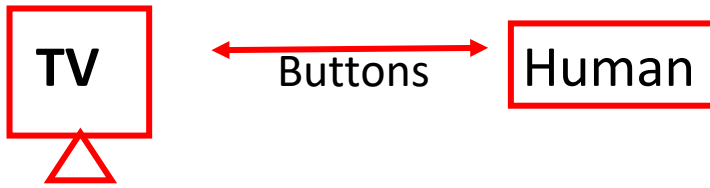


#### Note →

- It is possible to create reference of an abstract class
- It is not possible to create an object of an abstract class.
- We can also assign reference of an abstract class to the object of a concrete subclass.

## Interfaces in Java :

Interface in English is a point where two systems met and interact



In Java interface is a group of related methods with empty bodies

### An Example:

```
Java Custom - tarak.java

6  interface Bicycle{
7      void applyBreak(int decrement);
8      void speedUp(int increment);
9  }
10 class HeroCycle implements Bicycle{
11     int speed = 7;
12     void applyBreak(int decrement){
13         speed = speed - decrement;
14     }
15     void speedUp(int increment){
16         speed = speed + increment;
17     }
18 }
```

## Abstract class vs Interfaces :

We can't extend multiple abstract classes but we can implement multiple interfaces at a time. Interfaces are meant for dynamic method dispatch and run time polymorphism.

### Is multiple inheritance allowed in Java?

Multiple inheritance face problems when there exist methods with same signature in both the super classes.

Due to such problems, Java does not support multiple inheritance directly but the similar concept can be achieved using Interfaces

A class can implement multiple Interfaces and extend a class at the same time.

### Note:

1. Interfaces in Java is a bit like the Class but with a significant difference.
2. An Interface can only have method signatures, Constant fields and default methods.
3. The class implementing an Interface needs to declare the methods (not fields)
4. You can create a reference of Interfaces but not the Object



5. Interface methods are public by default.

## Default methods

An interface can have static and default methods.

Default methods enable us to add new "functionality to existing Interfaces

This feature was introduced in Java 8 to ensure backward Compatibility while updating an Interface.

Classes implementing the interface need not implement the default methods.

Interfaces can also include private methods for default methods to use.

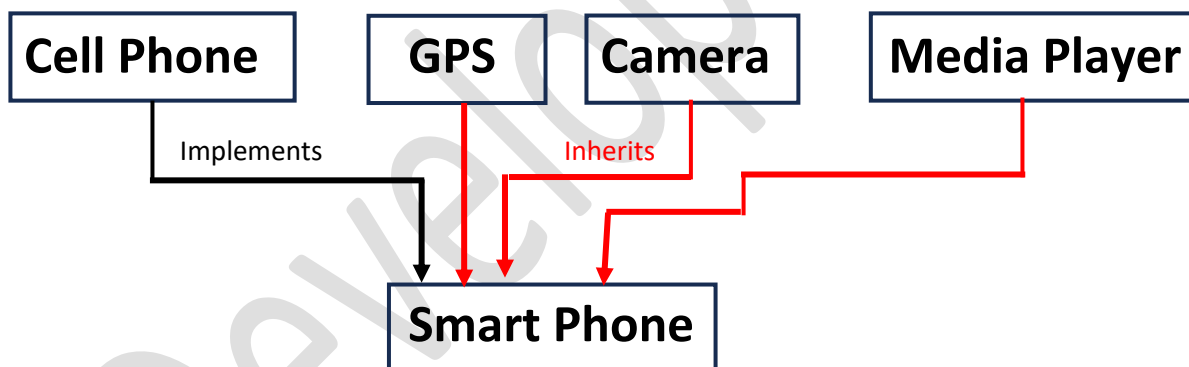
## Inheritance in Interfaces

Interfaces can extend another interfaces :

```
Java Custom - tarak.java
19 interface InterFace1{
20     void math1();
21 }
22 interface InterFace2 extends InterFace1{
23     void math2();
24 }
```

Remember that interface cannot implement another interface, only classes can do that!

## Polymorphism using Interfaces



Similar to Dynamic method dispatch in Inheritance

GPS g= new SmartPhone (); → Can only use GPS methods

SmartPhone S = new Smart Phone (); → Can only use Smart Phone methods

Implementing an Interface forces method implementation

## Chapter 11 - Practice Set

- Create an abstract class Pen with methods write() and refill () as abstract methods
- Use the Pen Class from Q1 to create a Concrete class Fountain Pen with additional method changeNib()

- Create a class Monkey with jump () and bite() methods. Create a class Human which inherits this Monkey class and implements BasicAnimal interface with eat() and sleep methods.
- Create a class Tele Phone with ring(), light() and disconnect () methods as abstract methods. Create another class Smart Telephone and demonstrate polymorphism
- Demonstrate polymorphism using monkey class from Ques3.
- Create an Interface TV Remote and use it to inherit another Interface Smart Tv Remote.
- Create a Class Tv which implements Tv Remote interface from Q1

## Chapter 12

### Packages

#### Interpreter Vs Compiler:

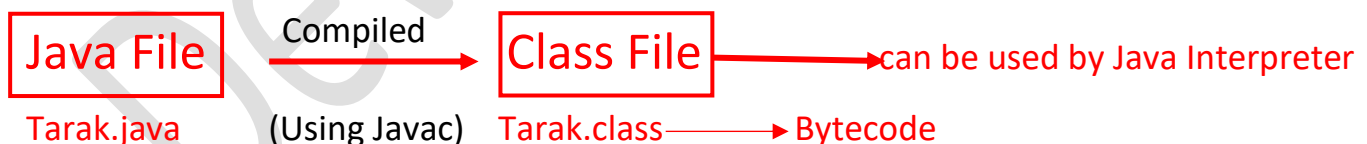
Interpreter translates one statement at a time into machine Code!

Compiler scans the entire program and translates whole of it into machine code.

Interpreter	Compiler
One statement at a time.	Entire program at a time
Interpreter is needed every time	Once compiled it is not needed
Partial execution if error	No execution if an error occurs
Easy for programmers	Usually not as easy as Interpreted ones

#### Is Java Compiled or Interpreted?

Java is a hybrid language both compiled as well as interpreted



- A JVM can be used to Interpret this bytecode
- This bytecode can be taken to any platform (Windows/Mac/Linux) for execution
- Hence Java is platform independent (write once run everywhere)

#### Executing a Java Program:

Javac Tarak.java → **Compiled**

Java Tarak → **Interpreted**

So far the execution of our program was being managed by IntelliJ Idea.

We can download a source code editor like VS Code to Compile & execute our Java programs.

## Packages in Java :

A package is used to group related classes.

Packages help in avoiding name conflicts.

There are two types of packages!!

- Built in packages → **Java API**
- User defined packages → **Custom packages**



1. class this.Java my.mp3  
Song.Java tarak.Java → Organized as Packages

## Using a Java package:

```
2 import java.lang.*;
3 import java.lang.String;
4 s = new java.lang.String("Tarak");
```

## Creating a package:

Javac Tarak.java → Creates Tarak.class

javac -d . Tarak.java → creates a package folder

We can keep adding classes to a package like this

We can also create inner packages by adding package.inner as package name

These packages once created can be used by other classes

## Access Modifiers in Java:

Access modifiers determine whether other classes can use a particular field or invoke a particular method Can be public, private, protected or default (no modifier)

Modifier	Class	Package	SubClass	World
Public	Y	Y	Y	Y
Protected	Y	Y	Y	N
Default(no)	Y	Y	N	N
Private	Y	N	N	N

## Chapter 12 - Practice Set

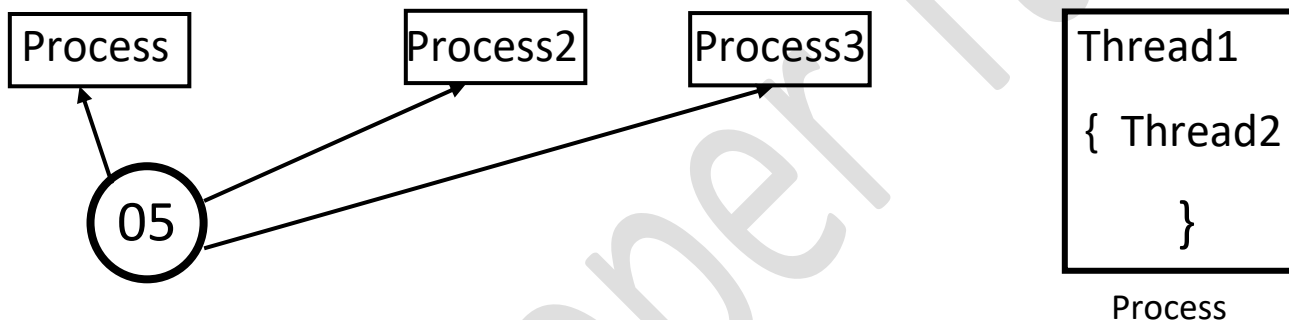
- Create three classes Calculator, Sc Calculator and Hybrid Calculate and group them into a package.
- Use a built-in package in Java to write a class which displays a message (by using sout) after taking input from the user.
- Create a package in class with three package levels folder, folder 1 folder L2
- Prove that you cannot access default property but Can Access protected property from the subclass.

## Chapter 13

### Multithreading

---

Multiprocessing and multithreading both are Achieve multitasking



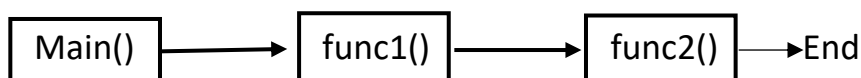
#### In a nut Shell...

- ✓ Threads use shared memory area
- ✓ Threads → Faster Content switching
- ✓ A Thread is light-weight whereas a process is heavyweight

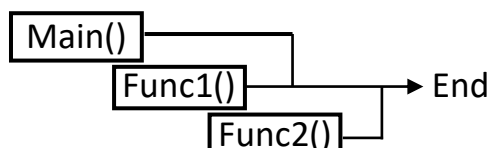
For Example → A word processor can have one thread running in foreground as an editor and another in the background auto saving the document!

#### flow of Control in Java

1. Without threading:



2. With threading:

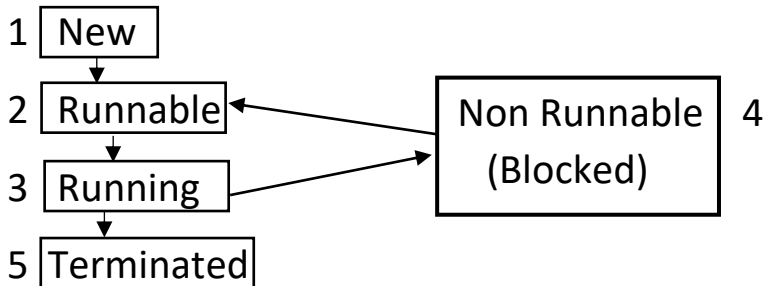


## Creating a Thread

There are two ways to create a thread in Java.

- By extending Thread class.
- By implementing Runnable interface

## Life cycle of a Thread



1. New →  
Instance of thread created which is not yet Started by invoking start ()
2. Runnable →  
After invocation of start () & before it is selected to be run by the scheduler.
3. Running →  
After thread scheduler has selected it.
4. Non Runnable →  
Thread alive, not eligible to run
5. Terminated →  
Run() method has exited

## The Thread class

Below are the Commonly used Constructors of Thread class:

- 1) Thread()
- 2) Thread(String name)
- 3) Thread( Runnable r)
- 4) Thread (Runnable r, String name)

## Methods Thread class

Thread class offers a lot of methods such as run(), Start(), join(), getPriority(), SetPriority() etc. More can be found on visiting Java docs.

## Chapter 13 - Practice Set

- Write a program to print "good morning" and "welcome" Continuously Threads. on the screen in Java using
- Add a sleep method in welcome thread of question 1 to delay its execution for 200 Ms.
- Demonstrate Get Priority () and Set Priority () methods In Java Threads.
- How do Java? you get state of a given thread in Java?
- How do you get reference to the current thread in Java?"

# Chapter 14

## Errors & Exceptions

---

No matter how smart we are, errors are Constant companions With practice, our we keep getting better at finding & Correcting them.

There are three types of errors in Java.

- ❖ Syntax errors
- ❖ Logical errors
- ❖ Runtime errors → Also called Exceptions

### Syntax Errors

When compiler finds something wrong with our program.. it throws a syntax error.

int a = 9 → No Semicolon, Syntax error!

a = a+3;

d = 4; → Variable not declared, Syntax error!

### Logical errors

A logical error or a bug occurs when a program compiles and runs but does the wrong thing.

- message delivered wrongly
- Whong time of chats being displayed
- incorrect redirects!

### Runtime Errors

Java may Sometimes encounter an error while the program is running. These are also called exceptions! These are encountered due to circumstances like bad input and (or) resource constraints

Ex: user supplies 'S' + 8 to a program which adds 2 numbers.

Syntax errors and logical errors are encountered by the programmer where as Runtime errors are encountered by the users.

### Exceptions in Java

An Exception is an event that occurs when a program is executed disrupting the normal flow of instructions. There are mainly two types of exceptions in Java :

- Checked Exception → Compile time exceptions (Handled by Compiler)

- Unchecked Exception → Runtime exceptions

## Commonly occurring Exceptions

Following are few commonly occurring exceptions in Java:

- Null Pointer Exception
- Arithmetic Exception
- Array Index Out of Bound Exception
- Illegal Argument Exception
- Number format Exception

## Try-catch block in Java

In Java, exceptions are managed using try-Catch blocks

Syntax:

```
Main-Java-Calculator - poble2.java

4  try{
5      //code to try
6  }
7  catch(Exception e){
8      //code if exception
9  }
```

## Handling specific Exceptions

In Java, we can handle specific exceptions by typing multiple Catch blocks.

```
Main-Java-Calculator - poble2.java

4  try{
5      //code to try
6  }
7  catch(IOException e){
8      //code if exception
9  }
10 catch(ArithmeticException e){
11     //code
12 }
13 catch(Exception e){
14     //code
15 }
```

## Nested try-catch

We can nest multiple try - catch blocks as follows:

```
Main-Java-Calculator - poblem2.java

4  try{
5      try{
6          //code
7      }
8      catch(Exception e){
9          //code
10     }
11 }
12 catch(Exception e){
13     //code
14 }
```

Similarly, we can further nest try catch blocks inside the nested try catch blocks.

**Quick Quiz:** Write a Java program that allows you to keep accessing on array until a Valid index is given by the user.

## Exception class in Java

We can write our custom Exceptions using Exception Class in Java

```
Main-Java-Calculator - poblem2.java

1  public class MyException extends Exception{
2      //overridden methods
3  }
```

The Exception class has following important methods :

- ❖ String toString() → executed when sout (c) is ran
- ❖ Void printStackTrace() → prints Stack trace
- ❖ String getMessage() → prints the Exception message

## The Throw keyword

The throw keyword is used to throw an exception explicitly by the programmer



```
Main-Java-Calculator - poblem2.java

7  if (b==0){
8      throw new ArithmeticException("Div by 0");
9  }else{
10     return a/b;
11 }
```

In a similar manner, we can throw user defined exceptions:

**throw new My Exception(" Exception thrown");**

## The throws exception

The Java throws Keyword is used to declare an exception This gives an information to the programmer that there might be an exception so its better to be prepared with a try catch block!

```
Main-Java-Calculator - poblem2.java

4  public void Calculate(int a, int b) throws IOException{
5      //code
6  }
```

## Java finally block

finally block contains the code which is always executed Whether the exception is handled or not. It is used to execute code containing instructions to release the system resources, close a connection etc.

## Chapter 14 - Practice Set

- Write a Java program to demonstrate syntax, logical & runtime errors.
- Write a Java program that prints "Halla" during Arithmetic exception and "Hette" during an Illegal argument exception
- Write a program that allows you to keep accessing an array until a valid index is given. If max retries exceed 5 print "Error"
- Modify program in Q3 to throw a custom Exception if max retries are reached.
- Wrap the program in Q3 inside a method which throws your custom Exception.

# Advanced Java-1

---

## Collections Framework

A Collection represents a group of object. Java Collections provide Classes and Interfaces for us to be able to write Code quickly and efficiently

## Why do we need Collections

We need Collections for efficient storage and better manipulation of data in Java.

For ex: We' use arrays to store integers but what if we want to

- Resize this array?
- Insert an element in between ?
- Delete an element in Array ?
- Apply Certain operations to change this array?

## How are collections available

Collections in Java are available as Classes and Interfaces. Following are few commonly used Collections in Java:

- ArrayList → for variable Size Collection
- Set → for distinct collection
- Stack → A LIFO data structure
- HashMap → for storing key-value pairs.

Collection class is available in java.util package Collection class also provides static methods for sorting, searching etc.

Written By,



SCAN ME



**Tarak Rahman**

*Programmer*

<https://devtarak.github.io/>