JAVA Basics:

Java is a widely used, object-oriented programming language known for its platform independence(WORA), robustness, and security. Here are some key basics:

1. Features of Java

- **Platform Independent:** "Write Once, Run Anywhere" (WORA) using the Java Virtual Machine (JVM).
- **Object-Oriented:** Everything in Java is based on objects and classes.
- **Simple and Secure:** No explicit pointers, built-in security features.
- **Multithreading:** Supports concurrent execution of multiple tasks.
- **Automatic Memory Management:** Uses garbage collection to free memory.

🔹 Java Execution Flow:

```
Source Code (.java)
        ↓
   Compiler (javac)
        ↓
 Bytecode (.class)
        ↓
      JVM
        ↓
 Machine Code (Output)
```

🔄 Summary Table

Component	Role
JDK	Java Development Kit - for development (includes JRE + tools)
JRE	Java Runtime Environment - to run Java programs
JVM	Java Virtual Machine - executes bytecode
Compiler (javac)	Converts source code to bytecode
Bytecode	Intermediate code executed by JVM

Object:

It is a real wold Entity having identity,state and Behaviour

Instance of class

Ex:Car

State(member var):Wheel,Gear,breaketc

Behaviour(method):We can drive car

Class:

In Java, **a class is a blueprint** for creating objects. It defines variables (fields) and methods (functions) that objects will have.

Group of object

Structure of class:

```
class Car
{
```

```
// Fields (Variables)

String brand = "Toyota"; int speed = 120;

// Method (Function)

 void displayCarInfo()

 {

System.out.println("Brand: " + brand);

System.out.println("Speed: " + speed + " km/h"); } }
```

Creating Object of the Class:

```
public class Main {
    public static void main(String[] args) {
        Car myCar = new Car(); // Creating an object
        myCar.displayCarInfo(); // Calling a method
    }
}
```

A class is a group of objects which have common properties.

A class in Java contains:

Constructors
Methods
Fields
Blocks

Nested class and interface

2. Basic Structure of a Java Program

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World!");
    }
}
```

- `public class HelloWorld` → Class declaration.
- `public static void main(String[] args)` → Main method, the entry point of the program.
- `System.out.println("Hello, World!");` → Prints output to the console.

Parameters used in First Java Program

- **class** keyword is used to declare a class in java.
- **public** keyword is an access modifier. It means it is visible to all.
- **static** is a keyword. If we declare any method as static, it is known as the static method. The core advantage of the static method is that there is no need to create an object to invoke the static method.
- **void** means it doesn't return any value.
- **main** represents the starting point of the program.
- **String[] args** is used for command line argument.
- **System.out.println()** is used to print statement.
- Here, System is a class, out is the object of PrintStream class, println() is the method of PrintStream class.

Data Types in Java

A **data type** in Java specifies the type of data a variable can store. Java has two main categories of data types:

1. **Primitive Data Types** (Basic types like int, float, char, etc.)
2. **Non-Primitive Data Types** (Objects, Arrays, Strings, etc.)

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1. Primitive Data Types

These are the most basic data types built into Java.

Data Type	Size	Default Value	Description
`byte`	1 byte	0	Stores small integers (-128 to 127)
`short`	2 bytes	0	Stores medium integers (-32,768 to 32,767)
`int`	4 bytes	0	Stores whole numbers (-2^{31} to $2^{31}-1$)
`long`	8 bytes	0L	Stores large integers (-2^{63} to $2^{63}-1$)
`float`	4 bytes	0.0f	Stores decimal numbers (up to 7 decimal places)
`double`	8 bytes	0.0d	Stores large decimal numbers (up to 16 decimal places)
`char`	2 bytes	'\u0000'	Stores a single character (Unicode)
`boolean`	1 bit	false	Stores `true` or `false`

Example Usage

```
public class DataTypesExample {
    public static void main(String[] args) {
        int num = 10;
        double price = 99.99;
        char grade = 'A';
        boolean isJavaFun = true;

        System.out.println("Number: " + num);
        System.out.println("Price: " + price);
        System.out.println("Grade: " + grade);
        System.out.println("Java is fun: " + isJavaFun);
    }
}
```

Output:

```
Number: 10
Price: 99.99
Grade: A
Java is fun: true
```

- **Non-Primitive Data Types:**
  - `String`, `Arrays`, `Classes`, `Interfaces`

JVM (Java Virtual Machine)

Definition:

JVM (**Java Virtual Machine**) is an abstract machine that enables a computer to run Java programs. It acts as a runtime environment that converts Java **bytecode** into machine-specific code.

How JVM Works?

1. **Java Source Code (.java)** → Written by the programmer.
2. **Compilation (Javac - Java Compiler)** → Converts the `.java` file into **bytecode** (`.class` file).
3. **JVM Execution** → The `.class` file (bytecode) is executed by the JVM, which converts it into machine code using the Just-In-Time (JIT) compiler.

JVM Architecture

JVM has the following main components:

1. **Class Loader**
   - Loads `.class` files into memory.
   - Performs **verification, linking, and initialization** of classes.
2. **Runtime Memory Areas (JVM Memory Structure)**
   - **Method Area** → Stores class-level information (method code, static variables).
   - **Heap Area** → Stores objects and instance variables.
   - **Stack Area** → Stores method execution details and local variables.
   - **PC Register** → Stores the address of the current instruction being executed.
   - **Native Method Stack** → Stores native (non-Java) method calls.
3. **Execution Engine**
   - **Interpreter** → Executes bytecode line by line (slow).
   - **JIT Compiler (Just-In-Time)** → Converts bytecode into native code for faster execution.
4. **Garbage Collector (GC)**
   - **Manages memory by automatically removing unused objects** to free up space.

Finalize:

The `finalize` method in Java is used to perform **cleanup operations** before an object is **garbage collected**. It is a **protected method** of the `Object` class, and it can be overridden in a class.

Java Component- JRE

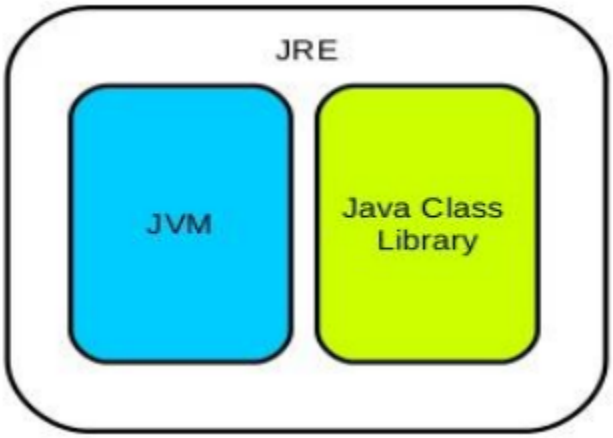
JRE stands for Java Runtime Environment.

It plays a key role while executing any java application.

It is a collection of tools that together allow the development of applications and provide a runtime environment.

The JVM is a part of JRE.

This is like JVM, platform-dependent.



Java Component- JDK

JDK stands for Java Development Kit.

It includes Development Tools to provide an environment to develop your Java programs and JRE to execute
your java code.

In order to create, compile and run Java program you would need JDK installed on your computer.

JVM vs JRE vs JDK

Component	Description
JVM (Java Virtual Machine)	Runs Java bytecode, converts it to machine code
JRE (Java Runtime Environment)	Contains JVM + libraries required to run Java programs
JDK (Java Development Kit)	Contains JRE + development tools (compiler, debugger)

JVM is Platform-Independent

Java code can run on **any OS (Windows, Mac, Linux, etc.)** because the JVM is different for each platform, but the bytecode remains the same. This is what makes Java **"Write Once, Run Anywhere" (WORA).**

Example: JVM Execution Flow

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, JVM!");
    }
}
```

- **Compilation:** `javac HelloWorld.java` → Produces `HelloWorld.class` (bytecode).
- **Execution:** `java HelloWorld` → JVM loads and runs bytecode.

`finalize` Keyword in Java

Definition:

The `finalize` method in Java is used to perform **cleanup operations** before an object is **garbage collected**. It is a **protected method** of the `Object` class, and it can be overridden in a class.

How `finalize()` Works?

- The **Garbage Collector (GC)** calls `finalize()` just before destroying an object.
- It is used for **closing resources** like files, database connections, etc.
- It **does not guarantee** immediate execution, as GC runs at an unpredictable time.

Example of `finalize()`

```
class Example {
    // Constructor
    Example() {
        System.out.println("Object Created");
    }

    // Overriding finalize() method
    @Override
    protected void finalize() {
        System.out.println("Object is being garbage collected!");
    }
}

public class Main {
    public static void main(String[] args) {
        Example obj1 = new Example();
        Example obj2 = new Example();

        obj1 = null; // Eligible for garbage collection
        obj2 = null; // Eligible for garbage collection

        // Requesting JVM to run Garbage Collector
        System.gc();

        System.out.println("Main method ends");
    }
}
```

Possible Output:

```
Object Created
Object Created
Main method ends
Object is being garbage collected!
Object is being garbage collected!
```

(Note: The order of garbage collection messages may vary.)

Key Points About `finalize()`

1. **Called by Garbage Collector (GC)** before removing an object.
2. **Used for resource cleanup**, but not a reliable method for closing resources.
3. **Deprecated in Java 9** because it is unpredictable and inefficient.
4. **Alternatives:** Use `try-with-resources` or `finally` blocks for proper resource management.

Variables in Java

Definition:

A **variable** in Java is a container that holds a value that can change during the execution of a program. Every variable has a **type**, **name**, and **scope**.

1. Types of Variables in Java

Java has three main types of variables:

Variable Type	Description	Scope
Local Variable	Declared inside a method or block	Within the method/block
Instance Variable	Defined inside a class but outside any method	Exists as long as the object exists
Static Variable	Declared with `static` keyword, shared among all objects of the class	Exists throughout the program

Local Variables

- Declared inside a **method, constructor, or block**.
- Only accessible within that method/block.
- **Must be initialized before use** (No default value).

Instance Variables (Non-Static Variables)

- Declared inside a class but **outside any method**.
- Each **object has its own copy** of instance variables.
- **Automatically initialized** with default values.

Static Variables (Class Variables)

- Declared with the **`static` keyword** inside a class.
- **Shared among all objects** of the class.
- **Memory is allocated only once** (when the class is loaded).

Naming Convention:

- Start with a **letter**, _ (underscore), or `$` (dollar sign).
- Use **letters, digits, _, `$`** after the first character.
- Case-sensitive (`age` and `Age` are different).

Operator in JAVA

In Java, operators are used for evaluation of expressions.

Operator in java is a **symbol** that is used to perform operations.

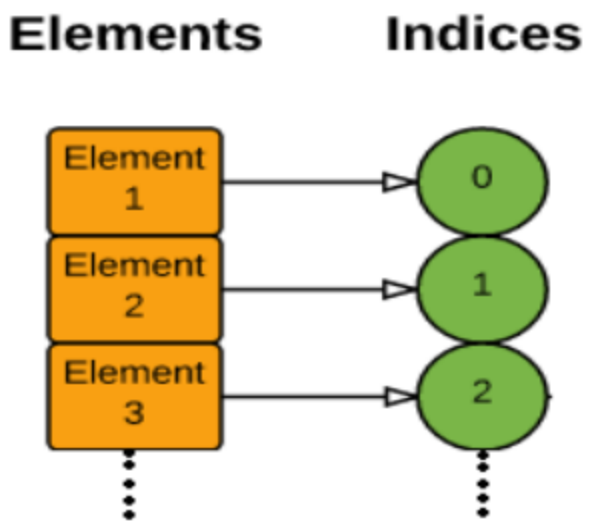
Java supports the following types of operators:
1. Unary Operator (++,--)
2. Arithmetic Operator (+,-,*,%,/)
3. Shift Operator (<<,>>)
4. Relational Operator (OR,AND)
5. Bitwise Operator (|,&)
6. Logical Operator (<=.<=,==,!=)
7. Ternary Operator(cond:True:false)

8. Assignment Operator(=)

Arrays in JAVA

•Array is an object
An array is a collection of similar types of elements.
• An array is a container that holds data of one single type.
For example, you can create an array that can hold
100 values of int type.

To make it more clear, a pictorial representation of array elements with their corresponding index values is
shown below.
•
The first element of the array is stored at the 0th index, second element of the array is stored at 1st index and
so on as shown in given figure.



Array Syntax

We can create Array in 2 way

1.Dyanamic (literal way)

•In Java, an array is an object of a dynamically generated class.
• Once the array is created, its length is fixed.
• Syntax to define array :
data type [ ] array name;
• **Example : int [ ] num;**
num = new int[10];
• Here, **num** array can hold 10 values of data type int.

2.Static(using new keyword)

Syntax

datatype arrayname[]=new datatype[size]

int[ ] num = new int[10];

value will be assign at the time of execution

new keyword using for assign the size of the array

There are two types of array in JAVA

1. Single Dimensional Array :

- A **one-dimensional (1D) array** is a simple list of elements stored in contiguous memory locations. It have only one row

  Ex: public class OneDArray { public static void main(String[] args) { int[] numbers = {10, 20, 30, 40, 50}; System.out.println("First Element: " + numbers[0]); // Output: 10 } }

2. Multi Dimensional Array :

A **two-dimensional (2D) array** is a matrix-like structure with rows and columns.
Having multiple rows and column

```
int[][] matrix = new int[3][3];
// 3x3 matrix
 int[][] matrix = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };
```

one more classification is there in Multidiamentinal aray-Jagged Array

A **jagged array** is a 2D array where the number of columns in each row **can be different**.

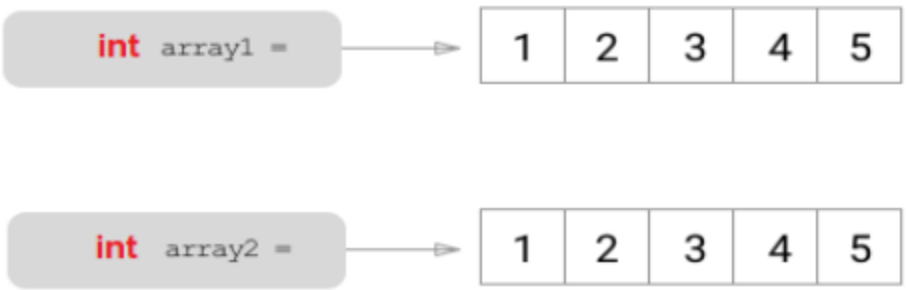
```
int[][] jagged = new int[3][];
jagged[0] = new int[]{1, 2};
jagged[1] = new int[]{3, 4, 5};
jagged[2] = new int[]{6};
```

Cloning of Arrays

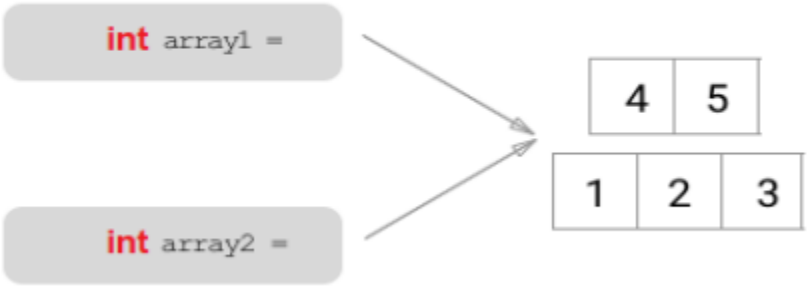
• Cloning creates copies that are clones of the original elements or reference elements.
• Cloning arrays are of two types shallow copy and deep copy in Java.
• In a single-dimensional array, a deep copy creates the clones of the original elements or reference elements.
• In a multi-dimensional array, a shallow copy is created, which means both arrays are pointing to the same memory address.

• Cloning shallow copy and deep copy in Java are the ways of copying the attributes of one object into another of the same type.
these arrays, you will be modifying both array

Deep Copy:



Shallow Copy:



STRING:

A **string** in Java is a **sequence of characters** stored as an **object** of the `String` class. Unlike primitive data types (`int`, `char`, etc.), a string is an **immutable object**, meaning (once created, it cannot be changed.)

There are two ways to create a String in Java
1. **String literal**
2. **Using new keyword**

1. **String literal :**

Java String literal is created by using double-quotes.

Example:
String s = “king";

String objects are stored in a special memory area known as the "string constant pool".

This is the most common way of creating the string.
2. **Using new keyword:**

String object can be created using new operator like java class.

Example:
String s = new String("king");

It creates two objects in String pool and in heap

Also one reference variable 's' is created that will refer to the object in the heap.
Java String Pool: Java String pool refers to collection of Strings which are stored in heap memory. So whenever a new
object is created. It will check whether the new object is already present in the pool or not. If it is present, then same
reference is returned to the variable else new object will be created in the String pool and the respective reference
will be returned.

Here is a list of **String** methods in Java:

1. `length()`
2. `toUpperCase()`
3. `toLowerCase()`
4. `concat()`
5. `substring(int beginIndex)`
6. `substring(int beginIndex, int endIndex)`
7. `contains(String str)`
8. `equals(String anotherString)`
9. `equalsIgnoreCase(String anotherString)`
10. `startsWith(String prefix)`
11. `endsWith(String suffix)`
12. `replace(char oldChar, char newChar)`
13. `replace(CharSequence target, CharSequence replacement)`
14. `split(String regex)`
15. `split(String regex, int limit)`
16. `trim()`
17. `indexOf(String str)`
18. `indexOf(String str, int fromIndex)`
19. `lastIndexOf(String str)`
20. `lastIndexOf(String str, int fromIndex)`
21. `charAt(int index)`
22. `isEmpty()`
23. `isBlank()` *(Java 11+)*
24. `toCharArray()`
25. `format(String format, Object... args)`
26. `valueOf(Object obj)`
27. `matches(String regex)`

28. `compareTo(String anotherString)`
29. `compareToIgnoreCase(String anotherString)`
30. `repeat(int count)` *(Java 11+)*
31. `strip()` *(Java 11+)*

1. What are StringBuffer and StringBuilder?

Both `StringBuffer` and `StringBuilder` are **mutable** classes used for modifying strings dynamically. Unlike `String`, which is **immutable**, these classes allow modification without creating new objects, making them **faster and memory-efficient** for string manipulation.

ENUM:

An **enum** (short for *enumeration*) is a special data type in Java that represents a fixed set of constants. It is used to define a collection of predefined values, making the code more readable and preventing invalid values.

2. How to Declare an Enum?

Enums are declared using the `enum` keyword. Each value in an enum is a constant and written in uppercase by convention.

Control Flow in Java

Control flow in Java determines the execution order of statements in a program. Java provides three types of control flow statements:

1. **Decision-Making Statements (Conditional Statements)**
2. **Looping Statements (Iteration Statements)**
3. **Branching Statements (Jump Statements)**

1.1 if Statement

Executes a block of code if the condition is `true`.

```
int num = 10;
if (num > 0) {
```

```
    System.out.println("Positive number");
}
```

1.2 if-else Statement

Executes different blocks based on whether the condition is `true` or `false`.

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

1.3 if-else if Ladder

Checks multiple conditions sequentially.

```
int num = 0;
if (num > 0) {
    System.out.println("Positive number");
} else if (num < 0) {
    System.out.println("Negative number");
} else {
    System.out.println("Zero");
}
```

1.4 Nested if Statement

An `if` statement inside another `if`.

```
int age = 20;
int weight = 55;

if (age > 18) {
    if (weight > 50) {
        System.out.println("Eligible to donate blood");
    }
}
```

1.5 switch Statement

Used when multiple conditions are checked for a single variable.

```
int day = 3;
switch (day) {
    case 1: System.out.println("Sunday"); break;
    case 2: System.out.println("Monday"); break;
    case 3: System.out.println("Tuesday"); break;
    default: System.out.println("Invalid day");
}
```

2. Looping Statements (Iteration)

Used to repeat a block of code multiple times.

2.1 for Loop

Executes a block multiple times.if the number of iteration is fixed we can use For loop

1.Initialization

2.Condition

3.Increment or Decrement

```
Ex:
for (int i = 1; i <= 5; i++) {
    System.out.println(i);
}
```

2.2 Enhanced for Loop (for-each)

To iterate Array Elements

```
int[] numbers = {10, 20, 30, 40};
for (int num : numbers) {
    System.out.println(num);
}
```

2.3 while Loop

Executes a block while a condition is `true`. if the number of iteration is not fixed we can use While or Do while

```
int i = 1;
while (i <= 5) {
    System.out.println(i);
    i++;
}
```

2.4 do-while Loop

Executes at least once, then checks the condition.

```
int i = 1;
do {
    System.out.println(i);
    i++;
} while (i <= 5);
```

---

3. Branching Statements (Jump Statements)

Used to change the normal flow of execution.

3.1 break Statement

Exits a loop or switch statement.

```
for (int i = 1; i <= 5; i++) {
    if (i == 3) {
```

```
        break;  // Exits loop when i == 3
    }
    System.out.println(i);
}
```

3.2 continue Statement

Skips the current iteration and moves to the next.

```
for (int i = 1; i <= 5; i++) {
    if (i == 3) {
        continue;  // Skips printing 3
    }
    System.out.println(i);
}
```

3.3 return Statement

Exits from a method.

```
public class ReturnExample {
    public static void main(String[] args) {
        System.out.println("Before return");
        return;
        // System.out.println("After return");  // This will not be executed
    }
}
```

Type	Statement	Description
Decision-Making	`if`, `if-else`, `switch`	Executes code based on conditions
Looping	`for`, `while`, `do-while`	Repeats code multiple times
Branching	`break`, `continue`, `return`	Controls flow by exiting or skipping

Methods:

Methods : In Java, a method is like a function, runs when it calls. Methods can be called anywhere in the program.

Advantages:-

1. **Code reusability** methods means we can use code many times by declaring only once.
2. **Code optimization** methods means we can reduce the line of code.

• Methods should be declared inside the class.

• It should be defined by method name followed by parenthesis ().

• Some predefined methods in java, is **System.out.println**(), etc.

• A syntax for creating method is shown below.

Access modifier return Type method name()

{

}

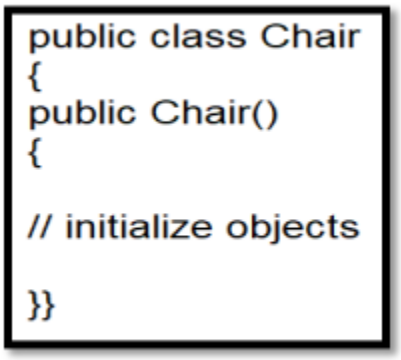
Ex:public int show()

{

}

Constructor:

Constructor: It is a block of codes similar to the method. It is a special type of method. Every class contains a minimum of one constructor. Constructor name must be the same as its class name.



Difference between Constructor and Method:

1.Constructor name is same as Class name where method name Can be anything

2.Method is having return type but Constructor Doesn’t have return type

6. Object-Oriented Programming (OOP) in Java

- **Class and Object**

```
class Car {
    String brand = "Toyota";
}

public class Main {
    public static void main(String[] args) {
        Car myCar = new Car();  // Creating an object
        System.out.println(myCar.brand);
    }
}
```

- **Encapsulation:** Data hiding using private variables and getters/setters.
- **Inheritance:** One class inherits from another using `extends`.
- **Polymorphism:** Same method behaving differently in different classes.
- **Abstraction:** Hiding details using abstract classes or interfaces.

Classes in Java

In Java, **a class is a blueprint** for creating objects. It defines variables (fields) and methods (functions) that objects will have.

---

1. Defining a Class

A class in Java is defined using the `class` keyword.

Example of a Simple Class

```
class Car {
    // Fields (Variables)
    String brand = "Toyota";
    int speed = 120;

    // Method (Function)
    void displayCarInfo() {
        System.out.println("Brand: " + brand);
        System.out.println("Speed: " + speed + " km/h");
    }
}
```

---

2. Creating Objects from a Class

An object is an instance of a class. You create objects using the `new` keyword.

```
public class Main {
    public static void main(String[] args) {
        Car myCar = new Car(); // Creating an object
        myCar.displayCarInfo(); // Calling a method
    }
}
```

Output:

```
Brand: Toyota
Speed: 120 km/h
```

---

3. Constructors in Java

A **constructor** is a special method that is called when an object is created. It initializes the object's properties.

Example of a Constructor

```
class Car {
    String brand;
    int speed;

    // Constructor
    Car(String b, int s) {
        brand = b;
        speed = s;
    }

    void displayCarInfo() {
        System.out.println("Brand: " + brand);
        System.out.println("Speed: " + speed + " km/h");
    }
}

public class Main {
    public static void main(String[] args) {
        Car myCar = new Car("Honda", 150); // Creating object with constructor
        myCar.displayCarInfo();
    }
}
```

Output:

```
Brand: Honda
Speed: 150 km/h
```

---

4. Types of Classes in Java

a) Normal Class

A regular class with methods and fields (like `Car` above).

b) Abstract Class

An abstract class **cannot be instantiated** and must be inherited. It can have abstract (without body) and non-abstract methods.

```
abstract class Animal {
    abstract void makeSound(); // Abstract method

    void sleep() {
        System.out.println("Sleeping...");
    }
}

class Dog extends Animal {
    void makeSound() {
        System.out.println("Bark!");
    }
}

public class Main {
    public static void main(String[] args) {
        Dog d = new Dog();
        d.makeSound();
        d.sleep();
    }
}
```

Output:

```
Bark!
Sleeping...
```

---

c) Final Class

A `final` class **cannot be extended (inherited)**.

```
final class Vehicle {
    void drive() {
        System.out.println("Driving...");
    }
}

// This will cause an error
// class Car extends Vehicle { }

public class Main {
    public static void main(String[] args) {
        Vehicle v = new Vehicle();
        v.drive();
    }
}
```

---

5. Inheritance (Extending a Class)

Inheritance allows a class to inherit properties and methods from another class using the `extends` keyword.

```
class Animal {
    void eat() {
        System.out.println("This animal eats food.");
    }
}

class Dog extends Animal {
    void bark() {
        System.out.println("The dog barks.");
    }
}

public class Main {
    public static void main(String[] args) {
        Dog myDog = new Dog();
        myDog.eat();  // Inherited method
        myDog.bark(); // Own method
    }
}
```

Output:

```
This animal eats food.
The dog barks.
```

---

6. Encapsulation (Using Private Variables)

Encapsulation is **hiding data** by making variables `private` and accessing them using getter and setter methods.

```
class Person {
    private String name;

    // Setter Method
    void setName(String newName) {
        name = newName;
    }

    // Getter Method
    String getName() {
        return name;
    }
}

public class Main {
    public static void main(String[] args) {
        Person p = new Person();
        p.setName("Alice");
        System.out.println("Name: " + p.getName());
    }
}
```

Output:

```
Name: Alice
```

---

7. Static Members in a Class

- `static` members **belong to the class itself, not to any object**.
- A static method can be called without creating an object.

```
class MathUtils {
    static int square(int x) {
        return x * x;
    }
}

public class Main {
    public static void main(String[] args) {
        System.out.println(MathUtils.square(5)); // No object needed
    }
}
```

Output:

```
25
```

Summary

Feature	Description
Class	Blueprint for creating objects
Object	Instance of a class
Constructor	Initializes an object when created
Inheritance	Allows a class to derive properties from another class
Encapsulation	Hides data using private variables
Static Members	Belong to the class, not to instances

---

2. Non-Primitive Data Types

These are more complex data types that refer to objects.

Data Type	Description
`String`	Represents a sequence of characters
`Array`	Collection of elements of the same type
`Class`	Blueprint for creating objects
`Interface`	Defines a contract for classes
`Enum`	Represents a fixed set of constants

Example Usage

```
public class NonPrimitiveExample {
    public static void main(String[] args) {
        String name = "Java";
        int[] numbers = {10, 20, 30}; // Array

        System.out.println("Name: " + name);
        System.out.println("First number: " + numbers[0]);
    }
}
```

Output:

```
Name: Java
First number: 10
```

Key Differences: Primitive vs Non-Primitive Data Types

Feature	Primitive Data Types	Non-Primitive Data Types
Memory Efficiency	More efficient	Less efficient (Objects require more memory)
Stored In	Stack memory	Heap memory
Examples	`int`, `char`, `boolean`	`String`, `Array`, `Class`
Operations	Direct operations	Methods required

Better Alternative to `finalize()`: Try-With-Resources

Instead of `finalize()`, **use `try-with-resources`** to close resources explicitly:

```
import java.io.*;

public class TryWithResourcesExample {
    public static void main(String[] args) {
        try (FileWriter file = new FileWriter("test.txt")) {
            file.write("Hello, World!");
        } catch (Exception e) {
            System.out.println(e);
        }
    }
}
```

Summary

Feature	Description
`finalize()` Purpose	Cleanup before garbage collection
Who Calls It?	JVM Garbage Collector

Feature	Description
Can We Call It Manually?	Yes, using `finalize()`, but not recommended
Is It Reliable?	No, GC timing is unpredictable
Java 9 Status	Deprecated
Alternatives	Try-with-resources, `finally` block

---

7. Constant Variables (`final` Keyword)

To make a variable **unchangeable**, use the `final` keyword.

Example of Final Variable

```
java
CopyEdit
class Example {
    final int MAX_VALUE = 100; // Constant variable

    void display() {
        // MAX_VALUE = 200; // ❌ Error (Cannot change final variable)
        System.out.println("Max Value: " + MAX_VALUE);
    }
}
```

Summary

Concept	Description
Local Variable	Declared inside a method/block, must be initialized
Instance Variable	Defined in a class, belongs to objects, gets default values
Static Variable	Shared among all objects, belongs to class
Final Variable	Cannot be changed after assignment

Packages in java

Package is a kind of bundle or container or library, where we put one or more Java classes, interfaces, and other related entities/information.

It means bundling the multiple related program files at one place. Package is the first statement of any Java program.

Packages can be categorized into two categories,
1.built in package
2.user defined package.

Built-in packages: The already predefined package by the java compiler is known as built-in packages.

Some of the commonly used built-in packages in java are as follows:
-
java.lang: It contains language support classes.
-
java.util: It contains utility classes such as vectors, lists, hash tables, etc.
-
java.awt: It contains classes for the graphic user interface.
-
java.applet: It contains a set of classes for applets.
-
java.net: It contains a set of network classes.
-
java.io: It contains classes for input and output operation.
•
2.User defined packages : These are the packages that are defined by the user. Now we will see how the packages are created and used in java.

Select a suitable name for the package to be created.
-
Name of the package must be same as the directory under which this file is saved.
-
Declare the name of the package with the "**package**" keyword.
-
Define a public class inside that package.

Java Access Modifiers

Java access modifiers are used to provide access control in java.

Access modifiers are used with Classes as well as Class variables and methods.

It is allowed to use only public or default access modifiers with java classes.

Java provides three types of access control through Keywords
1. Private
2. Protected
3. Public

Access modifier is a keyword that we use to set the visibility or scope or define the boundary of variable, method, and class.

This is also known as specifier.

Default is the default access modifier when we do not write any modifier with class declaration.

1.Default modifier makes a class accessible within the same package
2.“**private**” then it will be accessible only inside the same class. This is the most restricted access and the class member will not be visible to the outer world.
3. **public**” then it can be accessed from anywhere. Also member variable or method is

accessed globally.

4. If class member is “**protected**” then it will be accessible only to the classes in the same package and to

the subclasses.

Super keyword

The super() keyword should always be the first statement of the constructor.

The super keyword is used to call the constructor from a super class.

This super() will call the default constructor from the super class.

this keyword

The **this** keyword represents the members (for example, variables or methods) from same class.

this works in a similar manner as super keyword.

In the constructor, we use the **this()** keyword to call or refer a constructor, which is defined within the same class. this should be the first statement of a constructor. If you write **this()** as second statement or later, then the system will generate a compilation error.

A class can have any number of constructors and with the help of the **this()** keyword, a constructor can communicate with other constructors within the class.
It will avoid Name collision

Method Overloading

It allows the class to have more than one method having the same name, if their argument lists are different.

It is not possible by changing the return type of methods.

In order to overload a method, the argument lists of the methods must differ in either of the following:
1. **Number of argument :**
It is allowed within the class given that the number of arguments
are not the same.
Example :
Int max(int, int) // 2 argument
Int max (int, int, int) // 3 argument
2. **Data type of argument:**
It is allowed within the class given that at least one pair of arguments are of different data type.
Example :
max (int, int) // same data type
max(int, float) // different data type
Data type of argument : We have two methods with the name **max**(), one with argument of int type and another method with the argument of int & float type.
OOPS:

Method overriding & overridden

Declaring a method in sub class which is already present in parent class is known as method overriding.

Overriding is done so that a child class can give its own implementation to a method which is already provided by the parent class.

In this case the method in parent class is called overridden method and the method in child class is called overriding method.

A method declared in **child class** but it is already present in the **parent class** is known as method overriding.

- The method declared in the parent class is called overridden method and the method in the child class is called the overriding method.
- Method overriding is used for runtime polymorphism.
- A method declared static cannot be overridden but can be redeclared.

Encapsulation in Java

1. What is Encapsulation?

Encapsulation is one of the four fundamental principles of **Object-Oriented Programming (OOP)** in Java. It is the technique of **hiding the internal details of a class** and allowing access only through well-defined methods.

Key Features of Encapsulation:

✅ **Data Hiding** – Prevents direct access to instance variables.
✅ **Controlled Access** – Uses getter and setter methods for data manipulation.
✅ **Improved Security** – Restricts unauthorized modifications.
✅ **Easier Maintenance** – Code changes are localized within the class.

---

2. How to Achieve Encapsulation in Java?

Encapsulation is implemented by:

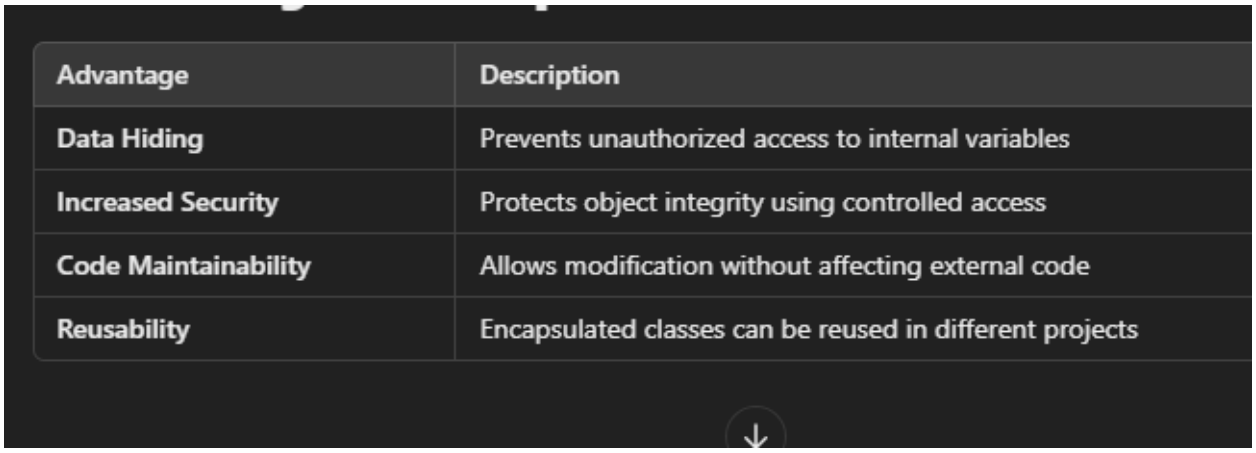
1. **Declaring instance variables as `private`** (to restrict direct access).
2. **Providing `public` getter and setter methods** (to allow controlled access).

Example of Encapsulation

```
class Person {
    private String name;  // Private variable
    private int age;      // Private variable

    // Getter method for name
    public String getName() {
        return name;
    }

    // Setter method for name
    public void setName(String name) {
        this.name = name;
    }

    // Getter method for age
    public int getAge() {
        return age;
    }

    // Setter method for age
    public void setAge(int age) {
        if (age > 0) {  // Adding validation
            this.age = age;
        } else {
            System.out.println("Age must be positive.");
        }
    }
}

public class EncapsulationExample {
    public static void main(String[] args) {
        Person p = new Person();
        p.setName("John Doe");
        p.setAge(25);

        System.out.println("Name: " + p.getName());
        System.out.println("Age: " + p.getAge());
    }
}
```

Output:

`makefile`



Advantage	Description
Data Hiding	Prevents unauthorized access to internal variables
Increased Security	Protects object integrity using controlled access
Code Maintainability	Allows modification without affecting external code
Reusability	Encapsulated classes can be reused in different projects

Abstraction

Abstraction is a process where you show only “relevant functional details” and “hide irrelevant details” of an object from the user.

Abstraction reduces the complexity of the view of objects to the user.

It increases security as information is kept hidden.

Abstraction is one of the most important features of oops.

Abstraction is a process of hiding the implementation details and only showing the functionality to the user.

Abstraction is created using abstract classes and interfaces.

There are two ways to achieve abstraction in java are as follows:
1. Abstract class
2. Interface

Abstract class

A class that is declared using “**abstract**” keyword is known as abstract class.

An Abstract class is a class that contains abstract as well as concrete methods.
We cannot create the object of an abstract class.

An abstract class can have static methods and constructors.

A class derived from the abstract class must implement all those methods that are declared as abstract in the parent class.

An abstract class can have an abstract and non abstract method.
(abstract method-no body, No Abstract method->having body))
A class can not be declared with both final and abstract keywords, because final keyword is used to prevent overriding whereas abstract methods need to be overridden.

An abstract method does not have implementation and body.

An abstract method does not have implementation and body. It defines only the signature of the method

Interface:

An **interface** in Java is a blueprint of a class that contains **only abstract methods (until Java 7)** and **default, static methods (from Java 8)**. It is used to achieve **full abstraction** and **multiple inheritance and Hybrid** in Java.

Key Features of an Interface:

✅ **Defines only method signatures (no implementation in Java 7 and earlier)**
✅ **Implemented by classes using the `implements` keyword**
✅ **Supports multiple inheritance (a class can implement multiple interfaces)**
✅ **Cannot be instantiated (like abstract classes)**
✅ **Can contain `default` and `static` methods (Java 8+ only)**

Ex:

```
interface Animal
{
void eat(); // Abstract method (no body)
void sleep();
}
```

Functional Interface:interface having only 1 method

Marker Interface (Interface with No Methods)

Inheritance

The process in which one class (object) acquires all the properties and behaviors (fields and methods) of another class (parent) is known as inheritance.

When we inherit from an existing class, we can reuse fields and methods of the parent class.

We can declare new fields in the subclass that are not in the superclass.

In real life, a child inherits the properties from his father just like that inheritance represents a parent child
relationship which is also known as IS-A relationship.

In inheritance “extends” keyword is used to inherit a class. (The extends keyword defines that we are making a new class that is derived from an existing class.
)

Use “implements” to inherit interface

HAS-A simply mean the use of instance variables that are references to other objects. For example, Maruti has Engine, or House has Bathroom.

Some terms used in Inheritance are :

Class : It is a blueprint from which objects are created.

Sub Class/Child Class: It is a class which inherits the other class. It is also called a derived class, extended class, or child class.

Super Class/Parent Class: The class whose properties and functionalities are used (inherited) by another class is called as base class or a parent class.
Reusability: We can use the same fields and methods already defined in the previous class.

Extends keyword : It indicates that you are making a new class that derives from an existing class.

Super keyword : It is used to access methods of the parent class.

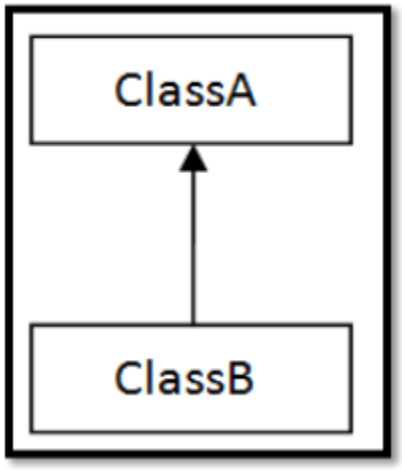
This keyword : It is used to access methods of the current class.

Types of Inheritance :
There are five types of Java Inheritance.
1. Single Inheritance
2. Multilevel Inheritance
3. Hierarchical Inheritance
4. Multiple Inheritance
5. Hybrid Inheritance

Note: Java does not support Multiple and Hybrid Inheritance with classes. Multiple and Hybrid inheritance can
only be achieved only through Interfaces.

Single Inheritance

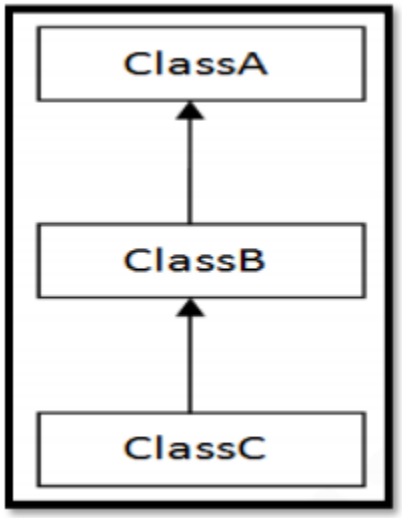
Single Inheritance : In single inheritance, the features and methods of the parent class are inherited by a single child class.



Multilevel Inheritance

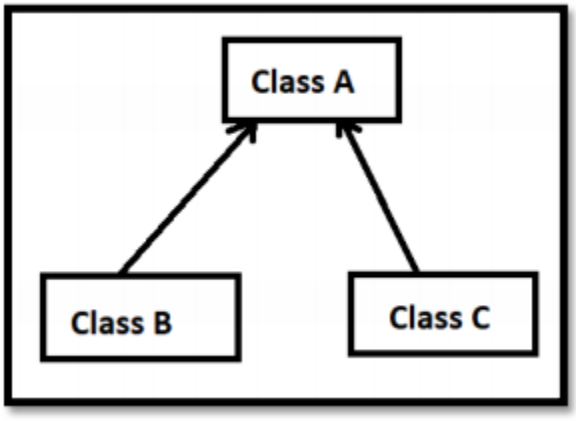
•

In multilevel inheritance, a child class will be inheriting a parent class as well as the child class, and also parent class for some other class.



Hierarchical Inheritance

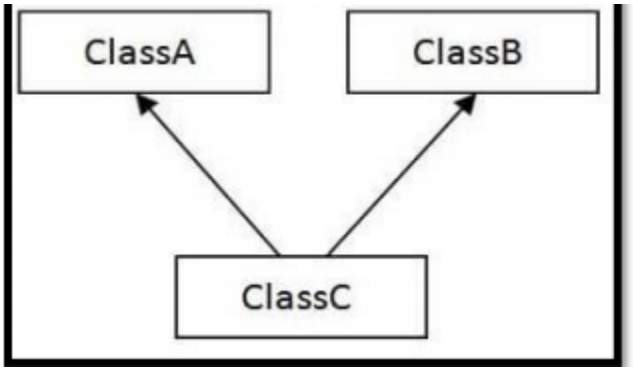
Hierarchical Inheritance : In hierarchical inheritance, more than one subclasses inherit the properties, behavior, features and methods from a single parent class.



Multiple Inheritance

•

Multiple Inheritance : In Multiple inheritance one class can have more than one superclass and inherit properties, behavior, features and methods from all parent classes.



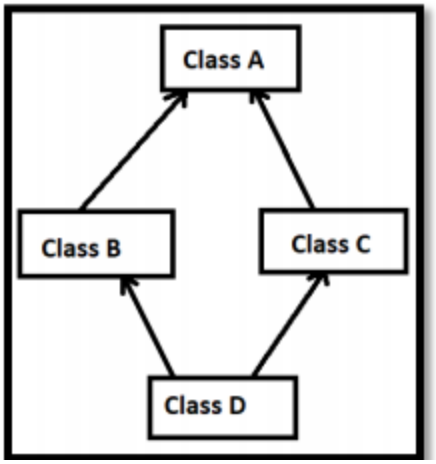
Hybrid Inheritance

•

Hybrid Inheritance : Hybrid Inheritance is a combination of both Single Inheritance and Multiple Inheritance.

•

Since in Java Multiple Inheritance is not supported directly we can achieve Hybrid inheritance also through Interfaces only.



Polymorphism in Java

It is the process of representing one form in multiple forms known as **Polymorphism,** in simple words it is the **OOPs** feature that allows to perform a single action but in different ways.

Polymorphism is derived from two greek words **poly** and **morphs**.

The word "**poly**" means many and "**morphs**" means forms.

So polymorphism means many forms.

There are mainly two types of polymorphism in Java as shown below:
1.compile-time polymorphism
-2.Runtime polymorphism

Compile time Polymorphism /Early Binding/Static (Overloading)

Compile time polymorphism is also known as static polymorphism or early binding.

Static polymorphism in java is achieved by method or function or operator overloading.

When there are multiple functions with same name but different arguments then these functions are said to be overloaded.
In order to overload a method, the argument lists of the methods must differ in either of the following:

Method Overloading allows to have more than one method having the same name, if the arguments of methods are different in number, sequence and data types of parameters.

It is a compile time process. :

The method definition and method call are linked during the compile time.

Actual object is not used for binding.

Program execution is faster.

The binding of static, private and final methods are done at compile time

Runtime Polymorphism

Dynamic polymorphism is a process in which a call to an overridden method is resolved at runtime, thats why
it is called runtime polymorphism.

Runtime polymorphism is also known as dynamic or late binding.

Runtime polymorphism in java is achieved by method overriding.

Overriding allows a child class to implement a method that is already provided by one of its parent class.

Late Binding

- It is a run time process.
- The method definition and method call are linked during the run time.
- Actual object is used for binding.
- For example: Method overriding.
- Program execution is slower.
- The binding of static, private and final methods are not done.

Exception:

An Exception is an unwanted event that interrupts the normal flow of the program.

- Errors are generated while writing a programming code.
- So these errors are displayed at compile time.
- Some of these errors do not show up at compile time but interrupts the normal flow of execution at run time.

- These errors are known as Exceptions in programming.
- An exception can occur for many different reasons. Following are some scenarios where an exception occurs.
- This is something that every programmer faces at any point of coding. They can occur from different kind of scenarios like entering the wrong data by user, hardware failure, network failure, class not found, out of memory, etc.
- Exception Handling is a mechanism to handle runtime errors.
- The main advantage of exception handling is to maintain the normal flow of the application.
- All exception and errors types are sub classes of class **Throwable.**
- Suppose if an exception is not handled, it may lead to a system failure. That is why handling an exception is very important.

Java Exception Keywords

-

Below 5 keywords are used to handle exceptions in Java.

1. try

2. catch

3. finally

4. throw

5. throws1. What is Exception Handling?

Exception handling in Java is a mechanism that handles runtime errors, ensuring that the normal flow of a program is maintained. When an exception occurs, Java creates an exception object that contains details about the error, and the program can **catch** and **handle** it appropriately.

Key Concepts:

✅ **Exception** → An unexpected event that disrupts program flow.
✅ **Try-Catch Block** → Handles exceptions gracefully.
✅ **Finally Block** → Always executes, even if an exception occurs.
✅ **Throws & Throw** → Used for explicitly throwing exceptions.
✅ **Custom Exceptions** → User-defined exceptions for specific scenarios.

---

2. Types of Exceptions in Java

Java exceptions are categorized into **Checked**, **Unchecked**, and **Errors**.

2.1 Checked Exceptions (Compile-Time Exceptions)

- Occur at compile time and must be handled using `try-catch` or `throws`.
- Examples: `IOException`, `SQLException`, `FileNotFoundException`.

Throw:throw is used to explicitily create and throw an instance of an exception.it will handle a specific error
Used within in the method or block of code
Can only throw one exceptio at a time
Throw throws an exception

Throws:
It is used in method signature to declare that method might throw one or more exception
Throws **declares that a method might throw an exception**

2.2 Unchecked Exceptions (Runtime Exceptions)

- Occur at runtime and do not require explicit handling.
- Examples: `NullPointerException`, `ArrayIndexOutOfBoundsException`, `ArithmeticException`.

2.3 Errors

- Occur due to system failures and cannot be handled.
- Examples: `OutOfMemoryError`, `StackOverflowError`.

Keyword	Description
`try`	Contains the code that may throw an exception.
`catch`	Handles the exception if it occurs in the `try` block.
`finally`	Always executes, regardless of exception occurrence.
`throw`	Used to throw an exception explicitly.
`throws`	Declares exceptions a method may throw.

Creating Custom Exceptions

You can create **your own exceptions** by extending the `Exception` class.

Java Collections Framework

Collections framework provides a set of interfaces and classes to implement various data structures and algorithms.

•
Collections framework is contained in java.util package.

•
It allows the programmers to program at the interfaces, instead of the actual implementation.

•
A well designed framework can improve your productivity and provide ease of maintenance.

•
The Java Collection Framework package (java.util) contains:
1. A set of interfaces
2. Implementation classes
3. Algorithms (like sorting and searching)

•
Java Collections are similar to containers that consists of multiple items in a single unit. for e,g. collections of
books, list of names etc.

•
Collections framework provides unified architecture for manipulating and representing collections.

•
Java collection framework can perform following activity :

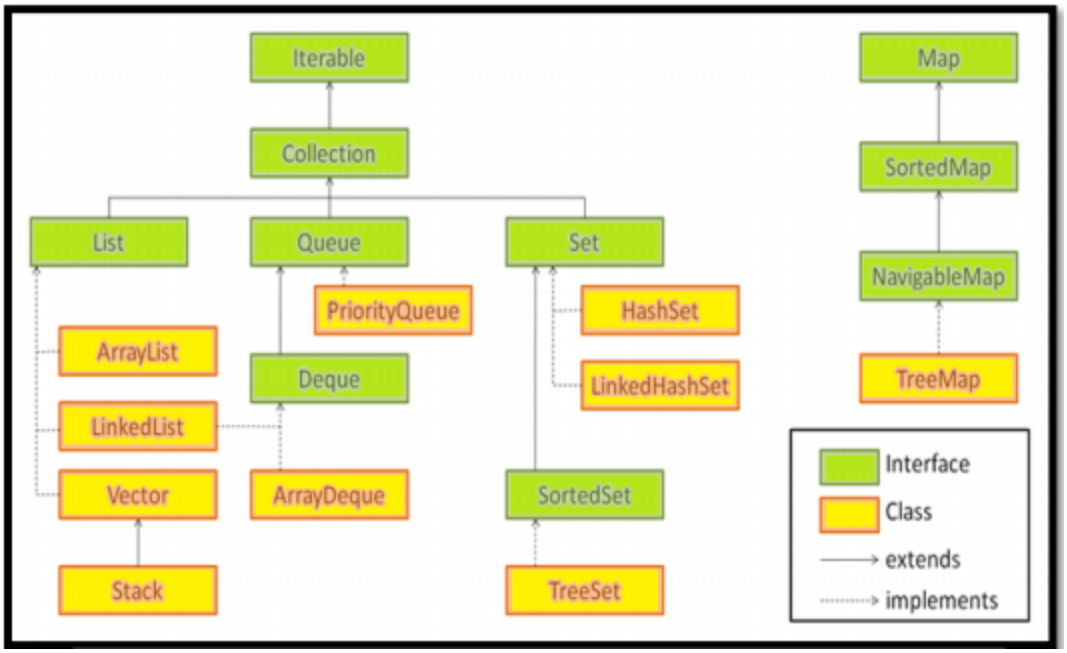
-
Add objects to collection

-
Remove objects from collection

-
Search for an object in collection

-
Retrieve/get object from collection

•
Collection framework contains different types of collections such as lists, sets, maps, stacks, queues, etc.



Multithreading in Java:

Multithreading is a Java feature that allows **concurrent execution** of two or more threads to maximize CPU utilization. It helps in **parallel processing** by running multiple tasks simultaneously.

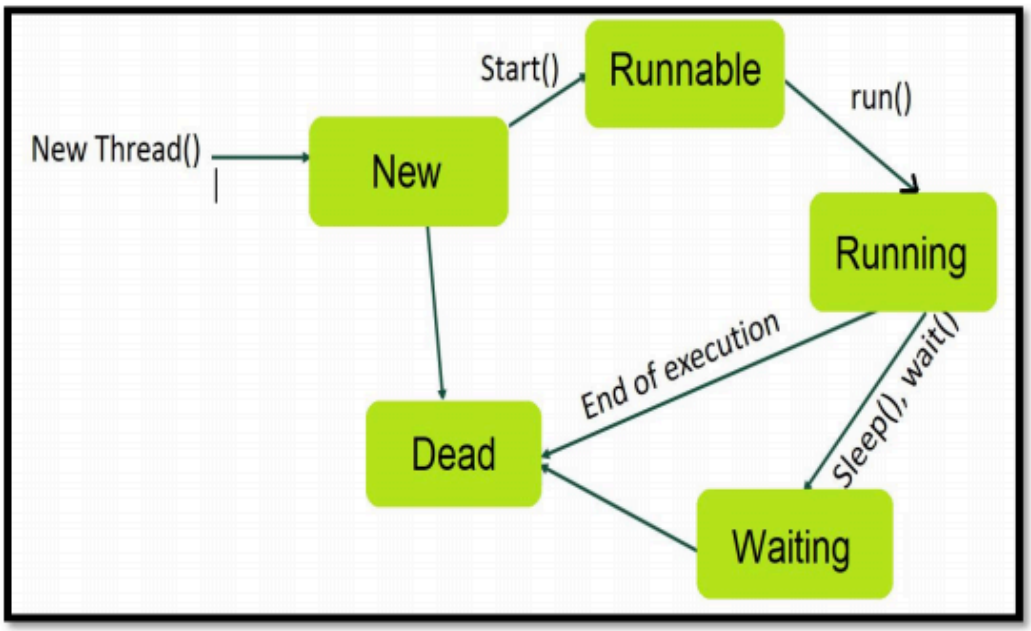
Key Features of Multithreading in Java

✅ **Threads share a common memory space** (efficient memory usage)
✅ **Independent execution** (one thread's failure doesn't affect others)
✅ **Better performance** (especially in multi-core processors)
✅ **Useful for tasks like gaming, web servers, and real-time applications**

Threads in JAVA

•
Thread is the smallest execution unit of a process and a process may have many threads that are executing at he same time.
•
Thread has its own execution path within the process and shares the memory of the process with other threads, which are running in the same process.
•
Thread doesn't allocate any memory, but it uses the memory allocated by its process; this helps faster and efficient communication between threads within the same process

Thread Lifecycle



Thread Synchronization

•

Synchronization is a keyword in the Java programming language that facilitates the programmer to control
threads that are sharing data.

DeadLock

•

Deadlock in Java is a part of multithreading.

•

Deadlock can occur in a situation when a thread is waiting for an object lock, that is acquired by another thread and second thread is waiting for an object lock that is acquired by first thread.