Java Definition :

- Java is a high-level programming language used to represent or correlate real-world entities.
- Java was developed by Sun Microsystems, with James Gosling as the lead developer, in 1995.

Program :

Program is a set of instruction which is use to perform specific operation.

Programing language:

The langue which is use to create a set of instruction.

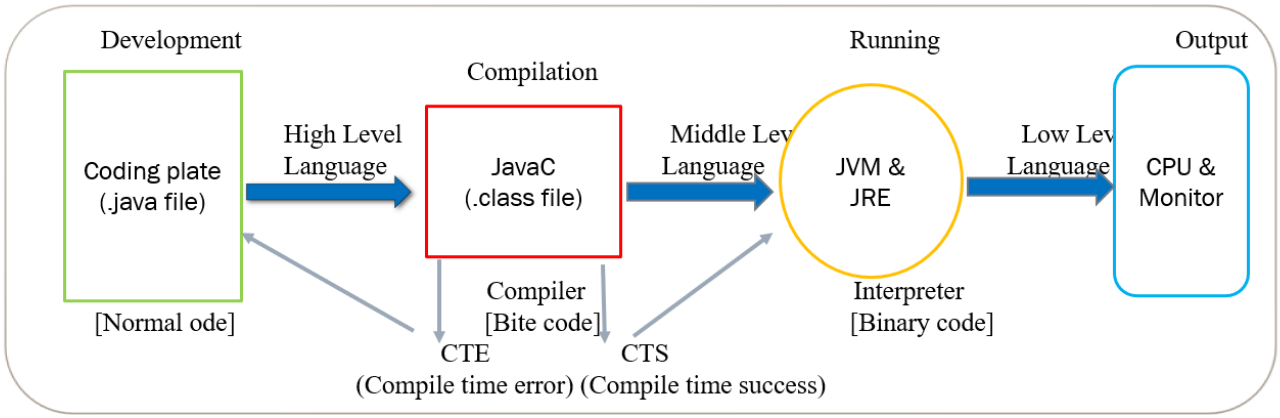
Type of Language:

- Low level Language : which is understandable by machine. (Exa Binary code)
- Middle level Language : Which is minimum understand by human.(Exa byte code)
- High level Language : Which is understandable by human.(Exa java, Paython, C++, C#, C)

Types of file in java :

- **.java file :** high level programing language which is created by developer as a java file with .java extension.
- **.class file :** middle level programing language which is created by compiler as class file with .class extension.

Process of Execution in java:



Steps:

- A developer writes the code and saves it as a Java file, which is in a high-level language.
- Then, the file is sent for compilation, where it may result in either a compilation error or success.
- If the compilation is successful, the code is converted into bytecode.
- The bytecode is then executed by the JVM (Java Virtual Machine),
- which converts it into binary code. Finally, the result is displayed on the monitor.

Java Features:

1. Platform Independence: Write Once, Run Anywhere" (WORA) via JVM.
2. Object-Oriente: Supports OOP principles: Encapsulation, Inheritance, Polymorphism, Abstraction.
3. Robust: Strong memory management, exception handling, and garbage collection.
4. Secure: Built-in security features (e.g., security manager, bytecode verification).

5. Multi-threadin: Supports concurrent execution of multiple threads for better performance.
6. High Performance: JIT compiler improves execution speed.
7. Dynamic: Can load classes dynamically and supports reflection.
8. Rich Standard Librar: Extensive APIs for data structures, I/O, networking, and GUIs.
9. Automatic Memory Management: Garbage collection eliminates memory management issues.
11. High-Level Language: Abstracts low-level details, making development easier.
12. Scalability: Suitable for both small and large-scale applications.

JVM (Java virtual machine) & JRE (Java run time environment):-

It is responsible for execution, it convert the byte code into a binary code. this is send to a machine to display the output.

Syntax:-

Class ClassName{

Public static void main(String[] arge){

code

}

}

Camel Case:

A naming convention where the first letter of the first word is lowercase, and the first letter of each subsequent word is uppercase (e.g., myVariableName), method and variable name follow camel case.

Pascal Case:

A naming convention where the first letter of each word is uppercase (e.g., MyVariableName), Class and Constructor name follow pascal case.

Data Type :-

Data type is use to create a memory, it is also use to specify size of memory.

Type:-

Primitive Datatype :

data type having size is called primitive data type.

1. **Boolean :** we are defining with true and false.

Exa : boolean a=true;

2. **Character :** any special and single alpha bate consider as a character, define by char in side single cod (‘’).

Exa : char a=‘x’ or ‘%’ or ‘1’;

1. **Number :** byte : it is hole number, declare by byte and it is smallest number in size(1byte)

Exa : byte a=100; this is max size (max 3 digit)

- **short :** it is hole number, declare by short and it is grater then byte.(2byte)

Exa : short c=10000; (max 5 digit)

- **int :** it is hole number, declare by int and it is less then 10 digit.(4byte)

Exa : int d=1000000000; (max 10 digit)

- **long :** it is hole number, declare by long,L or l should mentioned at the last.(8byte)

Exa : long a=1000000000000000000L; (max 19 digit)

4. **Float :**

- **float:** use to store decimal value, having smal size, mention at the F or f. (4byte)

Exa : float f=10000000000000000000000000000000000000.0F; (39 digit max)

- **double :** use to store decimal value, having large size. (8byte)

Exa : double f=10.0F;

Non-Primitive Datatype:- data type don't having side.

1. **String :** String is an immutable sequence(collection) of characters used to represent text. Writing in side double code ("").

Exa : String a="a";

2. **Array :** array in Java is a collection of elements of the same type stored in a contiguous memory location.

Exa : int[] numbers = {1, 2, 3, 4, 5};

2. **Collection :** A collection in Java is a framework that provides an architecture to store and group of objects.

Exa : List<String> list = new ArrayList<>();

list.add("Hello");

3. **Predefine data type :** it is an instance of a class provided by the Java standard library .

Variable :

it is a empty memory where we can store and declare the data.

Exa : int number = 5, double d=5.0;

Rule to declare variable :

Syntax : datatype variableName=value;

1. Variable start with alphabate(camel case)
2. no number and special character allowed

For taking run time input we use Scanner :

Scanner is use to take runtime input.

import java.util.Scanner;

```
public class ScannerExample {
public static void main(String[] args) {
Scanner scanner = new Scanner(System.in);
System.out.print("Enter your name: ");
String name = scanner.nextLine();
System.out.print("Enter your age: ");
int age = scanner.nextInt();
char c=scanner.next().charAt(0);
scanner.close();
}
}
```

Key words in java :

In Java, keywords are reserved words that have a predefined meaning, It is always small latter.

1. abstract	19. float	37. short	53. record
2. assert	20. for	38. static	
3. boolean	21. goto (not used)	39. strictfp	
4. break	22. if	40. super	
5. byte	23. implements	41. switch	
6. case	24. import	42. synchronized	
7. catch	25. instanceof	43. this	
8. char	26. int	44. throw	
9. class	27. interface	45. throws	
10. const (not used)	28. long	46. transient	
11. continue	29. native	47. try	
12. default	30. new	48. void	
13. do	31. null	49. volatile	
14. double	32. package	50. while	
15. else	33. private	51. var (added in Java 10 for local variable type inference)	
16. Enum	34. protected		
17. extends	35. Public		
18. final	36. return		

identifier :

An identifier in Java is a name used to identify variables, methods, classes, or other entities, and it must start with a letter, underscore (_), or dollar sign ($), followed by any combination of letters, digits, underscores, or dollar signs. and which is not keyword.

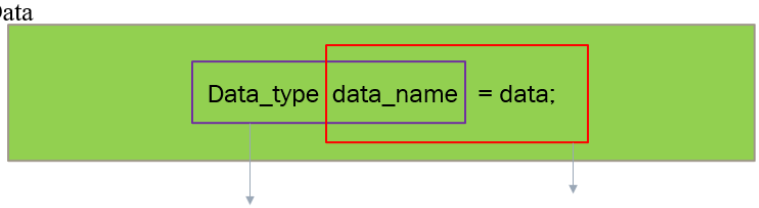
Exa : **int myVariable = 5;**

Variable initialization

- **byte** by=10;
- **short** so=100;
- **int** num=1;
- **long** lo=1000000L;
- **double** dou=1.00;
- **float** flo=1.00f;
- **char** ch='@';
- String string="String";
- **boolean** bool=**true**;

Variable : variable is a memory block. Which has 4 property.

1. Variable Name
2. Variable Type
3. Variable Size
4. Variable Data



Variable declaration **Variable initialization**

Re-initialization :- **variable_name= data;**

Operator :

Operator is use to perform operation.

1. Arithmetic Operators

Used to perform basic arithmetic operations.

Type : + : Addition and concatenation > - : Subtraction > * : Multiplication > / : Division > % : Modulus (remainder)

Exa : int a = 10, b = 5; int sum = a + b; // sum = 15 (add) > String sum = a + b; // sum = 105 (con) >

int diff = a - b; // diff = 5 > int prod = a * b; // prod = 50 int div = a / b; // div = 2 > int mod = a % b; // mod = 0

2. Relational Operators

Used to compare two values.

Type : == : Equal to / != : Not equal to / > : Greater than / < : Less than / >= : Greater than or equal to / <= : Less than or equal to

Exa : int x = 10, y = 10; > boolean result = x > y; // result = false > boolean result = x < y; // result = false >

boolean result = x <= y; // result = true > boolean result = x >= y; // result = true >

boolean result = x == y; // result = true > boolean result = x != y; // result = false >

3. Logical Operators

It used to perform logical operations on boolean values.

Type : && : Logical AND > || : Logical OR > ! : Logical NOT

Exa : boolean a = true, b = false; > boolean result = a && b; // result = false > boolean result = a || b; // result = true > boolean result = !b; // result = true

4. Assignment Operators

Used to assign values to variables.

Type : = : Simple assignment > += : Add and assign > -= : Subtract and assign > *= : Multiply and assign > /= : Divide and assign > %= : Modulus and assign

Exa : int x = 5; > x += 3; // x = x + 3; x = 8 > x *= 2; // x = x * 2; x = 16

5. Unary Operators

Which can performed using single operator and single operant.

++ : Increment , - - : decrement

Int a=10;

- Pre Increment : first increased by 1 and update it. Exa : ++a +a=20
- Post Increment : first update it and increased by 1. Exa : (a++) +a=21
- Pre decrement : first decrees by 1 and update it. Exa : - -a +a=20
- Post decrement : first update it and decrees by 1. Exa : (a- -) +a=19

6. Binary Operators

Which can performed using single operator and double operant.

Exa : a=10,b=10; a+b=20;

6. Ternary Operators

Which can performed using two or more then two operator and two or more then two portent.

Exa : a=10; String result=(a==10) ? “Hello”:”Byee”;

7. Bitwise Operators

Used to perform bit-level operations on integer data.

Type : & : Bitwise AND / | : Bitwise OR / ^ : Bitwise XOR / ~ : Bitwise NOT / << : Left shift

>> : Right shift

Example : int a = 5, b = 3; int result = a & b;

8. Instanceof Operator

Checks if an object is an instance of a specific class or interface.

instanceof : Checks type compatibility

Exa : String str = "Hello"; boolean isString = str instanceof String;

9. Typecast Operator

Used to explicitly convert one data type to another.

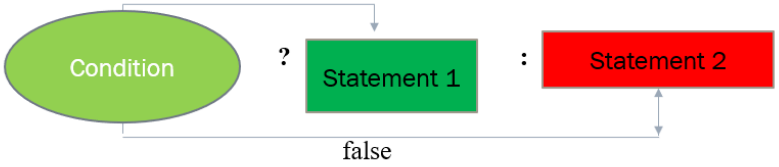
(type) : Type casting

Exa : boouble d = 5.5; int i = (int) d;

Ternary operator :

It is a one-liner conditional operator that takes three operands. It's used as a reduce the line of code, for if-else statements.

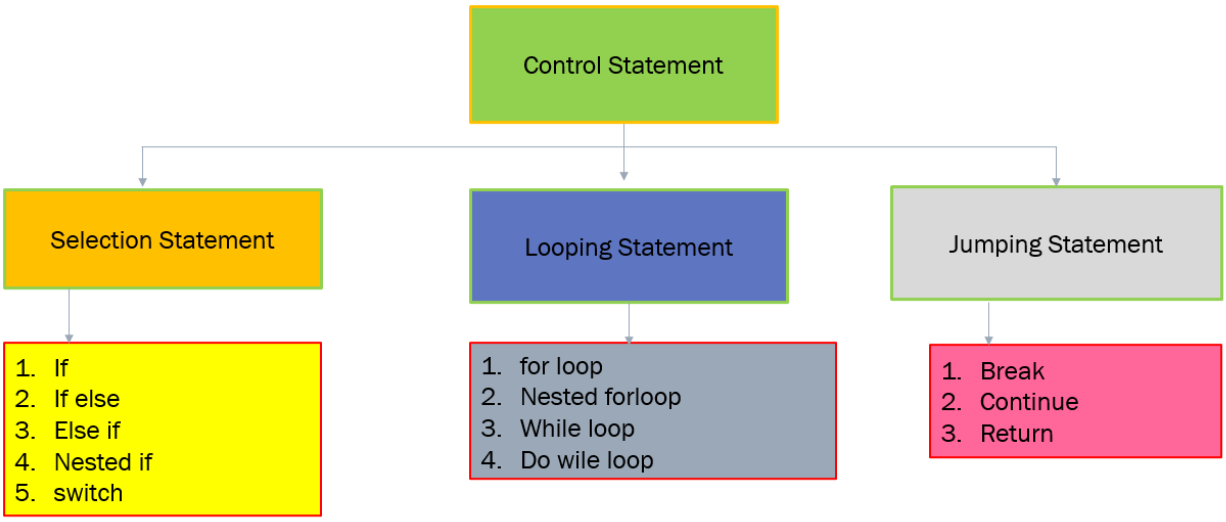
Syntax:



Exa : int a = 5, b = 10;
int min = (a < b) ? a : b; // min will be 5

Control Statement :

Which is use to control the flow of execution. Jvm always executed top to bottom and left to right.



ASCII (American Standard Code for Information Interchange) :

ASCII value refers to the numerical representation of a character in the ASCII encoding standard, which maps characters like letters, digits, and symbols to integers (e.g., 'A' is 65, 'a' is 97).

Exa :

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	117	118	119	120

z=121

INPUT1	INPUT2	OUTPUT	OPERATION
String	String	String	Concatenation
String	Number	String	Concatenation
Number	Boolean	String	Concatenation
String	Char	String	Concatenation
String	Bool	String	Concatenation
Bool	String	String	Concatenation
Number	Number	Number	Summation
Number	character	Number	ASCII
Character	Number	Number	ASCII
Character	Character	Number	ASCII

INPUT1	INPUT2	OUTPUT	OPERATION
Boolean	Boolean	Error	
Boolean	Number	Error	
Boolean	Character	Error	
Number	Boolean	Error	
Character	Boolean	Error	

If condition :

if condition in Java checks whether a condition is true or false and executes code based on that. if true execute it.

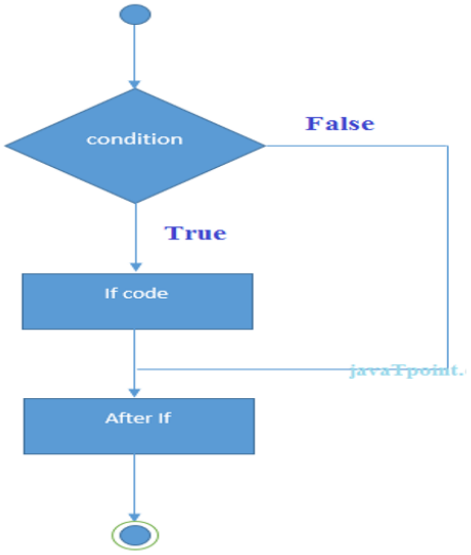
Exa :

```
int number = 10;
if (number > 5) {      //true
   System.out.println("Number is greater than 5");
}
```

***or ***

```
if (number > 5)       //true
   System.out.println("Number is greater than 5");
```

Note : if we have single line logic then, we no need to use



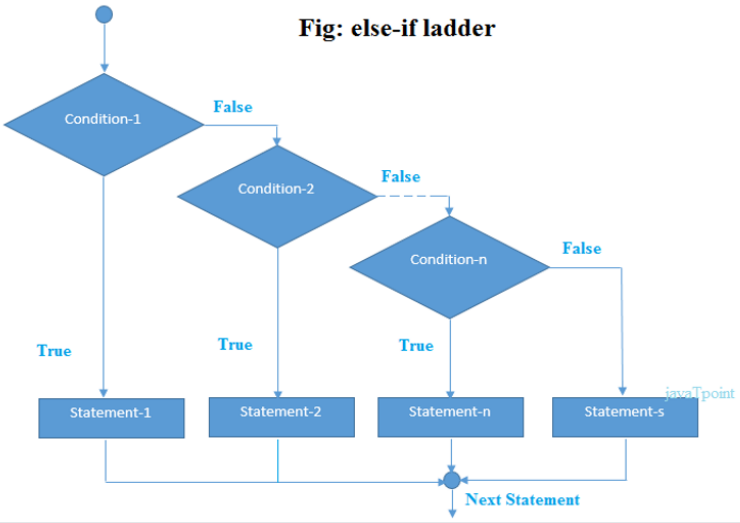
else if condition :

else if condition is used to test multiple conditions in sequence.
If the first if condition is false, the program checks the next else if condition, till contion is matched if all condition unmatched then else block will be executed.

Exa : int num = 10;

```
if (num > 15) {          //false
   System.out.println("Greater than 15");
} else if (num > 5) {    //true
   System.out.println("Greater than 5");
} else {
   System.out.println("5 or less");
}
```

Fig: else-if ladder

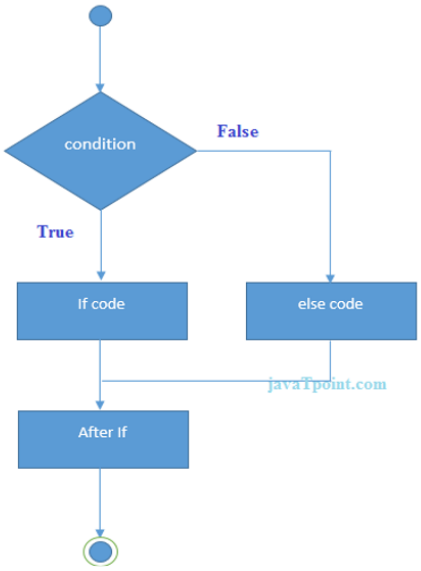


If else condition :

if-else condition is used to execute one block of code if a condition is true and if it is false then else will execute.

Exa :

```
int num = 5;
if (num > 0) {          //true
   System.out.println("Positive number");
} else {
   System.out.println("Non-positive number");
}
```

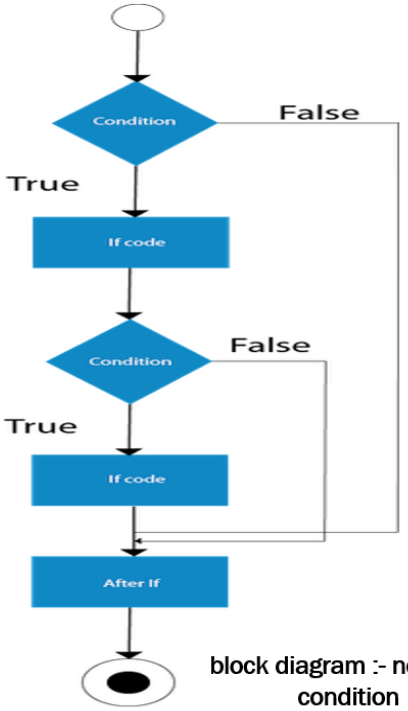


Nested if condition :

if statement placed inside another if statement. It allows for multi-level decision-making. if outer if will become true then only it will go to inner if condition.

Exa :

```
int num = 10;
if (num > 5) {            //true
   if (num < 15) {      //true
      System.out.println("Number is between 5 and 15");
   }
}
```



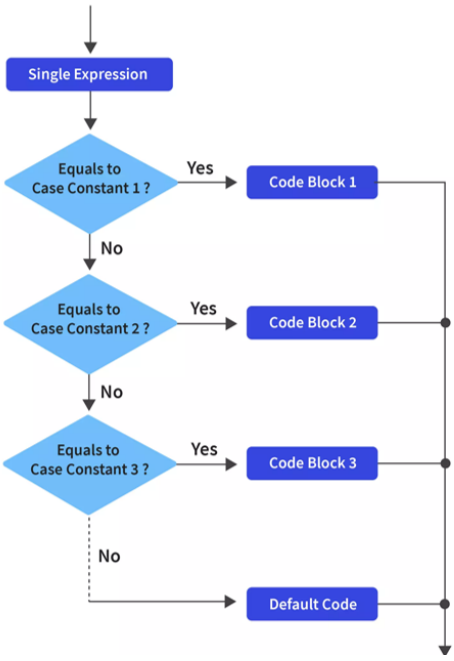
block diagram :- nested if condition

Switch case :

it is used to select one among multiple options based on the value of an expression.

Exa :

```
int day = 2;
switch (day) {
   case 1:
      System.out.println("Monday");
      break;
   case 2:
      System.out.println("Tuesday");
      break;
   default:
      System.out.println("Other day");
}
Output : Tuesday
```

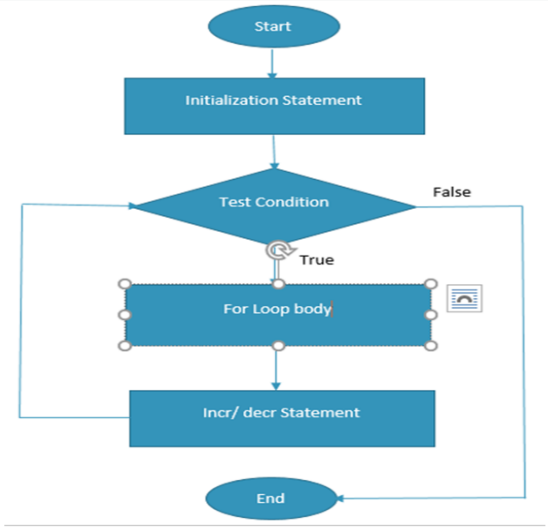


For loop :

it is used to execute the block of code a specific number of times.

Exa :

```
for (initialization; condition; update) { // Code}
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
System.out.println(i);
System.out.print(i);
}
}
}
o/p -       1  2  3  4 5
            12345
Note : System.out.println(i);
                ⇩
            this ln will print on next line.
```



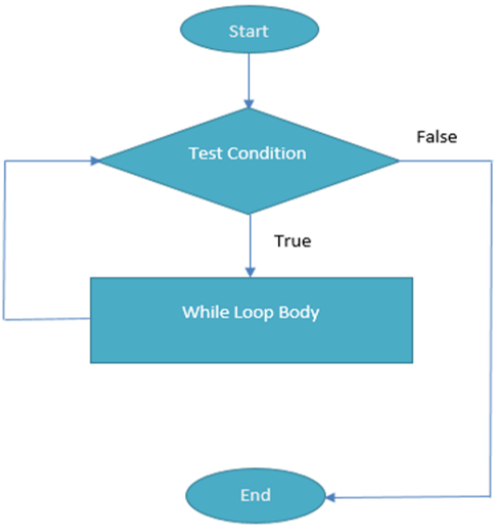
block diagram :- for loop

While loop :

it is repeatedly executes a block of code as long as the specified condition is true.

Exa :

```
while (condition) { // Code
Update;
 }
public class Test {
public static void main(String[] args) {
int i = 1;
while (i <= 5) {
System.out.println(i);
i++;
}
}}
o/p -       1  2  3 4 5
```



block diagram :- while loop

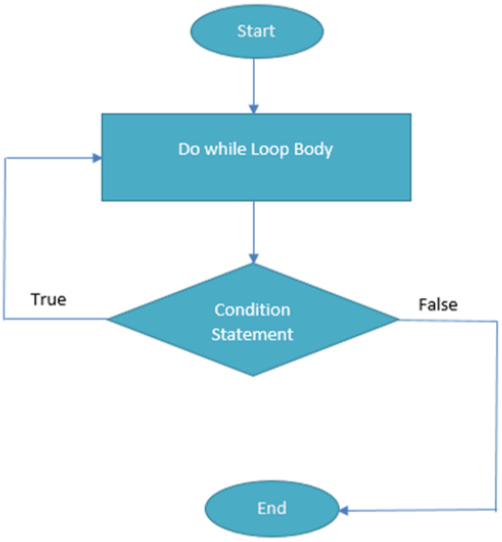
Do-while loop :

it is use to executes the code block at least once irrespective checking of condition, and then repeats the loop as long as the condition is true.

Exa : do { // Code
} while (condition);

```
public class Test {
public static void main(String[] args) {
int i = 1;
do {
System.out.println(i);
i++;
} while (i <= 5);
}
}
```

o/p - 1
2
3
4
5



block diagram :- Do-while loop

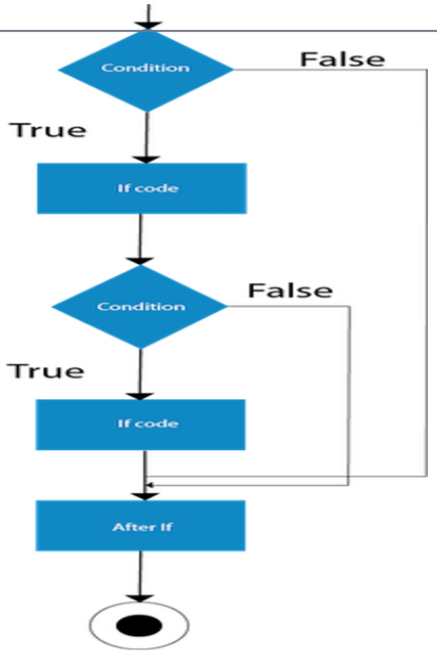
Nested-for loop :

it is a loop inside another loop. The inner loop runs completely for each iteration of the outer loop.

Exa :

```
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 3; i++) { // Outer loop
for (int j = 1; j <= 2; j++) { // Inner loop
System.out.println("i = " + i + ", j = " + j);
}
}
}
}
```

o/p :- i = 1, j = 1
i = 1, j = 2
i = 2, j = 1
i = 2, j = 2
i = 3, j = 1
i = 3, j = 2



block diagram :- Nested-for loop

Statement :-
break: it is use in loop or switch statement to break the condition.
continue: Skips the current iteration of a loop and proceeds with the next iteration.
return: it is use in method and condition, which is use to returns a value.
Example: break, continue, return

```
public class Example {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
if (i == 3) break; //Exit the loop when i==3
if (i == 2) continue; //Skip when i == 2
System.out.println(i); //Prints 1 and 4
}
System.out.println("End");
}
}
```

```
public class ReturnExample {
public static void main(String[] args) {
int result = addNumbers(5, 3);
System.out.println("Sum: " + result);
}
public static int addNumbers(int a, int b) {
return a + b; // Return the sum of a and b
}
}
```

Q) WAP to count no of digit by using while loop?

```
import java.util.Scanner;
public class CountDigits {
public static void main(String[] args) {
Int number='12345';
int count = 0;
if {
while (number != 0) {
number /= 10; // Remove the last digit
count++; // Increment the count
}
}
System.out.println("Number of digits: "
+count);
}
}
```

o/p :-Number of digits: 5

Q) WAP to sum of digit by using while loop using?

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

```
public class SumOfDigits {
public static void main(String[] args) {
Scanner scanner = new Scanner(System.in);
System.out.print("Enter a number: ");
int number = scanner.nextInt();
int sum = 0;
while (number != 0) {
sum += number % 10; // Get the last digit and add to sum
number /= 10; // Remove the last digit
}
System.out.println("Sum of digits:"+sum);
scanner.close();
}
}
```

o/p :- Sum of digits: according to input

Q) WAP to find the first digit of a given number using a while loop?

```
public class FirstDigitFinder {
public static void main(String[] args) {
int number = 56432; // Example number
int originalNumber = number; // To print in the output
if (number < 0) {
number = -number;
}
while (number >= 10) {
number /= 10;
}
System.out.println("The first digit of " + originalNumber + " is: " + number);
}
}
```

o/p:- The first digit of 56432 is: 5

Q) WAP to find the last digit of a given number using a while loop?

```
public class FirstDigitFinder {
```

```
public static void main(String[] args) {
int number = 56432; // Example number
int originalNumber = number; // To print in the output
if (number < 0) {
number = -number;
}
while (number >= 10) {
 number %= 10;
 }
System.out.println("The first digit of " + originalNumber + " is: " + number);
}
}
```

o/p:- The first digit of 56432 is: 2

spy number :-***

A spy number is a number where the sum of digits is equal to the product of digits.

Exa : 112 (211, 22, 123, 132, 141, 211, 221, 241)

Sum of digits: 1 + 1 + 2 = 4

Product of digits: 1 * 1 * 2 = 2

```
public class SpyNumberCheck {
public static void main(String[] args) {
int number = 121, sum = 0, product = 1, temp = number;
while (temp > 0) {
int digit = temp % 10;
sum += digit;
product *= digit;
temp /= 10;
}
if (sum == product) {
System.out.println(number + " is a spy number.");
} else {
System.out.println(number + " is not a spy number.");
}
```

```
scanner.close();
}
}
```

o/p:- 112 is a spy number

Q) WAP to product of even digit by using while loop using?

```
import java.util.Scanner;
public class SumOfDigits {
public static void main(String[] args) {
int prod = 1,c=1,number=1523;
while (number != 0) {
If(c%2==0){
prod *= number % 10;
C++;
}
number /= 10; // Remove the last digit
}
System.out.println(“prod of even digits:"+prod);
scanner.close();
}
}
```

o/p :- prod of even digits: 15

Q) WAP an integer number as input and finds the first digit raised to the power of the last digit.

```
import java.util.Scanner;
public class FirstDigitPowerLastDigit {
public static void main(String[] args) {
int number=4562;
int lastDigit = number % 10;
int firstDigit = number;
while (firstDigit >= 10) {
firstDigit /= 10;
}
```

```
int result = 1;
for (int i = 0; i < lastDigit; i++) {
result *= firstDigit;
}
System.out.println("The result of " + firstDigit + " raised to the power of " + lastDigit + " is: " + result);
}
}
```

o/p:- The result of 4 raised to the power of 2 is: 16

Q) WAP to find the largest and smallest digit from a given number?

```
public class LargeSmallDigitFinder {
public static void main(String[] args) {
int number = 5938267;
int largestDigit = 0;
int smallestDigit = 9;
while (number > 0) {
int currentDigit = number % 10; // Get the last digit of the number
if (currentDigit > largestDigit) {
largestDigit = currentDigit;
}
if (currentDigit < smallestDigit) {
smallestDigit = currentDigit;
}
number /= 10; // Remove the last digit
}
System.out.println("Largest digit: " + largestDigit+ "Smallest digit: " + smallestDigit);
}
}
```

o/p:- Largest digit: 9 Smallest digit: 2

Q) WAP to find repeated digits in a given number?

```
public class RepeatedDigitsFinder {
public static void main(String[] args) {
long number = 1223454; // Example input number
```

```
int[] digitCount = new int[10];
while (number > 0) {
int digit = (int) (number % 10); // Extract the last digit
digitCount[digit]++;
number /= 10; // Remove the last digit
}
for (int i = 0; i < 10; i++) {
if (digitCount[i] > 1) {
System.out.println("Digit " + i + " is repeated " + digitCount[i] + " times.");
}
}
}
}
```

o/p :-

*****Strong Number :*****

A Strong Number is a number for which the sum of the factorials of its digits is equal to the number itself.

Exa : 145 = 1! + 4! + 5! = 1 + 24 + 120 = 145.

```
public class StrongNumber {
public static void main(String[] args) {
int num = 145, sum = 0, temp = num, digit;
while (temp != 0) {
digit = temp % 10;
int fact = 1;
for (int i = 1; i <= digit; i++) {
fact *= i;
}
sum += fact;
temp /= 10;
}
if (sum == num) {
System.out.println(num + " is a Strong number.");
} else {
```

```
System.out.println(num + " is not a Strong number.");
}
}
}
```

Q) WAP for Strong numbers within a given range?

```
public class StrongNumber {
public static void main(String[] args) {
int start = 1, end = 1000;
for (int num = start; num <= end; num++) {
int sum = 0, temp = num;
while (temp != 0) {
int digit = temp % 10;
int fact = 1;
for (int i = 1; i <= digit; i++) {
fact *= i;
}
sum += fact;
temp /= 10;
}
if (sum == num) {
System.out.println(num + " is a Strong number.");
}
}
}
}
```

Q) WAP that reverses the second half of a given number and print it.

```
public class ReverseSecondHalf {
    public static void main(String[] args) {
        // Example number
        int number = 123456 , length = 0, temp = number;
```

```
        // Step 1: Calculate the length of the number
        while (temp > 0) {
            length++;
            temp /= 10;
        }

        // Step 2: Find the second half of the number
        int divisor = 1;
        for (int i = 0; i < length / 2; i++) {
            divisor *= 10;
        }

        int firstHalf = number / divisor;
        int secondHalf = number % divisor;

        // Step 3: Reverse the second half
        int reversedSecondHalf = 0;
        while (secondHalf > 0) {
            reversedSecondHalf = reversedSecondHalf * 10 + (secondHalf % 10);
            secondHalf /= 10;
        }

        // Step 4: Combine first half and reversed second half
        int result = firstHalf * divisor + reversedSecondHalf;

        // Step 5: Print the result
        System.out.println("Original Number: " + number);
        System.out.println("Modified Number: " + result);
    }
}
```

Perfect Square :-***

A perfect square is a number multiplied by it self will give you perfect squre.

Exa : 2*2=4, 3*3=9, 4*4=16

```
public class PerfectSquare {
    public static void main(String[] args) {
        int num = 16;
        int sqrt = 0;
        // Find the integer square root using a loop
        for (int i = 1; i <= num / 2; i++) {
            if (i * i == num) {
                sqrt = i;
                break;
            }
        }
        if (sqrt != 0) {
            System.out.println(num + " is a perfect square. Square root is " + sqrt);
        } else {
            System.out.println(num + " is not a perfect square.");
        }
    }
}
```

WAPTP perfect squares from given range ?

```
public class PerfectSquares {

    public static void main(String[] args) {
        // Loop through the numbers in the given range
        for (int num = 0; num <= 100; num++) {
            // Check if the number is a perfect square
            int i = 1;
            while (i * i <= num) {
                if (i * i == num) {
                    System.out.println(num + " is a perfect square.");
```

```
                break;
            }
            i++;
        }
    }
}
```

Neon Number:

A number is a Neon number if the sum of the digits of the square of the number is equal to the number itself.

Exa : 9 = 9*9 = 81 = 8 +1 = 9 (that means 9 is neon number) and 1

```
public class NeonNumber {
    public static void main(String[] args) {
        int num = 9;  // Example Neon number
        int square = num * num;  // Square of the number
        int sum = 0;
        // Calculate the sum of the digits of the square
        while (square > 0) {
            sum += square % 10;
            square /= 10;
        }

        // Check if the sum equals the original number
        if (sum == num) {
            System.out.println(num + " is a Neon Number.");
        } else {
            System.out.println(num + " is not a Neon Number.");
        }
    }
}
```

Armstrong Number:

An Armstrong number is a number which is sumation of each degit rise to the power of total number of digit is equal to the given number.

Exa : 153 = 1*1*1 + 5*5*5 + 3*3*3 =153

```
public class Armstrong {
    public static void main(String[] args) {
        int num = 153, originalNum = num, sum = 0, digitCount = 0;

        // Counting the number of digits
        int tempNum = num;
        while (tempNum != 0) {
            digitCount++;
            tempNum /= 10;
        }
        // Checking if the number is an Armstrong number
        tempNum = num;
        while (tempNum != 0) {
            int digit = tempNum % 10; // Get the last digit
            sum += Math.pow(digit, digitCount); // Raise digit to the power of the number of digits
            tempNum /= 10; // Remove the last digit
        }
        if (sum == originalNum)
            System.out.println(originalNum + " is an Armstrong number.");
        else
            System.out.println(originalNum + " is not an Armstrong number.");
    }
}
```

*****Prime number:*****

prime number can only be divided by 1 and itself without leaving a remainder.

```
public class PrimeNumber {
    public static void main(String[] args) {
        int number = 29;
```

```
        boolean isPrime = true;
        // 0 and 1 are not prime numbers
        if (number <= 1) {
            isPrime = false;
        } else {
            // Check for factors from 2 to sqrt(number)
            for (int i = 2; i <= number / 2; i++) {
                if (number % i == 0) {
                    isPrime = false; // number is divisible by i, so it's not prime
                    break; // No need to check further
                }
            }
        }
        if (isPrime)
            System.out.println(number + " is a prime number.");
        else
            System.out.println(number + " is not a prime number.");
    }
}
```

Q) WAP to find 5th prime number from number.

```
public class Main {
    public static void main(String[] args) {
        int count = 0, number = 2, fifthPrime = 0;

        // Loop until the 5th prime is found
        while (count < 5) {
            boolean isPrime = true;
            // Check if the number is prime
            for (int i = 2; i <= number / 2; i++) {
                if (number % i == 0) {
                    isPrime = false;
                    break;
```

```
            }
        }
        // If it's prime, increment the count and save the prime
        if (isPrime) {
            count++;
            fifthPrime = number;
        }
        // Check the next number
        number++;
    }
    System.out.println("The 5th prime number is: " + fifthPrime);
  }
}
```

Sunny Number:

A sunny number is a number n for which n + 1 is a perfect square. For example:

If n = 3, n + 1 = 4, which is a perfect square, so 3 is a sunny number.

```
public class Main {
  public static void main(String[] args) {
    int n = 3; // Smallest sunny number candidat
    // Check if n + 1 is a perfect square
    int check = n + 1;
    int squareRoot = 1;
    while (squareRoot * squareRoot < check) {
      squareRoot++;
    }

    if (squareRoot * squareRoot == check) {
      System.out.println(n + " is a sunny number.");
    } else {
      System.out.println(n + " is not a sunny number.");
    }
```

```
    }
}
```

*** Automorphic number ***

An Automorphic number is a number whose square ends with the same digits as the number itself.

exa: 5 = 5*5 = 25

6 = 6*6 = 36

```
public class AutomorphicNumber {
    public static void main(String[] args) {
        int number = 5, square = number * number, temp = number;
        boolean isAutomorphic = true;
 while (temp > 0) {
if (temp % 10 != square % 10) {
                isAutomorphic = false;
                break;
            }
            // Move to the next digit
            temp /= 10;
            square /= 10;
        }
if (isAutomorphic)
            System.out.println(number + " is an Automorphic number.");
        else
            System.out.println(number + " is not an Automorphic number.");
    }
}
```

o/p:- 5 is an Automorphic number.

*** Decennium number :***

Summation of the digit rise to the power of position of the digit.

Exa : 175 = 1+7*7+5*5*5 = 175

```
public class Deserium {
    public static void main(String[] args) {
        int num = 153, originalNum = num, sum = 0, digitCount = 0;
```

```
        // Counting the number of digits
        int tempNum = num;
        while (tempNum != 0) {
            digitCount++;
            tempNum /= 10;
        }
      tempNum = num;
      while (tempNum != 0) {
            int digit = tempNum % 10;
            sum += Math.pow(digit, digitCount);
            digitCount- -;
              //the power of the number of digits
            tempNum /= 10; // Remove the last digit
        }
        if (sum == originalNum)
            System.out.println(originalNum + " is an Armstrong number.");
        else
            System.out.println(originalNum + " is not an Armstrong number.");
    }
}
```

o/p:- 153 is an Armstrong number

Fibonacci series

The Fibonacci series is the sum of the two preceding once. The sequence typically starts with 0 and 1.

```
public class FibonacciSeries {
    public static void main(String[] args) {
        int n = 10, a = 0, b = 1; // Initial two terms
        System.out.print("Fibonacci Series: " + a + " " + b);
        for (int i = 2; i < n; i++) {
            int next = a + b;
            System.out.print(" " + next);
            a = b;
```

```
            b = next;
        }
    }
}
```

Output: Fibonacci Series: 0 1 1 2 3 5 8 13 21 34

```
public class ReverseFibonacciSeries {
    public static void main(String[] args) {
        int n = 10, a = 0, b = 1; // Initial two terms
        System.out.print("Fibonacci Series: " + a + " " + b);
        for (int i = 1; i < n; i++) {
            int next = a + b;
            a = b;
            b = next;
        }
        for (int i = 10; c >= n; i--) {
              c=b;
            b=a;
            a=c-b;
             System.out.print(" " + c);
        }
    }
}
```

Output: Fibonacci Series: 8 5 3 2 1 1 0

WAP to swap two numbers without using a third variable?

```
public class SwapNumbers {
    public static void main(String[] args) {
        int a = 5, b = 10;
     System.out.println("Before swap: a = " + a + ", b = " + b);
        // Swapping without using a third variable
        a = a + b; // a now becomes 15
        b = a - b; // b now becomes 5 (original value of a)
```

```
        a = a - b; // a now becomes 10 (original value of b)
        System.out.println("After swap: a = " + a + ", b = " + b);
    }
}
```

o/p:- Before swap: a = 10, b =20

after swap: a = 20, b =10

logic 2:- a = a * b;

b = a / b;

a = a / b;

logic 3:- // Swapping using XOR

a = a ^ b;

b = a ^ b;

a = a ^ b;

WAP to print non-Fibonacci series ?

```
package test;

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

        int a = 0, b = 1, c = 1; // Start checking numbers from 1
      for (int i = 0; i < 20; i++) {
        if (i== c) {
           a = b;
           b = c;
           c = a + b;
        }else {
                System.out.println( "non-Fibonacci numbers: " + i);
        }
      }
   }
}
```

WAP to convert int to binary?

```
public class Test {
   public static void main(String[] args) {
      int n = 1010,bin=1,rem=0;
      while (n>0) {
         rem=n%2;
```

```
        bin=bin*2+rem;
        n=n/2;
        }
    int rev=0;
    while (bin>1) {
        rem=bin%10;
        bin=bin/10;
        rev=rev*10+rem;
        }
    System.out.println(rev);
  }
}
```

WAP to convert binary to integer?

```
public class Test {
    public static void main(String[] args) {
    int n = 1010,sum=0,count=0,rem=0;
    while (n>0) {
        rem=n%2;
        int p=1;
        for (int i = 0; i < count; i++) {
            p=p*2;
        }
        int mul=p*rem;
        sum=sum+mul;
        n=n/10;
        count++;
    }
    System.out.println(sum);
  }
}
```

WAP to print nth smallest and largest digit?

```
package test;
public class Test {
        public static void main(String[] args) {
                int n = 32651, a = 2, nsmal = 1, c = 0, nlargest = 10;
                while (true) {
                        int temp = n, smal = 10, largest = 0;
                        while (temp > 0) {
                                int rem = temp % 10;
                                if (rem < smal && rem > nsmal) {
                                        smal = rem;
                                }
                                if (rem > largest && rem < nlargest) {
                                        largest = rem;
                                }

                                temp = temp / 10;
```

```
                }
                nsmal = smal;
                c++;
                if (a == c) {
                System.out.println(nsmal + " is " + a + "th small number");
                }
                if (a == c) {
                System.out.println(nlargest + " is " + a + "th largestl number");
                break;
                }
            }
        }
}
```

Co-prime number :

Two numbers are said to be co-prime or relatively prime if their greatest common divisor (GCD) is 1, all prime number are co-prime number.

Exa : 4 ,5 => 4%1 && 5%1 = 0

```
import java.util.Scanner;

class Test {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        System.out.print("Enter the first number: ");
        int num1 = scanner.nextInt();

        System.out.print("Enter the second number: ");
        int num2 = scanner.nextInt();

        if (gcd(num1, num2) == 1) {
            System.out.println(num1 + " and " + num2 + " are co-prime.");
        } else {
            System.out.println(num1 + " and " + num2 + " are not co-prime.");
        }

        scanner.close();
    }

    // Efficient GCD calculation using Euclidean Algorithm
    public static int gcd(int a, int b) {
        while (b != 0) {
            int temp = b;
            b = a % b;
            a = temp;
        }
        return a;
    }
```

```
}
```

2)

```
*
* *
* * *
* * * *
* * * * *
```

```
package test;
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= i; j++) {
System.out.print("*");
}
System.out.println();
}
}
}
```

3)

```
    *
   * *
  * * *
 * * * *
** * * *
```

```
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = 1; k <= i; k++) {
```

```
System.out.print("*");
}
System.out.println();
}
}
}
```

3)

```
a
bc
def
ghij
klmno
public class Test {
public static void main(String[] args) {
char ch = 'a';
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= i; j++) {
System.out.print(ch++);
}
System.out.println();
}
}
}
```

4)

```
    *
   ***
  *****
 *******
*********
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
```

```
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = 1; k <= 2 * i - 1; k++) {
System.out.print("*");
}
System.out.println();
}
}
}
```

5)

```
1
2 3
4 5 6
7 8 9 10
11 12 13 14 15
public class Test {
public static void main(String[] args) {
int num = 1;
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= i; j++) {
System.out.print(num++ + " ");
}
System.out.println();
}
}
}
```

6)

```
    1
   1 2 1
  1 2 3 2 1
 1 2 3 4 3 2 1
```

1 2 3 4 5 4 3 2 1

```
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = 1; k <= i; k++) {
System.out.print(k + " ");
}
for (int l = i - 1; l >= 1; l--) {
System.out.print(l + " ");
}
System.out.println();
}
```

7)

```
    1
  1 2
1 2 3
1 2 3 4
1 2 3 4 5
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = 1; k <= i; k++) {
System.out.print(k + " ");
}
System.out.println();
}
}
}
```

8)

```
    1
   2 1
  3 2 1
 4 3 2 1
5 4 3 2 1
```

```
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = i; k >= 1; k--) {
System.out.print(k + " ");
}
System.out.println();
}
}
}
```

9)

```
5 4 3 2 1
 4 3 2 1
  3 2 1
   2 1
    1
```

```
public class Test {
public static void main(String[] args) {
for (int i = 5; i >= 1; i--) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = i; k >= 1; k--) {
System.out.print(k + " ");
}
```

```
System.out.println();
}
}
}
```

10)

```
    1
   1 0
  1 0 1
 1 0 1 0
1 0 1 0 1
```

```
public class Test {
public static void main(String[] args) {
for (int i = 1; i <= 5; i++) {
for (int j = 1; j <= 5 - i; j++) {
System.out.print(" ");
}
for (int k = 1; k <= i; k++) {
if (k % 2 == 1) {
System.out.print("1 ");
} else {
System.out.print("0 ");
}
}
System.out.println();
}}}
```

Strings ,Arrays and Method calling

Object :

Object is a piece of memory.

Syntax : Object_data_type obj_reference_variable_name(ORV) = new Object_name();

Note: new keyword is use to create object in java

Methods : There are 2 type of methods

1) **Static method**
2) **Non-static method**

Syntax: **Access specifier access modifier return type methodName(){** //without argumented

//logic or code

}

Access specifier access modifier return type methodName(datatype argument){ //with argumented

//logic or code

}

Syntext to call :

```
MainMethodOrAnyMethod(){

ClassName. staticMethod();
ClassName orv = new ClassName();
orv.nonStaticMethod();
```

```
staticMethod(){
System.out.print("Hii");
}
}
```

```
nonStaticMethod(){
System.out.print(“Byee”);
}
```

Static method :

Static method having single copy nature in java , that’s why it is binding during compilation time.

Non- satanic method:

Non-static method having multiple copy nature. That’s why that is binding during run time.

Non-Static Without Arguments:

```
public void displayMessage() {
   System.out.println("This is a non-static method.");
}
```

Non-Static With Arguments:

```
public int multiply(int a, int b) {
   return a * b;
}
```

Static Method Without Arguments:

```
public static void greet() {
   System.out.println("Hello, world!");
}
```

Static Method With Arguments:

```
public static int add(int a, int b) {
   return a + b;
}
```

Static Method With Arguments return type :

```
public static String greet() {
return “Hello, world!";
}
```

Static Method Without Arguments return type:

```
public static int add(int a, int b) {
 return a + b;
}
```

Exa : method call

```
public class Test {
public static void main(String[] args) {
// Calling a static method directly using the class name
Test.staticMethod();
// Creating an object to call a non-static method
Test obj = new Test();
obj.nonStaticMethod();
}
public static void staticMethod() {
System.out.println("This is a static method.");
}
public void nonStaticMethod() {
System.out.println("This is a non-static   method.");
}
}
```

o/p:- This is a static method.

This is a non-static   method.

Exa : with argumenta method call

```
public class Test {
```

```
public static void main(String[] args) {
// Calling a static method with arguments
int sum = addNumbers(5, 10);
System.out.println("Sum: " + sum);
// Creating an object to call a non-static method with arguments
Test obj = new Test();
int product = obj.multiplyNumbers(2, 3);
System.out.println("Product: " + product);
}
public static int addNumbers(int a, int b) {
return a + b;
}
public int multiplyNumbers(int a, int b) {
return a * b;
}
}
```

o/p:-Sum: 15

Product: 6

Exa :

Static and no-static Method Without Arguments return typr**:**

```
public class Test {
public static int addNumbers() {
return 10+ 10;
}
public int multiplyNumbers(int a, int b) {
return a * b;
}
public static void main(String[] args) {
// Calling a static method without arguments and getting the return value
int sum = addNumbers();
System.out.println("Sum: " + sum);
// Creating an object to call a non-static method with arguments
```

```
Test orv = new Test();
int product = obj.multiplyNumbers(4, 2);
System.out.println("Product: " + product);
}
}
```

wap to given number is perfect squre or not?

```
import java.util.Scanner;
public class Test {
public static void main(String[] args) {
Scanner scanner = new Scanner(System.in);
System.out.print("Enter a number: ");
int num = scanner.nextInt();
boolean isPerfectSquare = isPerfectSquare(num);
if (isPerfectSquare)
System.out.println(num + " is a perfect square.");
else
System.out.println(num + " is not a perfect square.");
}
public static boolean isPerfectSquare(int num) {
for (int i = 0; i < num; i++) {
int sqr=i*i;
if (sqr==num)
return true;
}
return false;
}}
```

Access specifier :

which is use to specify the access layer. Where to access and where not.

Type of access specifier :

1) **public:** which can be access on any where in the java .

2) **private:** which can be access on the class in the java.

3) **protected:** which can be access on the same package and subclass in the java .

4) **Default (no keyword):** Accessible only within the same package.

accrss_modifier :

They are used to define type of method whether it is single copy or multiple copy.

Type of access modifier :

1) **Non-static:** having multiple copy nature, for no-static we are not using any keywords.

2) **Static:** having single copy nature.

Return type :

A return type specifies the data type of the value that a method returns to its caller. It is declared before the method name in the method declaration.

Examples of return types:

Primitive data types: int, double, boolean, char, etc.

Reference data types: String, Arrays, Objects, etc.

Void: Indicates that the method does not return any value.

*****Array*****

An array is a object which is use to store elements of the same data type.

points about arrays:

Elements: Each individual value in an array is called an element.

Index: Each element is associated with an index, which is used to access it.

Declaration: Arrays are declared by specifying the data type and the size of the array.

Syntax :

1D array :

ArrayType[ ] arrayName=new ArrayType[size];

2D array:

data_type[][] array_name = new data_type[rows][columns];

Array

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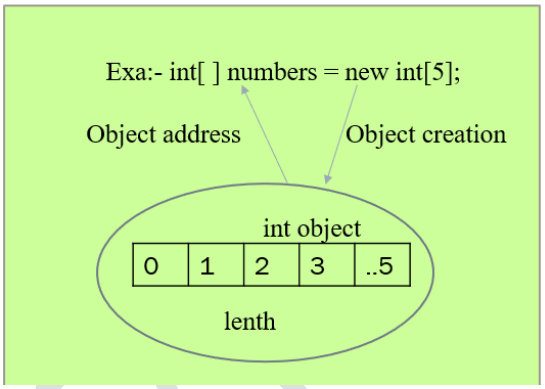
Syntax :

1D array :

ArrayType[ ] arrayName=new ArrayType[size];

2D array:

data_type[][] array_name = new data_type[rows][columns];



Explanation :-

- New keyword will create an integer array object.
- Integer array elements consist of integer values, index values start from 0.
- Default array element consists of integer value.
- Integer array object consists of length variable.
- length variable consists of the length of the elements.
- Array Name consists of the object address.
- Default value of int array is 0.

Exa:- **public class** Test {

public static void main(String[] args) {

int[] a = **new int**[4];

a[0] = 10;

a[1] = 20;

a[2] = 30;

a[3] = 40;

System.***out***.println(a[0]);

System.***out***.println(a[1]);

System.***out***.println(a[2]);

```
System.out.println(a[3]);
}
}
```

O/p:- 10 20 30 40 print line by line

- If we initialize the elements more than the given size, we can get an exception at run time (ArrayIndexOutOfBoundsException).

Exa :By looping :

```
public class Test {
   public static void main(String[] args) {
      int[] a = new int[4];
      a[0] = 10;
      a[1] = 20;
      a[2] = 30;
      a[3] = 40;
      for (int i = 0; i < a.length; i++) {
         System.out.println(a[i]);
      }
   }
}
```

O/p:- 10 20 30 40 print line by line

2nd method to initialize array :

```
class Array {
   public static void main(String[] args) {
      int[] a = {10, 20, 30, 40, 50};
      for (int i = 0; i < a.length; i++) {
         System.out.println(a[i]);
      }
}}
```

WAP to marge 2 integer array?

```
class Test {
```

```
public static void main(String[] args) {
int[] a = { 1, 2, 3, 4, 5 }, b = { 6, 7, 8, 9, 10 };
int[] c = new int[a.length + b.length];
for (int i = 0; i < c.length; i++) {
if (i < a.length) {
c[i] = a[i];
} else {
c[i] = b[i - a.length];
}}
for (int i = 0; i < c.length; i++) {
System.out.print(c[i] + " ");
}}}
```

Q) input int[] a={2,4,6,8};

o/p:- 3 5 7 9

```
class Test {
public static void main(String[] args) {
int[] a = { 2, 4, 6, 8 };
for (int i = 0; i < a.length; i++) {
a[i] = a[i] + 1;
}
for (int i = 0; i < a.length; i++) {
System.out.print(a[i] + " ");
}
}
}
```

WAP to print smallest and largest number?

```
class Test {
public static void main(String[] args) {
int[] a = { -4, -5, -8, -2, -10 };
int largest = a[0];
int smallest = a[0];
for (int i = 0; i < a.length; i++) {
if (largest < a[i]) {
```

```
largest = a[i];
}
if (smallest > a[i]) {
smallest = a[i];
}
}
System.out.println("Largest:" + largest);
System.out.println("Smallest: " + smallest);
}
}
```

WAP to add 100 at the 1st position of array?

```
class AddExtraElement {
   public static void main(String[] args) {
      int[] a = {3, 4, 5, 6, 7};
      int[] b = new int[a.length + 1];
      for (int i = 0; i < b.length; i++) {
         if (i == 0) {
            b[i] = 100;
         } else if (i == 1) {
            b[i] = a[i - 1];
         } else {
            b[i] = a[i - 2];
         }
      }
      for (int i = 0; i < b.length; i++) {
         System.out.print(b[i] + " ");
      }
   }
}
```

O/p:- 100 3 4 5 6 7

Replace the array element with 1 index forward?

```
class Test {
```

```
public static void main(String[] args) {
int[] a = { 10, 20, 30, 40, 50 };
// Reversing the array in-place
for (int i = 0; i < a.length / 2; i++) {
int temp = a[i];
a[i] = a[a.length - 1 - i];
a[a.length - 1 - i] = temp;
}
for (int i = 0; i < a.length; i++) {
System.out.print(a[i] + " ");
}
}
}
```

O/p:-50 40 30 20 10

Q) WAP to print even array elements.

```
class Test {
   public static void main(String[] args) {
      int[] a = {10, 20, 30, 40, 50};
      for (int i = 0; i < a.length; i++) {
         if (i%2==0) {
                  System.out.println(a[i]);
                  }
      }
   }
}
```

o/:- 20

40

Q) WAP to print the elements which are divisible by 3.

```
class Test {
   public static void main(String[] args) {
      int[] a = {10, 20, 30, 40, 50};
      for (int i = 0; i < a.length; i++) {
         if (i%3==0) {
                  System.out.println(a[i]);
                  }
      }
   }
}
```

➢ **WAP to print the sum of given array elements.**

```
class Test {
	public static void main(String[] args) {
		int[] a = { 10, 20, 30, 40, 50 };
		int sum = 0;
		for (int i = 0; i < a.length; i++) {
			sum = sum + a[i];
		}
		System.out.println(sum);
	}
}
```

o/p:- 150

➢ WAP to print the sum of first & last element.

```
class Test {
	public static void main(String[] args) {
		int[] a = { 10, 20, 30, 40, 50 };
		int sum = 0;
		for (int i = 0; i < a.length; i++) {
			if (i == 0 || i == a.length - 1) {
				sum = sum + a[i];
			}
		}
		System.out.println(sum);
	}
}
```

o/p:- 60

➢ WAP to print the given array elements in reverse order

```
class Test {
	public static void main(String[] args) {
		int[] a = { 10, 20, 30, 40, 50 };

		for (int i = a.length - 1; i >= 0; i--) {
			System.out.println(a[i]);
		}
	}
}
```

➢ WAP to print palindrome no. in the given integer array (no element).

```
class Test {
	public static void main(String[] args) {
		int[] a = { 10, 20, 33, 40, 50 };
```

```
		for (int i = 0; i < a.length; i++) {
			int temp = a[i];
			int rev = 0;
			while (temp > 0) {
				int rem = temp % 10;
				rev = rev * 10 + rem;
				temp = temp / 10;
			}
			if (rev == a[i]) {
				System.out.println(a[i] + " is a palindrome number");
			}
		}
	}
}
```
o/p:- 33 is a palindrome number

➢ WAP to print perfect square no. from the given integer array element.

```
class Test {
	public static void main(String[] args) {
		int[] a = { 10, 20, 25, 30, 40 };

		for (int i = 0; i < a.length; i++) {
			int temp = a[i];
			int j = 1;

			while (j * j <= temp) {
				if (j * j == temp) {
					System.out.println(a[i] + " is a perfect square number");
					break;
				}
				j++;
			}
		}
	}
}
```
o/p:- 25 is a perfect square number

WAP to marge 2 integer array?

```
class Test {
	public static void main(String[] args) {
		int[] a = { 1, 2, 3, 4, 5 }, b = { 6, 7, 8, 9, 10};
		int[] c = new int[a.length + b.length];

		for (int i = 0; i < c.length; i++) {
			if (i < a.length) {
				c[i] = a[i];
			} else {
				c[i] = b[i - a.length];
			}
		}
```

```
		for (int i = 0; i < c.length; i++) {
			System.out.print(c[i] + " ");
		}
	}
}
```

o/p :- 1 2 3 4 5 6 7 8 9 10

tracing :-

Step	i	a[i]	b[i - a.length]	c[i] or o/p
1	0	1	-	1
2	1	2	-	2
3	2	3	-	3
4	3	4	-	4
5	4	5	-	5
6	5	-	6	6
7	6	-	7	7
8	7	-	8	8
9	8	-	9	9
10	9	-	10	10

Q) input int[] a={2,4,6,8};
o/p:- 3 5 7 9

```
class Test {
	public static void main(String[] args) {
		int[] a = { 2, 4, 6, 8 };

		for (int i = 0; i < a.length; i++) {
			a[i] = a[i] + 1;
		}

		for (int i = 0; i < a.length; i++) {
			System.out.print(a[i] + " ");
		}
	}
}
```

Tracing :

Step	i	a[i]	a[i] + 1 (new value)
1	0	2	3
2	1	4	5
3	2	6	7

4	3	8	9

WAP to print smallest and largest number?

```
class Test {
	public static void main(String[] args) {
		int[] a = { -4, -5, -8, -2, -10 };
		int largest = a[0];
		int smallest = a[0];
		for (int i = 0; i < a.length; i++) {
			if (largest < a[i]) {
				largest = a[i];
			}
			if (smallest > a[i]) {
				smallest = a[i];
			}
		}
		System.out.println("Largest:" + largest);
		System.out.println("Smallest: " + smallest);
	}
}
```

o/p:- Largest:-2
Smallest: -10

Tracing :

Iteration	i	a[i]	largest	smallest
1	0	-4	-4	-4
2	1	-5	-4	-5
3	2	-8	-4	-8
4	3	-2	-2	-8
5	4	-10	-4	-10

WAP to add 100 at the 1st position of array?

```
class AddExtraElement {
   public static void main(String[] args) {
      int[] a = {3, 4, 5, 6, 7};
      int[] b = new int[a.length + 1];

      for (int i = 0; i < b.length; i++) {
         if (i == 0) {
            b[i] = 100;
         } else if (i == 1) {
            b[i] = a[i - 1];
         } else {
            b[i] = a[i - 2];
```

```
        }
    }

    for (int i = 0; i < b.length; i++) {
        System.out.print(b[i] + " ");
    }
  }
}
```

O/p:- 100 3 4 5 6 7

Iteration	i	b[i]	Explanation
1	0	100	Assigning 100 to the first element of b
2	1	3	Assigning the first element of a to the second element of b
3	2	4	Assigning the second element of a to the third element of b
4	3	5	Assigning the third element of a to the fourth element of b
5	4	6	Assigning the fourth element of a to the fifth element of b
6	5	7	Assigning the fifth element of a to the sixth element of b

Replace the array element with 1 index forword?

```
class Test {
public static void main(String[] args) {
int[] a = { 10, 20, 30, 40, 50 };
// Reversing the array in-place
for (int i = 0; i < a.length / 2; i++) {
int temp = a[i];
a[i] = a[a.length - 1 - i];
a[a.length - 1 - i] = temp;
}
for (int i = 0; i < a.length; i++) {
System.out.print(a[i] + " ");
}
}
}
```

O/p:-50 40 30 20 10

Iteration	i	a[i]	a[a.length - 1 - i]	temp	Swapped Array

1	0	10	50	10	[50, 20, 30, 40, 10]
2	1	20	40	20	[50, 40, 30, 20, 10]
3	2	30	30	30	[50, 40, 30, 20, 10]

Character array :

it is a data structure used to store a sequence of characters. Each character in the array is assigned an index, starting from 0.

Syntax :

char[] letters = new char[5]; or char[] vowels = {'a', 'e', 'i', 'o', 'u'};

Note:- default value of character is space (1 empty space).

Exa :

```
class Test {
public static void main(String[] args) {
char[] a = { 'a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j', 'k', 'l', 'm', 'n', 'o', 'p', 'q', 'r', 's', 't','u', 'v', 'w', 'x', 'y', 'z' };
for (int i = a.length - 1; i >= 0; i--) {
System.out.print(a[i]+" ");
}
}
}
```

o/p:- z y x w v u t s r q p o n m l k j i h g f e d c b a

Problem 2: Print Even Character Array Elements

```
class Array {
   public static void main(String[] args) {
         char[] chars = {'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V',
       'W', 'X', 'Y', 'Z'};

      for (int i = 0; i < chars.length; i += 2) {
         System.out.print(chars[i]);
      }
   }
}
```

Problem 3: Print Even Character Array Element Sum

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

```
        char[] chars = {'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L',  'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V',
        'W', 'X', 'Y', 'Z'};
      int sum = 0;

      for (int i = 0; i < chars.length; i += 2) {
        sum += chars[i];
      }

      System.out.println("Sum of even-indexed characters: " + sum);
   }
}
```

Double Array in Java

it is a data structure used to store multiple double or floting numbers.

Exa: double[] numbers = {1.23, 4.56, 7.89, 10.11}; or double[] numbers =new double[size];

```
class Test {
        public static void main(String[] args) {
                double[] prices = { 19.99, 24.99, 15.99 };
                for (int i = 0; i < prices.length; i++) {
                        System.out.println("Price: $" + prices[i]);
                }
        }
}
```

o/p:- Price: $19.99
Price: $24.99
Price: $15.99

String Array in Java

it is a data structure that stores multiple strings. It's similar to a regular array, but each element is a reference to a String object.
Exa : String[] fruits = {"apple", "banana".....}; or String[] args =new String[size];

```
class Test {
        public static void main(String[] args) {
                String[] colors = { "red", "green", "blue" };
                for (int i = 0; i < colors.length; i++) {
                        System.out.print(colors[i] + " ");
                }
        }
}
```

o/p:- red green blue

Q) WAP to print only alpha bate ?

```
class Test {
public static void main(String[] args) {
char[] a = { 'A', 'B', 'C', '@', 'E', '#', 'G', '*', 'I' };
```

```
for (int i = 0; i < a.length; i++) {
if ((a[i] >= 65 && a[i] <= 90) || (a[i] >= 97 && a[i] <= 122)) {
System.out.print(a[i] + " ");
}
}
}
}
```
o/p:-A B C E G I

Double Array in Java :
it is a data structure used to store multiple double or floating numbers.
Exa: double[] numbers = {1.23, 4.56, 7.89, 10.11}; or double[] numbers =new double[size];

```
public class DoubleArrayExample {
   public static void main(String[] args) {
      double[] prices = {19.99, 24.99, 15.99};
      for (int i = 0; i < prices.length; i++) {
         System.out.println("Price: $" + prices[i]);
      }
   }
}
```

String :
String is an Immutable object in java, as well as it is a predefined class. in simple term string is a group of character.

We can create string object by 2 way :-
1) By new key word approach.
2) By literals approach.

New Keyword:
The new keyword is used to create a new object in memory every time because of new keyword.
Object Reference Variable: The str variable stores the memory address of the String object.

By literal approach :
We use “” double code for creating string object. It will not create new object every time if object is already exist then.

Property:
String Elements: The String object contains a sequence of characters.
Each character has an index, starting from 0.

Default Value: default value of string is null.
Length: The length() method can be used to get the length of a String object.
Immutable: Once created, their object cannot be changed. if we try to change then it will change with newly created object.

String Pool: Java uses a String pool to optimize memory usage for strings. When you create a String object, the JVM checks the String pool to see if an identical string already exists. If it does, the existing object is returned instead of creating a new one.

Methods in string :

- **length()**: i**nteger**
  Returns the length of the string.

- **charAt(index): character**
  Returns the character at the specified index.

- **concat(str)**: **String**
  add substring to the end of this string.

- **indexOf(str): integer**
  Returns the index of the first occurrence of the specified substring.

- **lastIndexOf(str): integer**
  Returns the index of the last occurrence of the specified substring.

- **substring(beginIndex): string**
  Returns a substring starting from the specified index to the last.

- **substring(beginIndex, endIndex)**: string
  Returns a substring starting from the specified begin Index and ending Index between.

- **toLowerCase(): string**
  Converts all characters to lowercase.

- **toUpperCase(): string**
  Converts all characters to uppercase.

- **trim(): string**
  Removes white space from first and last.

- **startsWith(prefix): Boolean**
  Checks if the string starts with the specified prefix.

- **endsWith(suffix): Boolean**
  Checks if the string ends with the specified suffix.

- **replace(oldChar, newChar): string**
  Replaces all occurrences of the old character with the new character.

- **split(delimiter): string**
  Splits the string into an array of substrings based on the delimiter.

- **equals(str): Boolean**
  Compares two strings for equality.

- **equalsIgnoreCase(str): Boolean**
  Compares two strings for equality, ignoring case.

String Array in Java

it is a data structure that stores multiple strings. It's similar to a regular array, but each element is a reference to a String object.

Note Points:

1. When two users have created two string objects, to compare both strings, we make use of the inbuilt method equals().
2. We are not supposed to use comparison operator (==) as we are not comparing primitive values. We are comparing objects.
3. When the user has just initialized the value for the strings, JVM will create one object, at that time we can make use of comparison operator (==) as well as inbuilt method.
4. String array is implicitly implemented character array and length is final variable in this array.

Exa : String[] fruits = {"apple", "banana".....}; or String[] args =new String[size];

```
class Test {
public static void main(String[] args) {
String[] colors = { "red", "green", "blue" };
for (int i = 0; i < colors.length; i++) {
System.out.print(colors[i]+" ");
}
}
}
```

o/p:- red green blue

WAP to convert given string to character and print it?

```
class Test {
public static void main(String[] args) {
String s1 = "Hello";
char ch;
for (int i = 0; i < s1.length(); i++) {
ch = s1.charAt(i);
System.out.print(ch + " ");
}
}
}
```

o/p:- H e l l o

Note Points:

1. When two users have created two string objects, to compare both strings, we make use of the inbuilt method equals().

2. We are not supposed to use comparison operator (==) as we are not comparing primitive values. We are comparing objects.
3. When the user has just initialized the value for the strings, JVM will create one object, at that time.

Exa: Compare two string without case sensitive.

```
class Test {
public static void main(String[] args) {
String s1 = "mom";
String s2 = "MoM";
if (s1.equalsIgnoreCase(s2))
System.out.println("Equal");
else
System.out.println("Not equal");
}
}
```

o/p:- Equal

Question from string :

1. WAP to check given string is palindrome or not.
2. WAP to reverse a given string.
3. WAP to remove a given substring.
4. I/p : s1=J%A$V@A
   o/p : s2=JAVA

Q) input= Neeraj@1234JSP
o/p:- NeerajJSP
1234
@

```
class Test {
public static void main(String[] args) {
String s1 = "Neeraj@1234JSP";
String s2 = "";
String s3 = "";
String s4="";
char[] ch = s1.toCharArray();

for (int i = 0; i < s1.length(); i++) {
if ((ch[i] >= 'a' && ch[i] <= 'z') || (ch[i] >= 'A' && ch[i] <= 'Z')) {
s2 += ch[i];
} else if (ch[i] >= '0' && ch[i] <= '9') {
s3 += ch[i];
```

```
}else {
s4 += ch[i];
}
}
System.out.println(s2);
System.out.println(s3);
System.out.println(s4);
}
}
```

Anagram Checker:

An anagram is a formation of 1 word is re arrange to the another word and each character of 1st word is belong to 2nd word. For example, "listen" and "silent" are anagrams.

Note: both string length should be equal.

```
class Test {
	public static void main(String[] args) {
		String str1 = "listen";
		String str2 = "silent";

		// Convert both strings to character arrays
		char[] charArray1 = str1.toCharArray();
		char[] charArray2 = str2.toCharArray();

		// Sort both character arrays
		Arrays.sort(charArray1);
		Arrays.sort(charArray2);

		if (Arrays.equals(charArray1, charArray2)) {
			System.out.println("The two strings are anagrams.");
		} else {
			System.out.println("The two strings are not anagrams.");
		}
	}
}
```

Q) String s1 = "A3B5C2";

o/p:- AAABBBBBCC

```
class Test {
	public static void main(String[] args) {
		String s1 = "A3B5C2";
```

```
                char[] ch = s1.toCharArray();

                for (int i = 0; i < s1.length(); i++) {
                        if (Character.isAlphabetic(ch[i])) {
                                int count = Integer.parseInt(String.valueOf(ch[i + 1]));
                                for (int j = 0; j < count; j++) {
                                        System.out.print(ch[i]);
                                }
                                i++;
                        }
                }
        }
}
```

Q) String s = "OBGABBBBB";
o/p: O1B6G1A1

```
class Test {
        public static void main(String[] args) {
            String s = "OBGABBBBB";
            HashSet<Character> processedChars = new HashSet<>();

            for (int i = 0; i < s.length(); i++) {
                char ch = s.charAt(i);
                if (!processedChars.contains(ch)) {
                    int count = 0;
                    for (int j = 0; j < s.length(); j++) {
                        if (s.charAt(j) == ch) {
                            count++;
                        }
                    }
                    System.out.print(ch + "" + count);
                    processedChars.add(ch);
                }
            }
        }
}
```

Or

```
class Test {
        public static void main(String[] args) {
                String s = "aaabbbaaffbb";
                for (int i = 0; i < s.length(); i++) {
                        char ch = s.charAt(i);
                        int count = 1;
                        boolean isUnique = true;
                        // Check if the current character has already been processed
                        for (int j = 0; j < i; j++) {
                                if (s.charAt(j) == ch) {
                                        isUnique = false;
                                        break;
```

```
                        }
                    }
                    if (isUnique) {
                        // Count occurrences of the current character
                        for (int j = i + 1; j < s.length(); j++) {
                            if (s.charAt(j) == ch) {
                                count++;
                            }
                        }
                        System.out.print(ch + "" + count);
                    }
                }
            }
}
```

WAP to find largest substring from given string

```
class Test {
        public static void main(String[] args) {
      String s1 = "I got Capgemini placed in ";
      String[] s2=s1.split(" ");
      String largeWord=s2[2];
      int max=s2[2].length();
                for (int i = 0; i < s2.length; i++) {

                    if(max<s2[i].length() )
                    {
                        largeWord=s2[i];
                        max=s2[i].length();
                    }
                }
     System.out.println(largeWord);

   }
}
```

o/p:- Capgemini

WAP to find smalest substring from given string

```
class Test {
        public static void main(String[] args) {
      String s1 = "I got Capgemini placed in ";
      String[] s2=s1.split(" ");
      String largeWord=s2[0];
      int max=0;
      for (int i = 0; i < s2.length; i++) {

                    if(max>s2[i].length() )
                    {
                        largeWord=s2[i];
                        max=s2[i].length();
                    }
                }
```

```
        System.out.println(largeWord);

    }

}
```
o/p:- I

WAP to print given string is palindrome or not?

```
class Test {
        public static void main(String[] args) {
                String s = "mom";
                String rev = "";
                char[] ch = s.toCharArray();
                for (int i = s.length() - 1; i >= 0; i--) {
                        rev += ch[i];
                }
                if (s.equals(rev)) {
                        System.out.println("Palindrome");
                } else {
                        System.out.println("Not Palindrome");
                }
        }

}
```
O/p:- Palindrome

WAP to print only small latter if

Input= Suresh123@gmail.com

o/p= suresh123@gmail.com

```
class Test {
        public static void main(String[] args) {
                String s = "Suresh123@gmail.com";
                char[] ch = s.toCharArray();
                for (int i = 0; i < s.length(); i++) {
                        if ((ch[i] >= 'A' && ch[i] <= 'Z')) {
                                char c = (char) (ch[i] + 32);
                                System.out.print(c);
                        } else {
                                System.out.print(ch[i]);
                        }
                }
        }
}
```

WAP to sort array via bubble sort?

```
class Test {
	public static void main(String[] args) {
		int[] a = { 42, 1, 7, 56, 98, 33 };

		for (int i = 0; i < a.length - 1; i++) {
			for (int j = 0; j < a.length -1 ; j++) {
				if (a[j] > a[j + 1]) {
					int temp = a[j];
					a[j] = a[j + 1];
					a[j + 1] = temp;
				}
			}
		}

		for (int i = 0; i < a.length; i++) {
			System.out.print(a[i] + " ");
		}
	}
}
```

o/p- 1 7 33 42 56 98

WAP TO swap the 2 string without 3rd variable?

```
class Test {
public static void main(String[] args) {
    String s1 = "Hii";
    String s2 = "World";
    s1=s1+s2;
    s2=s1.substring(0,s1.length()-s2.length());
    s1=s1.substring(s2.length());
    System.err.println(s1);
    System.out.println(s2);
  }
}
```

o/p:- Hii
World

WAP TO swap the 2 string without 3rd variable?

```
class Test {
	public static void main(String[] args) {
		int a = 10, b = 20;
		a = a + b;
		b = a - b;
		a = a - b;
		System.out.println("After swapping:");
```

```
                System.out.println("a = " + a);
                System.out.println("b = " + b);
        }
}
```

WAP to print lexicographical series from given string?

```
class Test {
        public static void main(String[] args) {
                String originalString = "Aakash,Baby,Ajay,Raju,Bedprakash,Krishnamurthy";
                String[] sortedString = originalString.split(",");

                for (int i = 0; i < sortedString.length; i++) {
                        for (int j = i + 1; j < sortedString.length; j++) {
                                if (sortedString[i].compareTo(sortedString[j]) > 0) {
                                        String temp = sortedString[i];
                                        sortedString[i] = sortedString[j];
                                        sortedString[j] = temp;
                                }
                        }
                }

                for (int i = 0; i < sortedString.length; i++) {
                        System.out.println(sortedString[i]);
                }
        }
}
```

WAP to print most repeated digit from given string?

```
class Test {
        public static void main(String[] args) {
                int[] arr = { 1, 3, 1, 4, 2, 2, 6, 7, 7, 7 };
                int c = 0,
                char b = ' ';
                for (int i = 0; i < arr.length; i++) {
                        int count = 0;
                        for (int j = i; j < arr.length; j++) {
                                if (arr[i] == arr[j]) {
                                        count++;
                                }
                        }
                        if (c < count) {
                                b = arr[i];
                        }
                }
                System.out.print(b + " ");
        }
}
```

Foreach loop:

A `foreach` loop is a control flow statement, that iterate over the object. like arrays, lists, maps and predefine object.

Syntax:

```
for (dataType variableName : objectRefName) {
    // Code to be executed for each element
}
```

Example:

```
int[] numbers = {1, 2, 3, 4, 5};
for (int number : numbers) {
   System.out.println(number);
}
```

Feature	for Loop	foreach Loop
Syntax	for(initialization; condition; increment/decrement) { // code }	for(datatype variableName : collectionName) { // code }
Flexibility	Highly flexible, allows for specific number of iteration .	Less flexible, cannot modify the collection elements during iteration.
Efficiency	when dealing with collections that provide efficient iterators.	Generally more efficient for simple iterations.
Readability	Can be less readable for complex iterations.	More readable for simple iterations.

WAP to print nth maximum from given array?

```
class Test {
        public static void main(String[] args) {
                int[] arr = { 12, 35, 1, 10, 34, 1 };
                int n = 3; // Find the 3rd maximum
                Arrays.sort(arr);
                int len = arr.length;

                if (n > len) {
                        System.out.println("Invalid input: n cannot be greater than array length");
                        return;
                }
                int nthMax = arr[len - n];
                System.out.println("The " + n + "th maximum element is: " + nthMax);
        }
}
```

O/P:- The 3th maximum element is: 12

Or

WAP to print nth max or min from given array?

```
class Test {
	public static void main(String[] args) {
		int[] a = { 12, 35, 1, 10, 34, 1 };
		int n = 2;
		for (int i = 0; i < a.length; i++) {
			int countL = 0, countS = 0;
			for (int j = 0; j < a.length; j++) {
				if (a[i] < a[j]) {
					countL++;
				}
				if (a[i] > a[j]) {
					countS++;
				}
			}
			if (countL == (n - 1)) {
		System.out.println(n+"th largest no from "+Arrays.toString(a)+" array is "+a[i]);
			}
			if (countS == (n )) {
		System.out.println(n+"th smallest no from "+Arrays.toString(a)+" array is "+a[i]);
			}
		}
	}
}
```

o/p:- 2th smallest no from [12, 35, 1, 10, 34, 1] array is 10
2th largest no from [12, 35, 1, 10, 34, 1] array is 34

WAP to remove reputed character from given array?

```
class Test {
   public static String removeDuplicates(String str) {
      HashSet<Character> charSet = new HashSet<>();
      StringBuilder sb = new StringBuilder();
      for (int i = 0; i < str.length(); i++) {
         char c = str.charAt(i);
         if (charSet.add(c)) {
            sb.append(c);
         }
      }
      return sb.toString();
   }
   public static void main(String[] args) {
      String str = "hello world";
      String result = removeDuplicates(str);
      System.out.println(result);
   }
}
```

o/p:- helo wrd

```
class Test {
	public static void main(String[] args) {
		String s = "Hello how are you";
		for (int i = 0; i < s.length(); i++) {
			boolean repetedChar = false;
			for (int j = 0; j < i; j++) {
				if (s.charAt(i) == s.charAt(j)) {
					repetedChar = true;
					break;
				}
			}
			if (!repetedChar && s.charAt(i)!=' ') {
				System.out.print(s.charAt(i));
			}
		}
	}
}
```

o/p- Helohwaryu

Core Java

Class and Object :

As soon as class is created new data type will be created this data type is called user define data type or non-primitive datatype.

User define data type

It is created by the user not predefine.

Derived data type

It is predefine data type in java.

Primitive data type

Already define in java, which having size is called primitive data type.

Exa : int, char, float, double, byte, short, long

Non-primitive data type

It is introduced in java, but we need to create object.

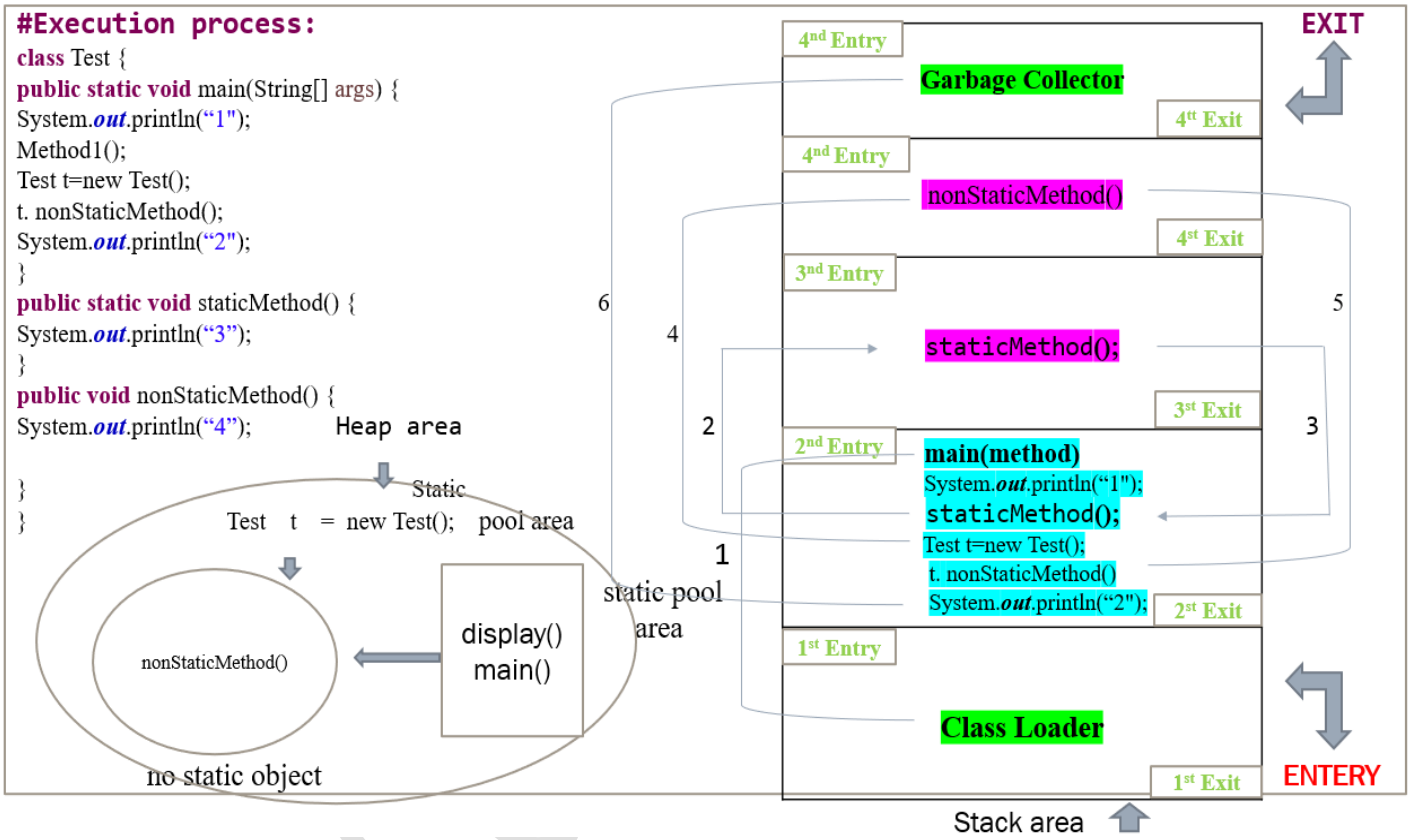
Exa : String, Array, Collection and predefine class.

Key Point For Class:

- As soon as class is created, new datatype is created
- Java language represent everything in the form of object.
- An object can be leaving or non-leaving entity, java see everythink in object.
- Creation of objects depends on project requirements.

Every object composed state and behaviour

- State represents 'What object knows?'
- Behaviour represent 'What object does?
- In simple word state is data behaviour is operation.
- Data assign to variable
- All operation performs by method.



Conclusion

- When a Java program is executed, two memory areas are created:
  - Stack Area
  - Heap Area
- Stack Area is used for execution purposes.
- Heap Area is used for storage purposes.
- JVM makes use to call resources:
  - Class loader
  - Main method
  - Garbage collector
- Every operation needs to be executed in the stack area.
- Class loader is responsible to create the static pool area and load all the static methods and variable into the static pool area.
- For each class, class loader will come and load the classes once.
- The new operator is responsible to create objects and load all the non static method and variable to the heap area, this will pointing to static pool area to the won class.
- Object address is assign to the object reference variable.

- After execution all the heap area clean by the garbage collector.

CALLER METHOD	CALLED METHOD	**Calling WAY** With in same class	**Calling Way** With in the different class
static	static	Directly	By class name
static	Non-static	By object reference variable Name	By object reference variable Name
Non-static	static	Directly	By class name
Non-static	Non-static	Directly	By object reference variable Name

Exa:-

```
public class MyClass {
    public static void staticMethod1() {
        System.out.println("Static method 1 called.");
        staticMethod2(); // Calling another static method within the same class
    }
    public static void staticMethod2() {
        System.out.println("Static method 2 called.");
    }
    public static void main(String[] args) {
        staticMethod1();
    }
}
```

2) Non-Static Method Calling a Static Method:

```
public class MyClass {
    public static void staticMethod1() {
        System.out.println("Static method 1 called.");
    }

    public void nonStaticMethod() {
        staticMethod1();
    }

    public static void main(String[] args) {
        MyClass obj = new MyClass();
        obj.nonStaticMethod();
    }
}
```

3. Non-Static Method Calling a Non-Static Method:

```
public class MyClass {
    public void nonStaticMethod1() {
        System.out.println("Non-static method 1 called.");
        nonStaticMethod2();
```

```
    }

    public void nonStaticMethod2() {
        System.out.println("Non-static method 2 called.");
    }

    public static void main(String[] args) {
        MyClass obj = new MyClass();
        obj.nonStaticMethod1();
    }
}
```

4. Calling Variables:

```
public class MyClass {
    int x = 10;
    static int y = 20;

    public void nonStaticMethod() {
        System.out.println("Value of x: " + x);
        System.out.println("Value of y: " + y);
    }

    public static void staticMethod() {
        System.out.println("Value of y: " + y);
    }

    public static void main(String[] args) {
        MyClass obj = new MyClass();
        obj.nonStaticMethod();
        staticMethod();
    }
}
```

5. calling method with multiple class

```
class ClassA {
    public void nonStaticMethodA() {
        System.out.println("Non-static method A called.");
    }

    public static void staticMethodA() {
        System.out.println("Static method A called.");
    }
}

class ClassB {
    public void nonStaticMethodB() {
        ClassA objA = new ClassA();
        objA.nonStaticMethodA(); // Calling a non-static method from another class
        ClassA.staticMethodA(); // Calling a static method from another class
    }
```

```
    public static void main(String[] args) {
        ClassB objB = new ClassB();
        objB.nonStaticMethodB();
    }
}
```

*****Method Overloading (Imp)*****

Creating multiple methods with the same method name but different parameters of argument is called method overloading, when we want to perform same operation in multiple why then we are going with method overloading.

Exa: real time :- mobile will open with password, pattern, fingerprint etc.

Note point :

- It can be perform with in the same class or diff class.

```
public class MethodOverloadingExample {
    public static void sum(int a, int b) {
        System.out.println("Sum of two integers: " + (a + b));
    }
    public static void sum(double a, double b) {
        System.out.println("Sum of two doubles: " + (a + b));
    }
    public static void sum(int a, int b, int c) {
        System.out.println("Sum of three integers: " + (a + b + c));
    }
    public static void main(String[] args) {
        sum(10, 20); // Calls the first sum method
        sum(10.5, 20.5); // Calls the second sum method
        sum(10, 20, 30); // Calls the third sum method
    }
}
```

 # Type Casting:

Object type casting means converting one object type to look like another object is called object type casting.

Object type casting is classified into two types:

1. **Upcasting**
    - Converting a subclass object to look like a superclass object by hiding subclass properties and showing superclass properties. This process is called upcasting.
    - Upcasting is possible because a subclass object is having superclass properties.
2. **Down casting**
    - The process of converting an upcasted object to look like a subclass object by making subclass properties visible. This process is called down casting.

- Down casting is possible only after upcasting.
- Direct down casting is not possible. That is, we cannot directly convert a superclass object to look like a subclass object because a superclass object will not have subclass properties.

Note :

Upcasting will have zero (0) effect on method overriding because an overridden method is a superclass property, and upcasting's job is only to hide subclass properties.

Exa:1

```
class Test {
public static void main(String[] args) {
  // Upcastin
  Animal animal = new Dog(); // Dog object is assigned to Animal reference
  animal.eat(); // Output: Animal is eating
  // Downcasting (with type checking)
  if (animal instanceof Dog) {
     Dog dog = (Dog) animal; // Safe downcasting
     dog.bark(); // Output: Dog is barking
  } else {
     System.out.println("Cannot downcast to Dog");
  }
}
}
class Animal {
   public void eat() {
      System.out.println("Animal is eating");
   }
}
class Dog extends Animal {
   public void bark() {
      System.out.println("Dog is barking");
   }
}
```

Exa :2

```
class Shape {
   public void draw() {
      System.out.println("Drawing a generic shape");
   }
}
class Circle extends Shape {
   @Override
   public void draw() {
```

```
        System.out.println("Drawing a circle");
    }
}
public class Main {
    public static void main(String[] args) {
        Shape shape = new Circle(); // Upcasting: Circle object to Shape reference
        shape.draw(); // Output: Drawing a circle
    }
}
```

Method Overriding

Multiple method with same signature but implementation can be different is called method Overriding.

Note point :

- Inheritance is mandatory.
- A subclass can change the method implementation of inherited methods.
- Changing the method implementation of inherited methods is called method overriding.
- In order to override an inherited method, the subclass should maintain the same method signature given by the superclass.
- Overriding is not a mandatory process; rather, it depends on project requirements.
- Only non-static methods can be overridden because of multiple copy nature.
- Static methods cannot be overridden because they do not support inheritance.
- Method overriding will only affect the current subclass because overriding is happening on the separate copy of the method given by the superclass.

Exa :

```
class Animal {
    public void makeSound() {
        System.out.println("Generic animal sound");
    }
}
class Dog extends Animal {
    @Override
    public void makeSound() {
        System.out.println("Woof!");
    }
}
public class Main {
    public static void main(String[] args) {
        Animal animal = new Dog();
        animal.makeSound(); // Output: Woof!
    }
}
```

Variables are classified into three types:

1. **Static Variable:**
   - Declared with the static keyword.
   - Single copy nature for all.
   - Shared by all objects of the class.
   - Can be accessed directly using the class name.
   - Default value we have for all data.
   - Exa account number in bank.
2. **Non-Static Variable:**
   - Declare without the static keyword.
   - Multiple copy nature for all.
   - Each object has its own copy of the non-static variable.
   - Can only be accessed through an object reference.
   - Default value we have for all data.
   - Exa IFSC code in bank.

Data Type	Default Value
byte	0
short	0
int	0
long	0L
float	0.0f
double	0.0d
boolean	FALSE
char	' ' (empty space)
String	null

3. Local Variable:
   - Declare with in the method.
   - Don't have default value.
   - Out of method we can not access.

Syntax for declaring static and non-static variables:

AccessSpecifier AccessModifier dataType variableName = data;

Exa : **public static int** *num*=10;

Code:1
```
public class MyClass {
    static int staticVar = 10; // Static variable
    int nonStaticVar = 20; // Non-static variable
```

```
    public static void staticMethod() {
        System.out.println("Static variable: " + staticVar);
        MyClass obj = new MyClass();
        System.out.println("Non-static variable (accessed through object): " + obj.nonStaticVar);
    }

    public void nonStaticMethod() {
        System.out.println("Static variable: " + staticVar);
        System.out.println("Non-static variable: " + nonStaticVar);
    }

    public static void main(String[] args) {
        MyClass obj = new MyClass();
        obj.nonStaticMethod();
        staticMethod();
    }
}
```

Code:2

```
public class ClassA {
    public static int staticVarA = 10;
    public int nonStaticVarA = 20;

    public void nonStaticMethodA() {
        System.out.println("Non-static method A: staticVarA = " + staticVarA + ", nonStaticVarA = " +
nonStaticVarA);
    }

    public static void staticMethodA() {
        System.out.println("Static method A: staticVarA = " + staticVarA);
        ClassA objA = new ClassA();
        System.out.println("Non-static variable (accessed through object): " + objA.nonStaticVarA);
    }
}

public class ClassB {
    public void nonStaticMethodB() {
        ClassA objA = new ClassA();
        objA.nonStaticMethodA(); // Calling a non-static method from another class
        ClassA.staticMethodA(); // Calling a static method from another class
    }

    public static void main(String[] args) {
        ClassB objB = new ClassB();
        objB.nonStaticMethodB();
    }
}
```

*****Encapsulation*****

- binding data members (variables and methods) with into a single unit (class) is called encapsulation.
- Steps of Encapsulation:
    1. Declare variables as private.
    2. Provide access to the variables through public methods.
    3. Provide validation conditions inside the methods.

```
class EncapsulationExample {
    private int age; // Private variable

    public int getAge() { // Public getter method
        return age;
    }

    public void setAge(int age) { // Public setter method
        if (age >= 0) {
            this.age = age;
        } else {
            System.out.println("Invalid age");
        }
    }
}

public class Main {
    public static void main(String[] args) {
        EncapsulationExample person = new EncapsulationExample();
        person.setAge(25); // Set the age through the setter
        int age = person.getAge(); // Get the age through the getter
        System.out.println("Age: " + age);
    }
}
```

*****Inheritance(imp)*****

It is a concept which is use to make sub class based on the parent class or existing class. by using extends keyword.

Exa:

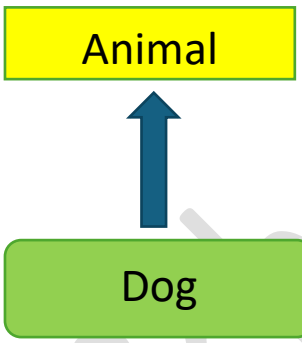
```
class Animal {
    public void eat() {
        System.out.println("Animal is eating");
    }
}
class Dog extends Animal {
    public void bark() {
        System.out.println("Dog is barking");
    }
}
public class Main {
    public static void main(String[] args) {
        Dog dog = new Dog();
        dog.eat(); // Inherited from Animal
```

```
        dog.bark();
    }
}
```

Types of inheritance:

1. Single inheritance
2. Multi level inheritance
3. Hierarchical inheritance
4. Multiple inheritance

1) **Single inheritance**



1 class exted the property of another class is Called single level of inheritance.

```
class Animal {
}
class Dog extends Animal {
}
```

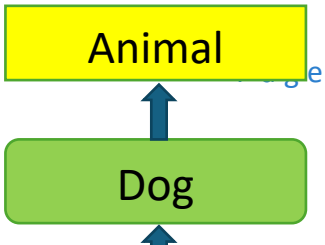
Exa :
Single Inheritance:

```
class Vehicle {
    protected String brand;
    protected int year;
    public Vehicle(String brand, int year) {
        this.brand = brand;
        this.year = year;
    }
}
class Car extends Vehicle {
    private String model;
    public Car(String brand, int year, String model) {
        super(brand, year); // Call the parent constructor
        this.model = model;
    }
}
```

2) Multilevel inheritance

One class inherit the property of parent class and that sub class again inherit 1 sub class is classed multilevel inheritance.

```
class Animal {
}
class Dog extends Animal {
}
class Puppy extends Dog {
}
```



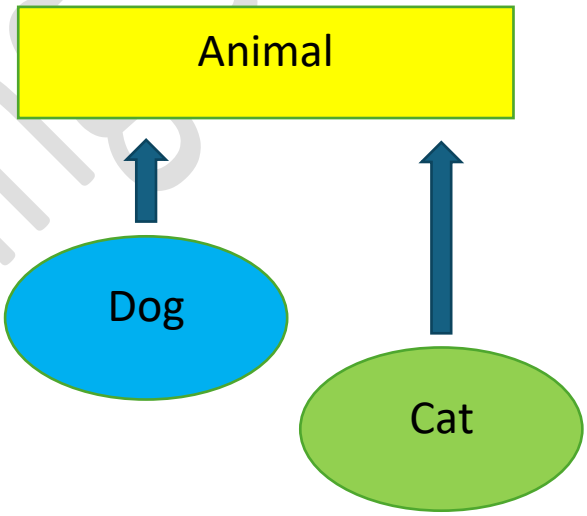
Exa :

```
interface Flyable {
    void fly();
}
interface Swimmable {
    void swim();
}
class Duck implements Flyable, Swimmable {
    public void fly() {
        System.out.println("Duck is flying");
    }
    public void swim() {
        System.out.println("Duck is swimming");
    }
}
```

3) Hierarchical inheritance

One super class having multiple sub class is called hierarchical inheritance.

```
class Animal {
}
class Dog extends Animal {
}
class Cat extends Animal {
}
```



Exa :

```
    protected String brand;
    protected int year;
    public Vehicle(String brand, int year) {
        this.brand = brand;
        this.year = year;
    }
    public void start() {
        System.out.println("Vehicle started");
    }
}
class Car extends Vehicle {
    private String model;
    public Car(String brand, int year, String model) {
        super(brand, year);
        this.model = model;
    }
    public void accelerate() {
        System.out.println("Car is accelerating");
    }
}
class Bike extends Vehicle {
    public void brake() {
        System.out.println("Bike is braking");
    }
}
```

4) Multiple inheritance***

Multiple inheritance is not possible in java class. Because of Dimond and ambiguity problem.

*Single subclass havening multiple supper class is called Multiple inheritance

Ambiguity problem :

- it is a constructor chaining problem, if we have 1 subclass and multiple supper class the we will try to call super class default or same argumenta constructor then it will give ambiguity error.

```
Class A{
public A(){
//code
}
```

```
Class B{
public B(){
//code
}
```

```
Class C extends A, B{
public A(){
    super(): //ambiguity
}
```

Dimond problem :

If we have 1 sub class and multiple supper class and supper class having same method and we try to call from sub class to the supper class method then we will get ambiguity problem.

```
Class A{
public static walk(){
//code
}
}
```

```
Class B{
public static walk(){
//code
}
}
```

```
Class C extends A, B{
supper.walk():
}
```

Constructor (imp)

- A constructor is a special method that is executed during object creation time.
- The constructor's name must be the same as the class name.
- Constructors are by default non-static and public. Developers should not use the static keyword with constructors.

  Syntax of a constructor:

```
accessSpecifier ConstructorName(arguments/non- arguments) {
    // Constructor body
}
```

- If a developer doesn't create any constructor, the compiler will create a default constructor. a constructor without arguments and with an empty body is called a default constructor.
- Constructors are classified into two types:
  - Constructor with arguments
  - Constructor without arguments
- Constructors are used for performing critical operations.
- One of the common critical operations in every program is the initialization of non-static variables.
- Creating multiple constructors with different argument data types is called constructor overloading.
- Calling one constructor from another constructor is called constructor chaining.
- A constructor cannot call another constructor by using its name.
- To call another constructor, we must use the this() statement with in the same class.

- To call another constructor on other class we use supper() statement.
- this() statement informs the JVM to call the appropriate constructor based on the argument data type.
- Syntax of the this() statement:
  this(arg1, arg2, ...);
- A constructor can chain with only one (single) constructor.
- To avoid breaking the above rule, the this() statement must be the first statement in the constructor.

Exa:1

```
class Box {
   int width, height, depth;
   // Default constructor
   Box() {
      width = height = depth = 5;
   }
   // Parameterized constructor
   Box(int w, int h, int d) {
      width = w;
      height = h;
      depth = d;
   }
}
```

Exa:2 Argumenta, non argumenta constructor and constructor overloading.

```
class Car {
   private String model;
   private int year;
   // Non-argumented constructor (default constructor)
   public Car() {
      model = "TATA";
      year =2024;
   }
   // Argumented constructor
   public Car(String model, int year) {
      this.model = model;
      this.year = year;
   }
   public void displayInfo() {
      System.out.println("Model: " + model);
      System.out.println("Year: " + year);
   }
}
public class Main {
   public static void main(String[] args) {
      // Creating a car object using the default constructor
      Car car1 = new Car();
      car1.displayInfo();
      // Creating a car object using the parameterized constructor
      Car car2 = new Car("Toyota Camry", 2023);
      car2.displayInfo();
   }
}
```

Exa : 3 Constructor chaining by using this()

```
class Car {
    private String model;
    private int year;
    // Default constructor
    public Car() {
        this("Unknown", 0); // Chaining to the parameterized constructor
    }
    // Parameterized constructor
    public Car(String model, int year) {
        this.model = model;
        this.year = year;
    }
}
```

Exm : 3 chaining with diff class by using supper key words.

```
class Parent {
    private String parentName;
    public Parent(String parentName) {
        this.parentName = parentName;
        System.out.println("Parent class constructor called");
    }
}
class Child extends Parent {
    private String childName;
    public Child(String childName) {
        super("Parent Name"); // Calling the parent class's constructor
        this.childName = childName;
        System.out.println("Child class constructor called");
    }
}
public class Main {
    public static void main(String[] args) {
        Child child = new Child("Child Name");
    }
}
```

Exa : 4 Constructor chaining by using supper() and this()

```
class Vehicle {
    protected String brand;
    protected int year;
    public Vehicle(String brand, int year) {
        this.brand = brand;
        this.year 1  = year;
    }
}
class Car extends Vehicle {
    private String model;
```

```
    public Car(String brand, int year, String model) {
        super(brand, year); // Call the parent class's constructor
        this.model = model;
    }
}
public class Main {
    public static void main(String[] args) {
        Car car = new Car("Toyota", 2023, "Camry");
    }
}
```

Feature	Is-A Relationship (Inheritance)	Has-A Relationship (Composition/Aggregation)
Keyword	extends	No specific keyword
Relationship	Hierarchical	Whole-part
Access	Inherited members can be accessed directly	Members of the composed object need to be accessed through its reference
Lifetime	Lifetime of the child object is tied to the parent object	Lifetime of the composed object is independent of the container object

The final Keyword in Java

The final keyword in Java is used to declare entities that cannot be modified once they are initialized. It can be applied to variables, methods, and classes.

1. Final Variables:

If we declare variable once final we cannot re-initialize.

- **Constant Variable**

```
final double PI = 3.14159;
```

- **Class-Level Constants:**

```
public class MyClass {
    public static final int MAX_VALUE = 100;
}
```

- **Final Methods:**

If we declare method once final we cannot override that method in the sub class.

- **Preventing Overriding:**

```
class Parent {

   public final void method () {
      // code
   }
}

class Child extends Parent {
   // Cannot override the final method
   public void method () {
      // code
   }
}
```

- **Final Classes:**

If we declare class once final, we cannot inherit that class.

Preventing Inheritance:

```
final class ImmutableClass {
   // code
}
class DerivedClass extends ImmutableClass { // Error: Cannot inherit from a final class
   // code
}
```

Method Binding***

- Method is divided into two parts:
    - Method signature
    - Method implementation
- Process of connecting method signature with method implementation is called method binding.
- During coding stage, developer is responsible only for creating method signature and method implementation.
- Methods are not bound during coding stage, rather methods are created during coding stage.
- Methods are bound either during compilation stage or execution stage.
- If methods are bound during compilation stage, then this binding is called compile-time binding.
- If methods are bound during execution stage, then this binding is called run-time binding.
- Compile-time binding is also known as static binding, because binding between method signature and method implementation can not be changed.

- **Run-time Binding** is also known as **dynamic binding or late binding** because the binding can be changed from one implementation to another implementation based on object creation.

- **Compile-time Binding** is also known as **early binding**, because methods are already bound before execution starts and methods are ready for execution at any point of time.

Note:

Main Method is static for two reasons:

1. Static methods are loaded first before non-static methods during compilation time.
2. Static methods are bound first (early binding) before non-static methods are bound.

Abstract

- Methods are classified into two types:
  - Concrete methods or complete method
  - In-complete methods
- Method which has method signature as well as method implementation is called concrete method.
- Method which has only method signature is called in-complete method or abstract method.
- **Steps to create abstract method:**
  - Step 1: Create only method signature.
  - Step 2: Declare end with semi-colon.
  - Step 3: Declare method as abstract.
  - Step 4: Declare class as abstract.

Exa :

```
abstract class Shape {
        public abstract void draw();
    }
```

Steps to use abstract method:

- Step 1: Create a sub-class to inherit in-complete method.
- Step 2: Complete the method or implement the method or override the method.
- If class contain even single abstract method, declare class as abstract.
- If subclass does not complete all the abstract methods, subclass is also abstract class.
- Declare super class as abstract class because to block super class object creation. (Because super class Object is not real)
- Classes are declared abstract in 3 cases:

Case 1: If class contain incomplete method, class is declared as abstract.

Case 2: To block object creation.

Case 3: If class contain all static members.

Exa :1

```
abstract class Shape {
    public abstract void draw();
    public void erase() {
        System.out.println("Erasing shape");
    }
}
abstract class Circle extends Shape {
    // Abstract method to be implemented by concrete subclasses
    public abstract void calculateArea();
    @Override
    public void draw() {
        System.out.println("Drawing a circle");
    }
}
class ColoredCircle extends Circle {
    @Override
    public void calculateArea() {
        // Implementation for calculating area of a circle
    }
}
```

*****Conclusion: Interface*****

- As soon as interface is created, new data type is created. This data type is called a user-defined data type or derived data type for non-primitive data types.
- As soon as interface are created, new blueprints are created.
- In interface all the methods are by default public and abstract.
- In interface all the variables are by default final and static.
- Class extends class
- Class extends class and implements interface
- Class implements multiple interfaces
- Interface extends interface
- Interface extends multiple interfaces
- Multiple inheritance is achievable using interface because there is no diamond problem because:
    - Interface does not allow constructors.
    - Have no ambiguity in constructor chaining.

Ambiguity problem :

- In interface does not allow constructor so there is no ambiguity problem.

Dimond problem :

In interface only method signature is there , there is no method implementation so we don't have diamond problem.

```
interface A{
public static walk();
}
```

```
interface B{
public static walk();
}
```

```
interface C extends A, B{
public static walk(){
//code
}
}
```

Inheritance By Using Interface :

1. Single level inheritance :

```
interface Animal {
   void eat();
   void sleep();
}

class Dog implements Animal {
   public void eat() {
      System.out.println("Dog is eating");
   }

   public void sleep() {
      System.out.println("Dog
 is sleeping");

   }
}
```

2. Multiple-Level Inheritance

```
 interface Pet {
    void pet();
 }
 interface Animal extends Pet {
    void eat();
    void sleep();
 }
 class Dog implements Animal {
```

```
    public void eat() {
        System.out.println("Dog is eating");
    }
    public void sleep() {
        System.out.println("Dog is sleeping");
    }
    public void pet() {
        System.out.println("Petting the dog");
    }
}
```

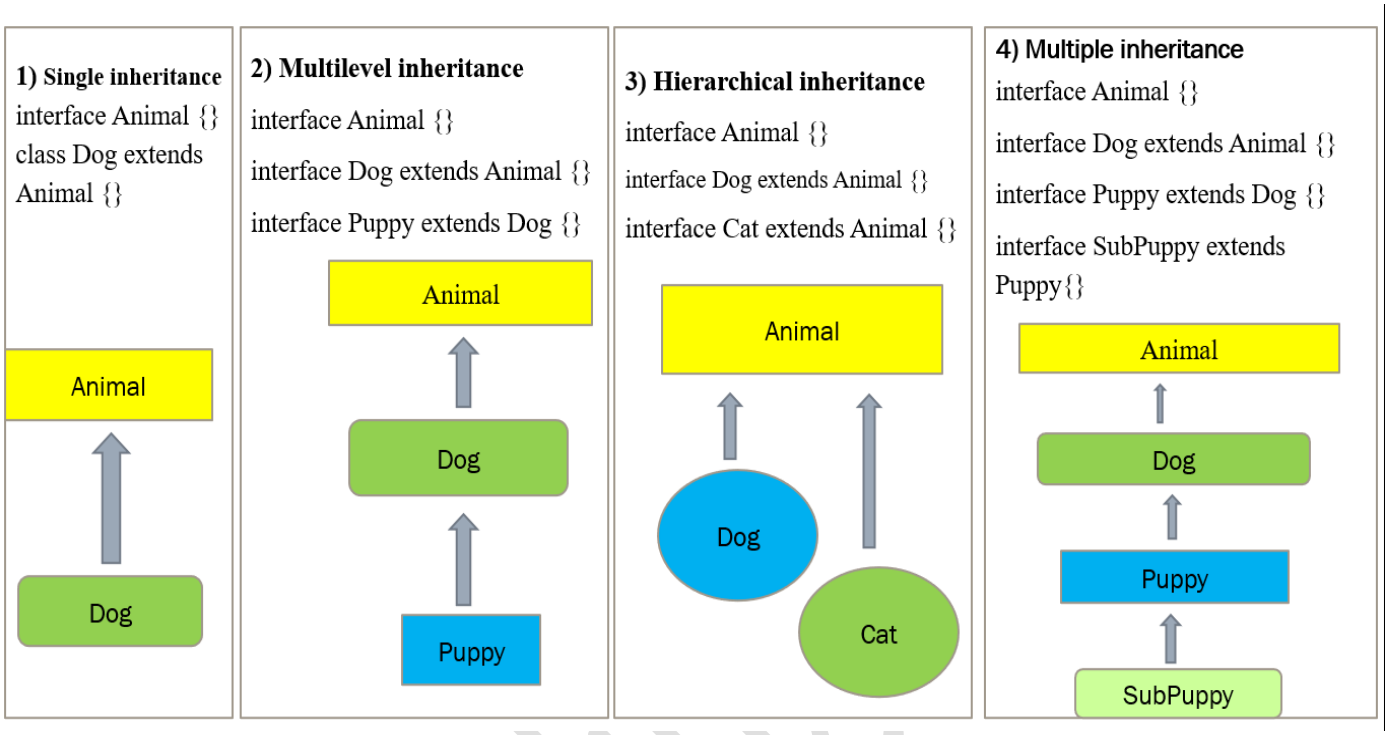
3. Multiple Inheritance

```
interface Flyable {
    void fly();
}
interface A{
}
interface Swimmable extends A{
    void swim();
}
class Duck implements Flyable, Swimmable {
    public void fly() {
        System.out.println("Duck is flying");
    }
    public void swim() {
        System.out.println("Duck is swimming");
    }
}
```

4. Hierarchical Inheritance

```
interface Vehicle {
    void move();
}
interface Car extends Vehicle {
    void drive();
}
interface Bike extends Vehicle {
    void ride();
}
class Sedan implements Car {
    public void move() {
        System.out.println("Sedan is moving");
    }
    public void drive() {
        System.out.println("Driving a sedan");
    }
}
class Motorcycle implements Bike {
    public void move() {
```

```
        System.out.println("Motorcycle is moving");
    }
    public void ride() {
        System.out.println("Riding a motorcycle");
    }
}
```



Specialization***

Process of creating a method which can take single objects. This process is called specialization and the method is called specialized method.

- Create specialized method.
- Create Static and non-static methods with arguments.
- Argument should be user define data type followed by object reference variable.
- Define repetitive code within specialized method.
- Call the method and pass object as an input to specialized method.

Note:

- User define data type and object type should be same.

#Generalization***

Process of creating a method which can take multiple objects of different types and have a common superclass. This process is called Generalization and the method is called generalized method.

→ Steps to create Generalized method:

- Create static or non-static method with arguments.
- Argument should be user-defined data type followed by object reference variable.
- Define repetitive code within generalized method.
- Call the method and pass an object as an input to generalized method.
- The passed object should be upcasted.
- User-defined data type should be superclass data type, whereas passed object should be subclass type.
- Finally, we concluded, by using specialization or generalization, we can minimize code repetition and implement code reusability.

Exa : Generalization :

```
class Shape {
    public void draw() {
        System.out.println("Drawing a shape");
    }
}
class Circle extends Shape {
    @Override
    public void draw() {
        System.out.println("Drawing a circle");
    }
}
class Square extends Shape {
    @Override
    public void draw() {
        System.out.println("Drawing a square");
    }
}
public class Main {
    public static void drawShape(Shape shape) {
        shape.draw();
    }
    public static void main(String[] args) {
        Circle circle = new Circle();
        Square square = new Square();

        drawShape(circle);
        drawShape(square);
    }
}
```

Exa : Specialization:

```
class Animal {
    public void makeSound() {
        System.out.println("Generic animal sound");
    }
}
```

```
class Dog extends Animal {
   @Override
   public void makeSound() {
      System.out.println("Woof!");
   }
}
public class Main {
         public static void  callDog(Dog dog) {
      System.out.println("Meow!");
   }
   public static void main(String[] args) {
      Dog dog1 = new Dog();
      Dog dog2 = new Dog();
      dog1.makeSound();
      dog2.makeSound();
   }
}
```

Abstraction(imp) ***

- In simple words, abstraction means hiding unnecessary detail and providing access only to necessary detail.
- In technical terms, abstraction means hiding method implementation detail and providing access only to method signature.

Abstraction is achieved in 2 ways: By using abstract class and by using interface.

Steps to design Abstraction:

Step 1: Create an interface / abstract class.
Step 2: Create a method in interface / abstract class.
Step 3: Create implementation class / sub class.
Step 4: Implement the method / Override the method.
Step 5: Create a helper class.
Step 6: Create helper methods.
Step 7: Helper method will create object of implementation class / sub class.
Step 8: Implementation class object is upcasted to interface / superclass.
Step 9: Upcasted object is returned.

Step 10: Call the helper method.

- If the helper method is static, call the helper method by using helper class name.
- If the helper method is non-static, create helper class object and call the helper method by using helper class object reference variable.

Step 11: Helper method will return implementation class object in upcasted manner.
Step 12: Receive the object by using interface datatype followed by object reference variable.
Step 13: Use object reference variable to call interface methods.

Exm :1

```
interface Shape {
   void draw();
}
class Circle implements Shape {
   @Override
   public void draw() {
      System.out.println("Drawing a circle");
   }
}
class HelperClass {
   public static Shape getShapeObject() {
                  Shape shape=new Circle();
      return shape;
   }
}
public class Main {
   public static void main(String[] args) {
      Shape shape = HelperClass.getShapeObject();
      shape.draw();  // Output: Drawing a circle
   }
}
```

 # Compile Time Polymorphism

- Polymorphism means single entity having multiple forms.
- Polymorphism classified into two types:
    1. **Compile-time polymorphism**
    2. **Run-time polymorphism**

➢ **Compile-time polymorphism*****

- Call to overloaded method is decided during compilation time based on the argument list. This is called compile-time polymorphism.
- In order to achieve compile-time polymorphism, we need to use:
    1. Static methods
    2. Method overloading

➢ **Run-time polymorphism*****

- Call to overridden method is decided during runtime based on the object creation. This is called runtime polymorphism.
- To achieve runtime polymorphism, we need to use:
    1. Interface/Superclass/abstract class

2. Implementation class/subclass
3. Method overriding.
4. Generalization
5. Upcasting

Exa : Compile time polymorphism*

```
class Calculator {
    public static int add(int a, int b) {
        return a + b;
    }
    public static double add(double a, double b) {
        return a + b;
    }
}
public class Main {
    public static void main(String[] args) {
        int sum1 = Calculator.add(2, 3);
        double sum2 = Calculator.add(2.5, 3.5);
    }
}
```

Exa : Run time polymorphism

```
class Animal {
    public void makeSound() {
        System.out.println("Generic animal sound");
    }
}
class Dog extends Animal {
    @Override
    public void makeSound() {
        System.out.println("Woof!");
    }
}
class Cat extends Animal {
    @Override
    public void makeSound() {
        System.out.println("Meow!");
    }
}
public class Main {
    public static void main(String[] args) {
        Animal animal1 = new Dog();
        Animal animal2 = new Cat();
        animal1.makeSound(); // Output: Woof!
        animal2.makeSound(); // Output: Meow!
    }
}
```

***Instanceof key word ***

It is used to check if an object is belong to particular class / interface or not, ensuring type safety during down casting.

Syntex : boolean result = object instanceof ClassName;

Exa :

```
class Animal {
    public void makeSound() {
        System.out.println("Generic animal sound");
    }
}
class Dog extends Animal {
    public void bark() {
        System.out.println("Woof!");
    }
}
public class Main {
    public static void main(String[] args) {
        Animal animal = new Dog();

        if (animal instanceof Dog) {
            Dog dog = (Dog) animal; 1
            dog.bark(); // This will print "Woof!"
        } else {
            System.out.println("Animal is not a Dog");
        }
    }
}

public class NeonNumber {
    public static void main(String[] args) {
        int num = 9, square = num * num, sum = 0;
        // Calculate the sum of the digits of the square
        while (square > 0) {
            sum += square % 10;
            square /= 10;
        }
 if (sum == num)
     System.out.println(num + " is a Neon Number.");
  else
     System.out.println(num + " is not a Neon Number.");
}
```

#Lambda***

- **Lambda expression** is an anonymous function that doesn't have a name, modifiers, or return type.

- Lambda expressions work only with functional interfaces, which are interfaces that contain only one abstract method.
- By using lambda expressions, we can convert Java from an object-oriented language to a functional programming language. Functional programming means any operation doesn't need to be written in an elaborate way. By using lambda expressions, we can simplify the code. This simplification process is known as functional programming.
- Lambda expressions were introduced in the year 2014 and in the JDK version of 1.8.

Syntax:

(parameter list) -> lambda body

Exa :1

```
import java.util.Arrays;
import java.util.Collections;
import java.util.List;
public class LambdaExample {
   public static void main(String[] args)
 {
      List<String> names = Arrays.asList("Alice", "Bob", "Charlie",
 "David");
      // Sort the list using a lambda expression
      Collections.sort(names, (a, b) -> a.compareToIgnoreCase(b));
      // Print the sorted list
      for (String name : names) {
         System.out.println(name);
      }
   }
}
```

#Object Class

- **Object class** is an inbuilt class present in the java.lang package.
- **Object class** is the super most class present in Java.
- **Object class** contains common methods which will be applicable in any type of object, so that the name they have given it is Object.
- In between our class and Object class, there is an implicit inheritance.
- When a developer needs to perform inheritance, the compiler itself will be performing the inheritance.
- Object class contains **11 common methods** which will be applicable in all the classes present in Java.
- All the object class methods are **non-static methods**.

- While performing inheritance, we have to create an object of the subclass. By using the subclass object reference variable, we are going to access object class properties.
- Object class properties follow **1st method** as:

Object class methods:

1. **toString()**: String
2. **equals(Object obj)**: boolean
3. **hashCode()**: int
4. **getClass()**: Class<?>
5. **clone()**: Object
6. **wait()**: void
7. **wait(long timeout)**: void
8. **wait(long timeout, int nanos)**: void
9. **notify()**: void
10. **notifyAll()**: void
11. **finalize()**: void

1. **toString(): String**
    - It is non static method, in entire java toString() will be executed without calling, that's why we are calling this special method.
    - **Example:** System.out.println(new Object().toString());
2. **equals(Object obj): boolean**
    - Compares this object with the specified object for equality.
    - **Example:** String s1 = "hello"; String s2 = "hello"; System.out.println(s1.equals(s2));
3. **hashCode(): int**
    - Returns a hash code value for the object.
    - **Example:** Integer i = new Integer(10); System.out.println(i.hashCode());
4. **getClass(): Class<?>**
    - Returns the Class object associated with this object.
    - **Example:** String s = "hello"; System.out.println(s.getClass());
5. **clone(): Object**
    - Creates and returns a copy of this object.
    - **Example:** Object obj = new Object(); Object cloneObj = obj.clone();
6. **wait(): void**
    - Causes the current thread to wait until another thread invokes the notify() method or the notifyAll() method for this object if developer for to call notify() then thread will go to dead lock situation.
    - **Example:** Used in inter-thread communication.
7. **wait(long timeout): void**
    - Causes the current thread to wait until another thread invokes the notify() method or the notifyAll() method for this object, or a specified timeout occurs.

- **Example:** Used in inter-thread communication with a timeout.

8. **wait(long timeout, int nanos): void**
   - Causes the current thread to wait until another thread invokes the notify() method or the notifyAll() method for this object, or a specified timeout occurs, with nanosecond precision.
   - **Example:** Used in inter-thread communication with a precise timeout.
9. **notify(): void**
   - Wakes up a single thread that is waiting on this object's monitor.
   - **Example:** Used in inter-thread communication to signal a waiting thread.
10. **notifyAll(): void**
    - Wakes up all threads that are waiting on this object's monitor.
    - **Example:** Used in inter-thread communication to signal all waiting threads.
11. **finalize(): void**
    - Called by the garbage collector on an object before it is garbage collected.
    - **Example:** Can be overridden to perform cleanup tasks, but it's generally discouraged.

#Wrapper Class**

#What is wrapper class?

- The class which will wrap the primitive data. Such classes we can call as wrapper class.

#Before wrapper class

- We can not conclude Java as 100% object-oriented language because we cannot create the object of pre-define data.

#After wrapper class

- We can conclude Java as 100% object-oriented language. Because not only for class we can create object even for predefine data also we can create the objects, by using wrapper classes.
- Each and every predefine datatype it having its own corresponding wrapper class.

Data Type	Wrapper Classes
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double
char	Character
boolean	Boolean 1

#Boxing

- The process of converting predefined data into Object is known as Boxing.
- Boxing can be done in 2 ways:
    - Explicit Boxing
    - Implicit Boxing

Explicit Boxing:

By using the new operator and constructors calling, if we do this type of boxing, such type is known as Explicit boxing.

```
package wrapper_class;

public class Explicit_Boxing_UnBoxing {
   public static void main(String[] args) {
      int intData = 10;
      Integer intObject = new Integer(intData);
   }
}
```

Implicit Boxing and Auto Boxing

- From JDK versions of 1.0 to 1.4, developers can perform only Explicit Boxing and unboxing but from JDK 1.5 developers can perform explicit and at the same time, he can also perform implicit boxing and unboxing.
- Implicit boxing is also known as auto boxing.

Exa :

```
Integer intObject = 10; // Implicit Boxing
```

#Unboxing

- The process of converting again back from object to predefined data. Is known as unboxing.
- Unboxing can be done in 2 ways:
    - Explicit Unboxing
    - Implicit Unboxing

#Explicit Unboxing

- To perform explicit unboxing, developer has to call value() method.
- This method will return corresponding primitive data.

```
int intVal = IntegerObject.intValue(); // Explicit Unboxing
byte byteVal = ByteObject.byteValue(); // Explicit Unboxing
```

```
package wrapper_class;

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

```
        int intData = 10;
        Integer intObject = new Integer(intData); // Explicit Boxing
        int intVal = intObject.intValue(); // Explicit Unboxing
    }
}
```

#Implicit Unboxing/Auto Unboxing

- From JDK 1.0 to 1.4, developers can perform only explicit unboxing.
- From JDK 1.5, developers can perform unboxing in both explicit and implicit ways.
- Implicit unboxing is also known as auto unboxing.

Exm :

```
Integer i=10;

int j=i;

public class BoxingUnboxingExample {
    public static void main(String[] args) {
        // Implicit Boxing
        int num = 10;
        Integer integerObject = num; // Implicitly boxed to Integer

        // Explicit Boxing
        float f = 2.5f;
        Float floatObject = new Float(f);

        // Implicit Unboxing
        int num1 = integerObject; // Implicitly unboxed to int

        // Explicit Unboxing
        char charValue = charObject.charValue();
    }
}
```

Converting Strings to Primitive Data Types in Java

To convert a string to a primitive data type in Java, you typically use the parseXXX() methods provided by the respective wrapper classes. Here are some common examples:

```
public class StringToPrimitiveConversion {
    public static void main(String[] args) {
        // Conversion to Integer
        String intStr = "123";
        int intNum = Integer.parseInt(intStr);
        System.out.println("Integer value: " + intNum);

        // Conversion to Double
        String doubleStr = "3.14";
        double doubleNum = Double.parseDouble(doubleStr);
```

```
        System.out.println("Double value: " + doubleNum);

        // Conversion to Boolean
        String boolStr = "true";
        boolean boolValue = Boolean.parseBoolean(boolStr);
        System.out.println("Boolean value: " + boolValue);

        // Conversion to Long
        String longStr = "1234567890";
        long longNum = Long.parseLong(longStr);
        System.out.println("Long value: " + longNum);

        // Conversion to Float
        String floatStr = "3.14f";
        float floatNum = Float.parseFloat(floatStr);
        System.out.println("Float value: " + floatNum);

        // Conversion to Character
        String charStr = "A";
        char charValue = charStr.charAt(0);
        System.out.println("Character value: " + charValue);
    }
}
```

Converting Primitive Data Types to Strings in Java

1. Using `String.valueOf()`

The `String.valueOf()` method is a way to convert various data types, including primitive data types, to the string.

```
int num = 42;
String str = String.valueOf(num);

double pi = 3.14159;
String piStr = String.valueOf(pi);

boolean isTrue = true;
String boolStr = String.valueOf(isTrue);

char ch = 'A';
String charStr = String.valueOf(ch);
```

2. Using `toString()` Method of Wrapper Classes

Each primitive data type has a corresponding wrapper class. These wrapper classes provide a `toString()` method to convert the primitive value to its string representation.

```
int num = 42;
String str = Integer.toString(num);
```

```
double pi = 3.14159;
String piStr = Double.toString(pi);

boolean isTrue = true;
String boolStr = Boolean.toString(isTrue);

char ch = 'A';
String charStr = Character.toString(ch);
```

 # Third way of performing Boxing

- Boxing can also be done by using valueOf().
- Which is presenting corresponding wrapper classes and we have to access this method by using class name.

Ex:

```
1. Character charObject = Character.valueOf('#');
2. Integer intObject = Integer.valueOf(10);
3. Byte byteObject = Byte.valueOf((byte) 10);
4. Short shortObject = Short.valueOf((short) 10);
5. Long longObject = Long.valueOf(1234567890L);
6. Float floatObject = Float.valueOf(10.5F);
7. Double doubleObject = Double.valueOf(10.5);
8. String stringObject = String.valueOf("text");
```

#Exception(imp):

- Exception is an unexpected event faced by JVM inside Stack area.
- Once an exception occurred in our program, JVM will be immediately terminated.

#Exception Handling

The process of handling the Exception is exception handling.

- If developer has given exception handling code, exception will be handled.
- If developer does not given exception handling code, JVM will be creating an exception object and with the property of:
  - Name, Description, Location
- With this property, JVM will be calling print stack trace method implicitly.
- print stack trace method will be using this exception property and this method will trace the stack area and what all happening in stack area will be printed.
- Exception can be handled by try and catch block
  - **try block**
  - **catch block**

- All the dangerous statements should be written inside **try block**.
- All the recovery statements should be written inside **catch block**.

Syntax :

```
try {
   // Code that might throw an exception
} catch (ExceptionType1 exceptionObject1) {
   // Handle ExceptionType1
} catch (ExceptionType2 exceptionObject2) {
   // Handle ExceptionType2
} finally {
   // Code that always executes, regardless of exceptions
}
```

Exm :

```
public class ExceptionExample {
   public static void main(String[] args) {
      int[] numbers = {10, 20, 30};
      try {
         // This line might throw an ArrayIndexOutOfBoundsException
         int value = numbers[5]; // Index 5 is out of bounds
         System.out.println("Value: " + value);
      } catch (ArrayIndexOutOfBoundsException e) {
         System.out.println("Array index out of bounds: " + e.getMessage());
      }
   }
}
```

#Exception Propagation

- The process of moving on or shifting or propagating from called method to caller method is called exception propagation.
- In our program if we use propagate Exception object from called method to caller method, this process is known as Exception propagation.

Exception propagation will done in two ways

1. Explicit propagation
2. Implicit propagation

There are two types of exception

1. Checked Exception
2. Unchecked Exception

Checked Exception

- If the statement is checked by compiler - those statements are known as checked statements.
- What all the exception classes are inheriting exception super class, those exceptions are becoming checked exception.
- Examples of Checked Exception:

  - **IOException:** Occurs when an I/O operation fails, such as reading or writing to a file.
  - **SQLException:** Occurs when a database operation fails.
  - **ClassNotFoundException:** Occurs when a class cannot be found.

Unchecked Exception

- If the statement is not checked by compiler, those statement are known as unchecked statements.
- what an all the exception classes are inheriting run time exception super class, that will become unchecked statement exception.
- If our program contains unchecked statement, we have to perform implicit propagation, implicit propagation can be done by using without throws keyword

Note

- If we are performing explicit propagation we have to make use of throws keyword followed by the exception type.

  Exa:

  - **NullPointerException:** Occurs when trying to use an object reference that has not been initialized.
  - **ArrayIndexOutOfBoundsException:** Occurs when trying to access an array element with an invalid index.
  - **ArithmeticException:** Occurs when an arithmetic operation, such as division by zero, fails.
  - **ClassCastException:** Occurs when trying to cast an object to an incompatible type.
  - **IllegalArgumentException:** Occurs when a method is called with an illegal or invalid argument.
  - **IllegalStateException:** Occurs when a method is called at an illegal or inappropriate time.
  - **IndexOutOfBoundsException:** Occurs when trying to access an index that is out of bounds of a list or array.

#User Defined Exception

- An exception created from user side this is known as user defined exception.
- To create user defined exception, a developer can create a class and class should inherit exception super class or RuntimeException super classes.
- According to the exception which you want to throw the exception, by using the try-catch block we have to catch.

How to Create User Defined Exception

1. **Create a Class**
   That class should inherit exception super class or implement RuntimeException super classes.
2. **Creating the exception**
   We can create the exception by using the throw keyword.

3. If in case our exception wants to become unchecked exception, we need to make use of RuntimeException.

Throws keyword :

- By using throws key word, we can propagate our exception from called method to caller method.
- We can use this for predefine exception and checked exception.
- unchecked exception will be propagated by implicit no need to throws by developer.

Exa :

```
public class InsufficientFundsException extends Exception {
   public InsufficientFundsException(String message) {
      super(message);
   }
}
public class Account {
   private double balance;

   public void withdraw(double amount) throws InsufficientFundsException {
      if (balance < amount) {
         throw new InsufficientFundsException("Insufficient balance");
      }
      balance -= amount;
   }
}
public class Main {
   public static void main(String[] args) {
      Account account = new Account();
      account.balance = 100;
      try {
         account.withdraw(200);
      } catch (InsufficientFundsException e) {
         System.out.println("Error: " + e.getMessage());
      }
   }
}
```

#Finally Block

- All the program terminative statement or imp. statement should be given inside the finally block.
- Finally block will be executed irrespective of exception means
    - If exception occurs catch and finally will be executed.
    - If exception does not occur try and finally block will be executed.

Exa :

```
public class FinallyBlockExample {
    public static void main(String[] args) {
        try {
            int result = 10 / 0; // This will throw an ArithmeticException
        } catch (ArithmeticException e) {
            System.out.println("Arithmetic Exception: " + e.getMessage());
        } finally {
            System.out.println("This will always execute.");
        }
    }
}
```

Exception Information will be printed by using following 3 methods.

1. **printStackTrace(); void**
2. **toString(); String**
3. **getMessage(); String**

1. printStackTrace(): void

- Prints a detailed stack trace .
- Which include exception name, description and location of the exception.

2. toString(): String

- Returns a string representation of the exception, typically including the exception's class name and a brief message.

3. getMessage(): String

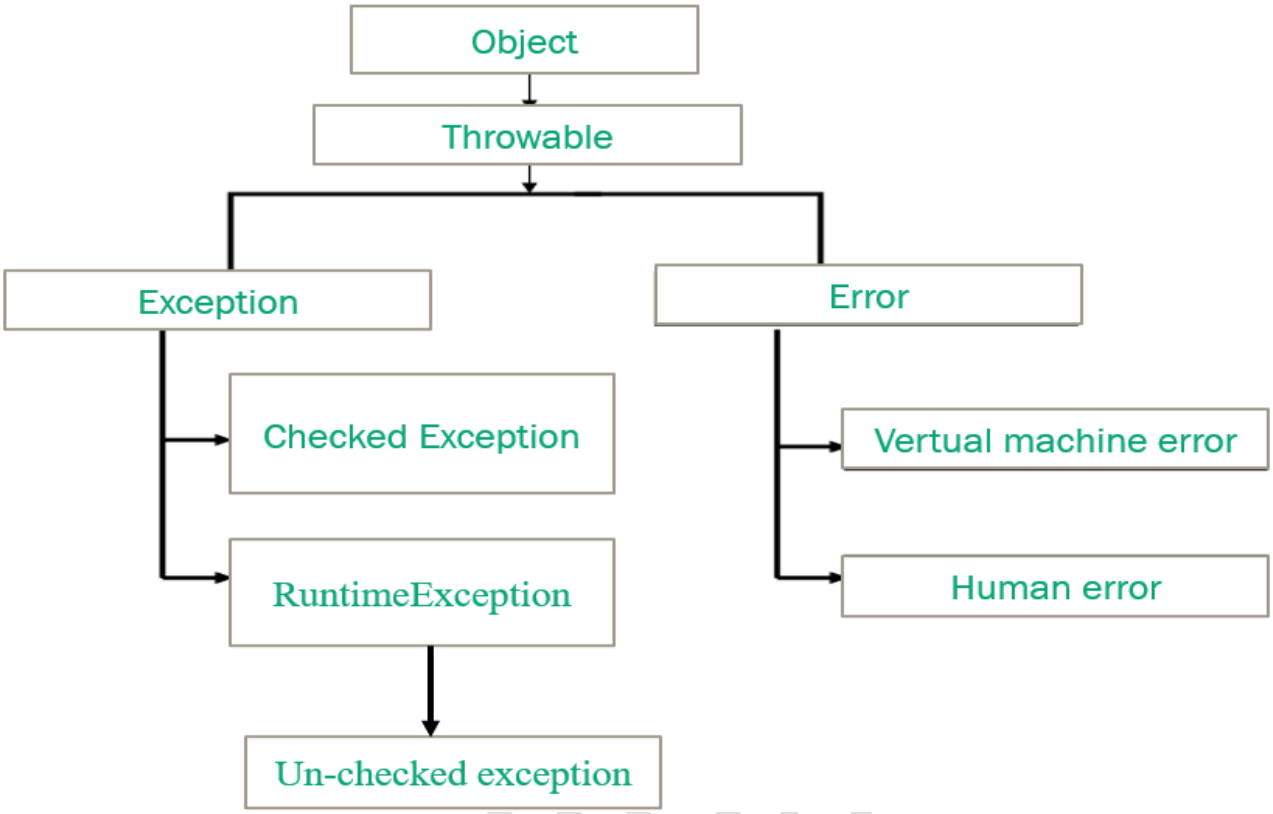
Diff b/w error and exception?

Feature	Errors	Exceptions
Definition	Severe issues that indicate system problems beyond the program's control.	Unexpected events that occur during program execution due to issues within the code.
Recoverability	Generally not recoverable	Can often be recovered from using try-catch blocks.
Checked/Unchecked	All errors are unchecked.	Can be both checked and unchecked.
Responsibility	System or environment	Program code
Package	java.lang.Error	java.lang.Exception
Examples	OutOfMemoryError, StackOverflowError, VirtualMachineError	NullPointerException, ArrayIndexOutOfBoundsException, IOException, SQLException

Diff b/w throe and throws keyword?

Feature	throw Keyword	throws Keyword
Purpose	Used to create and throw an exception	Used to declare that a method might throw one or more exceptions
Exception Type	Can throw only one exception at a time	Can declare multiple exceptions
Usage	Primarily used for unchecked exceptions	Primarily used for checked exceptions
Placement	Can be used inside methods, constructors, or conditional blocks	Must be declared in the method signature

Exception hierarchy :



Collection :

A collection is a data structure that organizes and stores multiple objects, providing efficient ways to manage. It can be dynamic, store various data types and it offers operations like adding, removing, searching, and sorting.

Feature	Array	Collection
Type	Object	Interface
Data Type	Homogeneous (same data type)	Heterogeneous (different data types)
Primitive Data Types	Can store	Cannot store
Fixed Size	Yes	No
Methods	Limited built-in methods	Rich set of methods for various operations

What is Collection (Interface)?

- Collection is a predefined interface in Java.
- It was introduced in version JDK 1.2.
- It is present in the java.util package.
- In Java, the collection framework provides a standard architecture to store groups of objects.

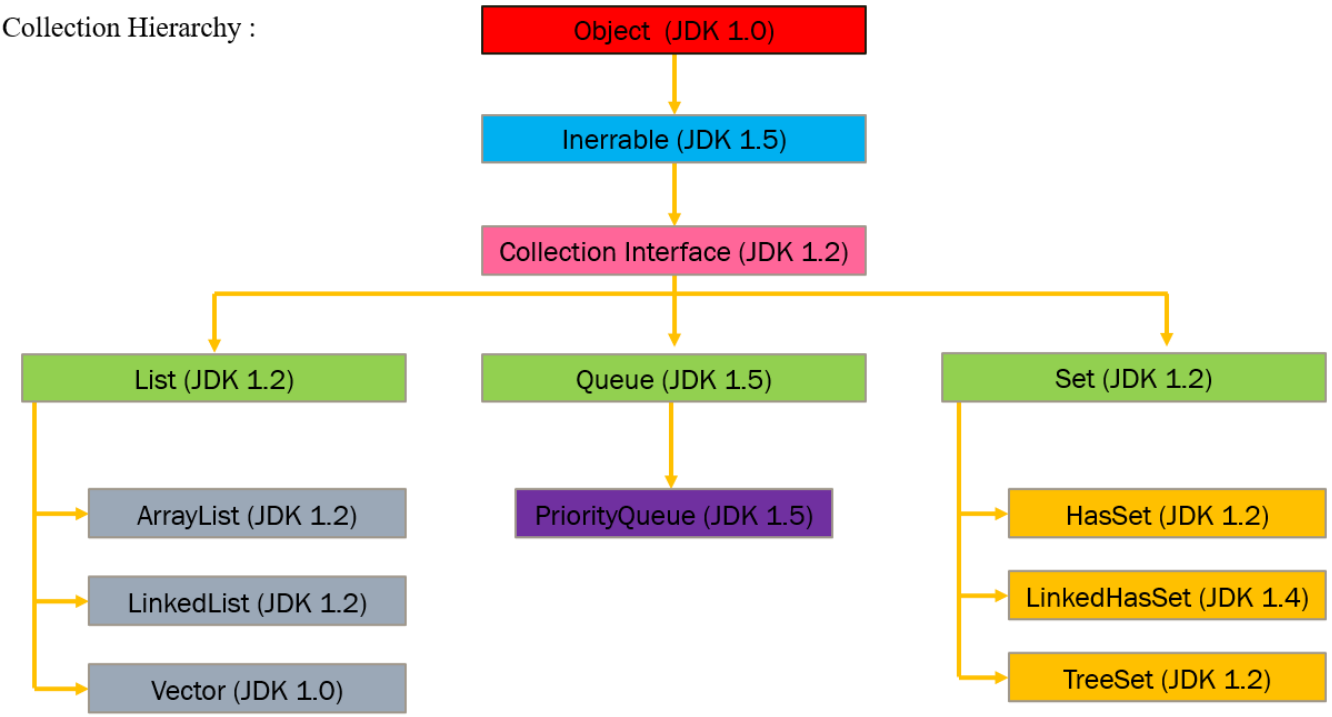
Note Point:

- Collection is nothing but a collection/group of objects.

What is Framework?

- Framework represents a group of classes and interfaces.

Collection Hierarchy :



Diff b/w Generic Type Collection and Raw Type Collection?

Feature	Generic Type Collection	Raw Type Collection
Type Safety	more type safety	less type safty
Flexibility	More flexible, because it can handle different data types with type parameters	Less flexible, can only handle Object types
Performance	Slightly slower due to type checking	Slightly faster due to less type checking
Recommended Usage	Strongly recommended for modern Java development	Discouraged in modern Java development
Example	ArrayList<String> names = new ArrayList<>();	ArrayList names = new ArrayList();

Exa :

```
// Generic ArrayList to store Strings
ArrayList<String> names = new ArrayList<>();
names.add("Alice");
names.add("Bob");
names.add("Charlie");

// Raw ArrayList
ArrayList list = new ArrayList();
list.add("Apple");
list.add(123);
list.add(true); // This is not type-safe and can lead to runtime errors

// Generic HashMap to store key-value pairs of Integer and String
HashMap<Integer, String> map = new HashMap<>();
map.put(1, "Apple");
map.put(2, "Banana");
map.put(3, "Cherry");

// Raw HashMap
HashMap map2 = new HashMap();
map2.put("name", "Alice");
map2.put("age", 30);
map2.put("city", "New York"); // Again, not type-safe
```

List

- List is a predefined subinterface of the Collection interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- List interface having 4 implementation classes:

1. ArrayList
2. LinkedList
3. Vector

Common qualities of List type of collection:

- It is index-based.
- It allows duplicate values.
- It allows null values.

Basic Operations:

- **add(E e):boolean**
  Adds the specified element to the end of the list.

- **add(int index, E element):void**
  Inserts the specified element at the specified position in the list.

- **clear():void**
  Removes all of the elements from this list.

- **contains(Object o):Boolean**
  Returns true if this list contains the specified element.

- **get(int index):object**
  Returns the element at the specified position in this list

- **indexOf(Object o):int**
  Returns the index of the first occurrence of the specified element in this list, or -1 if this list does not contain the element.

- **isEmpty():boolean**
  Returns true if this list contains no elements.

- **lastIndexOf(Object o):int**
  Returns the index of the last occurrence of the specified element in this list, or -1 if this list does not contain the element.

- **remove(int index):obje**ct
  Removes the element at the specified position in this list.

- **remove(Object o):boolean**
  Removes the first occurrence of the specified element from this list, if it is present.

- **set(int index, E element):object**
  Replaces the element at the specified position in this list with the specified element.

- **size():int**
  Returns the number of elements in this list.

Search and Sort:

- **containsAll(Collection<?> c):boolean**
  Returns true if this list contains all of the elements of the specified collection.

- **indexOfAll(Object o):**
  Returns a list containing all indices of the specified element in this list.

- **lastIndexOfAll(Object o):**
  Returns a list containing all indices of the last occurrence of the specified element in this list.

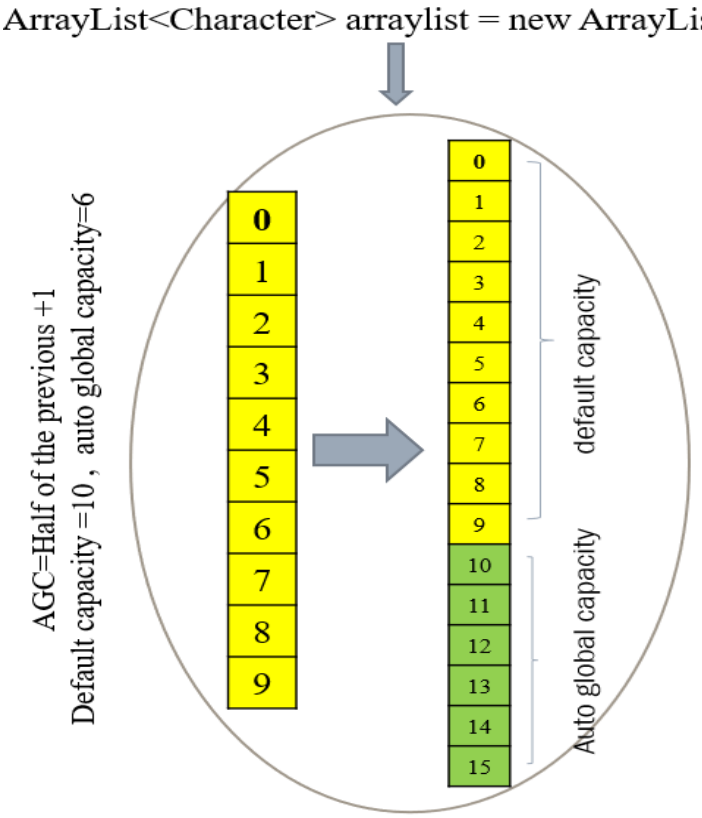
- **sort(Comparator<? super E> c): void**
  Sorts this list according to the order induced by the specified comparator.

ArrayList

- ArrayList is a predefined implementation class of the List interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- ArrayList is index-based.
- It allows duplicate values.
- It allows null values.
- ArrayList is both homogeneous as well as heterogeneous.
- ArrayList follows insertion order.
- The initial or default capacity of ArrayList is 10 continuous memory blocks.
- The auto-growable capacity of ArrayList is half of its previous capacity + 1.

Syntax :

```
ArrayList<Character> arraylist = new ArrayList<>();
```



Exa: All collection operation by using array list?

```
import java.util.ArrayList;
import java.util.Arrays;
import java.util.Collections;

public class ArrayListExample {
    public static void main(String[] args) {
        // Create an ArrayList to store integers
        ArrayList<Integer> numbers = new ArrayList<>();

        // Adding elements
        numbers.add(10);
        numbers.add(20);
        numbers.add(5);
        numbers.add(15);

        // Printing the ArrayList
        System.out.println("Original ArrayList: " + numbers);

        // Getting the size
        int size = numbers.size();
        System.out.println("Size of the ArrayList: " + size);

        // Checking if an element exists
        boolean contains20 = numbers.contains(20);
        System.out.println("Does the ArrayList contain 20? " + contains20);

        // Getting an element by index
        int thirdElement = numbers.get(2);
        System.out.println("Third element: " + thirdElement);

        // Removing an element by index
        numbers.remove(1);
        System.out.println("ArrayList after removing the second element: " + numbers);

        // Removing an element by value
        numbers.remove(Integer.valueOf(15));
        System.out.println("ArrayList after removing 15: " + numbers);

        // Clearing the ArrayList
        numbers.clear();
        System.out.println("ArrayList after clearing: " + numbers);

        // Adding multiple elements using the addAll method
        numbers.addAll(Arrays.asList(1, 2, 3, 4, 5));
        System.out.println("ArrayList after adding multiple elements: " + numbers);
```

```
        // Sorting the ArrayList
        Collections.sort(numbers);
        System.out.println("Sorted ArrayList: " + numbers);

        // Reversing the ArrayList
        Collections.reverse(numbers);
        System.out.println("Reversed ArrayList: " + numbers);

        // Checking if the ArrayList is empty
        boolean isEmpty = numbers.isEmpty();
        System.out.println("Is the ArrayList empty? " + isEmpty);
    }
}
```

Exa : 2 retrieve element from ArrayList 1 by 1?

```
import java.util.ArrayList;
public class ArrayListExample {
    public static void main(String[] args) {
        // Create an ArrayList to store strings
        ArrayList<String> names = new ArrayList<>();
        // Add elements to the ArrayList
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");
        // Iterate through the ArrayList using a for-each loop
        for (String name : names) {
            System.out.println(name);
        }
    }
}
```

Exa :3 WAP to convert array to arrayList ?

```
import java.util.ArrayList;
import java.util.Arrays;

public class ArrayToArrayListConversion {
    public static void main(String[] args) 1  {
        // Create an array of strings
        String[] colors = {"Red", "Green", "Blue", "Yellow"};

        // Convert the array to an ArrayList using Arrays.asList()
        ArrayList<String> colorList = new ArrayList<>(Arrays.asList(colors));

        // Print the ArrayList
        System.out.println("Color List: " + colorList);
    }
}
```

LinkedList: (Double Linked List)

- LinkedList is a predefined implementation class of the List interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- LinkedList is index-based.
- It allows duplicate values.
- It allows null values.
- LinkedList follows insertion order (Same inserting order).
- LinkedList is both homogeneous and heterogeneous.
- In LinkedList, there is no initial capacity.
- Whenever we are adding elements into the collection, that time instantly one memory block will get created.
- Each memory block knows where my next object is present and next object knows where my previous object is present.

Exa :

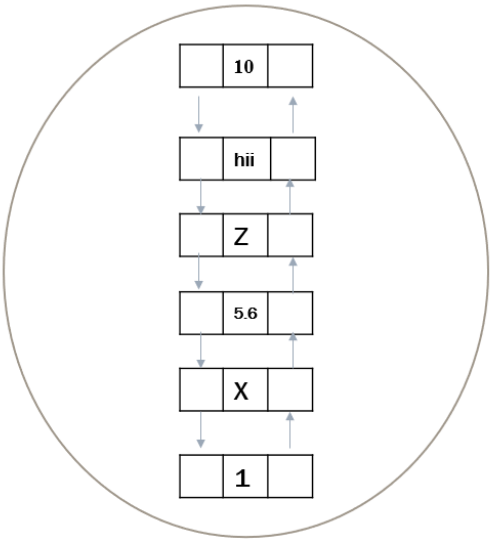
```
import java.util.LinkedList;

public class LinkedListExample {
    public static void main(String[] args) {
        // Create a LinkedList to store strings
        LinkedList<String> names = new LinkedList<>();

        // Add elements to the LinkedList
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");

        // Iterating through the LinkedList using a for-each loop
        for (String name : names) {
            System.out.println(name);
        }
    }
}
```

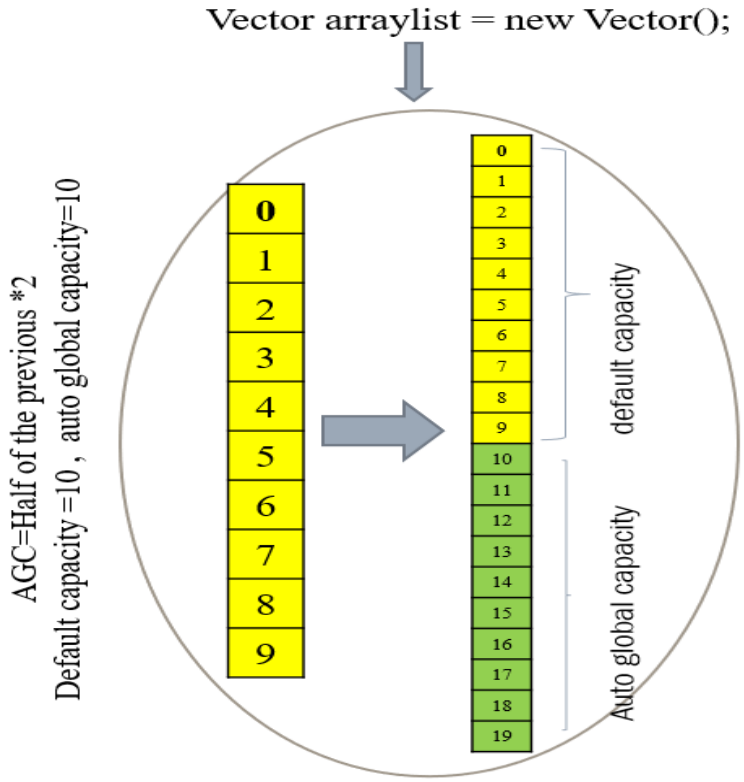
Work flow and architecture:



Vector/Legacy Class:

- Vector is a predefined implementation class of the List interface.
- It was introduced in the version of JDK 1.0.
- It is present in the java.util package.
- Vector class is also called as Legacy class because vector class was introduced before introducing collection.
- Vector class is thread-safe.
- It allows duplicate and null values.
- Vector follows insertion order.
- Vector is both homogeneous and heterogeneous.
- The initial capacity of vector is 10 continuous memory blocks.
- The auto-growable capacity of vector is half of its previous capacity + 1.

Sytaxt:
Vector vector = new Vector();




```
import java.util.Vector;

public class VectorExample {
    public static void main(String[] args) {
        // Create a Vector to store strings
        Vector<String> names = new Vector<>();

        // Add elements to the Vector
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");

        // Printing the Vector
        System.out.println("Original Vector: " + names);

        // Adding an element at the beginning
        names.add(0, "David");
        System.out.println("Vector after adding David at the beginning: " + names);

        // Removing the first element
        names.remove(0);
        System.out.println("Vector after removing the first element: " + names);

        // Getting the first and last elements
        String firstElement = names.firstElement();
        String lastElement = names.lastElement();
        System.out.println("First element: " + firstElement);
        System.out.println("Last element: " + lastElement);
```

```
        // Iterating through the Vector using a for-each loop
        for (String name : names) {
            System.out.println(name);
        }
    }
}
```

Queue

- Queue is a sub-interface of the Collection interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- Queue interface having one predefined implementation class.

Common qualities of Queue interface:

- Queue is not index-based.
- Queue allows duplicate values.
- Queue does not allow null values.

PriorityQueue

- PriorityQueue is a predefined implementation class of the Queue interface.
- It was introduced in the version of JDK 1.5.
- PriorityQueue is not index-based.
- It is present in the java.util package.
- It allows duplicate values.
- It does not allow null values.
- If the programmer tries to store a null value, that time null value will get a NullPointerException.
- PriorityQueue is only homogeneous. If we try to store different data types, we will get a ClassCastException.

Golden rules of priority queue:

- Insert the elements from top to bottom and left to right.
- The minimum element overall should always called as a parent element.
- Every parent element should not contain zero children, one children and two children.
- Parent element should not contain more than 2 children.00000.Always parent element should be less than child elements.
- Suppose if parent element is greater than child element, that time internally parent element is swapping with child element (interchange).
- While inserting the elements in priority queue, it maintains minimum heap order.
- While removing the element from priority queue, it follows FIFO (First in First Out) order.

Priority queue having two predefined own methods:

1. **peek(): Object**

   - it is non-static method present in PriorityQueue, peek() is used to return/retrieve/get the head element from the collection.

2. **poll(): Object**

- it is non-static method present in PriorityQueue, poll() first it will retrieve the head object and permanently remove it from the collection.

Exa :

```
import java.util.PriorityQueue;

public class PriorityQueueExample {
    public static void main(String[] args) {
        // Create a PriorityQueue 1  to store integers
        PriorityQueue<Integer> pq = new PriorityQueue<>();

        // Add elements to the PriorityQueue
        pq.add(10);
        pq.add(5);
        pq.add(15);
        pq.add(2);
        pq.add(8);

        // Printing the PriorityQueue
        System.out.println("PriorityQueue: " + pq);

        // Retrieving the minimum element without removing it
        int minElement = pq.peek();
        System.out.println("Minimum element: " + minElement);

        // Removing and returning the minimum element
        int removedElement = pq.poll();
        System.out.println("Removed minimum element: " + removedElement);

        // Printing the PriorityQueue after removal
        System.out.println("PriorityQueue after removal: " + pq);
    }
}
```

Set

- Set is a predefined sub interface of the Collection interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- Set having three important implementation classes:
    1. HashSet
    2. LinkedHashSet
    3. TreeSet

Common qualities of Set interface:

- Set is not index-based.
- Set does not allow duplicate values.

HashSet

- HashSet is a predefined implementation class of the Set interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- HashSet is not index-based.
- HashSet does not allow duplicate values.
- HashSet allows null value.
- HashSet is both homogeneous and heterogeneous.
- HashSet does not follow insertion order, but internally it follows hashing technique order.
- Initial capacity of HashSet is 16 continuous memory blocks.
- The fill ratio threshold value is 75%, which means whenever 12 memory blocks are filled, it will auto-grow half of its previous capacity.
- It will not wait until all memory blocks are filled.

Exa :

```
import java.util.HashSet;

public class HashSetExample {
    public static void main(String[] args) {
        // Create a HashSet to store strings
        HashSet<String> names = new HashSet<>();
        // Add elements to the HashSet
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");
        names.add("Alice"); // Duplicate element, will not be added

        // Printing the HashSet
        System.out.println("HashSet: " + names);
    }
}
```

LinkedHashSet

- LinkedHashSet is a predefined implementation class of the Set interface.
- It was introduced in the version of JDK 1.4.
- It is present in the java.util package.
- LinkedHashSet is not index-based.
- It does not allow duplicate values.
- It allows null value.
- LinkedHashSet is both homogeneous and heterogeneous.
- LinkedHashSet follows insertion order.
- The initial capacity of LinkedHashSet is 16 continuous memory blocks.
- The fill ratio threshold value is 75%.

- It will auto-grow half of its previous capacity.

Exm : retrive common element from 2 collection and store in 3rd collection?

```
package LinkedHashSet;

import java.util.LinkedHashSet;

public class PrintCommonObject {
   public static void main(String[] args) {
      LinkedHashSet<Integer> 11 = new LinkedHashSet<>();
      // ... (add elements to 11)

      LinkedHashSet<Integer> 12 = new LinkedHashSet<>();
      // ... (add elements to 12)

      // Find common elements and store them in a new LinkedHashSet
      LinkedHashSet<Integer> commonElements = new LinkedHashSet<>(11);
      commonElements.retainAll(12);

      // Print the common elements
      System.out.println("Common elements: " + commonElements);
   }
}
```

TreeSet

- TreeSet is a predefined implementation class of the Set interface.
- It was introduced in the version of JDK 1.2.
- It is present in the java.util package.
- TreeSet is not index-based.
- It does not allow duplicate values.
- It does not allow null values.
- If a programmer tries to store a null value, it will get a NullPointerException.
- TreeSet is only homogeneous. If a programmer tries to store heterogeneous values, we will get a ClassCastException.
- TreeSet does not follow insertion order, because internally it follows sorting order.
- Whenever we try to add an object, that time instantly one node will get created.

Exa :

```
import java.util.TreeSet;

public class TreeSetExample {
   public static void main(String[] args) {
      // Create a TreeSet to store integers
      TreeSet<Integer> numbers = new TreeSet<>();

      // Add elements to the TreeSet
      numbers.add(10);
      numbers.add(5);
```

```
        numbers.add(15);
        numbers.add(2);
        numbers.add(8);

        // Printing the TreeSet
        System.out.println("TreeSet: " + numbers);
    }
}
```

Diff b/w List vector and set implementation classes ?

Feature	ArrayList	LinkedList	Vector	PriorityQueue	HashSet	LinkedHashSet	TreeSet
Introduced	JDK 1.2	JDK 1.2	JDK 1.0 (Legacy)	JDK 1.5	JDK 1.2	JDK 1.4	JDK 1.2
Insertion Order	Follows	Follows	Follows	Follows minimum heap order (Parent-Child)	Not followed (Hashing order)	Follows insertion order	Not followed (Sorting order)
Index-based	Index-based	Index-based	Index-based	Not index-based	Not index-based	Not index-based	Not index-based
Duplicate Values	Allowed	Allowed	Allowed	Not allowed	Not allowed	Not allowed	Not allowed
Null Values	Allowed	Allowed	Allowed	Not allowed	Not allowed	Allows one null value	Not allowed
Homogeneous / Heterogeneous	H/H	H/H	H/H	Homogeneous	H/H	H/H	Homogeneous
Initial Capacity	10 continuous memory blocks	No initial capacity	10 continuous memory blocks	No initial capacity	16 continuous memory blocks	16 continuous memory blocks	No fixed capacity
Auto-growth	Half of previous capacity + 1	No auto-growth	Half of previous capacity + 1	No auto-growth	Half of previous capacity *2	Half of previous capacity *2	No auto-growth

Feature	ArrayList	LinkedList	Vector	PriorityQueue	HashSet	LinkedHashSet	TreeSet
Fill ratio	100%	Does not have	100%	Does not have	75%	75%	Don't have
Thread-safe	Not thread-safe	Not thread-safe	Thread-safe	Not thread-safe	Not thread-safe	Not thread-safe	Not thread-safe
Time complexity to add an element	O(1)	O(1)	O(1)	O(log n)	O(1)	O(1)	O(log n)
Time complexity to get an element by index	O(1)	O(n)	O(1)	Not applicable	Not applicable	Not applicable	Not applicable

Can we throw exception manually/explicitly?

- Yes, we can throw an exception by using the throws keyword. It will throw the exception called method to the caller method.

Are we allowed to use only a try block without a catch block and finally block?

- No, because both catch and try blocks are mutually combined. Without a catch block, how will you know which exception he needs to handle? You will get confused, hence must await with a try-catch block.

Is a finally block always executed in a Java program?

- Yes, a finally block gets executed in every condition irrespective of checking of conditions (abnormal or normal).

What will happen if an exception is thrown by the main method?

- We can able to throw an exception from the main method to the caller method by using the throws keyword.

Is it possible to keep other statements between the try and catch block and finally block?

- No, we cannot able to write code between the try-catch and finally blocks.

Can we keep other statements between the try and catch block and finally block?

- No, we cannot able to write code between the try-catch and finally blocks. They are mutually coupled.

Why do you use the throws keyword in Java?

- To propagate exceptions from a called method to a caller method, we use the throws keyword in Java.

*****Cursor*****

- Why we go for cursor/why cursor was introduced?
  - To overcome the limitation of set type of collection, cursor was introduced.
- What is the purpose of cursor?
  - The purpose of cursor is to retrieve the object one by one from the collection.
- What is cursor?
  - Cursor is nothing but traversing.
  - Traversing means cursor should move from one object to another object.
- In Java we have 3 predefined cursors:
  - Iterator
  - ListIterator
  - Enumeration

Iterator

- Iterator is a predefined interface in java.
- It is present in the java.util package.
- It was introduced in the version of JDK 1.2.
- Iterator cursor is also called as universal cursor, because it is applicable to all type of collection.
- Iterator cursor travels only in forward direction, that means it will retrieve only forward objects.

Iterator having 3 predefined methods:

1. next(): Object
2. hasNext(): boolean
3. remove(): void

Exa :

```
import java.util.ArrayList;
import java.util.Iterator;

public class IteratorExample {
    public static void main(String[] args) {
        // Create an ArrayList to store strings
        ArrayList<String> names = new ArrayList<>();
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");

        // Get an iterator for the ArrayList
        Iterator<String> iterator = names.iterator();

        // Iterate through the ArrayList using the iterator
        while (iterator.hasNext()) {
            String name = iterator.next();
            System.out.println(name);
        }

        // Remove an element using the iterator
        iterator = names.iterator();
        while (iterator.hasNext()) {
            String name = iterator.next();
            if (name.equals("Bob")) {
                iterator.remove();
            }
        }

        System.out.println("ArrayList after removing Bob: " + names);
    }
}
```

ListIterator

- ListIterator is a predefined interface which is present in java.util package.
- It was introduced in the version of JDK 1.2.
- ListIterator travels both forward direction and backward direction.

ListIterator having 5 predefined methods:

1. next(): Object
2. hasNext(): boolean
3. previous(): Object
4. hasPrevious(): boolean

5. remove(): void
6. add(): void

Exa :

```
import java.util.ArrayList;
import java.util.ListIterator;

public class ListIteratorExample {
    public static void main(String[] args) {
        // Create an ArrayList 1  to store strings
        ArrayList<String> names = new ArrayList<>();
        names.add("Alice");
        names.add("Bob");
        names.add("Charlie");
        names.add("David");
        // Get a ListIterator for the ArrayList
        ListIterator<String> iterator = names.listIterator();
        // Iterate forward
        while (iterator.hasNext()) {
            String name = iterator.next();
            System.out.println(name);
        }
        System.out.println();
        // Iterate backward
        while (iterator.hasPrevious()) {
            String name = iterator.previous();
            System.out.println(name);
        }
        // Add an element at the beginning
        iterator.add("Eve");
        System.out.println("ArrayList after adding Eve: " + names);
        // Remove an element
        iterator.next(); // Move to the next element (Bob)
        iterator.remove();
        System.out.println("ArrayList after removing Bob: " + names);
    }
}
```

Enumeration/Legacy Cursor

- Enumeration is a predefined interface which is present in java.util package.
- It was introduced in the version of JDK 1.0.
- Enumeration is also called as legacy cursor.
- Enumeration travels only forward direction.

Disadvantage:

- In Enumeration, we cannot remove the object because we don't have a remove method in the Enumeration interface.

Enumeration having two predefined methods:

1. nextElement(): Object
2. hasMoreElements(): Boolean

Exa :

```
import java.util.Enumeration;
import java.util.Vector;

public class EnumerationExample {
   public static void main(String[] args) {
      // Create a Vector 1  to store strings
      Vector<String> names = new Vector<>();
      names.add("Alice");
      names.add("Bob");
      names.add("Charlie");

      // Get an Enumeration for the Vector
      Enumeration<String> enumeration = names.elements();

      // Iterate through the Vector using the Enumeration
      while (enumeration.hasMoreElements()) {
         String name = enumeration.nextElement();
         System.out.println(name);
      }
   }
}
```

Which cursor is used in which type of collection?

Collection	Iterator	ListIterator	Enumeration
ArrayList	✓	✓	✓
LinkedList	✓	✓	✓
Vector	✓	✓	✓
PriorityQueue	✓	X	X
HashSet	✓	X	X
LinkedHashSet	✓	X	X
TreeSet	✓	X	X

Cursor Methods

next(): Object

- Return the next element of the collection.
- Present in java.util package with in iterator and listIterator interface.
- Non-static method.

hasNext(): boolean

- It will return true if there is a present next element otherwise false.
- Present in java.util package with in iterator and listIterator interface.
- Non-static method.

remove(): void

- Remove the current object.
- Present in java.util package with in iterator and listIterator interface.
- Non-static method.

previous(): Object

- Return the previous object from the collection.
- Present in java.util package with in listIterator interface.
- Non-static method.

hasPrevious(): boolean

- It will return true if more elements are present in the previous side.
- Present in java.util package with in listIterator interface.
- Non-static method.

elements(): Object

- Return the next object from the collection.
- Present in java.util package with in enumeration interface.
- Non-static method.

hasMoreElements(): boolean

- Return true if there are more elements are present otherwise return false.
- Present in java.util package.
- Non-static method.

Basic classes and interface present in side packages?

java.lang Package:

- Object class, Object, String, System, Exception, RuntimeException, Double, Integer

java.util Package:

- Collection<E>, List<E>, ArrayList<E>, LinkedList<E>, Queue

Java.io package:

- File, InputStream, OutputStream, Reader, Writer, FileInput Stream, FileOutputStream

Difference between length() and length variable:

- length() is used to find the length of a String. It is a method, so it requires parentheses () and is not applicable for arrays.
- length variable is used to find the length of an array.
- In Java, array size is constant. After declaration time, we cannot change the array size throughout the program. (Java arrays are fixed)

Map Object

- In collections, we can store values in key and value pair.
- Map is an interface which is having 3 implementation classes.
    1. HashMap
    2. LinkedHashMap
    3. TreeMap

Map Object will be containing object in the form of key and value.

- Key should not be duplicated and value can be duplicated.
- Each key and value pair are known as entry object.
- Because of this reason Map Object is also known as collection of entry objects.
- Whenever we want to store a single object, go with collection, whenever we want to store in the form of key and value pair at that time make use of Map Object.

Map Interface Methods:

1. put(KeyObject, ValueObject): ValueObject

- This method is used for adding the element inside the Map Object.
- This method is taking two inputs in the form of key and value.
- If we print this method, the mapped value will be printed.

2. containsKey(KeyObject): boolean

- This method will be checking whether the given key object is present or not.
- If the given key is present, this method will be returning true, if not, this method will be returning false.

3. remove(KeyObject): ValueObject

- This method will be removing the given key with associated object.

4. containsValue(ValueObject): boolean

- This method will be checking whether the given value is present or not.
- If the given value is present, this method will return true; if not, this method will return false.

5. values(): Collection<V>`

- Returns a Collection view of the values contained in this map.
- The collection is backed by the map, so changes to the map are reflected in the collection, and vice-versa.

6. replace(K key, V oldValue, V newValue): boolean

- Replaces the value associated with the specified key with the given value only if the current value associated with the key is equal to the given oldValue.
- Returns true if the value was replaced, false otherwise.

HashMap

- HashMap is an inbuilt class and implementation class of the Map interface.
- We can create HashMapObject in 4 ways:
    1. HashMap()
    2. HashMap(int initialCapacity)
    3. HashMap(int initialCapacity, float loadFactor)
    4. HashMap(Map<K,V> m)
- If we give initial capacity less than 0, it will give an exception.

Characteristics of HashMap

- HashMap will be taking objects in the form of key and value.
- Key should not be duplicated, but value can be duplicated.
- One null key is allowed, multiple null values are allowed.
- The data structure of HashMap is Hashtable.
- The output order of HashMap will be in the form of Hashing Technique order.

Exa :

```
import java.util.HashMap;

public class HashMapExample {
    public static void main(String[] args) {
        // Create a HashMap to store key-value pairs
        HashMap<String, Integer> ages = new HashMap<>();

        // Add key-value pairs to the HashMap
        ages.put("Alice", 25);
        ages.put("Bob", 30);
        ages.put("Charlie", 28);
        ages.put("David", 30); // Duplicate value is allowed

        // Accessing values
        int aliceAge = ages.get("Alice");
```

```
        System.out.println("Alice's age: " + aliceAge);

        // Checking if a key exists
        boolean containsBob = ages.containsKey("Bob");
        System.out.println("Does the HashMap contain Bob? " + containsBob);

        // Removing a key-value pair
        ages.remove("Charlie");
        System.out.println("HashMap after removing Charlie: " + ages);

        // Getting all keys
        System.out.println("Keys: " + ages.keySet());

        // Getting all values
        System.out.println("Values: " + ages.values());
    }
}
```

LinkedHashMap

- LinkedHashMap is an implementation class of Map interface.
- At the same time, it inherits HashMap class for code reusability.
- It was introduced in the JDK version of 1.4.
- In LinkedHashMap, we can store key and values, but key should not be duplicated, value can be duplicated.
- The data structure of LinkedHashMap is Hashtable + LinkedList implementation.
- When we want to store key and values and we want to get the insertion order at that time make use of LinkedHashMap Objects.

Notes:

- LinkedHashMap is maintaining both hashing and chaining.
- Inheriting HashMap for code reusability.

Exa :

```
import java.util.LinkedHashMap;

public class LinkedHashMapExample {
    public static void main(String[] args) {
        // Create a LinkedHashMap to store employee information
        LinkedHashMap<String, Employee> employees = new LinkedHashMap<>();

        // Create Employee objects
        Employee emp1 = new Employee("Alice", 30, "Software Engineer");
        Employee emp2 = new Employee("Bob", 25, "Data Scientist");
        Employee emp3 = new Employee("Charlie", 28, "Product Manager");

        // Add employees to the LinkedHashMap
        employees.put("Employee1", emp1);
        employees.put("Employee2", emp2);
        employees.put("Employee3", emp3);
```

```
        // Iterate through the LinkedHashMap and print employee details
        for (String key : employees.keySet()) {
            Employee employee = employees.get(key);
            System.out.println("Employee ID: " + key);
            System.out.println("Name: " + employee.getName());
            System.out.println("Age: " + employee.getAge());
            System.out.println("Role: " + employee.getRole());
            System.out.println();
        }
    }
    static class Employee {
        private String name;
        private int age;
        private String role;

        public Employee(String name, int age, String role) {
            this.name = name;
            this.age = age;
            this.role = role;
        }
        public String getName() {
            return name;
        }
        public int getAge() {
            return age;
        }
        public String getRole() {
            return role;
        }
    }
}
```

TreeMap

- TreeMap is an implementation class of the Map interface.
- It was introduced in the JDK version of 1.2.
- TreeMap will store objects in the form of key and value.
- Key should not be duplicated, but value can be duplicated.
- The data structure of TreeMap is Red-Black Tree.
- Red-Black Sorting is nothing but keys will be sorted according to the sorted key all the values are getting placed.
- The output order of TreeMap will be in the form of sorting order.

HashTable

- According to data structure, it is a table which contains key and value.
- According to Map interface, Hashtable is an implementation class of Map Interface which was introduced in JDK 1.0.
- Because it was introduced in 1.0, it is also known as a legacy class in Map Interface.

Exa :

```
import java.util.TreeMap;

public class TreeMapExample {
   public static void main(String[] args) {
      // Create a TreeMap to store key-value pairs 1
      TreeMap<String, Integer> ages = new TreeMap<>();

      // Add key-value pairs to the TreeMap
      ages.put("Alice", 25);
      ages.put("Bob", 30);
      ages.put("Charlie", 28);
      ages.put("David", 30); // Duplicate value is allowed

      // Printing the TreeMap
      System.out.println("TreeMap: " + ages);
   }
}
```

Stream api question :

```
import java.util.Arrays;
import java.util.Comparator;
import java.util.List;
import java.util.Optional;
import java.util.stream.Collectors;
import java.util.stream.IntStream;
import java.util.stream.Stream;

public class StreamApiExamples {

   public static void main(String[] args) {
      List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5, 6, 7, 8, 9, 10);
      List<String> words = Arrays.asList("apple", "banana", "orange", "grape");

      // 1. filter(Predicate<T>): Filters elements based on a condition.
      List<Integer> evens = numbers.stream().filter(n -> n % 2 == 0).collect(Collectors.toList());
         // Keep even numbers
      System.out.println("filter: " + evens); // Output: [2, 4, 6, 8, 10]

      // 2. map(Function<T, R>): Transforms each element to another value.
      List<Integer> squares = numbers.stream().map(n -> n * n).collect(Collectors.toList());
      // Square each number
      System.out.println("map: " + squares); // Output: [1, 4, 9, 16, 25, 36, 49, 64, 81, 100]

      // 3. flatMap(Function<T, Stream<R>>): Flattens a stream of collections into a single stream.
      List<List<Integer>> listOfLists = Arrays.asList(Arrays.asList(1, 2), Arrays.asList(3, 4));
      List<Integer> flattened = listOfLists.stream().flatMap(List::stream).collect(Collectors.toList());
      // Flatten the list of lists
```

```
System.out.println("flatMap: " + flattened); // Output: [1, 2, 3, 4]

// 4. distinct(): Removes duplicate elements.
List<Integer> withDuplicates = Arrays.asList(1, 2, 2, 3, 3, 3);
List<Integer> distinctNumbers = withDuplicates.stream().distinct().collect(Collectors.toList());
// Remove duplicates
System.out.println("distinct: " + distinctNumbers); // Output: [1, 2, 3]

// 5. sorted(): Sorts the elements in natural order.
List<Integer> sortedNumbers = numbers.stream().sorted().collect(Collectors.toList()); // Sort numbers
System.out.println("sorted: " + sortedNumbers); // Output: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

// 6. forEach(Consumer<T>): Performs an action for each element (terminal operation).
numbers.stream().forEach(System.out::print); // Print each number
System.out.println();

// 7. peek(Consumer<T>): Performs an action on each element without modifying the stream
(intermediate).
List<Integer> peekedNumbers = numbers.stream().peek(System.out::print).collect(Collectors.toList());
// Print each number during processing
System.out.println("\npeek: " + peekedNumbers);
// Output: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

// 8. limit(long maxSize): Limits the stream to a specified number of elements.
List<Integer> limitedNumbers = numbers.stream().limit(3).collect(Collectors.toList()); // Take first 3
System.out.println("limit: " + limitedNumbers); // Output: [1, 2, 3]

// 9. skip(long n): Skips the first n elements.
List<Integer> skippedNumbers = numbers.stream().skip(3).collect(Collectors.toList()); // Skip first 3
System.out.println("skip: " + skippedNumbers); // Output: [4, 5, 6, 7, 8, 9, 10]

// 10. count(): Returns the number of elements in the stream (terminal operation).
long count = numbers.stream().count(); // Count elements
System.out.println("count: " + count); // Output: 10

// 11. min(Comparator<T>): Finds the minimum element according to a comparator (terminal
operation).
Optional<Integer> min = numbers.stream().min(Comparator.naturalOrder()); // Find min
System.out.println("min: " + min.orElse(0)); // Output: 1

// 12. max(Comparator<T>): Finds the maximum element (terminal operation).
Optional<Integer> max = numbers.stream().max(Comparator.naturalOrder()); // Find max
System.out.println("max: " + max.orElse(0)); // Output: 10

// 13. anyMatch(Predicate<T>): Checks if any element matches a condition (terminal operation).
boolean anyMatch = numbers.stream().anyMatch(n -> n > 5); // Any number > 5?
System.out.println("anyMatch: " + anyMatch); // Output: true

// 14. allMatch(Predicate<T>): Checks if all elements match a condition (terminal operation).
boolean allMatch = numbers.stream().allMatch(n -> n > 0); // All numbers > 0?
System.out.println("allMatch: " + allMatch); // Output: true
```

```
        // 15. noneMatch(Predicate<T>): Checks if no elements match a condition (terminal operation).
        boolean noneMatch = numbers.stream().noneMatch(n -> n < 0); // No numbers < 0?
        System.out.println("noneMatch: " + noneMatch); // Output: true

        // 16. findFirst(): Finds the first element in the stream (terminal operation).
        Optional<Integer> first = numbers.stream().findFirst(); // Find first
        System.out.println("findFirst: " + first.orElse(0)); // Output: 1

        // 17. findAny(): Finds any element in the stream (terminal operation, useful for parallel streams).
        Optional<Integer> any = numbers.stream().findAny(); // Find any
        System.out.println("findAny: " + any.orElse(0)); // Output: 1 (likely, but not guaranteed in parallel streams)

        // 18. reduce(identity, BinaryOperator<T>): Combines elements using a binary operator (terminal operation).
        int sum = numbers.stream().reduce(0, Integer::sum); // Sum of all numbers
        System.out.println("reduce: " + sum); // Output: 55

        // 19. collect(Collector<T, A, R>): Collects elements into a collection (terminal operation).
        List<Integer> collected = numbers.stream().collect(Collectors.toList()); // Collect to List
        System.out.println("collect: " + collected); // Output: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

        // 20. toArray(IntFunction<A[]> generator): Converts the stream to an array (terminal operation).
        Integer[] array = numbers.stream().toArray(Integer[]::new); // To array
        System.out.println("toArray: " + Arrays.toString(array)); // Output: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

        // IntStream.rangeClosed(int startInclusive, int endInclusive): Creates an IntStream within a range.
        int intSum = IntStream.rangeClosed(1, 10).sum(); // Sum of integers from 1 to 10
        System.out.println("IntStream sum: "+intSum); //Output: 55

        //Stream.of(T... values): Creates a Stream from the given values.
        Stream<String> wordStream = Stream.of("Hello", "World"); // Stream of strings
        wordStream.forEach(System.out::println);

    }
}
```

Thread(Imp) :

- Thread is actually a path which is given to JVM for execution purpose by the Thread Scheduler.
- Thread scheduler is the 4th resource given by the Java Development Kit (JDK).
- According to java library, Thread is an inbuilt class which is present inside lang package, it was introduced in JDK version of 1.0.

When go for multi-threading

- Whenever in a program, there is no relation or connection between two methods at that time go for multithreading.
- The process of creating Multiple Threads by using single thread is known as multithreading.

Purpose of Multithreading:

- To reduce the CPU time at the same time developer time
- Creation of videogames and animation
- Servers are built using Multithreading
- User Defined Thread Creation

Ways to Create a Thread:

1. **Our Class Inheriting Thread Class**

   - Rules to create:

     - Our class has to inherit Thread class to get the property of Thread class
     - Override the run() method present in Thread class because whatever the logic provided inside run() will be executed inside our defined Thread or child Thread.

2. **Our Class Implementing Runnable Interface**

   - Create a class, class will implements the Runnable interface and Implement the run() Method:
   - Create a Thread object.
   - For Start the Thread Call the start() method on the Thread object to initiate the execution of the run() method.

What will happen if we call start() once after again by using same child Thread object?

- It will throw IllegalThreadStateException.

Thread execution:

- Thread creation
- Thread execution
- Thread Scheduler

Exa : By implementing RunableInterface

```
public class RunnableThreadExample {
    public static void main(String[] args) {
        MyRunnableThread thread = new MyRunnableThread();
        Thread t = new Thread(thread);
        t.start();

    }

    static class MyRunnableThread implements Runnable {
        public void run() {
            for (int i = 0; i < 5; i++) {
                System.out.println("Thread 1: " + i);
                try {
                    Thread.sleep(1000); // Sleep for 1 second
                } catch (InterruptedException e) {
```

```
                e.printStackTrace();
            }
        }
    }
}
```

Exa : By inheriting thread class

```
public class ThreadClassExample extends Thread {
    public void run() {
        for (int i = 0; i < 5; i++) {
            System.out.println("Thread 2: " + i);
            try {
                Thread.sleep(1000); // Sleep for 1 second
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
        }
    }

    public static void main(String[] args) {
        ThreadClassExample thread = new ThreadClassExample();
        thread.start();
    }
}
```

Exa: Thread property example ?

```
public class ThreadPropertiesExample {
    public static void main(String[] args) {
        // Creating a thread with a custom name and priority
        Thread thread1 = new Thread(() -> {
            System.out.println("Thread Name: " + Thread.currentThread().getName());
            System.out.println("Thread Priority: " + Thread.currentThread().getPriority());
        });
        thread1.setName("My Custom Thread");
        thread1.setPriority(Thread.MAX_PRIORITY);

        // Creating a daemon thread
        Thread thread2 = new Thread(() -> {
            System.out.println("Daemon Thread: " + Thread.currentThread().isDaemon());
        });
        thread2.setDaemon(true);

        // Creating a thread within a thread group
        ThreadGroup group = new ThreadGroup("My Thread Group");
        Thread thread3 = new Thread(group, () -> {
            System.out.println("Thread Group: " + Thread.currentThread().getThreadGroup().getName());
        });

        // Starting the threads
```

```
        thread1.start();
        thread2.start();
        thread3.start();
    }
}
```

Thread Property:

Every thread in this Java world has 2 properties:

1. **Name**
2. **Priority**

Thread Name:

- The default name given by the JVM is main for the main thread.
- The default name given by the JVM for user-defined threads is Thread-0, Thread-1, and so on.
- We can change the default name given by the JVM.
- Yes, we can modify/change the thread name using setName(String newName).
- By using getName(), we can retrieve the name which we have changed.

Inter-Thread Communication: (Multithreading)

- The process of making one thread to communicate with another thread is known as Inter-thread communication. Whenever we want one thread to communicate with another thread at that time we have to make use of inter-thread communication methods.
- There are 5 methods which are used for performing the communication in two threads:
    1. wait(): void
    2. wait(long milliseconds): void
    3. wait(long milliseconds, int nanos): void
    4. notify(): void
    5. notifyAll(): void

note :- all this method is present inside object class.

Thread Life Cycle

A thread in Java goes through several states during its lifetime:

Stage 1: New State

- When we create a thread object at that time newly thread is created.

Stage 2: Ready/Runnable

- When developer calls start() method explicitly, this stage is runnable state.

Stage 3: Running

- When JVM calls the run() method implicitly, this stage is running state.

Stage 4: Waiting/dead-lock State

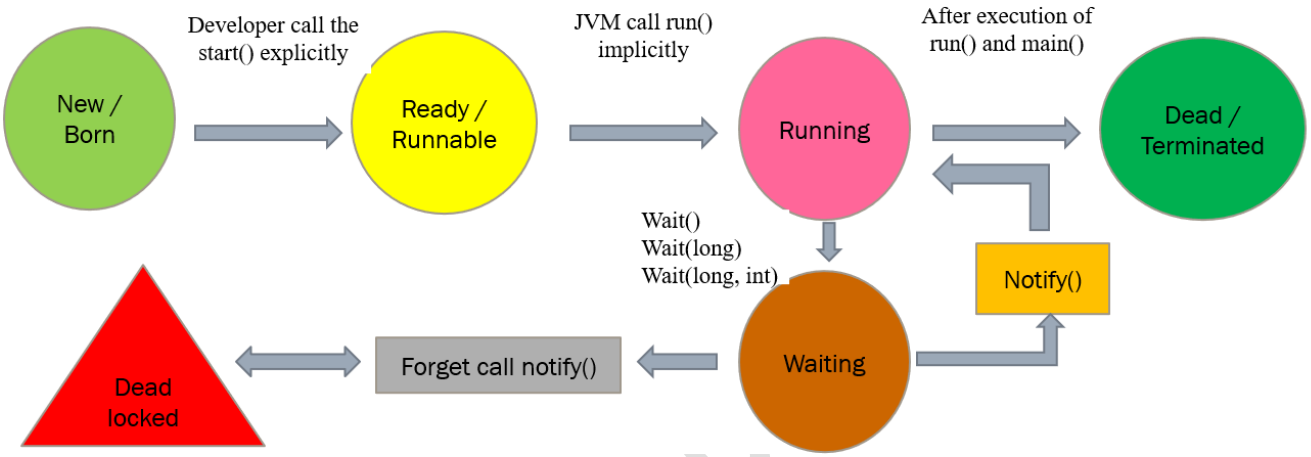
- When the developer calls the wait() method and the executing thread forgets to call notify(), at that time it will be in a dead-locked state, this process we are calling as deadlock situation.

- If the executing thread is calling the notify() method, then it will be going again back to the running stage.

Stage 5: Dead State/terminated

- The thread has finished executing its task or has been terminated.
- It no longer exists in the system.

Thread Life cycle:



Synchronization

- It is a process to make single thread to access single object in other words making an object thread-safe.
- Synchronization can be achieved by a keyword known as synchronized.
- synchronized keyword is applicable only for methods and it is not applicable for variables and constructors.

Exa :

```
public class SynchronizedCounter {
   private int count = 0;
   public synchronized void increment() {
      count++;
   }
   public static void main(String[] args) {
      SynchronizedCounter counter = new SynchronizedCounter();

      Thread thread1 = new Thread(() -> {
```

```
        for (int i = 0; i < 10000; i++) {
            counter.increment();
        }
    });
    Thread thread2 = new Thread(() -> {
        for (int i = 0; i < 10000; i++) {
            counter.increment();
        }
    });
    thread1.start();
    thread2.start();
    try {
        thread1.join();
        thread2.join();
    } catch (InterruptedException e) {
        e.printStackTrace();
    }
    System.out.println("Final count: " + counter.count);
  }
}
```

Exa :2

```
package Synchronization;
class Football {
  public synchronized void kickFootball(String playerName) {
    try {
      Thread.sleep(2000);
      System.out.println("Football came to " + playerName);
      Thread.sleep(2000);
      System.out.println(playerName + " is kicking the Football");
    } catch (InterruptedException e) {
      e.printStackTrace();
    }
  }
}
public class Player extends Thread {
  private String playerName;
  private Football footballObject;

  public Player(String playerName, Football footballObject) {
    this.playerName = playerName;
    this.footballObject = footballObject;
  }

  public void run() {
    footballObject.kickFootball(playerName);
  }

  public static void main(String[] args) {
    Football football = new Football();
```

```
        Player player1 = new Player("Messi", football);
        Player player2 = new Player("Ronaldo", football);


        player1.start();
        player2.start();
    }
}
```

Singleton Class:

We can create only one object of the class and for getting the object we can call the method and make constructor as a private.

Example 1:

```
package SINGLETON_CLASS;

public class Book {
   private static Book bookObject;

   private Book() {
   }
   public static Book createBook() {
      if (bookObject == null) {
         bookObject = new Book();
      }
      return bookObject;
   }
}
```

```
Book book1 = Book.createBook();
Book book2 = Book.createBook();

// book1 and book2 will reference the same object another class
```

Explanation of printing o/p in java

- **System**: This is a final class in the java.lang package. It provides access to system properties and environment variables.
- **out**: This is a public static field of the System class. It's an instance of the PrintStream class, which is used for writing text to an output stream, typically the console.
- **println()**: This is a method of the PrintStream class. It takes an argument, converts it to a string, and prints it to the standard output stream (usually the console). After printing, it adds a newline character, hence the name "println" (print line).

Exa :

```
package User;
import Lang.SystemLocal;
public class User {
        public static void main(String[] args){
            SystemLocal.outLocal.printlnLocal("hii");
   }
}
package Lang;
import IO.PrintStreamLocal;
public class SystemLocal {
        public static final PrintStreamLocal outLocal=new PrintStreamLocal();
}
```

```
package IO;

public class PrintStreamLocal {
public void printlnLocal(String message) {
        System.out.println(message);
}
}
```

Java Bin Class

- the classes with contain getter and setter method those classes called bin class.
- All encapsulated programs are not JavaBin Class programs but all JavaBin Class programs are encapsulated.
- we can not only initialized the non-static variable by using method and by using constructor we can also use getters and setters() for initializing. non static variable

Condition to Create setter's method :

- setters method should be public and nonstatic.
- it should have argument but it should not have return type
- this method is used for setting or modifying non-static variable.

Condition to create getters method:

- getters method should be public and non static.
- it should not have return type but it should not have argument.
- it is use for fetching/getting/returning/retrieving non static variable.
- by how many Method we are able to initialized. non static variable While Class creation.

Exa :

```
public class Person implements Serializable {
   private String firstName;
   private int age;
   // Default constructor
   public Person() {
   }
   // Parameterized constructor
   public Person(String firstName, String lastName, int age) {
      this.firstName = firstName;
      this.age = age;
   }
   // Getters and setters
   public String getFirstName() {
      return firstName;
   }
   public void setFirstName(String firstName) {
      this.firstName = firstName;
   }
   public int getAge() {
      return age;
   }
   public void setAge(int age) {
      this.age = age;
   }
}
```

Garbage Collector :

- The process of automatically cleaning memory used by objects that are not needed is known as garbage collection.
- In older languages like C++, developers were responsible for both creating and destroying objects.
- To address this issue, modern languages like Java have implemented automatic garbage collection. The garbage collector periodically scans the heap for objects that are no longer and clean their memory.
- If object don't have reference those are eligible for garbage collection

There are several ways to make an object eligible for garbage collection:

1. **Nullifying the object:** Setting the reference to the object to null.
2. **Reassigning the object:** Assigning a new object to the same reference.
3. **Creating the object inside a method:** The object becomes eligible for garbage collection when the method returns.

*****Enum *****

Enum is a keyword used for creating a user-defined data type.

While classes can also be used to create user-defined data types, using enum is more concise and efficient for representing a fixed set of values.

By using enum , we can create our own data types and represent a group of named constants.

Enums were introduced in Java in JDK version 1.5.

Characteristics of enum types:

1. Enum constants are implicitly public, static, and final.
2. To access enum constants from another class, use the class name.
3. When declaring enum constants, semicolons are optional after the last constant.

Exa :

```
public enum Day {
   MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY, SUNDAY
}

public class EnumExample {
   public static void main(String[] args) {
      Day today = Day.MONDAY;
      if (today == Day.MONDAY) {
         System.out.println("It's Monday!");
      }
      // Iterate over all enum values
      for (Day day : Day.values()) {
```

```
            System.out.println(day);
        }
    }
}
```

Default Method

Default methods were introduced in Java 8.

If a new method is added to an interface, all implementing classes must be updated to provide an implementation for the new method.

To avoid this breaking change, we can use default methods.

Default methods can only be declared within interfaces, not classes.

Subclasses that implement an interface with a default method are not required to provide their own implementation.

Exa :

```
interface Shape {
    void area();

    default void draw() {
        System.out.println("Drawing a shape");
    }
}
class Circle implements Shape {
    @Override
    public void area() {
        // Implementation for calculating the area of a circle
    }
}
class Rectangle implements Shape {
    @Override
    public void area() {
        // Implementation for calculating the area of a rectangle
    }
}
```

File Handling :

File:

A file is a storage medium where we can store various types of data, such as audio, video, text documents, code, and more.

Why File Handling?

- **Data Persistence:** Local variables and objects in memory are temporary and lost when the program or method ends.
- **Data Protection:** To ensure data is preserved beyond the program's execution, we store it in files.
- **Data Management:** File handling allows us to perform operations like reading, writing, updating, and deleting data from files.

Streams:

A stream is a sequence of data that flows from one place to another.

Java provides three standard streams:

1. **System.in:** Represents the standard input stream, typically the keyboard.
2. **System.out:** Represents the standard output stream, typically the console.
3. **System.err:** Represents the standard error stream, also typically the console.

In order to create streams, we need to use the following classes:

1. **File:** Represents a file or directory in the file system.
2. **FileInputStream:** Reads bytes from a file.
3. **FileOutputStream:** Writes bytes to a file.
4. **BufferedInputStream:** Reads bytes from a file with buffering for improved performance.
5. **BufferedOutputStream:** Writes bytes to a file with buffering for improved performance.
6. **ObjectInputStream:** Reads serialized objects from a file.
7. **ObjectOutputStream:** Writes serialized objects to a file.
8. **FileReader:** Reads characters from a file.
9. **FileWriter:** Writes characters to a file.

File Creation:

- To create a new file, we use the createNewFile() method, which is non-static and returns a boolean value. This method is part of the File class.
- To access this method, we first create a File object and provide the desired file name with its extension in the constructor.
- The createNewFile() method can throw an IOException. It's our responsibility to handle this exception using a try-catch block.
- The method returns true if the file is created successfully, otherwise, it returns false.

Exa :

```
File textFile = new File("TextFile.txt");

try {
   boolean isCreated = textFile.createNewFile();
   if (isCreated) {
      System.out.println("File created successfully");
   } else {
      System.out.println("File already exists");
   }
} catch (IOException e) {
   e.printStackTrace();
```

}

File Writing :

- To write to a file, we first need to create the file.
- After creating the file, we use the write() method, which is non-static and overloaded. This method is part of the FileWriter class.
- To access the write() method, we create a FileWriter object, passing either a File object or a file name as a parameter.
- Along with the write() method, we should use the flush() and close() methods. flush() pushes the data to the underlying storage, and close() releases the resources associated with the stream. Both methods are part of the OutputStreamWriter class.

Exa :

```
package file;

import java.io.File;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Arrays;

public class WritingInsideFile {
   public static void main(String[] args) {
      File demoFile = new File("Demo.txt");
      try {
         if (demoFile.createNewFile()) {
            System.out.println("File created successfully");
            FileWriter writer = new FileWriter(demoFile);
            writer.write("Hello, world!");
            writer.flush();
            writer.close();
         }
      } catch (IOException e) {
         e.printStackTrace();
      }
   }
}
```

Reading from a File:

- To read from a file, we use the read() method, which is part of the FileReader class. This class inherits from InputStreamReader.
- The read() method reads a single character at a time. To read multiple characters, we typically use loops and conditional checks.
- If the character is present in the file, the read() method returns the character's ASCII value. If the end of the file is reached, the read() method returns -1**.**

Exa :

```
package File;
```

```
import java.io.File;
import java.io.FileReader;
import java.io.IOException;
public class FileReading {
   public static void main(String[] args) 1  {
      File demoFile = new File("Demo.txt");
      try (FileReader reader = new FileReader(demoFile)) {
         int character;
         while ((character = reader.read()) != -1) {
            System.out.print((char) character);
         }
      } catch (IOException e) {
         e.printStackTrace();
      }
   }
}
```

Exa : File creation, write and read code

```
import java.io.*;

public class FileOperations {
   public static void main(String[] args) {
      String fileName = "example.txt";
      try {
         // Create a new file
         File file = new File(fileName);
         file.createNewFile();

         // Write to the file
         FileWriter writer = new FileWriter(file);
         writer.write("This is a line of text.\n");
         writer.write("This is another line.\n");
         System.out.println("File written successfully.");

         // Read from the file
         FileReader reader = new FileReader(file);
         int character;
         while ((character = reader.read()) != -1) {
            System.out.print((char) character);
         }
      } catch (IOException e) {
         e.printStackTrace();
      }
   }
}
```

Stream API

The Stream API in Java provides a way to process collections of objects in a functional style. It allows you to perform operations like filtering, mapping, and reducing on collections and prowide efficient way .

Important Stream Operations

1. Filter

- **Definition:** The filter() operation selects elements from a stream that satisfy a given condition (predicate).
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class FilterExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5, 6, 7, 8, 9, 10);

        List<Integer> evenNumbers = numbers.stream()
                .filter(n -> n % 2 == 0) // Keep only even numbers
                .collect(Collectors.toList());

        System.out.println(evenNumbers); // Output: [2, 4, 6, 8, 10]
    }
}
```

2. Map

- **Definition:** The map() operation transforms each element in a stream into a new element using a given function.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class MapExample {
    public static void main(String[] args) {
        List<String> words = Arrays.asList("hello", "world", "java");

        List<Integer> wordLengths = words.stream()
                .map(String::length) // Transform each word to its length
                .collect(Collectors.toList());

        System.out.println(wordLengths); // Output: [5, 5, 4]
    }
}
```

3. Reduce

- **Definition:** The reduce() operation combines all elements in a stream into a single result using a given function.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class ReduceExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        int sum = numbers.stream()
                .reduce(0, (a, b) -> a + b); // Calculate the sum of all numbers

        System.out.println(sum); // Output: 15
    }
}
```

4. Distinct

- **Definition:** The distinct() operation returns a stream with duplicate elements removed.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class DistinctExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 2, 3, 3, 3, 4, 5);

        List<Integer> distinctNumbers = numbers.stream()
                .distinct() // Remove duplicate numbers
                .collect(Collectors.toList());

        System.out.println(distinctNumbers); // Output: [1, 2, 3, 4, 5]
    }
}
```

5. Sorted

- **Definition:** The sorted() operation returns a stream with elements sorted in natural order or according to a custom comparator.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class SortedExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(5, 2, 1, 4, 3);

        List<Integer> sortedNumbers = numbers.stream()
                .sorted() // Sort numbers in natural order
```

```
            .collect(Collectors.toList());

        System.out.println(sortedNumbers); // Output: [1, 2, 3, 4, 5]
    }
}
```

6. ForEach

- **Definition:** The forEach() operation performs an action for each element in a stream.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class ForEachExample {
    public static void main(String[] args) {
        List<String> words = Arrays.asList("hello", "world");

        words.stream()
             .forEach(System.out::println); // Print each word

        // Output:
        // hello
        // world
    }
}
```

7. Collect

- **Definition:** The collect() operation gathers the elements of a stream into a collection (e.g., List, Set, Map).
- **Example (Java):**

Java

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class CollectExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        List<Integer> evenNumbers = numbers.stream()
            .filter(n -> n % 2 == 0)
            .collect(Collectors.toList()); // Collect even numbers into a List

        System.out.println(evenNumbers); // Output: [2, 4]
    }
}
```

1. flatMap

- **Definition:** The flatMap() operation is used to flatten a stream of collections into a single stream. It takes a function that returns a stream for each element in the original stream, and then concatenates all the resulting streams into one.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;
import java.util.stream.Stream;

public class FlatMapExample {
    public static void main(String[] args) {
        List<List<Integer>> listOfLists = Arrays.asList(
                Arrays.asList(1, 2, 3),
                Arrays.asList(4, 5),
                Arrays.asList(6, 7, 8, 9)
        );

        List<Integer> numbers = listOfLists.stream()
                .flatMap(List::stream) // Flatten the list of lists into a single stream
                .collect(Collectors.toList());

        System.out.println(numbers); // Output: [1, 2, 3, 4, 5, 6, 7, 8, 9]

        // Example with String arrays
        List<String[]> arrayOfArrays = Arrays.asList(
                new String[]{"hello", "world"},
                new String[]{"java", "streams"}
        );

        List<String> words = arrayOfArrays.stream()
                .flatMap(Arrays::stream)
                .collect(Collectors.toList());

        System.out.println(words); // Output: [hello, world, java, streams]
    }
}
```

2. findFirst

- **Definition:** The findFirst() operation returns an Optional containing the first element of the stream, or an empty Optional if the stream is empty.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.Optional;

public class FindFirstExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        Optional<Integer> firstEven = numbers.stream()
```

```
            .filter(n -> n % 2 == 0)
            .findFirst();

        System.out.println(firstEven.orElse(-1)); // Output: 2 (or -1 if no even number is found)

        List<Integer> emptyList = Arrays.asList();
        Optional<Integer> firstOfEmpty = emptyList.stream().findFirst();
        System.out.println(firstOfEmpty.orElse(-1)); // Output: -1
    }
}
```

3. findAny

- **Definition:** The findAny() operation returns an Optional containing any element of the stream. It's useful in parallel streams where finding the absolute first element might be computationally expensive.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;
import java.util.Optional;

public class FindAnyExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        Optional<Integer> anyEven = numbers.stream()
            .filter(n -> n % 2 == 0)
            .findAny();

        System.out.println(anyEven.orElse(-1)); // Output: 2 (or another even number, or -1 if none)
    }
}
```

4. anyMatch

- **Definition:** The anyMatch() operation returns true if any element in the stream matches the given predicate, otherwise false.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class AnyMatchExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        boolean hasEven = numbers.stream()
            .anyMatch(n -> n % 2 == 0);

        System.out.println(hasEven); // Output: true

        boolean hasGreaterThan10 = numbers.stream().anyMatch(n -> n > 10);
        System.out.println(hasGreaterThan10); // Output: false
    }
```

```
}
```

5. allMatch

- **Definition:** The allMatch() operation returns true if all elements in the stream match the given predicate, otherwise false.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class AllMatchExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(2, 4, 6, 8, 10);

        boolean allEven = numbers.stream()
                .allMatch(n -> n % 2 == 0);

        System.out.println(allEven); // Output: true

        List<Integer> mixedNumbers = Arrays.asList(2, 3, 4, 6, 8, 10);
        boolean allEvenMixed = mixedNumbers.stream().allMatch(n -> n % 2 == 0);
        System.out.println(allEvenMixed); // Output: false
    }
}
```

6. noneMatch

- **Definition:** The noneMatch() operation returns true if no elements in the stream match the given predicate, otherwise false.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class NoneMatchExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 3, 5, 7, 9);

        boolean noEven = numbers.stream()
                .noneMatch(n -> n % 2 == 0);

        System.out.println(noEven); // Output: true

        List<Integer> mixedNumbers = Arrays.asList(1, 3, 4, 5, 7, 9);
        boolean noEvenMixed = mixedNumbers.stream().noneMatch(n -> n % 2 == 0);
        System.out.println(noEvenMixed); // Output: false
    }
}
```

7. count

- **Definition:** The count() operation returns the number of elements in the stream.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.List;

public class CountExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        long evenCount = numbers.stream()
                .filter(n -> n % 2 == 0)
                .count();

        System.out.println(evenCount); // Output: 2
    }
}
```

8. min and max

- **Definition:** The min() and max() operations return an Optional containing the minimum or maximum element in the stream according to a given comparator.
- **Example (Java):**

```
import java.util.Arrays;
import java.util.Comparator;
import java.util.List;
import java.util.Optional;

public class MinMaxExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(5, 2, 1, 4, 3);

        Optional<Integer> min = numbers.stream()
                .min(Comparator.naturalOrder());

        System.out.println(min.orElse(-1)); // Output: 1

        Optional<Integer> max = numbers.stream()
                .max(Comparator.naturalOrder());

        System.out.println(max.orElse(-1)); // Output: 5
    }
}
```

The java.util.Arrays class provides static methods to manipulate arrays in Java. Here's a breakdown of the important methods with examples:

1. asList()

- **Definition:** Returns a fixed-size list backed by the specified array. Changes to the list will affect the array and vice-versa.
- **Example:**

```
import java.util.Arrays;
import java.util.List;

public class AsListExample {
    public static void main(String[] args) {
        String[] array = {"apple", "banana", "orange"};
        List<String> list = Arrays.asList(array);

        System.out.println(list); // Output: [apple, banana, orange]

        list.set(0, "grape"); // Modifying the list
        System.out.println(Arrays.toString(array)); // Output: [grape, banana, orange] (array is also changed)

        // list.add("kiwi"); // This will throw UnsupportedOperationException because the list is fixed-size.
    }
}
```

2. toString()

- **Definition:** Returns a string representation of the contents of the specified array.
- **Example:**

```
import java.util.Arrays;

public class ToStringExample {
    public static void main(String[] args) {
        int[] numbers = {1, 2, 3, 4, 5};
        System.out.println(Arrays.toString(numbers)); // Output: [1, 2, 3, 4, 5]

        String[] fruits = {"apple", "banana"};
        System.out.println(Arrays.toString(fruits)); // Output: [apple, banana]
    }
}
```

3. deepToString()

- **Definition:** Returns a string representation of the "deep contents" of the specified array. Use this for multidimensional arrays.
- **Example:**

```
import java.util.Arrays;
```

```
public class DeepToStringExample {
    public static void main(String[] args) {
        int[][] matrix = {{1, 2}, {3, 4, 5}};
        System.out.println(Arrays.deepToString(matrix)); // Output: [[1, 2], [3, 4, 5]]

        String[][] names = {{"Mr.", "Smith"}, {"Ms.", "Jones"}};
        System.out.println(Arrays.deepToString(names)); // Output: [[Mr., Smith], [Ms., Jones]]
    }
}
```

4. equals() and deepEquals()

- **Definition:** equals() checks if two arrays are equal (same length and same elements in the same order). deepEquals() does the same for multidimensional arrays.
- **Example:**

```
import java.util.Arrays;

public class EqualsExample {
    public static void main(String[] args) {
        int[] arr1 = {1, 2, 3};
        int[] arr2 = {1, 2, 3};
        int[] arr3 = {3, 2, 1};
        int[] arr4 = {1, 2, 3, 4};

        System.out.println(Arrays.equals(arr1, arr2)); // Output: true
        System.out.println(Arrays.equals(arr1, arr3)); // Output: false
        System.out.println(Arrays.equals(arr1, arr4)); // Output: false

        int[][] matrix1 = {{1, 2}, {3, 4}};
        int[][] matrix2 = {{1, 2}, {3, 4}};
        int[][] matrix3 = {{1, 2}, {4, 3}};

        System.out.println(Arrays.deepEquals(matrix1, matrix2)); // Output: true
        System.out.println(Arrays.deepEquals(matrix1, matrix3)); // Output: false
    }
}
```

5. fill()

- **Definition:** Assigns the specified value to each element of the specified array.
- **Example:**

```
import java.util.Arrays;

public class FillExample {
    public static void main(String[] args) {
        int[] numbers = new int[5];
        Arrays.fill(numbers, 10);
        System.out.println(Arrays.toString(numbers)); // Output: [10, 10, 10, 10, 10]

        String[] fruits = new String[3];
        Arrays.fill(fruits, "unknown");
        System.out.println(Arrays.toString(fruits)); // Output: [unknown, unknown, unknown]
```

```
    }
}
```

6. sort()

- **Definition:** Sorts the specified array into ascending order. There are overloaded versions for different data types and for sorting a range within the array.
- **Example:**

```
import java.util.Arrays;

public class SortExample {
    public static void main(String[] args) {
        int[] numbers = {5, 2, 8, 1, 9, 4};
        Arrays.sort(numbers);
        System.out.println(Arrays.toString(numbers)); // Output: [1, 2, 4, 5, 8, 9]

        String[] fruits = {"orange", "apple", "banana"};
        Arrays.sort(fruits);
        System.out.println(Arrays.toString(fruits)); // Output: [apple, banana, orange]
    }
}
```

7. binarySearch()

- **Definition:** Searches for the specified value in the specified *sorted* array using the binary search algorithm. Returns the index of the search key, if it is contained in the array; otherwise, (-(insertion point) - 1).
- **Example:**

```
import java.util.Arrays;

public class BinarySearchExample {
    public static void main(String[] args) {
        int[] numbers = {1, 2, 4, 5, 8, 9}; // Must be sorted!
        int index = Arrays.binarySearch(numbers, 5);
        System.out.println(index); // Output: 3

        int notFound = Arrays.binarySearch(numbers, 6);
        System.out.println(notFound); // Output: -5 (-(4+1) where 4 would be the insertion point)

        String[] fruits = {"apple", "banana", "orange"};
        int fruitIndex = Arrays.binarySearch(fruits, "banana"); // Must be sorted!
        System.out.println(fruitIndex); // Output: 1
    }
}
```

8. copyOf() and copyOfRange()

- **Definition:** copyOf() creates a new array that is a copy of the specified array, truncating or padding with nulls (if needed) to obtain the specified length. copyOfRange() copies a specific range of the original array.
- **Example:**

```
import java.util.Arrays;

public class CopyOfExample {
    public static void main(String[] args) {
        int[] original = {1, 2, 3, 4, 5};
        int[] copy1 = Arrays.copyOf(original, 3); // Copy first 3 elements
        System.out.println(Arrays.toString(copy1)); // Output: [1, 2, 3]

        int[] copy2 = Arrays.copyOf(original, 7); // Pad with 0s
        System.out.println(Arrays.toString(copy2)); // Output: [1, 2, 3, 4, 5, 0, 0]

        int[] copyRange = Arrays.copyOfRange(original, 1, 4); // Copy from index 1 (inclusive) to 4 (exclusive)
        System.out.println(Arrays.toString(copyRange)); // Output: [2, 3, 4]
    }
}
```

Modifying Collections

- **addAll(Collection<? super T> c, T... elements):** Adds all of the specified elements to the specified collection.

```
import java.util.*;

public class AddAllExample {
    public static void main(String[] args) {
        List<String> list = new ArrayList<>();
        Collections.addAll(list, "apple", "banana", "orange");
        System.out.println(list); // Output: [apple, banana, orange]
    }
}
```

- **fill(List<? super T> list, T obj):** Replaces all of the elements of the specified list with the specified element.

```
import java.util.*;

public class FillExample {
    public static void main(String[] args) {
        List<String> list = new ArrayList<>(Arrays.asList("a", "b", "c"));
        Collections.fill(list, "x");
        System.out.println(list); // Output: [x, x, x]
    }
}
```

- **copy(List<? super T> dest, List<? extends T> src):** Copies all of the elements from one list into another. The destination list must be at least as long as the source list.

```
import java.util.*;

public class CopyExample {
    public static void main(String[] args) {
        List<String> src = Arrays.asList("apple", "banana");
        List<String> dest = new ArrayList<>(Arrays.asList("1", "2", "3")); // Destination must be large enough
        Collections.copy(dest, src);
        System.out.println(dest); // Output: [apple, banana, 3]
    }
}
```

- **swap(List<?> list, int i, int j):** Swaps the elements at the specified positions in the specified list.

```
import java.util.*;

public class SwapExample {
    public static void main(String[] args) {
        List<String> list = new ArrayList<>(Arrays.asList("a", "b", "c"));
        Collections.swap(list, 0, 2);
        System.out.println(list); // Output: [c, b, a]
    }
}
```

- **reverse(List<?> list):** Reverses the order of the elements in the specified list.

```
import java.util.*;

public class ReverseExample {
    public static void main(String[] args) {
        List<String> list = new ArrayList<>(Arrays.asList("a", "b", "c"));
        Collections.reverse(list);
        System.out.println(list); // Output: [c, b, a]
    }
}
```

- **rotate(List<?> list, int distance):** Rotates the elements in the specified list by the specified distance.

```
import java.util.*;

public class RotateExample {
    public static void main(String[] args) {
        List<String> list = new ArrayList<>(Arrays.asList("a", "b", "c", "d", "e"));
        Collections.rotate(list, 2); // Rotate right by 2
        System.out.println(list); // Output: [d, e, a, b, c]
    }
}
```

- **shuffle(List<?> list):** Randomly permutes the specified list using a default source of randomness.
- **shuffle(List<?> list, Random rnd):** Randomly permutes the specified list using the specified source of randomness.

```
import java.util.*;

public class ShuffleExample {
    public static void main(String[] args) {
        List<Integer> list = new ArrayList<>(Arrays.asList(1, 2, 3, 4, 5));
        Collections.shuffle(list);
        System.out.println(list); // Output: (random permutation of the list)

        Collections.shuffle(list, new Random(42)); // Using a specific seed for reproducibility
        System.out.println(list); // Output: (a specific random permutation)
    }
}
```

- **sort(List list):** Sorts the specified list into ascending order, according to the natural ordering of its elements.
- **sort(List list, Comparator c):** Sorts the specified list according to the order induced by the specified comparator.

```
import java.util.*;

public class SortExample {
    public static void main(String[] args) {
        List<Integer> list = new ArrayList<>(Arrays.asList(5, 2, 8, 1));
        Collections.sort(list);
        System.out.println(list); // Output: [1, 2, 5, 8]

        List<String> strings = new ArrayList<>(Arrays.asList("zebra", "apple", "Banana"));
```

```
        Collections.sort(strings, String.CASE_INSENSITIVE_ORDER);
        System.out.println(strings); // Output: [apple, Banana, zebra]
    }
}
```

Searching and Finding

- **binarySearch(List<? extends Comparable<? super T>> list, T key):** Searches the specified list for the specified object using the binary search algorithm. The list *must* be sorted prior to making this call.
- **binarySearch(List<? extends T> list, T key, Comparator<? super T> c):** Searches the specified list for the specified object using the binary search algorithm. The list *must* be sorted according to the specified comparator prior to making this call.

```
import java.util.*;

public class BinarySearchExample {
    public static void main(String[] args) {
        List<Integer> list = Arrays.asList(1, 3, 5, 7, 9); // Must be sorted!
        int index = Collections.binarySearch(list, 5);
        System.out.println(index); // Output: 2

        List<String> strings = Arrays.asList("apple", "banana", "zebra"); // Must be sorted!
        int stringIndex = Collections.binarySearch(strings, "banana");
        System.out.println(stringIndex); // Output: 1
    }
}
```

- **min(Collection<? extends T> coll):** Returns the minimum element of the given collection, according to the *natural ordering* of its elements.
- **min(Collection<? extends T> coll, Comparator<? super T> comp):** Returns the minimum element of the given collection, according to the order induced by the specified comparator.
- **max(Collection<? extends T> coll):** Returns the maximum element of the given collection, according to the *natural ordering* of its elements.
- **max(Collection<? extends T> coll, Comparator<? super T> comp):** Returns the maximum element of the given collection, according to the order induced by the specified comparator.

```
import java.util.*;

public class MinMaxExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(3, 1, 4, 1, 5, 9);
        System.out.println(Collections.min(numbers)); // Output: 1
        System.out.println(Collections.max(numbers)); // Output: 9

        List<String> strings = Arrays.asList("zebra", "apple", "Banana");
        System.out.println(Collections.min(strings, String.CASE_INSENSITIVE_ORDER)); // Output: apple
        System.out.println(Collections.max(strings, String.CASE_INSENSITIVE_ORDER)); // Output: zebra
    }
}
```

- **frequency(Collection<?> c, Object o):** Returns the number of elements in the specified collection equal to the specified object.

```
import java.util.*;

public class FrequencyExample {
   public static void main(String[] args) {
      List<String> list = Arrays.asList("a", "b", "a", "c", "a");
      int count = Collections.frequency(list, "a");
      System.out.println(count); // Output: 3
   }
}
```

Creating Special Collections

- **emptyList(), emptySet(), emptyMap():** Returns empty, immutable lists, sets, and maps, respectively.

```
import java.util.*;

public class EmptyCollectionsExample {
   public static void main(String[] args) {
      List<String> emptyList = Collections.emptyList();
      System.out.println(emptyList); // Output: []
      // emptyList.add("test"); // Throws UnsupportedOperationException

      Set<Integer> emptySet = Collections.emptySet();
      System.out.println(emptySet); // Output: []

      Map<String, Double> emptyMap = Collections.emptyMap();
      System.out.println(emptyMap); // Output: {}

      // Trying to add elements will result in UnsupportedOperationException
      try {
         emptyList.add("test");
      } catch (UnsupportedOperationException e) {
         System.out.println("Caught exception: " + e.getMessage());
      }

      try {
         emptySet.add(1);
      } catch (UnsupportedOperationException e) {
         System.out.println("Caught exception: " + e.getMessage());
      }

      try {
         emptyMap.put("key", 1.0);
      } catch (UnsupportedOperationException e) {
         System.out.println("Caught exception: " + e.getMessage());
      }
   }
}
```

Comparable and Comparator

Both are interfaces in Java used for sorting objects. They define ways to compare two objects and determine their relative order and they have different purposes and usage:

1. Comparable

- **Definition:** The Comparable interface is implemented by a class whose objects need to be ordered "naturally." It defines a *natural ordering* for objects of that class. It has a single method:

  int compareTo(T o);

  - This method compares the current object (this) with the specified object o.
  - It returns:
    - A negative integer if this is less than o.
    - Zero if this is equal to o.
    - A positive integer if this is greater than o.
- **Usage:** When a class implements Comparable, its objects can be sorted directly using methods like Collections.sort() or Arrays.sort().
- **Example:**

```
import java.util.ArrayList;
import java.util.Collections;
import java.util.List;

class Student implements Comparable<Student> {
    String name;
    int rollNumber;

    public Student(String name, int rollNumber) {
        this.name = name;
        this.rollNumber = rollNumber;
    }

    @Override
    public int compareTo(Student other) {
        // Compare based on roll number (natural ordering)
        return this.rollNumber - other.rollNumber; // Ascending order
        // return other.rollNumber - this.rollNumber; // Descending order
    }

    @Override
    public String toString() {
        return "Name: " + name + ", Roll Number: " + rollNumber;
    }
}

public class ComparableExample {
    public static void main(String[] args) {
        List<Student> students = new ArrayList<>();
        students.add(new Student("Alice", 10));
        students.add(new Student("Bob", 5));
        students.add(new Student("Charlie", 15));
```

```
        Collections.sort(students); // Sorts based on compareTo()

        for (Student student : students) {
            System.out.println(student);
        }
        // Output:
        // Name: Bob, Roll Number: 5
        // Name: Alice, Roll Number: 10
        // Name: Charlie, Roll Number: 15
    }
}
```

2. Comparator

- **Definition:** The Comparator interface defines a comparison function that does *not* require the objects being compared to implement Comparable. It's used to define custom sorting logic or provide multiple ways to sort objects of the same class. It has a single method:

  int compare(T o1, T o2);

  - This method compares the two specified objects o1 and o2.
  - It returns:
    - A negative integer if o1 is less than o2.
    - Zero if o1 is equal to o2.
    - A positive integer if o1 is greater than o2.
- **Usage:** Comparator is used with methods like Collections.sort(list, comparator) or Arrays.sort(array, comparator).
- **Example:**

```
import java.util.ArrayList;
import java.util.Collections;
import java.util.Comparator;
import java.util.List;

class Student { // Doesn't implement Comparable now
    String name;
    int rollNumber;

    public Student(String name, int rollNumber) {
        this.name = name;
        this.rollNumber = rollNumber;
    }

    @Override
    public String toString() {
        return "Name: " + name + ", Roll Number: " + rollNumber;
    }
}

public class ComparatorExample {
    public static void main(String[] args) {
        List<Student> students = new ArrayList<>();
        students.add(new Student("Alice", 10));
        students.add(new Student("Bob", 5));
        students.add(new Student("Charlie", 15));
```

```
        // Comparator to sort by name
        Comparator<Student> nameComparator = Comparator.comparing(s -> s.name);

        Collections.sort(students, nameComparator);

        System.out.println("Sorted by Name:");
        for (Student student : students) {
            System.out.println(student);
        }
        // Output:
        // Sorted by Name:
        // Name: Alice, Roll Number: 10
        // Name: Bob, Roll Number: 5
        // Name: Charlie, Roll Number: 15

        // Comparator to sort by roll number in descending order
        Comparator<Student> rollNumberComparatorDescending = Comparator.comparingInt(s ->
s.rollNumber).reversed();

        Collections.sort(students, rollNumberComparatorDescending);
        System.out.println("Sorted by Roll Number Descending:");

        for (Student student : students) {
            System.out.println(student);
        }

        // Output:
        // Sorted by Roll Number Descending:
        // Name: Charlie, Roll Number: 15
        // Name: Alice, Roll Number: 10
        // Name: Bob, Roll Number: 5
    }
}
```

Feature	Comparable	Comparator
Interface	java.lang.Comparable	java.util.Comparator
Method	int compareTo(T o)	int compare(T o1, T o2)
Implemented by	The class whose objects are to be sorted	A separate class or lambda expression
Purpose	Defines natural ordering	Defines custom ordering or multiple orderings
Sorting Method	Collections.sort(list) or Arrays.sort(array)	Collections.sort(list, comparator) or Arrays.sort(array, comparator)

Serialization

It is the process of converting an object's state into a byte stream.

Deserialization

It is the reverse process: reconstructing an object from a byte stream.

This is useful for objects to storage (like files or databases) or transmitting them over a network.

example of serialization and deserialization:

```
import java.io.*;

class Person implements Serializable {
    private static final long serialVersionUID = 1L; // Important for versioning
    String name;
    int age;
    transient String secret; // This field will not be serialized

    public Person(String name, int age, String secret) {
        this.name = name;
        this.age = age;
        this.secret = secret;
    }

    @Override
    public String toString() {
        return "Name: " + name + ", Age: " + age + ", Secret: " + secret;
    }
}

public class SerializationExample {
    public static void main(String[] args) {
        Person person = new Person("Alice", 30, "My super secret!");

        // Serialization
        try (FileOutputStream fileOut = new FileOutputStream("person.ser");
             ObjectOutputStream out = new ObjectOutputStream(fileOut)) {
            out.writeObject(person);
            System.out.println("Object serialized successfully.");
        } catch (IOException i) {
            i.printStackTrace();
        }

        // Deserialization
        Person deserializedPerson = null;
        try (FileInputStream fileIn = new FileInputStream("person.ser");
             ObjectInputStream in = new ObjectInputStream(fileIn)) {
            deserializedPerson = (Person) in.readObject();
            System.out.println("Object deserialized successfully.");
        } catch (IOException i) {
            i.printStackTrace();
        } catch (ClassNotFoundException c) {
            System.out.println("Person class not found");
            c.printStackTrace();
        }

        if (deserializedPerson != null) {
```

```
            System.out.println("Deserialized object: " + deserializedPerson);
            // Output: Deserialized object: Name: Alice, Age: 30, Secret: null (secret is transient)
        }
    }
}
```

Explanation and Key Points:

1. Present in side java.io.Serializable interface.
2. This is a marker interface (it has no methods) that indicates that objects of this class can be serialized.
3. **serialVersionUID:** The private static final long serialVersionUID = 1L; field is crucial for versioning. It's a unique identifier for the class version. If you modify the class structure (e.g., add or remove fields), you should change the serialVersionUID to avoid InvalidClassException during deserialization of objects serialized with an older version of the class. If you don't explicitly declare serialVersionUID, the JVM calculates it based on the class structure, which can lead to issues if the class is modified.
4. **transient Keyword:** The transient keyword is used to mark fields that should *not* be serialized. In the example, the secret field is marked as transient, so it's not saved to the file, and its value is null after deserialization. This is useful for sensitive information that shouldn't be persisted.
5. **ObjectOutputStream:** The ObjectOutputStream is used to write objects to an output stream (in this case, a file stream). The writeObject() method serializes the object.
6. **ObjectInputStream:** The ObjectInputStream is used to read objects from an input stream. The readObject() method deserializes the object. It's important to cast the returned object to the correct type.

Java 8 Features:

1. Lambda Expressions

- **Definition:** Lambda expressions provide a concise way to represent anonymous functions (functions without a name). They enable functional programming in Java.
- **Example:**

```
import java.util.Arrays;
import java.util.List;

public class LambdaExample {
    public static void main(String[] args) {
        List<String> strings = Arrays.asList("apple", "banana", "kiwi");

        // Using lambda expression to print each string
        strings.forEach(s -> System.out.println(s));

        // Lambda expression with multiple statements
        strings.forEach(s -> {
            String upperCase = s.toUpperCase();
            System.out.println(upperCase);
        });

        // Lambda expression for comparing strings (used in sorting)
        strings.sort((s1, s2) -> s1.compareToIgnoreCase(s2));
        System.out.println(strings);
    }
}
```

2. Functional Interfaces

- **Definition:** Functional interfaces are interfaces with only one abstract method. They can be used with lambda expressions. The `@FunctionalInterface` annotation can be used to explicitly mark an interface as functional.
- **Example:**

```
@FunctionalInterface
interface MyFunction<T, R> {
    R apply(T t);
}

public class FunctionalInterfaceExample {
    public static void main(String[] args) {
        MyFunction<String, Integer> stringLength = s -> s.length();
        int length = stringLength.apply("Hello");
        System.out.println(length); // Output: 5
    }
}
```

3. Method References

- **Definition:** Method references are a shorthand for lambda expressions that refer to existing methods.

- **Example:**

```
import java.util.Arrays;
import java.util.List;

public class MethodReferenceExample {
    public static void main(String[] args) {
        List<String> strings = Arrays.asList("apple", "banana", "kiwi");

        // Method reference to System.out::println
        strings.forEach(System.out::println);

        // Method reference to String::toUpperCase
        strings.stream().map(String::toUpperCase).forEach(System.out::println);
    }
}
```

4. Stream API

- **Definition:** The Stream API provides a way to process collections of data in a functional style, allowing for operations like filtering, mapping, and reducing.
- **Example:**

```
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class StreamExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5, 6, 7, 8, 9, 10);

        List<Integer> evenNumbers = numbers.stream()
                .filter(n -> n % 2 == 0)
                .collect(Collectors.toList());

        int sumOfSquares = numbers.stream()
                .map(n -> n * n)
                .reduce(0, Integer::sum);

        System.out.println(evenNumbers);
        System.out.println(sumOfSquares);
    }
}
```

5. Default Methods in Interfaces

- **Definition:** Default methods allow you to add new methods to interfaces without breaking existing implementations.
- **Example:**

```
interface MyInterface {
    void myMethod();

    default void defaultMethod() {
        System.out.println("Default implementation");
    }
}
```

```
class MyClass implements MyInterface {
    @Override
    public void myMethod() {
        System.out.println("My implementation");
    }
}

public class DefaultMethodExample {
    public static void main(String[] args) {
        MyClass obj = new MyClass();
        obj.myMethod();       // Output: My implementation
        obj.defaultMethod();  // Output: Default implementation
    }
}
```

6. Static Methods in Interfaces

- **Definition:** Java 8 allows static methods in interfaces, similar to classes.
- **Example:**

```
interface MyInterface {
    static void staticMethod() {
        System.out.println("Static method in interface");
    }
}

public class StaticMethodInterfaceExample {
    public static void main(String[] args) {
        MyInterface.staticMethod(); // Output: Static method in interface
    }
}
```

7. Date and Time API (java.time)

- **Definition:** A new Date and Time API was introduced to address the shortcomings of the old Date and Calendar classes.
- **Example:**

```
import java.time.LocalDate;
import java.time.LocalTime;
import java.time.LocalDateTime;
import java.time.format.DateTimeFormatter;

public class DateTimeExample {
    public static void main(String[] args) {
        LocalDate today = LocalDate.now();
        LocalTime now = LocalTime.now();
        LocalDateTime currentDateTime = LocalDateTime.now();

        System.out.println("Today's Date: " + today);
        System.out.println("Current Time: " + now);
        System.out.println("Current Date and Time: " + currentDateTime);

        DateTimeFormatter formatter = DateTimeFormatter.ofPattern("yyyy-MM-dd HH:mm:ss");
        String formattedDateTime = currentDateTime.format(formatter);
        System.out.println("Formatted Date and Time: " + formattedDateTime);
    }
}
```

8. Optional

- **Definition:** The Optional class is a container object that may or may not contain a non-null value. It helps avoid NullPointerExceptions.
- **Example:**

```
import java.util.Optional;

public class OptionalExample {
   public static void main(String[] args) {
      String str = "Hello";
      Optional<String> optionalStr = Optional.ofNullable(str);

      if (optionalStr.isPresent()) {
         System.out.println(optionalStr.get());
      }

      optionalStr.ifPresent(s -> System.out.println(s.toUpperCase()));

      String orElseValue = optionalStr.orElse("Default Value");
      System.out.println(orElseValue);

      Optional<String> emptyOptional = Optional.ofNullable(null);
      String orElseEmpty = emptyOptional.orElse("Default Value for Empty");
      System.out.println(orElseEmpty);
   }
}
```

.

Advance Java

Advanced Java

Java is used to develop applications.

To develop an application using Java, you can use the following approaches:

1. **Standalone Application:**

- A standalone application is a self-contained program that runs on a single computer.
- Examples include console applications, GUI applications and desktop applications.

2. **Web Application:**
   - A web application is an application that runs on a web server and is accessed through a web browser.
   - It interacts directly with the user.
3. **Enterprise Application:**
   - An enterprise application is a large-scale application that typically runs on a server with multiple clients,
   - It often uses a distributed architecture.

Components of a Web Application

A web application typically consists of two main components:

1. **Front-end:**
   - The front-end is the user interface, which is visible to the user.
   - It is primarily built using HTML, CSS, and JavaScript.
2. **Back-end:**
   - The back-end handles the server-side logic and data processing.
   - It typically involves databases, servers, and application logic written in languages like Java, Python, or Node.js.

Types of Web Applications

1. **Static Web Applications:**
   - These applications have fixed content that doesn't change dynamically.
   - They are primarily HTML and CSS-based.
2. **Dynamic Web Applications:**
   - These applications can generate content dynamically based on user input or other factors.
   - They can be further categorized into:
     - **Client-side Web Applications:**
       - The application logic primarily runs on the client-side (browser).
       - JavaScript plays a significant role in these applications.
     - **Server-side Web Applications:**
       - The application logic primarily runs on the server-side.
       - Server-side languages like Java, Python, or Node.js handle the request processing and response generation.

Java Editions

There are four main editions of Java:

1. **Java SE (Standard Edition):** Used for developing standalone applications.
2. **Java EE (Enterprise Edition):** Used for developing web and enterprise applications.
3. **Java ME (Micro Edition):** Used for developing applications for embedded devices.
4. **JavaFX:** Used for developing rich desktop applications.

Perspectives

Perspectives are used to specify the development environment to the specific type of application you're building.

There are two main perspectives in Java development environments:

1. **Java Perspective:** Primarily used for Java SE development.
2. **Java EE Perspective:** Primarily used for Java EE development.

JDBC Driver

A JDBC driver is a software component that enables Java applications to communicate with a database. It acts as a bridge between the Java application and the database management system (DBMS).

There are two main types of classes in advanced Java:

1. **Normal Class:** A regular Java class that can be executed from the main method.
2. **Servlet Class:** A specialized class that extends the HttpServlet class and is used to handle HTTP requests and generate dynamic web content

Servlet

- In dynamic web projects, servlets are used to handle client requests and generate dynamic responses.
- We call all the Java classes that extend the HttpServlet class as servlet classes.
- Servlets are used to connect the front-end and back-end components of a web application.
- To develop the front-end, we use web technologies like HTML, CSS, and JavaScript.
- To develop the back-end, we use core Java and JSP (JavaServer Pages).
- Servlets provide additional features like multithreading and session management.

Multithreaded Application

- A multithreaded application can handle multiple client requests concurrently, improving performance and responsiveness.
- This is achieved by creating multiple threads, each of which can handle a separate request.

Session

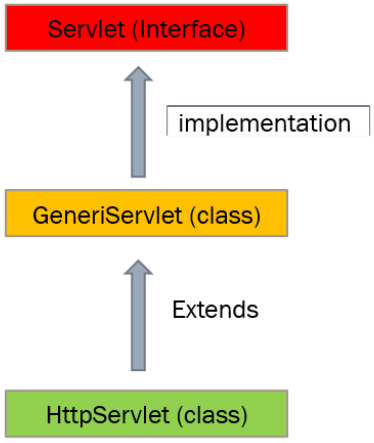
A session is a time interval assigned to a user to perform specific tasks on a web application. It is typically used to maintain user state and track user activity across multiple web pages.

servlet class

1. create a normal class in the project.
2. make a class to behave as implementation class (or) subclass for predefined servlet classes and interface.

3. All predefined classes are present in javax.servlet package
4. javax.servlet package is present in a jar file called servlet-api.jar
5. servlet-api.jar file is present inside Tomcat server

Hierarchy of servlet



Servlet interface

To create a servlet class by implementing the Servlet interface, you need to override all of its methods.

The Servlet interface defines five methods that must be implemented by any class that implements it:

1. **service():** This method is called by the servlet container to handle incoming requests. It's typically overridden to process requests and generate responses.
2. **destroy():** This method is called by the servlet container when the servlet is being unloaded. It's used to release resources and perform any necessary clean-up.
3. **getServletInfo():** This method returns information about the servlet, such as its author, version, and description.
4. **init():** This method is called by the servlet container when the servlet is first loaded. It's used to initialize the servlet and any resources it needs.
5. **getServletConfig():** This method returns a ServletConfig object, which provides information about the servlet's configuration.

Exa :

```
public class MyServlet implements Servlet {
   // Implementation of the five methods
   public void service(ServletRequest req, ServletResponse res) throws ServletException, IOException {
      // Handle the request and generate the response
   }
   public void destroy() {
      // Clean up resources
   }
   public String getServletInfo() {
      return "My Servlet";
```

```
    }
    public void init(ServletConfig config) throws ServletException {
        // Initialize the servlet
    }
    public ServletConfig getServletConfig() {
        // Return the servlet configuration
    }
}
```

GenericServlet

To create a Servlet class by using the GenericServlet class, you need to override only one method.

The GenericServlet class is an abstract class that provides a basic implementation of the Servlet interface. It has one abstract method, service(), which you must override to handle requests.

Exa :

```
public class MyServlet extends GenericServlet {
    public void service(ServletRequest req, ServletResponse res) throws ServletException, IOException {
        // Implement the logic to handle the request and generate the response
    }
}
```

HttpServlet :

If we want to create a Servlet class by using HttpServlet class we no need to complete any method.
HttpServlet class is an abstract class which is present with all complete methods

```
public class Myservlet extends HttpServlet
{
 // no need to complete any method.
}
```

PrintWriter

- The PrintWriter class is a predefined class in the java.io package.
- It is used to write text to a character-output stream.
- To print output, we use two methods:
    1. print(): Prints the specified string without a newline.
    2. println(): Prints the specified string followed by a newline.

Both print() and println() are non-static methods, so they must be called on an instance of the PrintWriter class.

To create a PrintWriter object, we typically use the getWriter() method from a HttpServletResponse object.

Syntax:

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

The `getWriter()` method takes no arguments and returns a `PrintWriter` object. This `PrintWriter` object can then be used to write text to the response.

Using `PrintWriter`:

```
out.print("Hello, world!");
out.println("This is a new line.");
```

To inform the browser to print HTML code only:-

By default, browsers typically interpret content as plain text. To instruct the browser to render HTML content, we use the `setContentType()` method.

`setContentType()` Method:

This is a method that accepts a string representing the content type. To specify HTML content, we use the following syntax:

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

Fetching Data from Front-end to Back-end:

Front-end:

In the front-end (HTML), we use input tags to capture user input. Each input tag should have a unique `name` attribute to identify the data it represents.

Example:

```
<form action="your_servlet" method="post">
    <input type="text" name="username">
    <input type="password" name="password">
    <input type="submit" value="Submit">
</form>
```

Back-end

To fetch data from the front-end in the back-end, we use the `getParameter()` method.

The `getParameter()` method is a non-static method present in the `ServletRequest` interface. It takes a string argument representing the name of the parameter and returns the corresponding value as a string.

Syntax:

```
String parameterValue = req.getParameter("parameterName");
```

Example:

```
String email = req.getParameter("email");
String password = req.getParameter("password");
```

Annotations

- it use to do auto configuration which start from @ and follow pascal case.
- To replace XML-based configuration and reduce line of code, we can use the @WebServlet annotation. This annotation should be placed above the servlet class declaration.

@WebServlet Annotation

The @WebServlet annotation is used to specify the URL patterns that a servlet should handle. It takes a URL pattern as an argument.

Syntax:

@WebServlet("/url-pattern")

HttpServlet

HttpServlet is a concrete class that implements the Servlet interface. It provides a basic implementation for handling HTTP requests. It's located in the javax.servlet.http package.

Handling Requests:

To handle HTTP GET, PUT and POST requests, we override the doGet(), doPut() and doPost() methods of the HttpServlet class. These methods receive HttpServletRequest and HttpServletResponse objects as parameters.

Syntax:

```
protected void doGet(HttpServletRequest req, HttpServletResponse resp) throws ServletException, IOException {
    // Code to handle GET requests
}

protected void doPost(HttpServletRequest req, HttpServletResponse resp) throws ServletException, IOException {
    // Code to handle POST requests
}
```

Servlet chaining is a technique in Java web applications where one servlet can forward a request to another servlet to handle processing.

There are two main ways to achieve servlet chaining:

1. **Using RequestDispatcher:**
    - The RequestDispatcher interface provides methods to forward requests to another resource, such as a servlet or a JSP.
    - To obtain a RequestDispatcher object, you can use the getRequestDispatcher() method of the ServletRequest object.
2. **Using sendRedirect():**
    - The sendRedirect() method redirects the client to a different URL. This is useful for redirecting to external resources or to a different servlet.

RequestDispatcher Interface:

The `RequestDispatcher` interface is used to forward requests to another resource, such as a servlet or a JSP. It's located in the `javax.servlet` package.

Obtaining a RequestDispatcher Object:

To get a `RequestDispatcher` object, we use the `getRequestDispatcher()` method of the `HttpServletRequest` interface.

Syntax:

RequestDispatcher rd = request.getRequestDispatcher("/path/to/resource");

The `getRequestDispatcher()` method takes a URL path as an argument and returns a `RequestDispatcher` object.

Servlet Chaining:

To combine the functionality of multiple servlets, we can use servlet chaining. This involves sending the request and response objects from one servlet to another.

Methods for Servlet Chaining:

Two common methods for servlet chaining are:

1. **forward():**
    - This method forwards the request to another resource, such as a servlet or a JSP.
    - The original request and response objects are passed to the target resource.
    - The client's browser URL remains unchanged.
2. **include():**
    - This method includes the content of another resource into the current response.
    - The original request and response objects are also passed to the included resource.
    - The client's browser URL remains unchanged.

sendRedirect() Method

The `sendRedirect()` method is used to redirect the client's browser to a different URL. This is useful for:

- Redirecting to a different page or servlet.
- Redirecting after a form submission.
- Redirecting after a successful operation.

Syntax:

response.sendRedirect("url");

- The url parameter can be a relative or absolute URL.

- It redirects the client's browser to the specified URL, and the original request and response objects are discarded.

Sending Additional Data with `sendRedirect()`:

The `sendRedirect()` method itself doesn't directly allow you to send additional data to the target URL. However, you can use alternative methods to achieve this:

1. Hidden Input Fields:

- Create hidden input fields in your HTML form with the desired data.
- When the form is submitted, the values of these hidden fields will be included in the request parameters.
- In the target servlet, you can access these values using the getParameter() method.

2. URL Rewriting:

- Append the additional data as parameters to the URL in the sendRedirect() method.
- The target servlet can then extract the data from the request URL.

Example:

```
<form action="targetServlet" method="post">
   <input type="hidden" name="hiddenData" value="secretValue">
   <input type="submit" value="Submit">
</form>

// In the target servlet
String hiddenValue = request.getParameter("hiddenData");
```

Sending Data from Front-end to Back-end:

To send data from the front-end to the back-end using URL rewriting, you need to include the data as parameters in the URL. Use the `&` symbol to separate multiple parameters.

Example:

http://example.com/myServlet?name=Alice&age=30

In the back-end servlet, you can retrieve these values using the `getParameter()` method:

```
String name = request.getParameter("name");
int age = Integer.parseInt(request.getParameter("age"));
```

Sending Data Between Servlets:

To send data from one servlet to another, you can use:

1. **Session Objects:**
    - Create a session object using HttpSession session = request.getSession().
    - Store data in the session using session.setAttribute("key", value).

    - Retrieve data in the target servlet using session.getAttribute("key").
2. **Cookie Objects:**
    - Create a cookie object using Cookie cookie = new Cookie("name", "value").
    - Set the cookie's attributes (e.g., expiration time, path, domain).
    - Add the cookie to the response using response.addCookie(cookie).
    - Retrieve the cookie in the target servlet using request.getCookies().

HttpSession Interface:

- **Definition:** HttpSession is an interface in the jakarta.servlet.http package. It represents a session between a client and a server.
- **Creating a Session:** To get a session object, we use the getSession() method of the HttpServletRequest interface. This method creates a new session if one doesn't exist or returns an existing session.

  HttpSession session = request.getSession();

- **Storing and Accessing Data:** We can store and retrieve data from the session using the setAttribute() and getAttribute() methods.

  ```
  // Store data
  session.setAttribute("key", value);

  // Retrieve data
  Object value = session.getAttribute("key");
  ```

HttpSession Interface:

The HttpSession interface represents a session between a client and a server. It's used to store session-specific data, such as user preferences, shopping cart items, or authentication information.

The HttpSession interface is used to manage user sessions in web applications. It allows you to store and retrieve data associated with a specific user session.

Key Methods:

- **setAttribute(String key, Object value):**
    - Stores an object under the specified key in the session.
    - The value can be any object type.
- **getAttribute(String key):**
    - Retrieves the object associated with the specified key from the session.
    - The returned object needs to be cast to the appropriate type.

setAttribute() Method:

The setAttribute() method is used to store an object in the session. It takes two arguments:

1. **Key:** A string that identifies the object.
2. **Value:** The object to be stored.

Exa :

```
HttpSession session = request.getSession();
session.setAttribute("id", 101);
session.setAttribute("name", "Hiuga");

// Retrieve values
int id = (Integer) session.getAttribute("id");
String name = (String) session.getAttribute("name");
```

Setting Session Timeout

To set the maximum inactive interval for a session, we use the setMaxInactiveInterval() method. This method is available in the HttpSession interface.

Syntax:

```
session.setMaxInactiveInterval(seconds);
```

JSP (JavaServer Pages)

- JSP stands for JavaServer Pages.
- It allows you to combine HTML code with Java code within a single file.
- This approach helps to overcome the limitations of using PrintWriter to generate dynamic HTML content.
- When a programmer needs to print only static HTML, they can use PrintWriter.
- However, when dynamic content and server-side logic are required, JSPs are a more convenient and efficient solution.
- The JSP engine automatically generates a servlet class for each JSP file at runtime.

JSP Tags

JSP (JavaServer Pages) files allow you to combine HTML and Java code within a single file. To structure and separate the different types of code, JSP provides three main types of tags:

1. **Declaration Tag:**
    - Used to declare variables and methods that can be accessed throughout the JSP page.
    - Syntax: <%! Java code %>
2. **Scriptlet Tag:**
    - Used to execute Java code within the JSP page.
    - Syntax: <% Java code %>
3. **Expression Tag:**
    - Used to print the value of an expression directly to the output.
    - It must be placed within a scriptlet tag or inside a method.
    - Syntax: <%= expression %>

Syntax:

```
<%= expression %>
<%!
   int principle = 1000000;
   double interestRate = 10.5;
   int periodInYears = 10;
%>
```

```
<%
    double rateOfInterest = interestRate / 12 / 100;
    int periodInMonths = periodInYears * 12;

    double emi = principle * rateOfInterest * Math.pow(1 + rateOfInterest, periodInMonths) / (Math.pow(1 + rateOfInterest, periodInMonths) - 1);
%>

EMI: <%= emi %>
```

JDBC (Java Database Connectivity)

- It is an API that provides a standard way to connect to and interact with relational databases from Java applications.
- JDBC acts as a bridge between the Java application and the database, allowing you to execute SQL queries and retrieve results.

JDBC Architecture:

To understand database connectivity using JDBC, it's important to understand the key components of JDBC architecture:

1. **Java Application:**
   - It is used to collect user information.
   - Java application cannot store user information permanently so we make use of database application to store data permanently.

2. **JDBC Driver:**
   - A software component that enables communication between a Java application and a specific database.
   - It translates JDBC calls into database-specific calls.

3. **JDBC API:**
   - A set of interfaces and classes that define the standard way to interact with databases.
   - It provides methods for connecting to databases, executing SQL queries, and processing results.
   - It provide connection b/w database and java application.

4. **Database Driver:**
   - A software component provided by the database vendor that implements the JDBC API and interacts with the database.

Collecting User Information in Java Applications

We can collect user information in Java applications through two primary methods:

1. **Basic Level Data Collection:**
    - This involves using the Scanner class to read input from the console.
    - It's suitable for simple applications where user input is limited to text-based commands or data.
2. **High Level Data Collection:**
    - This involves using web technologies like HTML forms to collect user input.
    - The user interacts with the web page, fills out forms, and submits the data to the server.

Key Points:

- **Java Language:** Java applications can only understand Java code.
- **Database Language:** Databases understand SQL queries.
- **JDBC Driver's Role:** The JDBC driver converts Java-specific data and commands into SQL queries that the database can execute.

Reasons for using MySQL:

- **Cost-Effective:** MySQL is an open-source database, making it free to use.
- **Ease of Use:** It's relatively easy to learn and set up.
- **Popularity:** MySQL is a widely used database, making it a popular choice for developers.

Creating a Database in MySQL Workbench:

1. Open MySQL Workbench.
2. Connect to your MySQL server.
3. Right-click on the server connection and select "Create Schema."
4. Specify the desired name for your new database.
5. Click "Apply" and then "Finish."

CRUD operation query :

SELECT * FROM table_name; -- Selects all columns and rows

SELECT column1, column2 FROM table_name; -- Selects specific columns

INSERT INTO table_name (column1, column2) VALUES (value1, value2);

UPDATE table_name SET column1 = value1, column2 = value2 WHERE condition;

DELETE FROM table_name WHERE condition;

Establishing a Database Connection in Java

To establish a connection between a Java application and a database, we use the Connection interface from the java.sql package. Here's a breakdown of the steps involved:

1. **Load the JDBC Driver:**

- Load the appropriate JDBC driver for your database (e.g., MySQL, Oracle, PostgreSQL). This is typically done using the Class.forName() method.

2. **Establish a Connection:**
   - Use the DriverManager.getConnection() method to create a connection to the database.
   - Provide the database URL, username, and password as arguments.

Exa :

```
try {
   Class.forName("com.mysql.cj.jdbc.Driver"); // Replace with your JDBC driver class name

   Connection connection = DriverManager.getConnection(
      "jdbc:mysql://localhost:3306/mydatabase", "username", "password"
   );

   // Use the connection to execute SQL queries
   // ...

} catch (ClassNotFoundException | SQLException e) {
   e.printStackTrace();
}
```

getConnection() Method:

- The getConnection() method is a static method within the DriverManager class.
- It takes a URL as an argument, which specifies the database connection details (e.g., database URL, username, password).
- It returns a Connection object, representing the established database connection. Connection

  connection = DriverManager.getConnection(url);

Example:

```
try {
   Connection connection = DriverManager.getConnection("jdbc:mysql://localhost:3306/mydatabase",
"username", "password");
   // Use the connection to execute SQL queries
} catch (SQLException e) {
   e.printStackTrace();
}
```

URL (Uniform Resource Locator)

Example: https://www.google.com/search

Key Components of a URL:

- **Protocol:** The communication protocol used to access the resource (e.g., HTTP, HTTPS, FTP).
- **Domain Name:** The address of the server hosting the resource.
- **Path:** The specific location of the resource within the server.

User Information and Database Connections

User Information:

- Usernames and passwords are essential for security when accessing databases.
- They help protect sensitive data from unauthorized access.

Database Connection Strings:

- **MySQL:**

  jdbc:mysql://localhost:3306?user=root&password=12345

- **Oracle:**

  jdbc:oracle:thin:@localhost:1521:XE?user=scott&password=tiger

Java Applications:

Java applications can combine both Java code (for business logic) and HTML code (for user interface) to create dynamic web applications.

Creating a Platform for Query Execution

A platform, such as a Java application, serves as a bridge between the Java code and the database. It allows you to write Java code to execute SQL queries and process the results.

Key Points:

- **Java Code vs. SQL Code:**
  - Java code is understood by the Java compiler.
  - SQL code is interpreted by the database engine.
- **Platform's Role:**
  - The platform is responsible for:
    - Converting Java code into SQL queries.
    - Sending the SQL queries to the database.
    - Processing the results returned by the database.
    - Presenting the results to the user.

Registering a JDBC Driver:

To establish a database connection in Java, you need to register the appropriate JDBC driver. This is typically done using the `Class.forName()` method.

Steps:

1. **Load the Driver Class:**
   - Use Class.forName() to load the driver class.
   - Provide the fully qualified class name of the JDBC driver as an argument.

```
Class.forName("com.mysql.cj.jdbc.Driver"); // For MySQL
```

2. **Establish the Connection:**
   - Use DriverManager.getConnection() to create a connection to the database.
   - Provide the database URL, username, and password as arguments.

```
Connection connection = DriverManager.getConnection(
    "jdbc:mysql://localhost:3306/mydatabase", "username", "password"
);
```

ClassNotFoundException:

- The Class.forName() method can throw a ClassNotFoundException if the specified driver class is not found in the classpath.
- This is a checked exception, meaning you must handle it using a try-catch block.

Exa :

```
try {
    Class.forName("com.mysql.cj.jdbc.Driver");
    // ...
} catch (ClassNotFoundException e) {
    e.printStackTrace();
}
```

Types of Platforms:

There are two main types of platforms for executing SQL queries in Java:

1. **Statement Platform:**

- Uses Statement interface to execute static SQL queries.
- Less efficient for repeated queries with different parameters.

2. **PreparedStatement Platform:**
   - Uses PreparedStatement interface to execute parameterized SQL queries.
   - More efficient and secure, especially for dynamic queries.

Statement Interface:

The Statement interface provides methods for executing SQL statements. Here are two common methods:

1. **executeUpdate(String query):**
   - Used to execute SQL statements that modify data, such as INSERT, UPDATE, and DELETE statements.
   - Returns the number of rows affected by the statement.
2. **executeQuery(String query):**
   - Used to execute SQL statements that retrieve data, such as SELECT statements.
   - Returns a ResultSet object containing the result set.

Processing Resultant Data

In a database system, data can exist in two primary states:

1. Actual Data:

- This is the data that is permanently stored in the database.
- It's accessed and modified through SQL queries.

2. Resultant Data:

- This is temporary data that is generated as a result of executing a SQL query.
- It's typically stored in memory and can be accessed and processed by the application.

Database Query Execution:

When a SQL query is sent to the database, it undergoes a three-step process:

1. **Compilation:** The database compiler checks the syntax and semantics of the query.
2. **Execution:** The database engine executes the query, accessing and manipulating the actual data.
3. **Output:** The results of the query are returned to the application in the form of a result set.

Resultant Data :

- **Resultant Data:**
  - Data that is temporarily stored in memory after being retrieved from the database.
  - It's not permanently stored in the database.

SELECT * FROM employees;

Steps :

- The query is sent to the database.
- The database compiler checks the syntax and semantics of the query.
- The database engine executes the query, retrieves the data from the employees table.
- The retrieved data is stored in buffer memory as a result set.
- The result set is sent back to the application.

Result Set and Buffer Memory

When you execute a SELECT query using a Statement object, the result is stored in a ResultSet object. This ResultSet object acts as a cursor over the result set, allowing you to iterate through the rows of data.

Buffer Memory:

- The ResultSet object maintains an internal buffer to store the data fetched from the database.
- This buffer memory typically holds a subset of the entire result set to optimize performance.
- The buffer memory is associated with two pointers:
  - **BFR (Before First Record):** Points to the position before the first row.
  - **ALR (After Last Record):** Points to the position after the last row.

Navigating the Result Set:

To move the cursor within the result set, you can use various methods provided by the ResultSet interface:

- **first():** Moves the cursor to the first row.
- **last():** Moves the cursor to the last row.
- **next():** Moves the cursor to the next row.
- **previous():** Moves the cursor to the previous row.
- **absolute(int row):** Moves the cursor to the specified row number.
- **relative(int rows):** Moves the cursor relative to the current position.

Getter Methods in ResultSet:

Getter methods in the ResultSet interface are used to retrieve data from a specific column in the result set. They accept either the column name or the column index as an argument.

Common Getter Methods:

- **getInt(columnLabel):** Retrieves an integer value from the specified column.
- **getString(columnLabel):** Retrieves a string value from the specified column.
- **getDouble(columnLabel):** Retrieves a double value from the specified column

Exa :

```
ResultSet rs = stmt.executeQuery("SELECT * FROM employees");

while (rs.next()) {
    int id = rs.getInt("empid");
    String name = rs.getString("ename");
    double salary = rs.getDouble("salary");
    // ...
```

}

PreparedStatement

A PreparedStatement is an interface in the java.sql package that represents a precompiled SQL statement. It's used to execute SQL statements with parameters, providing several advantages:

- **Performance:** Prepared statements are precompiled, which can significantly improve performance, especially for frequently executed queries.
- **Security:** Using prepared statements helps prevent SQL injection attacks by separating SQL statements from user-provided data.
- **Code Readability:** Prepared statements make your code more readable and maintainable.

Using PreparedStatement:

1. **Create a PreparedStatement:**

PreparedStatement preparedStatement = connection.prepareStatement("INSERT INTO employee VALUES (?, ?, ?)");

2. **Set Parameters**:

```
preparedStatement.setInt(1, 101);
preparedStatement.setString(2, "Dinga");
preparedStatement.setInt(3, 1000);
```

Using a PreparedStatement:

- **Setting Parameters:**
  - Use setInt, setString, setDouble, etc., to set values for the placeholders in the SQL statement.
- **Executing the Statement:**
  - Use executeUpdate() for INSERT, UPDATE, and DELETE statements.
  - Use executeQuery() for SELECT statements.

Setter Methods in PreparedStatement

Setter methods in the PreparedStatement interface are used to set values for the placeholders in a prepared statement. These methods accept two arguments:

1. **Placeholder Position:** An integer indicating the position of the placeholder in the SQL statement, starting from 1.
2. **Value:** The value to be assigned to the placeholder.

Common Setter Methods:

- setInt(int placeHolder, int value): Sets an integer value.
- setString(int placeHolder, String value): Sets a string value.
- setDouble(int placeHolder, double value): Sets a double value

Exa :

```
PreparedStatement pstmt = connection.prepareStatement("INSERT INTO employees (id, name, salary) VALUES (?, ?, ?)");
pstmt.setInt(1, 101);
pstmt.setString(2, "Alice");
pstmt.setDouble(3, 50000);
pstmt.executeUpdate();
```

JDBC Connection steps :

- For making connection b/w java and database we are using Connection interface
- For Getting connection object we are using getConnection() method which is present in DriverManager class.
- For taking input we have 2 interface PreparedStatement and statement.
- If we want to take run time input then we are using PreparedStatement otherwise Statement interface, for getting this object we need to call PreparedStatement() or statement() which is present in side connection interface and it is non-static method so call by orv name.
- Now for executing query we have 2 method executeQuery() and executeUpdate().
- Which is present in side PreparedStatement or Statement interface and non-static method.
- For executeUpdate() return type is intiger type and for executeQuery() return type is ResultSet.

Exa :2

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.SQLException;
import java.sql.Statement;

public class UpdateStudentPercentage {
   public static void main(String[] args) {
      String url = "jdbc:mysql://localhost:3306?user=root&password=12345";
      String update = "update training_student set percentage = 80 where student_id = 1";
      try {
         Connection connection = DriverManager.getConnection(url);
         Statement statement = connection.createStatement();
         int result = statement.executeUpdate(update);
         System.out.println(result);
      } catch (SQLException e) {
         e.printStackTrace();
      }
```

```
    }
}
```

Exa :3

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.sql.Statement;

public class EmployeeDetail {

    public static void main(String[] args) {
        String url = "jdbc:mysql://localhost:3306?user=root&password=12345";
        String select = "select * from training_employee";

        try (Connection connection = DriverManager.getConnection(url);
             Statement statement = connection.createStatement();
             ResultSet resultSet = statement.executeQuery(select)) {

            while (resultSet.next()) {
                int id = resultSet.getInt("emp_id");
                String name = resultSet.getString("emp_name");
                double salary = resultSet.getDouble("emp_salary");
                int deptno = resultSet.getInt("emp_deptno");

                System.out.println("Emp id: " + id);
                System.out.println("Emp name: " + name);
                System.out.println("Emp salary: " + salary);
                System.out.println("Emp deptno: " + deptno);
            }

        } catch (SQLException e) {
            System.err.println("Error fetching employee details: " + e.getMessage());
            e.printStackTrace(); // For debugging
        }
    }
}
```

Exa :3

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.SQLException;
import java.sql.Statement;
```

```
public class InsertIntoTable {

    public static void main(String[] args) {
        String insert = "insert into userinfo (username, user_lastname, user_address, user_email_id,
user_pincode, user_mobileno, user_address) values ('Dinga', 'Kumar', 'Arimail.com', '1234', '108001',
'1234567890', '1234567890')";
        String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

        try (Connection connection = DriverManager.getConnection(url);
             Statement statement = connection.createStatement()) {

            int rowsInserted = statement.executeUpdate(insert);

            if (rowsInserted > 0) {
                System.out.println("Insertion successful.");
            } else {
                System.out.println("Insertion failed.");
            }

        } catch (SQLException e) {
            System.err.println("Error inserting data: " + e.getMessage());
            e.printStackTrace(); // For debugging
        }
    }
}
```

Exa : 4

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.sql.Statement;

public class LoginCheck {

    public static void main(String[] args) {
        String select = "select * from userinfo where username = 'Dinga' and password = '1234'";
        String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

        try (Connection connection = DriverManager.getConnection(url);
             Statement statement = connection.createStatement();
             ResultSet resultSet = statement.executeQuery(select)) {

            if (resultSet.next()) {
                System.out.println("Login Successful");
            } else {
                System.out.println("Invalid login password");
            }

        } catch (SQLException e) {
            System.err.println("Error checking login: " + e.getMessage());
```

```
            e.printStackTrace(); // For debugging
        }
    }
}
```

Exa : 5 WAP to take run time input and use PreparedStatement interface?

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.SQLException;
import java.util.Scanner;

public class Registration {

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

        System.out.print("Enter first name: ");
        String firstName = scanner.nextLine();

        // ... (similar code for other fields)

        String insert = "insert into userinfo (firstname, lastname, email, password) values (?, ?, ?, ?)";
        String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

        try (Connection connection = DriverManager.getConnection(url);
             PreparedStatement statement = connection.prepareStatement(insert)) {

            statement.setString(1, firstName);
            // ... (set other parameters)

            int rowsInserted = statement.executeUpdate();

            if (rowsInserted > 0) {
                System.out.println("Registration successful.");
            } else {
                System.out.println("Registration failed.");
            }

        } catch (SQLException e) {
            System.err.println("Error during registration: " + e.getMessage());
            e.printStackTrace(); // For debugging
        }
    }
}
```

Exa : 6

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.SQLException;
import java.util.Scanner;
```

```
public class Registration {

   public static void main(String[] args) {
      Scanner scanner = new Scanner(System.in);
      System.out.print("Enter first name: ");
      String firstName = scanner.nextLine();
      System.out.print("Enter last name: ");
      String lastName = scanner.nextLine();
      System.out.print("Enter email: ");
      String email = scanner.nextLine();
      String insert = "insert into userinfo (firstname, lastname, email, password, mobileno, address) values (?,
?, ?, ?, ?, ?)";
      String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

      try (Connection connection = DriverManager.getConnection(url);
           PreparedStatement statement = connection.prepareStatement(insert)) {

         statement.setString(1, firstName);
         statement.setString(2, lastName);
         statement.setString(3, email);
         int rowsInserted = statement.executeUpdate();

         if (rowsInserted > 0) {
            System.out.println("Registration successful.");
         } else {
            System.out.println("Registration failed.");
         }

      } catch (SQLException e) {
         System.err.println("Error during registration: " + e.getMessage());
         e.printStackTrace(); // For debugging
      }
   }
}
```

Exa : 7

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.util.Scanner;

public class LoginCheck {

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

      System.out.print("Enter Email ID: ");
      String email = scanner.nextLine();

      System.out.print("Enter Password: ");
      String password = scanner.nextLine();
```

```
        String select = "select * from userinfo where user_email = ? and user_password = ?";
        String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

        try (Connection connection = DriverManager.getConnection(url);
             PreparedStatement statement = connection.prepareStatement(select)) {

            statement.setString(1, email);
            statement.setString(2, password);

            ResultSet resultSet = statement.executeQuery();

            if (resultSet.next()) {
                System.out.println("Login Successful");
            } else {
                System.out.println("Invalid input");
            }

        } catch (SQLException e) {
            System.err.println("Error checking login: " + e.getMessage());
            e.printStackTrace(); // For debugging
        }
    }
}
```

Dynamic Web Project:

- right click on left side bar
- Dynamic Right click -> New -> Dynamic Web Project
- Select Target runtime: Apache Tomcat 9.0
- Dynamic Web Module version: 4.0
- Deployment descriptor: web.xml

Run:

- Window -> Show View -> Servers
- Right click -> Add Server -> Apache Tomcat 9.0
- Right click on Server -> Add or Remove Deployments

Exa : 8 Employee detail

```
<!DOCTYPE html>
<html>
<head>
    <title>Employee Detail</title>
</head>
<body>

<form action="empAction">
    <input type="text" placeholder="Enter Id" name="id">
    <input type="text" placeholder="Enter Name" name="name">
```

```
    <input type="number" placeholder="Enter Salary" name="salary">
    <input type="text" placeholder="Enter Department No" name="deptno">
    <input type="submit" value="Submit">
</form>

</body>
</html>

package com;

import java.io.IOException;
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.SQLException;
import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

public class EmpAction extends HttpServlet {

    protected void doPost(HttpServletRequest request, HttpServletResponse response) throws
ServletException, IOException {
        String id = request.getParameter("id");
        String name = request.getParameter("name");
        String salary = request.getParameter("salary");
        String deptno = request.getParameter("deptno");

        String insert = "insert into employee (emp_id, emp_name, emp_salary, emp_deptno) values (?, ?, ?, ?)";
        String url = "jdbc:mysql://localhost:3306/test?user=root&password=12345";

        try (Connection connection = DriverManager.getConnection(url);
             PreparedStatement statement = connection.prepareStatement(insert)) {

            statement.setString(1, id);
            statement.setString(2, name);
            statement.setString(3, salary);
            statement.setString(4, deptno);

            int rowsInserted = statement.executeUpdate();

            if (rowsInserted > 0) {
```

```
            response.getWriter().println("Employee details inserted successfully.");
        } else {
            response.getWriter().println("Error inserting employee details.");
        }

    } catch (SQLException e) {
        response.getWriter().println("Error: " + e.getMessage());
        e.printStackTrace(); // For debugging
    }
  }
}
```

xml file (.web.xml)

```
<web-app>
  <servlet>
    <servlet-name>employeeDetail</servlet-name>
    <servlet-class>com.EmployeeDetail</servlet-class>
    </servlet>

  <servlet-mapping>
    <servlet-name>employeeDetail</servlet-name>
    <url-pattern>/employeeDetail</url-pattern>
  </servlet-mapping>
</web-app>
```

Annotation:

- @WebServlet("/url-pattern")
- It connects the frontend to the servlet class.
- It is used to reduce the line of code.
- No need to use web.xml file.
- It is used globally.

Tomcat - 9:

- javax.servlet - package name

Tomcat 10:

- jakarta.servlet - package name

Feature	Maven Project	Web Project
Purpose	Used to configure the project	Used to configure frontend and backend
Configuration File	pom.xml	web.xml
Servlet Configuration	Not directly used	Uses <servlet> and <servlet-mapping> tags
Simplicity	Simpler for managing dependencies and build process	More complex for configuring web components

EXA : JSP connection

```
<!DOCTYPE html>
<html>
<head>
   <title></title>
</head>
<body>
   <form action="AdminAccess.jsp" method="post">
      <input type="number" name="mobileNumber">
      <input type="submit">
   </form>
</body>
</html>
```

Java file

```
import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.servlet.http.HttpSession;
import java.io.IOException;
import java.sql.*;

public class AdminAccessServlet extends HttpServlet {

   protected void doPost(HttpServletRequest request, HttpServletResponse response) throws
ServletException, IOException {
      String mobileNumber = request.getParameter("mobileNumber");

      try {
         Class.forName("com.mysql.cj.jdbc.Driver");
         Connection connection =
DriverManager.getConnection("jdbc:mysql://localhost:3306/schoolManagementSystem?user=root&passwor
d=12345");
```

```
        PreparedStatement ps = connection.prepareStatement("SELECT * FROM studentinfo WHERE
student_mobile = ?");
        ps.setString(1, mobileNumber);
        ResultSet rs = ps.executeQuery();

        if (rs.next()) {
            HttpSession session = request.getSession();
            session.setAttribute("userId", rs.getInt("student_id")); // Assuming student_id is an integer
            session.setMaxInactiveInterval(30 * 60); // Set session timeout to 30 minutes

            // Redirect to StudentUpdate.jsp
            response.sendRedirect("StudentUpdate.jsp");
        } else {
            // Handle invalid mobile number
            response.sendRedirect("error.jsp");
        }

        rs.close();
        ps.close();
        connection.close();
    } catch (ClassNotFoundException | SQLException e) {
        e.printStackTrace();
    }
  }
}
```

Exa : reducing xml config with @WebServlet(“/StudentLogin”) annotation

```
package com.jsp.student.servlet;

import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import java.io.IOException;

@WebServlet(“/StudentLogin”)
public class StudentLogin extends HttpServlet {
  @Override
  protected void doPost(HttpServletRequest req, HttpServletResponse resp) throws ServletException,
IOException {
    String email = req.getParameter("email");
    String pass = req.getParameter("pass");

    StudentDAO dao = new StudentDAOImplementation();
    StudentLogin studentLogin = dao.studentLogin(email, pass);

    // Assign the value from backend to object
  }
}
```

Spring Core

Spring Framework

- Open-source, loosely coupled, lightweight Java framework.
- Reduces complexity of developing enterprise applications.
- Supports various other frameworks like Hibernate.

Modules

- Core Container: Manages objects (beans) in an application.
- Data Access/Integration: Simplifies database interactions.

- Web: Simplifies web application development (MVC, security).
- AOP (Aspect-Oriented Programming): Implements cross-cutting concerns.
- Messaging: Supports asynchronous communication.
- Test: Offers tools for unit and integration testing.

Benefits

- Reduced complexity
- Loose coupling (components independent of each other)
- Improved maintainability
- Increased productivity

Configuration

- XML-based configuration: Defines beans and dependencies in XML files.
- Java-based configuration: Uses annotations for configuration within Java classes.

Bean Scopes

- **Singleton:** Single instance for entire application lifecycle (default).
- **Prototype:** New instance for every bean request.

Dependency Injection

- Spring injects dependencies into beans:
    - Constructor Injection: Dependencies passed through the constructor.
    - Setter Injection: Dependencies injected using setter methods.

Annotations

- Common annotations for configuration and dependency injection:
    - @Component: Marks a class as a Spring bean.
    - @Autowired: Marks a field or method for dependency injection.
    - @Qualifier: Used with @Autowired to specify a particular bean.
    - @Bean: Used in Java-based configuration to define a bean method.

Principles

- **Inversion of Control (IoC):** Spring manages object creation and lifecycle.
- **Dependency Injection (DI):** Objects rely on Spring for dependencies.

IoC Container

- Manages object creation (beans).
- Focuses on business logic, not object creation.
- Uses ApplicationContext or BeanFactory for creation.
    - ApplicationContext supports XML and annotations.
    - BeanFactory supports only XML.

Bean

- Special object created by the IoC container.

Example:

<bean id="ref" class="fully.qualified.class.name"></bean>

Demo demo = (Demo) context.getBean("demo");
demo.sample();

Syntax:

1. Demo demo = (Demo) context.getBean("demo");
2. Demo demo = context.getBean("demo", Demo.class);
3. Demo demo = context.getBean(Demo.class); (throws exception if multiple)

Spring Configuration XML File

- Used for Java configurations.
- Uses tags to define beans.
- bean tag with id and class attributes defines a bean.

ApplicationContext

- Interface in org.springframework.context package.
- Supports both XML and annotation configuration.
- Implementation class: ClassPathXmlApplicationContext (in org.springframework.context.support).

Accessing Objects from IoC Container

- Use getBean( ) method in ApplicationContext.
- Provide bean id as an argument.
- Downcast the returned object to the required class.

Creating a Spring Core Java Project

1. Create a Java project.
2. Access Spring Core jar files.
3. Configure Java build path.
4. Create an XML file or import an existing one.
5. Create a class with the main method.
6. Access the IoC container and objects in the main method.

getBean( ) Method Overloads

1. Provide a class reference variable (downcast required).
2. Provide a reference variable and class name.
3. Provide only class name (throws exception if multiple objects exist).

Accessing Objects from IoC Container

- Use getBean( ) method in ApplicationContext.
- Provide bean id as an argument.
- Downcast the returned object to the required class.

Constructor Injection (continued):

- **index attribute:** Used to specify the index position of a variable in the constructor arguments.
- **Index always starts with 0.**

c Namespace:

- XML property to avoid <constructor-arg> tag.
- Import URL: xmlns:c="http://www.springframework.org/schema/c"
- With c namespace, no need for name, index, type, value, or <value> tag.
    - Mention variable names directly within the bean tag.

Example:

```
<bean id="emp4" class="org.jsp.employee.Employee"
    c:name="King"
    c:deptno="30"
    c:salary="50000"
    c:id="105"></bean>
```

Constructor Injection for Objects:

- Use ref attribute within <constructor-arg> tag.

Syntax:

```
<constructor-arg ref="referenceVariableName"></constructor-arg>
```

Passing Reference Variable:

- Use <ref> tag with bean attribute to pass the reference variable of the dependent.

Syntax:

```
<constructor-arg>
  <ref bean="referenceVariableName"></ref>
</constructor-arg>
```

Passing List of Objects:

- Use <list> tag within <constructor-arg> tag.
- Inside <list>, use <ref> tag to pass object reference variables.

Syntax:

```
<constructor-arg>
  <list>
```

```
    <ref>refVariable1</ref>
    <ref>refVariable2</ref>
    <ref>refVariable3</ref>
  </list>
</constructor-arg>
```

Setter Injection

- Process of injecting data (dependencies) using setter methods.
- Involves:
    1. Default constructor to create an object.
    2. Setter methods to initialize non-static properties.
    3. IoC container uses setter methods after object creation.

Syntax:

1. Create setter methods for non-static properties.
2. Use <property> tag in the bean definition:
    - name attribute: specifies the property name.
    - value attribute: specifies the value to inject.

```
<bean id="student3" class="com.jsp.setters.Student">
  <property name="id" value="101"></property>
</bean>
```

p Namespace:

- XML property to avoid <property> tag.
- Import URL: xmlns:p="http://www.springframework.org/schema/p"
- With p namespace, directly define properties within the bean tag.

Example:

```
<bean id="student3" class="com.jsp.setters.Student"
    p:id="104" p:studentName="Raja" p:studentemailid="raja@gmail.com"
    p:studentPercentage="85.5"></bean>
```

Setter Injection for Objects:

- Use ref attribute within <property> tag to inject a reference to another bean.

Syntax:

```
<property name="address" ref="add"></property>
```

Passing Reference Variable:

- Use <ref> tag with bean attribute to pass the reference variable of the dependent.

Syntax:

XML

```
<property>
  <ref bean="referenceVariable"></ref>
</property>
```

Setter Injection vs. Constructor Injection

Feature	Setter Injection	Constructor Injection
Method	Uses setter methods to inject	Uses constructor arguments to inject
XML Tag	<property>	<constructor-arg>
Identification	Setter method name (name attribute)	Constructor argument name/type/index
Speed	Slower (injection after creation)	Faster (injection during creation)
IoC Container Creation	Creates target bean first	Creates target bean first
Default Constructor	Uses 0-parameter constructor	Uses parameter constructors
XML Namespace	p namespace (optional)	c namespace (optional)

Autowire

- This annotation is use to inject automatic dependency injection.
- Replaces manual ref attribute usage.
- **Values:**
    - byName: Injects by property name (id must match variable name).
    - byType: Injects by class name (setter injection).
    - constructor: Injects through constructor arguments.

Note:

- @Autowired annotation is for non-primitive data types.
- Autowire values use camel case (e.g., byName).

Annotations

- Placed above class, method, or variable names.
- Executed at compile time or runtime.
- Optional in Java, but mandatory for Spring configuration.
- Reduce XML configuration and code size.

Important Spring Core Annotations:

- @Component: Creates a bean (object).
- @Autowired: Performs dependency injection (automatically).
- @Qualifier: Qualifies a bean for injection (if multiple candidates exist).
- @Bean: Defines a bean method in Java configuration.
- @ComponentScan: Scans for @Component annotations in packages.
- @Configuration: Marks a class as a Spring configuration class.
- @Value: Injects values from properties files or environment variables.

@Component:

- Replaces the <bean> tag for creating beans.
- Placed above the class definition.
- Requires <context:component-scan base-package="com.jsp.annotation.AutoWiredAnnotation"> in XML configuration to scan for @Component annotations.

@Autowired:

- Performs automatic dependency injection for non-primitive data types.
- Used in three ways:
  - Above the non-primitive data type field.
  - Above the setter method.
  - Above a constructor with arguments.

@Qualifier:

- Used to specify which bean to inject when multiple beans of the same type are available.
- Avoids ambiguity in autowiring.

@Value:

- Injects values into fields or methods.
- Used for primitive data types.
- Can be used on fields, setter methods, or constructor arguments.

Java-Based Configuration

- Reduces XML configuration.
- Uses @Configuration annotation on configuration classes.
- Defines beans using @Bean annotation on methods.
- Uses @ComponentScan to scan for @Component annotated classes.

Example:

```
@Configuration
@ComponentScan("com.example")
public class AppConfig {

    @Bean
```

```
    public MyService myService() {
        MyService service = new MyService();
        service.setRepository(myRepository());
        return service;
    }

    @Bean
    public MyRepository myRepository() {
        return new MyRepositoryImpl();
    }
}
```

Exa : of all spring core ?

Setter Injection:

```
public class MyClass {
    private MyDependency dependency;

    public void setDependency(MyDependency dependency) {
        this.dependency = dependency;
    }
}
```

Field Injection:

```
public class MyClass {
    @Autowired
    private MyDependency dependency;
}
```

XML-based Configuration:

```
<bean id="myBean" class="com.example.MyClass">
    <property name="dependency" ref="myDependency" />
</bean>
```

Annotation-based Configuration:

```
@Configuration
public class AppConfig {
    @Bean
    public MyClass myBean() {
        return new MyClass(myDependency());
    }

    @Bean
    public MyDependency myDependency() {
        return new MyDependency();
```

```
    }
}
```

Example: A Simple Spring Core Application

```
// MyDependency.java
public class MyDependency {
    public void doSomething() {
        System.out.println("Doing something...");
    }
}

// MyClass.java
public class MyClass {
    private final MyDependency dependency;

    @Autowired
    public MyClass(MyDependency dependency) {
        this.dependency = dependency;
    }

    public void myMethod() {
        dependency.doSomething();
    }
}

// AppConfig.java
@Configuration
public class AppConfig {
    @Bean
    public MyDependency myDependency() {
        return new MyDependency();
    }

    @Bean
    public MyClass myClass() {
        return new MyClass(myDependency());
    }
}

// MainApp.java
public class MainApp {
    public static void main(String[] args) {
        AnnotationConfigApplicationContext context = new
AnnotationConfigApplicationContext(AppConfig.class);


        MyClass myClass = context.getBean(MyClass.class);
        myClass.myMethod();
    }
```

```
}
```

Spring JDBC

Spring JDBC

- Simplifies database operations.
- Provides JdbcTemplate class for common database operations.
- Handles connection management and exception handling.

JdbcTemplate

- Pre-built methods for:
  - Insert, update, delete operations (update())
  - Select queries (queryForObject(), query())
- Requires a DataSource object to establish database connections.
- Uses RowMapper interface to map database results to Java objects.

Configuration

- XML-based or Java-based configuration.
- Define DataSource and JdbcTemplate beans.

Example (XML-based):

XML

```
<bean id="dataSource" class="org.springframework.jdbc.datasource.DriverManagerDataSource">
   <property name="driverClassName" value="com.mysql.cj.jdbc.Driver"/>
   <property name="url" value="jdbc:mysql://localhost:3306/mydb" />
   <property name="username" value="root" />
   <property name="password" value="password"/>
</bean>

<bean id="jdbcTemplate" class="org.springframework.jdbc.core.JdbcTemplate">
   <property name="dataSource" ref="dataSource" />
</bean>
```

Example (Java-based):

```
@Configuration
public class AppConfig {

   @Bean
   public DataSource dataSource() {
      DriverManagerDataSource dataSource = new DriverManagerDataSource();
      dataSource.setDriverClassName("com.mysql.cj.jdbc.Driver");

      dataSource.setUrl("jdbc:mysql://localhost:3306/mydb");

      dataSource.setUsername("root");
      dataSource.setPassword("password");
      return dataSource;

   }

   @Bean
   public JdbcTemplate jdbcTemplate(DataSource dataSource) {
      return new JdbcTemplate(dataSource);

   }
}
```

RowMapper

- Interface used to map database results to Java objects.
- mapRow() method is implemented to map each row.
- BeanPropertyRowMapper can be used for simplify mapping.

Database Operations

- **Insert, Update, Delete:**

  ```
  jdbcTemplate.update(sql, new PreparedStatementSetter() {
      // Set parameters here
  });
  ```

  Select (single row):

  ```
  Object result = jdbcTemplate.queryForObject(sql, new RowMapper<Object>() {

      // Map result to an object
  });
  ```

- **Select (multiple rows):**

  ```
  List<Object> results = jdbcTemplate.query(sql, new RowMapper<Object>() {
      // Map each row to an object
  });
  ```

Exa :

- **pom.xml (Maven) or build.gradle (Gradle):**

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-jdbc</artifactId>
</dependency>
```

- **Configure DataSource: application.property**

```
spring.datasource.url=jdbc:mysql://localhost:3306/mydatabase
spring.datasource.username=your_username
spring.datasource.password=your_password
spring.datasource.driver-class-name=com.mysql.cj.jdbc.Driver
```

- **Create a Model Class:**

```
public class Employee {
    private int id;
    private String name;
    private String department;
```

```
    // Getters and setters
}
```

- **Create a DAO Class:**

```
@Repository
public class EmployeeDao {

    @Autowired
    private JdbcTemplate jdbcTemplate;

    public void insertEmployee(Employee employee)
 {
        String sql = "INSERT INTO employees (id, name, department) VALUES (?, ?, ?)";
        jdbcTemplate.update(sql, employee.getId(), employee.getName(), employee.getDepartment());
    }
}
```

- **Create a Service Class:**

```
@Service
public class EmployeeService {

    @Autowired
    private EmployeeDao employeeDao;

    public void saveEmployee(Employee employee) {
        employeeDao.insertEmployee(employee);

    }
}
```

- **Create a Controller Class:**

```
@RestController
@RequestMapping("/employees")
public class EmployeeController {

    @Autowired
    private EmployeeService employeeService;


    @PostMapping
    public ResponseEntity<String> saveEmployee(@RequestBody Employee employee)
 {
        employeeService.saveEmployee(employee);
        return ResponseEntity.ok("Employee saved successfully");

    }
```

```
}
```

Spring Data JPA

Spring Data JPA (Java persistence API)

- Simplifies data access with JPA.
- Provides JpaRepository interface for common CRUD operations.
- Uses annotations for mapping entities to database tables.

Additional Topics:

- Spring MVC (Model-View-Controller)
- Spring Security
- Spring Boot
- Spring AOP
- Spring Batch
- Spring Integration

Feature	Spring JDBC	Spring JPA
Level of Abstraction	Low-level	High-level
SQL Queries	Manual SQL	Uses JPQL or native SQL
Object-Relational Mapping	No	Yes
Transaction Management	Manual or declarative	Declarative
Learning Curve	Steeper	Gentler

Note: This is a brief overview. For more in-depth information, refer to official Spring documentation and tutorials.

Sources and related content

XML-Based Configuration:

```
<bean id="temp" class="org.springframework.jdbc.core.JdbcTemplate">
   <property name="dataSource" ref="ds"></property>
</bean>

<bean id="ds" class="org.springframework.jdbc.datasource.DriverManagerDataSource">
   <property name="url" value="jdbc:mysql://localhost:3306/demo"></property>
   <property name="username" value="root"></property>
   <property name="password" value="12345"></property>
   <property name="driverClassName" value="com.mysql.jdbc.Driver"></property>
</bean>

<bean id="empdao" class="com.jsp.jdbc.SpringJdbcByUsingXmlFile.Dao.EmployeeDaoImp">
   <property name="jdbcTemplate" ref="temp"></property>
</bean>

<bean id="emp" class="com.jsp.jdbc.SpringJdbcByUsingXmlFile.model.Employee"></bean>
```

Java-Based Configuration:

```
@Configuration
```

```
@ComponentScan(basePackages = "org.jsp.jdbc")
public class EmployeeConfig {

   @Bean
   public JdbcTemplate getJdbcTemplate() {
      return new JdbcTemplate(getDataSource());
   }

   @Bean
   public DataSource getDataSource()
 {
      DriverManagerDataSource dataSource = new DriverManagerDataSource();
      dataSource.setDriverClassName("com.mysql.cj.jdbc.Driver");
      dataSource.setUrl("jdbc:mysql://localhost:3306/demo");

      dataSource.setUsername("root");
      dataSource.setPassword("12345");
      return dataSource;

   }
}
```

Database Operations:

- **Write Operations (update())**
  - Use update() method from JdbcTemplate.
  - Arguments:
    - String sql: Write query (INSERT, UPDATE, DELETE).
    - PreparedStatementSetter pss: Provides runtime values for placeholders.

Syntax:

```
jdbcTemplate.update(String sql, PreparedStatementSetter pss);
```

Example:

```
String sql = "INSERT INTO users (name, email) VALUES (?, ?)";
jdbcTemplate.update(sql, (ps) -> {
   ps.setString(1, "John Doe");
   ps.setString(2, "john.doe@example.com");
});
```

- **Read Operations**
  - Use queryForObject() for single data retrieval.
  - Use query() for multiple data retrieval.
  - Both methods are argument methods.
  - Arguments:
    - String sql: Read query (SELECT).
    - RowMapper<T> rowMapper: Maps database records to Java objects.

Syntax:

```
// Single data
Object result = jdbcTemplate.queryForObject(String sql, RowMapper<T> rowMapper);

// Multiple data
List<T> results = jdbcTemplate.query(String sql, RowMapper<T> rowMapper);
```

RowMapper Interface

- Used to map database data to Java objects.
- Contains mapRow() method (incomplete) for mapping each row.
- Arguments:
    - ResultSet: Retrieves data from the database.
    - int rowNum: Current row number.

Example (Simple Mapping):

```
class User {
  private String name;
  private String email;
  // Getters and setters
}

public class UserMapper implements RowMapper<User> {
  @Override
  public User mapRow(ResultSet rs, int rowNum) throws SQLException
 {
    User user = new User();
    user.setName(rs.getString("name"));
    user.setEmail(rs.getString("email"));
    return user;

  }
}
```

RowMapper Implementation:

- Create a class implementing RowMapper<T>.
- Specify the class type for the mapped object.
- Override mapRow() method.
- Use ResultSet getters to retrieve data for each row.
- Set retrieved data to object properties.

Example:

```
class User {
  private String name;
  private String email;
  // Getters and setters
}

public class UserMapper implements RowMapper<User> {
  @Override
```

```
 public User mapRow(ResultSet rs, int rowNum) throws SQLException
{
   User user = new User();
   user.setName(rs.getString("name"));
   user.setEmail(rs.getString("email"));
   return user;

  }
}
```

BeanPropertyRowMapper:

- Simplifies object mapping for classes with matching property names.
- Use BeanPropertyRowMapper<T>(EntityClass.class) constructor.

Syntax:

```
BeanPropertyRowMapper<User> mapper = new BeanPropertyRowMapper<>(User.class);
```

JPA Project Setup (Eclipse):

1. **Create New Project:**
   - Go to "File" -> "New" -> "Other..."
   - Select "JPA Project" and click "Next."
2. **Project Details:**
   - Enter project name, target runtime, and JPA version.
   - Choose "Basic JPA configuration."
   - Click "Next."
3. **JPA Provider:**
   - Select "EclipseLink" and desired version.
   - Choose "Disable Library Configuration."
4. **Database Connection:**
   - Select the previously created MySQL connection.
   - Click "Finish."

JPA Project Structure:

- **Source:** Contains Java source files for your application.
- **Build:** Used for testing and building the project.
- **META-INF:** Contains persistence.xml for configuring JPA.

persistence.xml Configuration:

1. Open persistence.xml in the META-INF folder.
2. Set Transaction-Type to "RESOURCE_LOCAL."
3. Choose "populated from connection" for connection details.
4. Select the previously created MySQL connection.
5. Save the file.

Entity Class:

- Represents database tables.
- Mapped to database tables using Object-Relational Mapping (ORM).
- Follows conventions for table and column names:
    - Entity class name suggests table name.
    - Variable names suggest column names.
- Annotated with @Entity to mark it as a JPA entity.
- Primary key identified by @Id annotation.

Creating an Entity Class:

1. Create a JPA project.
2. Configure database connection in persistence.xml.
3. Create a package in the source folder.
4. Right-click on package -> New -> JPA Entity.
5. Enter class name and choose variables for table columns.
6. Select the primary key field.
7. Finish.

Generating Tables from Entity Class:

1. Right-click project -> JPA Tools.
2. Select "Generate Tables from Entities."
3. Finish.
4. Verify table creation in your database application.

Feature	JDBC	Hibernate
Connection	DriverManager.getConnection(url)	Persistence.createEntityManagerFactory("Project Name")
Return Type	Connection interface	EntityManagerFactory interface
Platform	Static methods (Statement, PreparedStatement, CallableStatement)	EntityManager

Connection in JDBC vs. Hibernate:

Key Differences:

- **Connection Establishment:**
    - JDBC uses a static method DriverManager.getConnection(url).
    - Hibernate uses Persistence.createEntityManagerFactory("ProjectName") to create an EntityManagerFactory.
- **Platform:**
    - JDBC uses static platform types for executing queries.

- Hibernate uses the EntityManager interface for managing entity object states.

Hibernate EntityManager Operations (Formatted)

EntityManager:

- Manages entity lifecycles in JPA applications.
- Used to interact with the database.

Opening EntityManager:

```
EntityManagerFactory factory = Persistence.createEntityManagerFactory("ProjectName");
EntityManager manager = factory.createEntityManager();
```

Starting Transaction:

```
manager.getTransaction().begin();
```

Database Operations:

- Perform operations like insert, update, delete, and retrieve.

Saving Changes:

```
manager.getTransaction().commit();
```

Closing Resources:

```
manager.close();
factory.close();
```

Insert Operation (persist())

1. Create an entity object.
2. Initialize object variables using setters.
3. Call manager.persist(entityObject).

Syntax:

```
manager.persist(entityObject);
```

Retrieve Record (find())

1. Use manager.find(EntityClass.class, primaryKeyValue).

Syntax:

```
EntityClass record = manager.find(EntityClass.class, primaryKeyValue);
```

Note:

- find() returns null if the primary key doesn't exist.

Update Operation

1. Use find() to retrieve the record.
2. Modify object state using setters.
3. No separate update method required. Changes are saved in commit().

Example:

```
Employee emp = manager.find(Employee.class, 103);
emp.setSalary(45000);
manager.getTransaction().commit();
```

Delete Operation (remove())

1. Use find() to retrieve the record (optional for safety).
2. Call manager.remove(entityObject).

Syntax:

```
manager.remove(entityObject);
```

- XML

```
<dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
```

- **Configure Data Source: application.yml or application.property**

```
spring.datasource.url=jdbc:mysql://localhost:3306/mydatabase
spring.datasource.username=your_username
spring.datasource.password=your_password
spring.datasource.driver-class-name=com.mysql.cj.jdbc.Driver
```

- **Create a Domain Class:**

```
@Entity
public class Employee {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;
    private String name;
    private String department;

    // Getters and
```

```
 setters
}
```

- **Create a Repository Interface:**

```
public interface EmployeeRepository extends JpaRepository<Employee, Long> {
   // Custom query methods if needed
}
```

- **Create a Service Class:**

```
Java
@Service
public class EmployeeService {
   @Autowired
   private EmployeeRepository employeeRepository;

   public Employee saveEmployee(Employee employee) {
      return
 employeeRepository.save(employee);
   }

   public List<Employee> getAllEmployees() {
      return employeeRepository.findAll();

   }
}
```

- **Create a Controller Class:**

```
@RestController
@RequestMapping("/employees")
public class EmployeeController {
   @Autowired
   private EmployeeService employeeService;


   @PostMapping
   public Employee saveEmployee(@RequestBody Employee employee) {
      return employeeService.saveEmployee(employee);
   }

   @GetMapping

   public List<Employee> getAllEmployees() {
      return employeeService.getAllEmployees();

   }
}
```

Spring Data JPA

Spring Data JPA:

Spring Data JPA is a high-level abstraction layer for JPA repositories. It simplifies data access by providing a repository interface-based approach.

Creating a Maven Project:

1. Create a Maven project with the spring-boot-starter-data-jpa dependency.
2. Add dependencies for database driver (e.g., MySQL Connector/J), Hibernate, and Spring Data JPA.

Configuring Persistence.xml:

- Configure the persistence unit name, JPA provider, and database connection details.

Entity Class:

- Annotate the class with @Entity.
- Define fields and getters/setters.
- Use @Id to mark the primary key field.

Repository Interface:

- Extend JpaRepository<T, ID> interface.
- Specify the entity type (T) and ID type (ID).
- Inherit CRUD methods: save(), deleteById(), findById(), findAll(), delete().

Example:

```
@Entity
public class User {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;
    private String name;
    private String email;
    // Getters and setters

}

public interface UserRepository extends JpaRepository<User, Long> {
    // Custom query
 methods can be added here
}
```

Spring Configuration:

- Configure DataSource and EntityManagerFactory beans.
- Use @EnableJpaRepositories annotation to scan for repository interfaces.

Example:

```
@Configuration
@EnableJpaRepositories("com.example.repository")
public class AppConfig {

    @Bean
    public DataSource dataSource() {
```

```
        // ...
    }

    @Bean
    public LocalContainerEntityManagerFactoryBean entityManagerFactory() {
        // ...
    }

    @Bean
     transactionManager() {
        JpaTransactionManager transactionManager = new JpaTransactionManager();
        transactionManager.setEntityManagerFactory(entityManagerFactory().getObject());

        return transactionManager;
    }
}
```

Using the Repository:

```
@Autowired
private UserRepository userRepository;

// Save a user
User user = new User();
// ... set user properties
userRepository.save(user);

// Find a user by ID
User userById = userRepository.findById(userId).orElse(null);

// Delete a user
userRepository.deleteById(userId);

// Find all users
List<User> allUsers = userRepository.findAll();
```

Key Points:

- Spring Data JPA simplifies database operations by providing a repository-based approach.
- It automatically generates implementations for common CRUD operations.
- Custom query methods can be defined using JPQL or Spring Data JPA's query methods.
- Consider using @Query annotation or @NamedQuery for complex queries.
- Leverage Spring Data JPA's features like pagination, sorting, and specification for advanced data access scenarios.

JpaRepository provides a set of predefined methods for common database operations.

Core Methods:

1. **save(Entity entity):**
    - Persists or updates an entity.

- Returns the saved entity.

2. **deleteById(ID id):**
   - Deletes an entity by its primary key.
   - Throws EmptyResultDataAccessException if no entity is found.
3. **findById(ID id):**
   - Returns an Optional<Entity> containing the entity if found, otherwise an empty Optional.
4. **findAll():**
   - Returns a List of all entities.
5. **delete(Entity entity):**
   - Deletes an entity.

Custom Query Methods:

- Spring Data JPA allows creating custom query methods using method names.
- Use keywords like findBy, getBy, findDistinctBy, countBy, etc., followed by property names and keywords like And, Or, Not, Between, LessThan, GreaterThan, LessThanEqual, GreaterThanEqual, Like, StartingWith, EndingWith, Containing, OrderBy, Asc, and Desc.

Example:

```
public interface UserRepository extends JpaRepository<User, Long> {
   List<User> findByFirstName(String firstName);
   List<User> findByFirstNameAndLastName(String firstName, String lastName); [1]
   List<User> findByAgeGreaterThan(int age);
}
```

Spring Data JPA Specifications:

- Create custom query specifications using Specification interface.
- Combine multiple criteria using CriteriaBuilder and Predicate.
- Dynamically construct complex queries.

Example:

```
public interface UserRepository extends JpaRepository<User, Long>, JpaSpecificationExecutor<User> {
   // ...
}

// Usage:
Specification<User> spec = (root, query, criteriaBuilder) -> {
   return criteriaBuilder.and(
      criteriaBuilder.equal(root.get("firstName"), "John"),
      criteriaBuilder.greaterThanOrEqualTo(root.get("age"), 30)
   );
};

List<User> users = userRepository.findAll(spec);
```

Creating Custom Methods:

- Use keywords like findBy, readOnlyBy, getBy, etc.
- Combine keywords with variable names from the entity class.
- Utilize operators like And, Or, Not, Between, etc.

Example:

```
public interface UserRepository extends JpaRepository<User, Long> {
   User findByEmailIdAndPassword(String email, String password);
}
```

Spring Web MVC - Model-View-Controller Pattern

MVC Design Pattern:

- A development approach for building web applications.
- Separates the application into three layers:
    - **Model:** Holds application data (POJOs).
    - **View:** Renders the UI (JSP/HTML files).
    - **Controller:** Handles user requests and business logic.

Benefits:

- Improved code organization and maintainability.
- Easier testing and reusability of components.

Spring MVC Implementation:

- Spring MVC provides a framework for building MVC applications.
- Leverages key concepts like dependency injection and annotations.

Components:

- **Model:** POJO classes representing application data.
- **View:** JSP or HTML templates for displaying the UI.
- **Controller:** Handles user requests, interacts with the model, and returns views.

DispatcherServlet (Front Controller):

- Receives requests from the user.
- Maps requests to appropriate controllers.
- Manages the application flow.

Configuration:

- DispatcherServlet configured in web.xml file.
- Spring configuration file details view resolver and beans.

View Resolver:

- Responsible for resolving view names to actual JSP/HTML templates.
- Uses InternalResourceViewResolver by default.
- Configured with prefix and suffix for view paths.

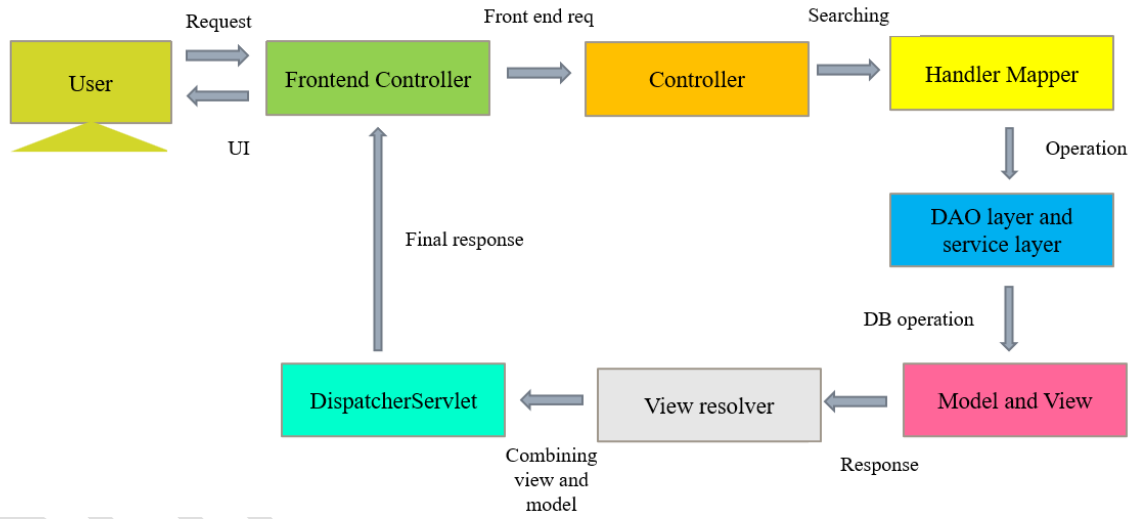
Creating a Spring MVC Application:

1. Configure DispatcherServlet in web.xml.
2. Create a Spring configuration file with view resolver configuration.
3. Develop a controller class annotated with @Controller.
4. Create view templates (JSP/HTML files).

Benefits of Spring MVC:

- Simplified MVC implementation.
- Easier application development and testing.
- Leverage Spring features like dependency injection and annotations.

Diagram of Spring MVC Architecture :



Setting Up a Spring MVC Project

1. Project Setup:

- **Create a Maven Project:** Use a Maven archetype to create a new web application project.
- **Set Java Version:**
  - Right-click on the project, go to "Properties" -> "Java Build Path".
  - Add Library -> JRE System Library -> Select Java 1.8.

2. Add Dependencies:

- Edit the pom.xml file and add the following dependencies:

```
<dependency>
        <groupId>org.springframework</groupId>
        <artifactId>spring-webmvc</artifactId>
        <version>5.3.23</version>
</dependency>
```

3. Configure DispatcherServlet in `web.xml`:

```
<web-app xmlns="http://xmlns.jcp.org/xml/ns/javaee"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/javaee http://xmlns.jcp.org/xml/ns/javaee/web-app_4_0.xsd"

     version="4.0">

  <servlet>
    <servlet-name>spring</servlet-name>
    <servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
  </servlet>

  <servlet-mapping>
    <servlet-name>spring</servlet-name>
    <url-pattern>/</url-pattern>
  </servlet-mapping>
</web-app>
```

4. Create Spring Configuration File (e.g., `spring-servlet.xml`)

XML

```
<beans xmlns="http://www.springframework.org/schema/beans"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:context="http://www.springframework.org/schema/context"

      xmlns:mvc="http://www.springframework.org/schema/mvc"
      xsi:schemaLocation="http://www.springframework.org/schema/beans

       http://www.springframework.org/schema/beans/spring-beans.xsd
       http://www.springframework.org/schema/context
       http://www.springframework.org/schema/context/spring-context.xsd
       http://www.springframework.org/schema/mvc
       http://www.springframework.org/schema/mvc/spring-mvc.xsd">


   <context:component-scan base-package="com.example" />

   <bean id="viewResolver"
        class="org.springframework.web.servlet.view.InternalResourceViewResolver">
      <property name="prefix" value="/WEB-INF/views/" />
      <property name="suffix" value=".jsp" />
   </bean>
```

```
    <mvc:annotation-driven
 />
</beans>
```

5. Create a Controller Class:

```
@Controller
public class HelloWorldController {

    @RequestMapping("/")
    public String helloWorld(Model model) {
        model.addAttribute("message", "Hello, World!");
        return "hello";

    }
}
```

6. Create a View (JSP File):

```
<%@ page contentType="text/html;charset=UTF-8" language="java" %>
<html>
<head>
    <title>Hello World</title>
</head>
<body>
<h1>${message}</h1>
</body>
</html>
```

Key Points:

- **DispatcherServlet:** The central controller of the Spring web application.
- **View Resolver:** Maps view names to physical views (JSPs, HTML, etc.).
- **@Controller:** Annotation to mark a class as a controller.
- **@RequestMapping:** Annotation to map HTTP requests to controller methods.
- **Model:** Used to pass data from the controller to the view.

By following these steps, you'll have a basic Spring MVC application set up. You can further customize it with more advanced features like form handling, validation, data binding, and more.

```
<bean id="viewResolver"
    class="org.springframework.web.servlet.view.InternalResourceViewResolver">
    <property name="prefix" value="/WEB-INF/views/" />
    <property name="suffix" value=".jsp" />
</bean>
```

Spring Boot

A Simplified Approach to Spring Development

Spring Boot is a powerful tool that streamlines the development of Spring-based web applications. It offers two core features:

- **Auto-Configuration:** Spring Boot automatically configures your application based on the dependencies you include in your project. This eliminates the need for extensive manual configuration.
- **Opinionated Configuration:** Spring Boot provides default configurations for common scenarios, reducing the amount of boilerplate code you need to write.

Key Benefits of Spring Boot:

- **Simplified Setup:** Quickly set up a Spring-based application with minimal configuration.
- **Dependency Management:** Easily manage dependencies and their versions.
- **Embedded Server:** Run your application directly without deploying it to a separate server.
- **Auto-Configuration:** Leverage automatic configuration for common scenarios.
- **Production-Ready Features:** Benefit from features like metrics, health checks, and security.

Creating a Spring Boot Project:

1. **Use Spring Initializr:**
    - Visit https://start.spring.io/
    - Select your project dependencies (e.g., Spring Web, Spring Data JPA, Spring Security).
    - Generate the project.
2. **Use Your IDE:**
    - Create a new Spring Starter Project in your IDE (e.g., IntelliJ IDEA, Eclipse).
    - Select your dependencies and project settings.

- @Getter @Setter @ToString @AllArgsConstructor @NoArgsConstructor @Data @Id @Repository, @Controller(o/p with frontend page), @Repository,
- @RestController(without frontend page);- @controller + @ResponseBody
- @Column
- (updatable = false):- first time only it will fill the data then it will not update.

- @Column(insertable = false):-Not necessary during insertion time.
- @CreatedDate :- automatically capture the created date.
- @CreatedBy :- Automatically populates the annotated field with the identifier of the user who created the entity.
- @MappedSuperclass :- act as a supper class in entity class
  @EntityListeners(AuditingEntityListener.class):- act as a supper class in entity class.
- @Entity :-is use to create table as a entity class.
- @Table(name=”xyz”):- it is also use to give name of the table in the db.
- @GeneratedValue(strategy = GenerationType.*IDENTITY*):-auto generated
- @Transactional :-using upside of method in case exception occurs it will rollback automatically.
- @Modifying :- when the query is not a select query, but instead performs an update, insert, or delete operation.
- @NotEmpty(message = "Branch Address cannot be a null or empty")
- @Schema(description = "Account type of Eazy Bank account", example = "Savings")
- @RequestMapping(path="/api", produces = {MediaType.*APPLICATION_JSON_VALUE*})
- @GetMapping @PostMapping @PutMapping @PatchMapping @DeleteMapping
- @RequestBody:-map the json/xml data to our entity object.
- @ResponseBody :- map the entity object to json/xml format.
- @RequerstParam, @QuetryParam:- used to extract parameters from HTTP requests
- @ResponseStatus(value = HttpStatus.*BAD_REQUEST/NOT_FOUND*) :- we are declearing this up side of exception class/veriable.
- @ControllerAdvice/@RestControllerAdvice :- for handling any global exception up of global exception class regarding controller class.
- @ExceptionHandler(Exception.class) :- class is going to handle the exception.
- @Transactional :-any error will be come at run time it will roll back

  @Modifying :- telling this method is going to modify

  void deleteByCustomerId(Long customerId); //repository methods
- For validating data eject dependency

  <dependency>

  <groupId>org.springframework.boot</groupId>

  <artifactId>spring-boot-starter-validation</artifactId>

  </dependency>

  And Extend your global exception to the not mandatory extends

  ResponseEntityExceptionHandler

- @NotEmpty(message = "Name can not be a null or empty")
- @Size(min = 5, max = 30, message = "The length of the customer name should be between 5 and 30")
- @Email(message = "Email address should be a valid value")
- @Min(value = 0, message = "Price must be greater than or equal to 0")
- @Max(value = 10000, message = "Price must be less than or equal to 10000")
- @Future(message = "Event date must be in the future")

private Date eventDate;

- @Past(message = "Birthdate must be in the past")
- @AssertTrue(message = "User must accept terms")
  private boolean acceptedTerms;
- @AssertFalse(message = "User must not be blocked")
  private boolean blocked;
- @DecimalMin(value = "0.0", inclusive = false, message = "Price must be greater than 0") @DecimalMax(value = "10000.0", inclusive = true, message = "Price must be less than or equal to 10000") private BigDecimal price;
- @Pattern(regexp = "^[a-zA-Z0-9]+$", message = "Username must be alphanumeric")
- @SerializedName(value="customerId",alternate = {"customerID","customerid"})
- @Pattern(regexp = "(^$|[0-9]{10})", message = "Mobile number must be 10 digits")
- @PositiveOrZero(message = "Total loan amount paid should be equal or greater than zero")
- @Validated :- it is use to tell the class validate all the validation in controller class **it is also part of validation dependency**

➢ Spring. Open api's (Swagger UI)

```
<dependency>
        <groupId>org.springdoc</groupId>
        <artifactId>springdoc-openapi-starter-webmvc-ui</artifactId>
        <version>2.3.0</version>
</dependency>
```

- @OpenAPIDefinition(

```
        info = @Info(
                title = "Accounts microservice REST API Documentation",
description = "Olive Bank Accounts microservice REST API Documentation",
                version = "v1",
                contact = @Contact(
                        name = "Prakash",
                        email = "prakash@eazybytes.com",
                        url = "https://olivecrypto.com"
                ),
                license = @License(
                        name = "Apache 2.0",
                        url = " https://olivecrypto.com"
                )
        ),
        externalDocs = @ExternalDocumentation(
description =  "OliveBank Accounts microservice REST API Documentation",
                url = " https://olivecrypto.com/swagger-ui.html"
```

)

)

It is regarding swagger header, written up side of main method

- @Tag(

name = "CRUD REST APIs for Accounts in OliveBank",

description = "CRUD REST APIs in OliveBank to CREATE, UPDATE, FETCH AND DELETE account details"

)

Head of the api's, written up side of class

- @Operation(

summary = "Create Account REST API",

description = "REST API to create new Customer & Account

inside OliveBank"

)

@ApiResponses({

@ApiResponse(

responseCode = "201",

description = "HTTP Status CREATED"

),

@ApiResponse(

responseCode = "500",

description = "HTTP Status Internal Server Error",

content = @Content(

schema = @Schema(implementation = ErrorResponseDto.class)

)

)

}

)

It is use to give api description, written up side of method

- @Schema(

name = "Customer",

description = "Schema to hold Customer and Account

information"

)

- @Schema(description = "amount", maxLength = 9, minLength = 4, example = "3.00")

It is use to give detail about the deoclass/class/variable . Up side of class or veriable

- @ComponentScans({ @ComponentScan("com.eazybytes.accounts.controller") })

  @EnableJpaRepositories("com.eazybytes.accounts.repository")

  @EntityScan("com.eazybytes.accounts.model")

  @EnableJpaAuditing(auditorAwareRef = "auditAwareImpl")

  If we are not declare main class as parent package then use this all annotation.
- @ConfigurationProperties(prefix = "accounts") :- use to make class as a configuration public record

  (String message, Map<String, String> contactDetails, List<String> onCallSupport) {}
  And declare this property on application.yml

  accounts:

  message: "Welcome to EazyBank accounts related local APIs "

  contactDetails:

  name: "John Doe - Developer"

  email: "john@eazybank.com"

  onCallSupport:

  - (555) 555-1234

  - (555) 523-1345

  //user diffin property

  @Autowired

  private AccountsContactInfoDto accountsContactInfoDto;

  @Inject

  3Autowired :- same as auto wire but we want to migrate from java to python then use inject.

  @GetMapping("/contact-info")

  public ResponseEntity<AccountsContactInfoDto> getContactInfo() {

  return ResponseEntity

  .*status*(HttpStatus.*OK*)

  .body(accountsContactInfoDto);

  }

  It will allow only read not write. Only getter method is their.
  @ConfigurationProperties(prefix = "accounts") :- main class use this for fetching all the configure property

Monolithic Architecture

Definition: A monolithic application is a single-tiered application with interdependent modules.

Advantages:

- **Simplicity:** Easier to develop, test, and deploy.
- **Performance:** Can be optimized for specific use cases.

Disadvantages:

- **Tight Coupling:** Changes to one module can impact others.
- **Scalability Challenges:** Scaling the entire application becomes difficult as it grows.
- **Technology Constraints:** Adopting new technologies can be challenging due to the monolithic nature.
- **Deployment Frequency:** Deploying updates to the entire application can be time-consuming and risky.

Service-Oriented Architecture (SOA)

Definition: SOA is a software design approach where applications are composed of discrete services. These services communicate with each other using well-defined interfaces.

Advantages:

- **Reusability:** Services can be reused across multiple applications.
- **Modularity:** Changes to one service can be made independently.
- **Scalability:** Services can be scaled individually.
- **Flexibility:** The system can be adapted to changing business needs.

Disadvantages:

- **Complexity:** Increased complexity due to multiple services and communication protocols.
- **Governance:** Requires careful planning and management to ensure consistency and interoperability.
- **Performance Overhead:** Communication between services can introduce latency.

Microservices Architecture

Definition: A microservices architecture is a specific type of SOA where services are designed to be small, independent, and deployable.

Advantages:

- **Scalability:** Individual services can be scaled independently.
- **Flexibility:** Rapid development and deployment of new features.
- **Resilience:** Failure of one service does not necessarily impact the entire system.
- **Technology Diversity:** The ability to use different technologies for different services.

Disadvantages:

- **Complexity:** Increased complexity due to multiple services and distributed systems.
- **Operational Overhead:** Requires more infrastructure and management.
- **Network Latency:** Communication between services can introduce latency.
- **Security Challenges:** Securing multiple services can be more complex.

Aspect	Monolithic Architecture	Microservices Architecture	SOA Architecture
Definition	Single unified codebase, tightly coupled.	Collection of small, independent services.	Collection of services communicating over a network.
Granularity	Coarse-grained, single codebase.	Fine-grained, smaller services.	Medium-grained services, broader than microservices.
Independence	Low; all components run as a single unit.	High; services are independently deployable.	Moderate; services are loosely coupled but share more.
Technology Stack	Typically homogeneous stack.	Can use diverse tech stacks per service.	Generally uses shared tech stack or standards.
Communication	In-process calls, direct function calls.	Lightweight protocols (e.g., REST, gRPC).	Typically uses enterprise protocols (e.g., SOAP).
Scalability	Limited, scaled as a whole application.	High; each service can be scaled individually.	Moderate; scalable but can require enterprise tools.
Deployment	Single deployment unit.	Independent deployment for each service.	Managed deployments but often centralized.
Data Management	Shared database for entire application.	Each service often has its own database.	Shared data models but may use separate databases.
Complexity	Simpler to develop but complex as it grows.	Complex initial setup but manageable growth.	Complex governance with many services.
Fault Isolation	Low; a single failure can impact the whole system.	High; failures are contained within services.	Moderate; failure impacts vary by implementation.

Summary:

- **Monolithic** is simpler and suitable for small to medium-sized applications but becomes harder to scale and maintain over time.
- **Microservices** offer flexibility, scalability, and independence, making them ideal for modern applications with different teams.
- **SOA** is more enterprise-focused, with more significant integration capabilities but usually more governance overhead compared to microservices.

REST(Representational state transfer):- it is a most easy and economical way to implement communication b/w 2 web app.
CRUD:- Create(post),Retrieve(get),update(put/patch), Delete

DTO: - use to transfer data b/w different part(layer) of application like presentation layer, data access layer. It contains only data not logic.

Spring security:-

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-security</artifactId>
  <version>3.1.2</version> <!-- Make sure to use the latest version compatible with your Spring Boot version -->
</dependency>
```

Application.property:-

```
spring.security.user.name=admin
spring.security.user.password=secret
```

API gateway:-

An API Gateway is a server that acts as an intermediary between clients (such as web browsers, mobile devices, or external systems) and backend services or microservices. Use manage, secure, and route requests from clients to appropriate backend services and functionalities like authe ntication, rate-limiting, logging, and load balancing.

Key Responsibilities of an API Gateway:

1. Routing: Forwards client requests to the appropriate microservice or backend based on the request path.
2. Load Balancing: Distributes incoming requests across multiple instances of services to manage traffic and ensure high availability.
3. Authentication & Authorization: Enforces security policies, authenticates clients (e.g., using OAuth2 or JWT), and ensures only authorized clients can access certain endpoints.
4. Rate Limiting: Limits the number of API requests that a client can make in a specific time frame to protect services from being overwhelmed.
5. Caching: Stores the responses of frequently accessed endpoints to improve performance by reducing the load on the backend services.
6. Logging & Monitoring: Captures logs, metrics, and analytics of requests and responses for monitoring and debugging.
7. Security: Protects services by validating input, performing SSL termination, and preventing security threats like DDoS attacks.

Common Use Cases for an API Gateway:

- Microservices Architecture: In a microservices environment, each service handles different parts of the application. The API Gateway consolidates the communication, routing, and security concerns, making it easier to manage.
- Mobile and Web Clients: Provides a unified API for different clients like mobile apps, web browsers, and other systems by abstracting the complexity of the underlying services.

API Gateway Pattern in Microservices:

In a microservices architecture, multiple microservices exist, each handling a specific business functionality.

- Acting as a single-entry point for clients.
- Hiding the complexity of multiple microservices.
- Aggregating responses from multiple microservices into a single client-facing response (e.g., for mobile apps).

Example: API Gateway Flow

1. A client sends a request to the API Gateway.
2. The API Gateway routes the request to the appropriate backend service.
3. If needed, the API Gateway authenticates and authorizes the client.
4. The backend service processes the request and sends the response to the API Gateway.
5. The API Gateway transforms the response (if necessary) and forwards it back to the client.

Common API Gateway Solutions:

- NGINX: A popular web server that can be configured as an API Gateway.
- Kong: A scalable, open-source API Gateway built on NGINX.
- AWS API Gateway: A fully managed service from AWS for building, deploying, and managing APIs.
- Zuul: A Netflix open-source API Gateway used for dynamic routing and filtering.
- Spring Cloud Gateway: A Spring framework solution for building API Gateways in Java applications.

Sample Code (Using Spring Cloud Gateway)

```
@SpringBootApplication
public class ApiGatewayApplication {

    public static void main(String[] args) {
        SpringApplication.run(ApiGatewayApplication.class, args);
    }

    @Bean
    public RouteLocator customRouteLocator(RouteLocatorBuilder builder) {
        return builder.routes()
            .route("user_route", r -> r.path("/user/**")
                .uri("http://user-service:8081")) // Route to user-service
            .route("order_route", r -> r.path("/order/**")
                .uri("http://order-service:8082")) // Route to order-service
            .build();
    }
}
```

Service registry:-

A service registry is a keeps track of the available services in a distributed system. It acts as a dynamic catalog where services can register themselves.

Key Components:

1. Service Registration: When a service starts, it registers its location (e.g., IP address and port), capabilities, and other metadata with the service registry.
2. Service Discovery: Other services or clients can query the registry to find and connect to the services they need.

Service discovery:-

In a microservices environment, each service may run on a different host or port, and it might scale dynamically (instances can be added or removed). Service discovery automates the process of locating these services, making the system more resilient and scalable.

REST controller in another service that calls the eureka-client service using **Ribbon** or **RestTemplate**.

Types of Service Discovery:

1. Client-Side Discovery: The client queries a service registry to find out where a service is located and then directly makes a request to that service.
2. Server-Side Discovery: The client sends a request to a load balancer or API gateway, which queries the service registry and forwards the request to the appropriate service instance.

Benefits of Service Discovery:

- Scalability: Easily add or remove service instances without updating configuration.
- Fault Tolerance: Automatically reroute traffic to healthy instances if one fails.
- Dynamic Environments: Handles dynamic changes in service locations and instances.

Exa:-

```
dependencies {
   implementation 'org.springframework.cloud:spring-cloud-starter-netflix-eureka-server'
}
```

Eureka Server Code

```
package com.example.eurekaserver;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.cloud.netflix.eureka.server.EnableEurekaServer;

@SpringBootApplication
@EnableEurekaServer
public class EurekaServerApplication {

   public static void main(String[] args) {
      SpringApplication.run(EurekaServerApplication.class, args);
   }
}
```

application.yml Configuration

Configure the Eureka Server in application.yml:

Yml

```
server:
  port: 8761

eureka:
  client:
    register-with-eureka: false  # The server should not register with itself
    fetch-registry: false        # It doesn't need to fetch the registry
  server:
    enable-self-preservation: false  # Disable self-preservation for local setup
```

Dependencies (Eureka Client)

Add the following dependencies for a Eureka client (service that will register with Eureka).

```
dependencies {
   implementation 'org.springframework.cloud:spring-cloud-starter-netflix-eureka-client'
}
```

Eureka Client Code

Create a Spring Boot application and annotate it with @EnableEurekaClient.

```
package com.example.eurekaclient;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.cloud.netflix.eureka.EnableEurekaClient;

@SpringBootApplication
@EnableEurekaClient
public class EurekaClientApplication {

   public static void main(String[] args) {
      SpringApplication.run(EurekaClientApplication.class, args);
   }
}
```

application.yml Configuration

Configure the client service to register itself with the Eureka server.

yaml
Copy code

```
spring:
  application:
    name: eureka-client  # Unique service name for discovery

eureka:
  client:
    service-url:
      defaultZone: http://localhost:8761/eureka/  # Eureka server URL
```

Ribbon-Enabled RestTemplate for Service Discovery:

```
package com.example.clientcaller;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.cloud.client.loadbalancer.LoadBalanced;
import org.springframework.context.annotation.Bean;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RestController;
import org.springframework.web.client.RestTemplate;

@RestController
public class ServiceCaller {

   @Autowired
   private RestTemplate restTemplate;

   @GetMapping("/call-service")
   public String callService() {
      // Call eureka-client service by its service name
      String response = restTemplate.getForObject("http://eureka-client/service-endpoint", String.class);
      return "Response from eureka-client: " + response;
   }

   @Bean
   @LoadBalanced  // Enable client-side load balancing via Eureka
   public RestTemplate restTemplate() {
      return new RestTemplate();
   }
```

}

Aspect	Client-Side Discovery	Server-Side Discovery
Responsibility	Clients are responsible for determining the network location of available service instances.	A central server or load balancer is responsible for determining the network location of service instances.
Service Registry	Clients query the service registry directly to get the list of available instances.	The server-side component (e.g., load balancer) queries the service registry and routes client requests accordingly.
Traffic Distribution	The client selects which instance to connect to, often using round-robin or other algorithms.	The server (or load balancer) selects which instance the client should connect to.
Complexity	Client logic is more complex as it must handle discovery and load balancing.	Simplifies client logic, as discovery and load balancing are handled server-side.
Scalability	Can scale well if clients are capable, but adds complexity to each client.	Centralized control can simplify scaling, but the server/discovery service can become a bottleneck.
Flexibility	More flexible as clients can implement custom discovery logic.	Less flexible for clients, as they rely on the server's discovery and routing decisions.
Failure Handling	Clients must handle instance failures and retry mechanisms.	The server/load balancer handles failures and retries, abstracting this from clients.
Examples	Common in microservices architectures where clients use a service registry like Eureka or Consul.	Used in traditional and cloud environments, often with load balancers like AWS Elastic Load Balancer (ELB) or NGINX.
Configuration Management	Each client needs to be configured to interact with the service registry.	Centralized configuration management; clients don't need to know about all service instances.

How It Works:

1. Service Discovery:
   - When a client service needs to communicate with another service (e.g., an order service calling a payment service), it queries the service registry (like Eureka) to get a list of available instances of the payment service.
2. Load Balancing:
   - The list of available service instances is then passed to Spring Cloud Load Balancer, which selects an instance based on the configured load balancing algorithm.
3. Request Routing:
   - The request is routed to the selected service instance. If the instance fails, Spring Cloud Load Balancer can retry with a different instance, depending on the configuration.

Example:

Consider a microservices architecture where a UserService needs to communicate with an OrderService. The OrderService has multiple instances running for scalability and redundancy.

- Service Registration: The OrderService instances register themselves with a service registry like Eureka.
- Service Discovery: When the UserService needs to place an order, it queries Eureka to find the available instances of OrderService.
- Load Balancing: Spring Cloud Load Balancer selects an instance of OrderService using the round-robin algorithm (or any other configured algorithm) and sends the request to that instance.

- Fault Tolerance: If the selected instance is down, Spring Cloud Load Balancer can automatically retry the request with a different instance.
- Self-Preservation Mode:
  Eureka has a self-preservation mode to handle scenarios where a large number of services might suddenly become unreachable (e.g., network partition). In this mode, Eureka prioritizes availability and avoids removing services from the registry too quickly to maintain stability in the system.

Load balancing:-

A load balancer acts as a "traffic manager" for applications, routing client requests to the appropriate server based on factors like server load, health, and proximity. By spreading out requests, a load balancer ensures that no single server bears too much traffic, which could lead to slow performance or server crashes. This also provides redundancy, so if one server fails, the load balancer can reroute traffic to other healthy servers.

Eureka yml.property:-

```
server:
  port: 8080

eureka:
  client:
    registerWithEureka: true  # Register this application with Eureka
    fetchRegistry: true       # Fetch the registry from the Eureka server
    serviceUrl:
      defaultZone: http://${eureka.instance.hostname}:${server.port}/eureka/  # URL of the Eureka server
```

Self-preservation mode in Netflix Eureka is a mechanism designed to protect the stability of the service registry during network issues or massive service failures.
When Eureka detects that many services have suddenly stopped sending heartbeats (possibly due to network issues), it enters **self-preservation mode**. In this mode, Eureka temporarily stops expiring services from the registry to prevent mass de-registration, which could destabilize the entire system. This helps maintain the availability of services, even if some instances are temporarily unreachable.
For the threshold time period. After that it will remove from the eureka service.

Circuit Breaker Pattern

The **Circuit Breaker Pattern** is a design pattern used in software development to detect failures and prevent the continuous attempts to perform an operation that is likely to fail. It helps in making a system more resilient by preventing cascading failures in a distributed environment, like microservices.

How It Works:

- **Closed State**: The circuit is initially closed, meaning that all requests to a service are allowed to pass through.
- **Open State**: After a certain threshold of failures is reached, the circuit breaker "trips" and enters an open state. In this state, all further requests to the service are blocked for a specified period (or until the circuit breaker is reset). This prevents the system from wasting resources on requests that are likely to fail.
- **Half-Open State**: After a timeout period, the circuit breaker allows a limited number of test requests to pass through. If these requests succeed, the circuit breaker may reset back to the closed state. If they fail, it goes back to the open state.

Benefits:

- **Fault Tolerance**: It helps prevent cascading failures in distributed systems by stopping requests to failing services.
- **Resilience**: Improves the overall resilience of the system by allowing it to handle partial failures more gracefully.
- **Stability**: Reduces the load on struggling services, giving them time to recover.

Implementation in Java with Resilience4j

Resilience4j is a popular library that provides an easy-to-use implementation of the Circuit Breaker pattern in
Java.

Step-by-Step Example:

1. **Add Dependency**:
   - Add the Resilience4j dependency to your pom.xml or build.gradle.

```
<dependency>
  <groupId>io.github.resilience4j</groupId>
  <artifactId>resilience4j-spring-boot2</artifactId>
</dependency>
```

2. **Configure the Circuit Breaker**:
   - You can configure the circuit breaker properties in application.yml or application.properties.

```
resilience4j.circuitbreaker:  # Base configuration for Resilience4j CircuitBreaker
 configs:
  default:            # Name of the default configuration
   slidingWindowSize: 100    # Number of calls to record in the sliding window (100 calls will be tracked)
   minimumNumberOfCalls: 10     # Minimum number of calls needed before calculating failure rate
   failureRateThreshold: 50          # circuit opens when 50% of the calls fail
   waitDurationInOpenState: 10s    # Time period the circuit breaker stays open before transitioning to half-
                                    open state
   permittedNumberOfCallsInHalfOpenState: 3
   slidingWindowType: COUNT_BASED        # COUNT_BASED means it tracks a fixed number of calls
   slowCallDurationThreshold: 2s       # any call taking longer than 2 seconds is considered slow
   slowCallRateThreshold: 50          # circuit will open if 50% of calls are slow
```

3. **Use the Circuit Breaker**:
   - Annotate your service methods with @CircuitBreaker to apply the circuit breaker.

```
import io.github.resilience4j.circuitbreaker.annotation.CircuitBreaker;
import org.springframework.stereotype.Service;

@Service
public class MyService {

  @CircuitBreaker(name = "myService", fallbackMethod = "fallbackMethod")
  public String someRemoteCall() {
    // Code that calls a remote service
    return remoteService.call();
  }

  public String fallbackMethod(Throwable t) {
```

```
        // Fallback logic when the circuit is open or the call fails
        return "Fallback response";
    }
}
```

Round-robin is a simple, widely used algorithm for distributing tasks or requests evenly across a group of resources, such as servers or processes. In the context of load balancing, round-robin distributes incoming requests sequentially and cyclically among a pool of servers.

Feature	Server-Side Load Balancing	Client-Side Load Balancing
Load Balancer Location	Centralized server or device in the network.	Logic is distributed on the client-side (application or browser).
Traffic Distribution	The load balancer decides which server will handle each request.	The client determines which server to send requests to.
Complexity	Managed centrally, easier to update and manage.	More complex as each client needs to maintain and use load-balancing logic.
Scalability	Easily scales as more servers can be added behind the load balancer.	Scalability depends on client capabilities and logic distribution.
Fault Tolerance	High, as the load balancer can redirect traffic if a server fails.	Limited, as clients must handle server failures individually.
Performance	Can introduce latency due to the extra hop to the load balancer.	Potentially faster as there's no intermediary, but dependent on client implementation.
Configuration	Centralized, changes need to be made only on the load balancer.	Distributed, requiring updates on each client.
Example	AWS Elastic Load Balancer (ELB), Nginx, HAProxy.	DNS-based load balancing, where the client selects from multiple IPs.

Aspect	Traditional Load Balancers	Latest (Modern) Load Balancers
Architecture	Typically hardware-based, deployed on-premises.	Software-based, often cloud-native or containerized.
Scalability	Limited scalability; scaling up requires additional hardware.	Highly scalable, often auto-scales based on demand in cloud environments.
Deployment Flexibility	Requires manual configuration and deployment.	Easily deployed across cloud, hybrid, and multi-cloud environments.
Performance	Performance can be limited by hardware capacity.	Optimized for high performance with distributed architecture.
Traffic Distribution	Uses simple algorithms like round-robin or least connections.	Supports advanced algorithms, including AI/ML-driven traffic management.
Fault Tolerance	Single point of failure if not configured for redundancy.	Built-in redundancy and fault tolerance, often with automatic failover.
Management & Monitoring	Basic monitoring and manual intervention required.	Advanced monitoring, automation, and integration with CI/CD pipelines.

Aspect	Traditional Load Balancers	Latest (Modern) Load Balancers
Cost	High licence costs for hardware and maintenance.	Typically lower cost with pay-as-you-go models in cloud environments.
Security Features	Basic security features like SSL termination.	Enhanced security with WAF (Web Application Firewall), DDoS protection, and more.
Protocol Support	Limited to traditional protocols (HTTP, TCP, UDP).	Supports modern protocols (HTTP/2, QUIC) and APIs for microservices.

Protocol :

A **protocol** is a set of rules or standards that define how data is transmitted and received over a network.

Types of Protocols

Protocols can be categorized based on the layer of the OSI (Open Systems Interconnection) model they operate in or their function. Here's an overview of some common types:

*1. **Network Protocols***

- **IP (Internet Protocol):** Governs how data packets are addressed and routed between devices on a network.
- **ICMP (Internet Control Message Protocol):** Used for error reporting and diagnostics, such as the ping command.

*2. **Transport Layer Protocols***

- **TCP (Transmission Control Protocol):** Ensures reliable, ordered, and error-checked delivery of data between applications.
- **UDP (User Datagram Protocol):** Provides a faster, connectionless communication method, without ensuring delivery, often used in streaming.

*3. **Application Layer Protocols***

- **HTTP (Hypertext Transfer Protocol):** Used for transmitting web pages over the internet.
- **FTP (File Transfer Protocol):** Facilitates the transfer of files between a client and a server.
- **SMTP (Simple Mail Transfer Protocol):** Used for sending emails between servers.
- **DNS (Domain Name System):** Resolves domain names into IP addresses.

*5. **Security Protocols***

- **SSL/TLS (Secure Sockets Layer / Transport Layer Security):** Encrypts data for secure communication over the internet.
- **IPsec (Internet Protocol Security):** Secures IP communications by authenticating and encrypting each IP packet.

*6. **Wireless Communication Protocols***

- **Wi-Fi (IEEE 802.11):** Wireless networking technology for LANs.
- **Bluetooth:** A short-range wireless communication standard for exchanging data between devices.

Netflix Eureka

Netflix Eureka is a service discovery tool developed by Netflix as part of their open-source microservices platform. It plays a crucial role in the Netflix OSS (Open Source Software) ecosystem, helping microservices in a distributed system to locate and communicate with each other efficiently.

Key Features of Netflix Eureka:

1. Service Registry:
2. Service Discovery:

3. Load Balancing:
4. Self-Preservation Mode:
5. Instance Health Checks:

Rate Limiter Pattern

used to control the rate at which an operation is performed. This helps prevent overloading systems, ensures fair usage of resources, and improves system stability by mitigating the risk of abuse.

Use Cases:

- **API Rate Limiting:** To prevent clients from making too many requests to an API in a short period.

Implementation Strategies:

1. **Token Bucket Algorithm:** Limiting API requests, where tokens represent the allowed number of requests.
2. **Leaky Bucket Algorithm:** Ensuring a steady processing rate, useful in traffic shaping for networks.
3. **Fixed Window Counter:** Simple rate limiting for operations that need to be capped in defined intervals (e.g., 100 requests per minute).
4. **Sliding Window Log:** Provides a more accurate rate limiting by accounting for bursts that might occur at the boundary of time windows.
5. **Sliding Window Counter:** Used when you want to smooth out spikes in traffic while maintaining simplicity.

Example Implementation in Java Using Guava:

```
import com.google.common.util.concurrent.RateLimiter;

public class RateLimiterExample {
   public static void main(String[] args) {
      // Create a RateLimiter that allows 5 permits per second
      RateLimiter rateLimiter = RateLimiter.create(5.0);

      // Simulate processing 10 requests
      for (int i = 1; i <= 10; i++) {
         // Acquires a permit from the RateLimiter, blocking if necessary
         rateLimiter.acquire();
         System.out.println("Processing request " + i + " at " + System.currentTimeMillis());
      }
   }
}
```

Key Considerations:

Fallback Mechanism:

Distributed Rate Limiting:

Advantages:

- **Prevents Resource Exhaustion:**
- **Fair Usage**
- **Improved Stability**

Disadvantages:

- **Complexity in Distributed Systems:**
- **User Experience:** Poorly configured rate limits can negatively impact user experience if legitimate requests are throttled too aggressively.

```
<dependencies>
<dependency> <groupId>com.google.guava</groupId>
<artifactId>guava</artifactId>
```

```
<version>32.1.2-jre</version> <!-- Use the latest stable version -->
</dependency>
</dependencies>
```

Exa:-

```
import com.google.common.util.concurrent.RateLimiter;

public class ApiService {

   // Create a RateLimiter that allows 3 requests per second
   private final RateLimiter rateLimiter = RateLimiter.create(3.0);

   public void processRequest(String request) {
      // Acquire a permit before processing the request. This will block if necessary
      rateLimiter.acquire();
      System.out.println("Processing request: " + request + " at " + System.currentTimeMillis());
   }

   public static void main(String[] args) {
      ApiService apiService = new ApiService();

      // Simulate 10 incoming API requests
      for (int i = 1; i <= 10; i++) {
         String request = "Request-" + i;
         new Thread(() -> apiService.processRequest(request)).start();
      }
   }
}
```

Output

The output might look something like this:

```
Processing request: Request-1 at 1693041125000
Processing request: Request-2 at 1693041125000
Processing request: Request-3 at 1693041125000
Processing request: Request-4 at 1693041128333
Processing request: Request-5 at 1693041128333
Processing request: Request-6 at 1693041128333
Processing request: Request-7 at 1693041131666
Processing request: Request-8 at 1693041131666
Processing request: Request-9 at 1693041131666
Processing request: Request-10 at 1693041135000
```

Spring Security :-

Spring Security is a powerful and customizable authentication and access-control framework for Java applications. It provides comprehensive security services for Java EE-based enterprise software applications.

Key Features:

1. **Authentication and Authorization:**
   - Supports a wide range of authentication mechanisms, including HTTP Basic, form-based login, OAuth2, JWT, and more.
   - Role-based access control (RBAC) to manage user permissions.
   - Method-level security using annotations like @PreAuthorize, @Secured.
2. **Protection Against Common Vulnerabilities:**
3. **Integration with Other Technologies:**
   - Seamless integration with OAuth2 for resource server and authorization server configurations.
   - Integration with LDAP, databases, and other identity providers for user authentication.
4. **Flexible and Extensible:**

Basic Setup with Spring Boot

Step 1: Add Dependencies

In a Spring Boot project, include the Spring Security dependency in your pom.xml:

xml

Copy code

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-security</artifactId>
  </dependency>
</dependencies>
```

Step 2: Configure Security in application.properties : (authentication default username password)

```
spring.security.user.name=admin
spring.security.user.password=secret
```

Step 3: Customizing Security Configuration

```
import org.springframework.context.annotation.Configuration;
import org.springframework.security.config.annotation.web.builders.HttpSecurity;
import org.springframework.security.config.annotation.web.configuration.EnableWebSecurity;
import org.springframework.security.config.annotation.web.configuration.WebSecurityConfigurerAdapter;

@Configuration
@EnableWebSecurity
public class SecurityConfig extends WebSecurityConfigurerAdapter {

  @Override
  protected void configure(HttpSecurity http) throws Exception {
    http
      .authorizeRequests()
        .antMatchers("/public/**").permitAll() //public acc. without authentication
        .anyRequest().authenticated()    //other requests require authentication
        .and()
      .formLogin()                    // Enable form-based login
        .loginPage("/login")              // Custom login page
        .permitAll()
        .and()
```

```
        .logout()                    // Enable logout
          .permitAll()
          .and()
        .httpBasic();                // Enable HTTP Basic authentication
    }
}
```

Example Flow

1. **Authentication:**
   - Spring Security intercepts the request and checks if the user is authenticated.
   - If not authenticated, the user is redirected to the login .
   - Upon successful login, Spring Security creates a SecurityContext containing the user's details and roles.
2. **Authorization:**
   - Spring Security checks if the authenticated user has the necessary permissions to access the requested resource.
   - Access is granted or denied based on the roles/authorities associated with the user.

Custom Login Page

To use a custom login page, you can create a simple HTML form:

```
<!DOCTYPE html>
<html>
<head>
  <title>Login</title>
</head>
<body>
  <h2>Login</h2>
  <form action="/login" method="post">
    <div>
      <label>Username:</label>
      <input type="text" name="username" />
    </div>
    <div>
      <label>Password:</label>
      <input type="password" name="password" />
    </div>
    <div>
      <button type="submit">Login</button>
    </div>
  </form>
</body>
</html>
```

Role-Based Access Control

You can secure methods or entire controllers using annotations:

- **Controller-level:**

```
@RestController
@RequestMapping("/admin")
@PreAuthorize("hasRole('ADMIN')")
```

```
public class AdminController {
   // Methods here will only be accessible to users with the "ADMIN" role
}
```

- **Method-level:**

```
@GetMapping("/admin")
@PreAuthorize("hasRole('ADMIN')")
public String adminPage() {
   return "Admin content";
}
```

OAuth 2.0 Overview

OAuth 2.0 is an open standard for authorization, commonly used as a way to grant websites or applications limited access to a user's information without exposing their credentials.

Key Concepts in OAuth 2.0

1. **Resource Owner (User):** The person or entity that can grant access to a protected resource. In most cases, this is the end-user.
2. **Client:** The application requesting access to the resource owner's protected resources on their behalf. This could be a web app, mobile app, or other service.
3. **Authorization Server:** The server that authenticates the resource owner and issues access tokens to the client after successful authentication and authorization.
4. **Resource Server:** The server hosting the protected resources. It accepts and validates access tokens to grant or deny access to resources.
5. **Access Token:** A credential that represents the authorization granted by the resource owner. The client uses this token to access protected resources on the resource server.
6. **Refresh Token:** A long-lived token that can be used to obtain a new access token without requiring the user to re-authenticate.

OAuth 2.0 Grant Types (Flows)

1. **Authorization Code Grant:**
   - **Use Case:** Most common flow, used for web and mobile apps where the client (application) can securely store client secrets.
   - **How It Works:**

1. The client redirects the user to the authorization server.
2. The user logs in and consents to grant access.
3. The authorization server redirects back to the client with an authorization code.
4. The client exchanges the authorization code for an access token.

2. **Implicit Grant:**
   - **Use Case:** Used in scenarios like single-page applications (SPAs) where the client cannot securely store a secret.
3. **Resource Owner Password Credentials Grant:**
   - **How It Works:** The client collects the user's credentials (username and password) directly and exchanges them for an access token. This flow is considered less secure and is generally discouraged.

4. **Client Credentials Grant:**
   - **Use Case:** Used when the client is acting on its own behalf, not on behalf of a user. Commonly used for machine-to-machine (M2M) interactions.
5. **Refresh Token Grant:**

- **Use Case:** Allows the client to obtain a new access token using a refresh token when the current access token expires.

Example Flow: Authorization Code Grant

Let's walk through the **Authorization Code Grant** flow, which is the most secure and commonly used flow in OAuth 2.0.

1. ***User Authorization***

The user initiates the process by clicking a "Login with [Service]" button in the client application.

plaintext

GET /authorize?response_type=code&client_id=CLIENT_ID&redirect_uri=REDIRECT_URI&scope=SCOPE&state=STATE

- **response_type=code:** Indicates that the client is initiating the authorization code flow.
- **client_id:** The client ID obtained during the client registration process.
- **redirect_uri:** The URI to redirect the user to after authorization.
- **scope:** The scope of the access requested (e.g., read, write).
- **state:** A random string to protect against CSRF attacks.

2. ***User Logs In and Authorizes Access***

The user is redirected to the authorization server, where they log in and grant access to the requested scope.

3. ***Authorization Server Redirects to Client***

GET /callback?code=AUTHORIZATION_CODE&state=STATE

- **code:** The authorization code that the client will exchange for an access token.
- **state:** The original state parameter to prevent CSRF attacks.

4. ***Client Exchanges Authorization Code for Access Token***

The client sends a request to the authorization server to exchange the authorization code for an access token.

plaintext

POST /token
Content-Type: application/x-www-form-urlencoded

grant_type=authorization_code&code=AUTHORIZATION_CODE&redirect_uri=REDIRECT_URI&client_id=CLIENT_ID&client_secret=CLIENT_SECRET

- **grant_type=authorization_code:** Specifies the grant type.
- **code:** The authorization code received in the previous step.
- **client_secret:** The client's secret, used to authenticate the client.

5. ***Authorization Server Returns Access Token***

The authorization server responds with an access token, and optionally, a refresh token.

```
{
  "access_token": "ACCESS_TOKEN",
  "token_type": "bearer",
  "expires_in": 3600,
  "refresh_token": "REFRESH_TOKEN"
}
```

- **access_token:** The token that the client uses to access protected resources.
- **expires_in:** The lifetime in seconds of the access token.
- **refresh_token:** A token that can be used to obtain a new access token.

6. ***Client Accesses Protected Resources***

Securing OAuth 2.0 in Spring Security

In a Spring Boot application, OAuth 2.0 can be easily integrated using the Spring Security OAuth2 module. Below is a simplified example of configuring OAuth 2.0 in a Spring Boot application.

Step 1: Add Dependencies

xml

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-oauth2-client</artifactId>
  </dependency>
</dependencies>
```

Step 2: Configure OAuth 2.0 in application.properties

```
spring.security.oauth2.client.registration.google.client-id=YOUR_CLIENT_ID
spring.security.oauth2.client.registration.google.client-secret=YOUR_CLIENT_SECRET
spring.security.oauth2.client.registration.google.scope=profile,email
spring.security.oauth2.client.registration.google.redirect-uri={baseUrl}/login/oauth2/code/google
spring.security.oauth2.client.registration.google.authorization-grant-type=authorization_code
spring.security.oauth2.client.provider.google.authorization-
uri=https://accounts.google.com/o/oauth2/auth
spring.security.oauth2.client.provider.google.token-uri=https://oauth2.googleapis.com/token
spring.security.oauth2.client.provider.google.user-info-
uri=https://www.googleapis.com/oauth2/v3/userinfo
```

Step 3: Implement Security Configuration

```
import org.springframework.context.annotation.Configuration;
import org.springframework.security.config.annotation.web.builders.HttpSecurity;
import org.springframework.security.config.annotation.web.configuration.EnableWebSecurity;
import org.springframework.security.config.annotation.web.configuration.WebSecurityConfigurerAdapter;

@Configuration
@EnableWebSecurity
public class SecurityConfig extends WebSecurityConfigurerAdapter {

  @Override
  protected void configure(HttpSecurity http) throws Exception {
    http
      .authorizeRequests()
        .antMatchers("/", "/login").permitAll()
        .anyRequest().authenticated()
        .and()
      .oauth2Login(); // Enables OAuth2 login
  }
}
```

OpenID Overview

OpenID is an open standard and decentralized authentication protocol that allows users to authenticate with multiple websites using a single identity, typically managed by a third-party provider. The original OpenID standard has evolved over time, and today, the most commonly used form of OpenID is **OpenID Connect (OIDC)**, which is built on top of OAuth 2.0 and adds an identity layer.

Key Concepts of OpenID Connect

1. **Issuer (Identity Provider, IdP):**
   - The entity that provides the authentication service. Examples include Google, Facebook, and Microsoft. The Issuer verifies the user's identity and provides identity tokens to clients.
2. **Relying Party (Client):**
   - The application that relies on the identity provided by the IdP. The Relying Party uses the identity information to authenticate the user and authorize access.
3. **End-User:**
   - The person who owns the identity and uses it to access services or applications.
4. **Identity Token (ID Token):**
   - A JWT (JSON Web Token) that contains claims about the authentication event, such as the user's identity, issued by the IdP. The ID Token is used by the client to verify the identity of the user.
5. **UserInfo Endpoint:**
   - An endpoint provided by the IdP that returns additional claims about the authenticated user, such as their name, email address, and profile information.
6. **Authorization Endpoint:**
   - The URL where the client sends the user to authenticate with the IdP.
7. **Token Endpoint:**
   - The URL where the client exchanges an authorization code for an access token and an ID token.

OpenID Connect Flow

OpenID Connect is most commonly used in the **Authorization Code Flow**, which is very similar to the OAuth 2.0 Authorization Code Grant but with the addition of an ID token.

1. ***User Initiates Authentication***

The user clicks a "Sign in with [Provider]" button on the client application.

GET /authorize?response_type=code&client_id=CLIENT_ID&redirect_uri=REDIRECT_URI&scope=openid profile email&state=STATE&nonce=NONCE

- **response_type=code:** Indicates that the client is initiating the authorization code flow.
- **scope=openid profile email:** The openid scope is required for OpenID Connect. Additional scopes like profile and email can be requested for more information.
- **nonce:** A random string that is used to associate a client session with an ID token and to mitigate replay attacks.

2. ***User Authenticates with the Identity Provider***

The user is redirected to the identity provider's login page, where they log in and grant permission to share their identity information with the client.

3. ***Identity Provider Issues Authorization Code***

Upon successful authentication, the identity provider redirects the user back to the client's redirect URI with an authorization code.

GET /callback?code=AUTHORIZATION_CODE&state=STATE

- **code:** The authorization code that the client will exchange for an access token and an ID token.

4. ***Client Exchanges Authorization Code for Tokens***

The client sends a request to the token endpoint to exchange the authorization code for an ID token and an access token.

POST /token
Content-Type: application/x-www-form-urlencoded

grant_type=authorization_code&code=AUTHORIZATION_CODE&redirect_uri=REDIRECT_URI&client_id=CLIENT_ID&client_secret=CLIENT_SECRET

5. ***Identity Provider Responds with Tokens***

The identity provider responds with an ID token, access token, and optionally a refresh token.

json
Copy code

```
{
  "id_token": "ID_TOKEN",
  "access_token": "ACCESS_TOKEN",
  "refresh_token": "REFRESH_TOKEN",
  "expires_in": 3600,
  "token_type": "Bearer"
}
```

- **id_token:** Contains identity information about the user.
- **access_token:** Can be used to access additional resources like the UserInfo endpoint.

6. ***Client Verifies ID Token***

The client verifies the ID token's integrity, ensuring it was issued by the expected provider and that it has not been tampered with.

ID Token Structure

The ID token is a JWT (JSON Web Token) and contains three parts:

1. **Header:** Metadata about the token, such as the signing algorithm used.
2. **Payload:** Contains claims about the user and the authentication event, such as sub (subject, or user ID), iss (issuer), and exp (expiration time).
3. **Signature:** Used to verify the token's integrity.

Example of OpenID Connect with Spring Security

To integrate OpenID Connect in a Spring Boot application, you can use Spring Security's OAuth2 support.

Step 1: Add Dependencies

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-oauth2-client</artifactId>
  </dependency>
</dependencies>
```

Step 2: Configure OpenID Connect in application.properties

properties
Copy code

```
spring.security.oauth2.client.registration.google.client-id=YOUR_CLIENT_ID
spring.security.oauth2.client.registration.google.client-secret=YOUR_CLIENT_SECRET
spring.security.oauth2.client.registration.google.scope=openid, profile, email
spring.security.oauth2.client.registration.google.redirect-uri={baseUrl}/login/oauth2/code/google
spring.security.oauth2.client.registration.google.authorization-grant-type=authorization_code
```

```
spring.security.oauth2.client.provider.google.authorization-
uri=https://accounts.google.com/o/oauth2/auth
spring.security.oauth2.client.provider.google.token-uri=https://oauth2.googleapis.com/token
spring.security.oauth2.client.provider.google.user-info-
uri=https://www.googleapis.com/oauth2/v3/userinfo
spring.security.oauth2.client.provider.google.jwk-set-uri=https://www.googleapis.com/oauth2/v3/certs
```

Step 3: Implement Security Configuration

```
import org.springframework.context.annotation.Configuration;
import org.springframework.security.config.annotation.web.builders.HttpSecurity;
import org.springframework.security.config.annotation.web.configuration.EnableWebSecurity;
import org.springframework.security.config.annotation.web.configuration.WebSecurityConfigurerAdapter;

@Configuration
@EnableWebSecurity
public class SecurityConfig extends WebSecurityConfigurerAdapter {

    @Override
    protected void configure(HttpSecurity http) throws Exception {
        http
            .authorizeRequests()
                .antMatchers("/", "/login").permitAll()
                .anyRequest().authenticated()
                .and()
            .oauth2Login()  // Enables OAuth2 login with OpenID Connect
                .defaultSuccessUrl("/home", true); // Redirects to /home after successful login
    }
}
```

Advantages of OpenID Connect

1. **Simplified User Experience:** Users can log in to multiple applications with a single identity.
2. **Security:** Relies on proven security mechanisms like OAuth 2.0 and JWT, providing robust security.
3. **Interoperability:** Widely adopted by major identity providers, making it easy to integrate with various services.
4. **Extensibility:** Allows for the inclusion of additional claims and user information, enabling more personalized user experiences.

Prometheus is responsible for collecting and storing metrics from your services and infrastructure. It provides real-time monitoring and alerting.

Grafana acts as the visualization layer, allowing you to create rich dashboards that combine metrics from Prometheus and logs from Loki.

Loki serves as the logging component, capturing, storing, and indexing logs from your systems. Logs can be visualized and correlated with metrics in Grafana.

Kafka Overview

Apache Kafka is an open-source distributed event streaming platform used for building real-time data pipelines and streaming applications. Originally developed by LinkedIn and later open-sourced through the Apache Software Foundation, Kafka is designed to handle large volumes of data with low latency and high throughput.

Key Concepts in Kafka

1. **Producer:**

- The application or service that publishes messages (records) to Kafka topics. Producers send data to Kafka brokers, which then store and manage the data.

2. **Consumer:**
- The application or service that reads messages from Kafka topics. Consumers can be part of a consumer group, where multiple consumers work together to process data from a topic.

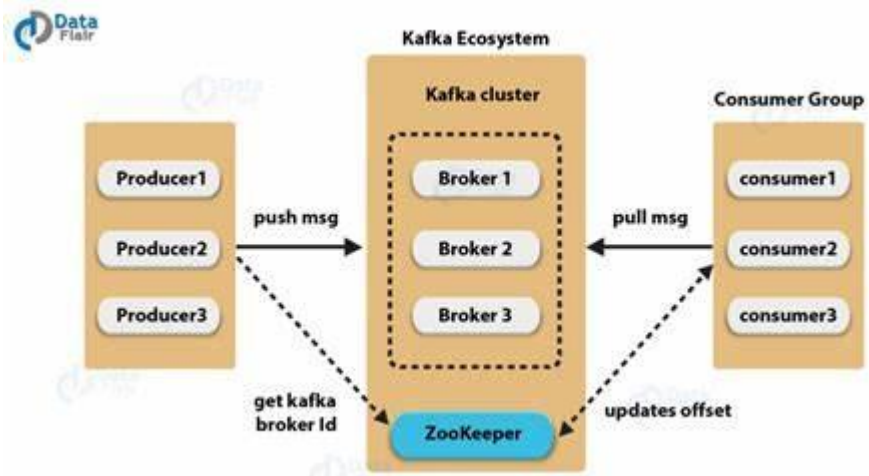
3. **Broker:**
- Kafka brokers are servers that form a Kafka cluster, managing the storage and retrieval of messages. Each broker is responsible for one or more partitions of a topic.

4. **Topic:**
- A topic is a category or feed name to which records are published. Topics are partitioned, meaning that the data within a topic can be split across multiple brokers, allowing for parallel processing.

5. **Partition:**
- A partition is a division of a topic that allows Kafka to distribute data across multiple brokers. Each partition is ordered, and messages within a partition have a unique offset.

6. **Offset:**
- An offset is a unique identifier for a message within a partition. It helps Kafka track the position of each consumer in the topic.

7. **ZooKeeper:**



- Although Kafka is moving towards replacing ZooKeeper, traditionally, ZooKeeper has been used to manage and coordinate Kafka brokers in the cluster. It helps with tasks like leader election, configuration management, and state storage.

Use Cases for Kafka

1. **Real-Time Data Streaming:**
- Kafka is commonly used to build real-time streaming data pipelines that process and analyze data on the fly. For example, you can stream user activity logs from a website to Kafka and process them in real-time to generate insights.

2. **Event Sourcing:**

- Kafka can be used to implement event sourcing, where every change to the state of an application is logged as an event. This allows you to reconstruct the state of an application by replaying events from Kafka.

3. **Log Aggregation:**
- Kafka is often used for log aggregation, where logs from different services are published to Kafka topics and then processed or stored by consumers. This enables centralized log management and analysis.

4. **Stream Processing:**
- Kafka, combined with stream processing frameworks like Apache Flink, Apache Storm, or Kafka Streams, can be used to process data streams in real-time, performing tasks such as filtering, transforming, and aggregating data.

5. **Message Queuing:**
- Kafka can act as a message queue, where producers send messages to topics, and consumers read and process these messages asynchronously. Kafka's durability and scalability make it suitable for high-throughput messaging.

Example: Kafka in a Java Application

Here's a simple example of how you might produce and consume messages in Kafka using Java.

Step 1: Add Dependencies

Add the necessary Kafka dependencies to your Maven pom.xml file.

```
<dependencies>
  <dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-clients</artifactId>
    <version>3.5.0</version>
  </dependency>
</dependencies>
```

Summary

- **Kafka** is a distributed streaming platform that allows you to build real-time data pipelines and streaming applications. It is designed for high throughput, fault tolerance, and horizontal scalability.
- **Producers** send data to Kafka topics, which are divided into partitions for parallel processing.
- **Consumers** read data from Kafka topics, often as part of a consumer group to balance the load.
- **Kafka's architecture** includes brokers for storage and replication, ensuring that data is durable and available even in the case of failures.
- Kafka is widely used for real-time data streaming, log aggregation, event sourcing, and more, making it a key component of modern data architectures.

The **Publish/Subscribe (Pub/Sub) model** is a messaging pattern where senders of messages, called **publishers**, do not send messages directly to specific receivers, called **subscribers**. Instead, messages are sent to a **topic** or **channel**, and subscribers receive messages by subscribing to that topic. This decouples the producers and consumers, allowing for scalable, flexible, and asynchronous communication.

Key Concepts of Pub/Sub Model

1. **Publisher:**
- The entity that produces and sends messages to a topic. Publishers are not concerned with who receives the messages; they simply send data to a topic.

2. **Subscriber:**
- The entity that receives messages from a topic. Subscribers express interest in one or more topics and receive only the messages that are published to those topics.

3. **Topic (or Channel):**
- A named entity to which publishers send messages and from which subscribers receive messages. Topics can be thought of as logical channels that connect publishers and subscribers.

4. **Broker:**

- The intermediary that manages topics, receives messages from publishers, and delivers them to subscribers. Examples of brokers include Apache Kafka, Google Cloud Pub/Sub, and MQTT brokers.

How the Pub/Sub Model Works

1. **Publishers Send Messages to a Topic:**
2. **Subscribers Subscribe to Topics:**
3. **Broker Delivers Messages:**

- The broker ensures that every message sent to a topic is delivered to all subscribers of that topic. The delivery mechanism can vary depending on the system—messages can be delivered in real-time, stored and replayed later, etc.

4. **Decoupling of Components:**

- Publishers and subscribers are decoupled in time, space, and synchronization. This means:
  - **Time Decoupling:** Publishers and subscribers do not need to be active at the same time.
  - **Space Decoupling:** Publishers do not need to know who the subscribers are and vice versa.
  - **Synchronization Decoupling:** Messages are sent asynchronously, so publishers do not wait for subscribers to receive the message before continuing.

Benefits of the Pub/Sub Model

1. **Scalability:**

- The decoupling of publishers and subscribers allows the system to scale more easily. Multiple publishers can publish to the same topic, and multiple subscribers can consume from it without impacting each other.

2. **Flexibility:**

- New subscribers can be added without modifying existing publishers. Similarly, new publishers can send messages to a topic without needing to know about the existing subscribers.

3. **Fault Tolerance:**

- Since messages are often stored by the broker, subscribers can retrieve missed messages even after a failure or downtime.

4. **Asynchronous Communication:**

- Publishers do not have to wait for subscribers to process messages. This enables faster message production and consumption at different rates.

5. **Broadcasting:**

- Messages can be broadcasted to multiple subscribers simultaneously, making it efficient for scenarios where the same message needs to reach multiple consumers.

Example Implementations of Pub/Sub

1. ***Apache Kafka***

Kafka is a distributed streaming platform that implements the Pub/Sub model. Here's a simplified example:

- **Publisher:** Sends messages to a Kafka topic.
- **Topic:** Stores the messages in partitions for scalability.
- **Subscriber:** Reads messages from the Kafka topic, often as part of a consumer group.

2. ***Google Cloud Pub/Sub***

Google Cloud Pub/Sub is a fully-managed messaging service that also follows the Pub/Sub model.

- **Publisher:** An application sends messages to a topic in Google Cloud Pub/Sub.
- **Topic:** Acts as a channel to which messages are sent.
- **Subscriber:** Another application subscribes to the topic and receives the messages.

Example Code with Kafka in Java

Here's an example of how you might implement the Pub/Sub model using Kafka in Java:

Step 1: Create a Kafka Topic

bash
Copy code

kafka-topics.sh --create --topic my-topic --bootstrap-server localhost:9092 --partitions 1 --replication-factor 1

Step 2: Publisher (Producer)

java
Copy code

```
import org.apache.kafka.clients.producer.KafkaProducer;
import org.apache.kafka.clients.producer.Producer;
import org.apache.kafka.clients.producer.ProducerRecord;
import java.util.Properties;

public class SimpleKafkaProducer {

   public static void main(String[] args) {
      Properties props = new Properties();
      props.put("bootstrap.servers", "localhost:9092");
      props.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer");
      props.put("value.serializer", "org.apache.kafka.common.serialization.StringSerializer");

      Producer<String, String> producer = new KafkaProducer<>(props);

      producer.send(new ProducerRecord<>("my-topic", "key", "Hello, Pub/Sub!"));
      producer.close();
   }
}
```

Step 3: Subscriber (Consumer)

java
Copy code

```
import org.apache.kafka.clients.consumer.ConsumerRecord;
import org.apache.kafka.clients.consumer.KafkaConsumer;
import org.apache.kafka.clients.consumer.ConsumerRecords;
import java.util.Collections;
import java.util.Properties;

public class SimpleKafkaConsumer {

   public static void main(String[] args) {
      Properties props = new Properties();
      props.put("bootstrap.servers", "localhost:9092");
      props.put("group.id", "test-group");
      props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
      props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");

      KafkaConsumer<String, String> consumer = new KafkaConsumer<>(props);
      consumer.subscribe(Collections.singletonList("my-topic"));

      while (true) {
         ConsumerRecords<String, String> records = consumer.poll(100);
         for (ConsumerRecord<String, String> record : records) {
```

```
            System.out.printf("offset = %d, key = %s, value = %s%n", record.offset(), record.key(), record.value());
        }
    }
  }
}
```

Use Cases for Pub/Sub

1. **Event-Driven Architectures:**
   - Applications that react to events in real-time, such as microservices architectures, often use the Pub/Sub model to propagate events between components.
2. **Logging and Monitoring:**
   - Centralized logging systems aggregate logs from multiple sources using a Pub/Sub model, making it easier to monitor and analyze logs in real-time.
3. **Data Streaming:**
   - Use cases like real-time analytics, data ingestion, and ETL (Extract, Transform, Load) pipelines often rely on Pub/Sub to stream data between systems.
4. **Notification Systems:**
   - Sending notifications to users or systems based on certain events, such as order confirmations or system alerts, is a common use of the Pub/Sub model.

Summary

- The **Pub/Sub model** is a powerful messaging pattern that decouples message producers (publishers) from consumers (subscribers).
- It provides scalability, flexibility, and fault tolerance, making it ideal for distributed systems, event-driven architectures, and real-time data processing.
- **Kafka** and **Google Cloud Pub/Sub** are popular implementations of the Pub/Sub model, widely used in modern software architectures.

Hikari pool :- use to make connection b/w java db.

Api's testing:-

1. Functional Testing

- **Purpose**: Ensures the API works as intended and returns the correct responses for given input.
- **Tools**: JUnit, TestNG, RestAssured.
- **Example**: Testing the endpoint `/api/users` to ensure it returns a list of users.

2. Integration Testing

- **Purpose**: Tests the interaction between different modules or systems to verify that they work together as expected.
- **Tools**: Spring Boot Test, WireMock, TestContainers.
- **Example**: Ensuring that an API interacts properly with a database or an external service.

3. Performance Testing

- **Purpose**: Measures the responsiveness and stability of the API under various load conditions.
- **Tools**: JMeter, Gatling.
- **Example**: Checking how an API performs under a simulated load of thousands of users.

4. Load Testing

- **Purpose**: Tests how the API behaves under expected and peak load conditions to ensure it can handle high traffic.
- **Tools**: Apache JMeter, Gatling.
- **Example**: Simulating multiple concurrent users accessing the API.

5. Stress Testing

- **Purpose**: Determines the breaking point of the API by pushing it beyond its normal capacity.
- **Tools**: JMeter, Locust.
- **Example**: Gradually increasing the number of requests to identify when the API fails.

6. Security Testing

- **Purpose**: Checks the API for vulnerabilities and ensures that data is protected from unauthorized access.
- **Tools**: OWASP ZAP, Burp Suite.
- **Example**: Testing for SQL injection vulnerabilities or ensuring that user data is encrypted.

7. Validation Testing

- **Purpose**: Verifies that the API meets the specified business requirements and that its behavior is correct.
- **Tools**: Postman, RestAssured.
- **Example**: Validating the format of the data returned (e.g., JSON schema).

8. Error Handling Testing

- **Purpose**: Ensures that the API responds correctly to incorrect inputs or unexpected situations.
- **Tools**: RestAssured, JUnit.
- **Example**: Sending invalid data to test if the API returns proper error messages and status codes.

9. Security Authentication and Authorization Testing

- **Purpose**: Verifies that authentication and authorization mechanisms are implemented correctly.
- **Tools**: Postman, RestAssured, OAuth libraries.
- **Example**: Testing API access with and without valid credentials.

10. Regression Testing

- **Purpose**: Ensures that new code changes do not break existing functionality.
- **Tools**: JUnit, TestNG, automated test scripts.
- **Example**: Running a suite of existing tests after code modifications.

11. Compliance Testing

- **Purpose**: Ensures that the API meets the industry regulations and standards.
- **Tools**: Custom scripts, compliance check tools.
- **Example**: Verifying that an API complies with data privacy regulations like GDPR.

12. End-to-End Testing

- **Purpose**: Tests the complete flow from start to finish to ensure all parts of the system work together seamlessly.
- **Tools**: Cucumber, Karate.
- **Example**: Testing the full user journey, from logging in to making a transaction via the API.

CDC (Consumer-Driven Contract)

In Java, **CDC (Consumer-Driven Contract)** is an approach in microservices testing where the contract between a service provider and a consumer is defined by the consumer's expectations. It ensures that changes made to a service do not break the consumer's integration.

Reactive Extensions (Rx) in microservices refer to the use of reactive programming principles to build asynchronous, non-blocking, and event-driven services. This approach helps handle real-time data streams and manage large numbers of concurrent requests efficiently. In Java, libraries like **Project Reactor** and **RxJava** are commonly used for implementing reactive patterns, supporting the development of more responsive and resilient microservices that scale better under load and maintain high performance.