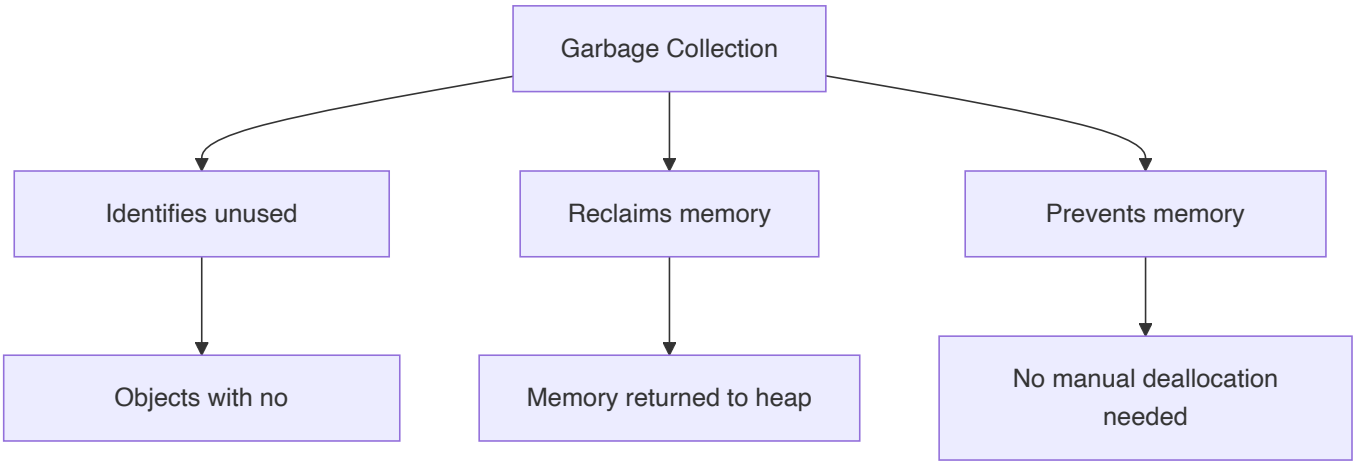
4343203 Summer 2024 Solution - English

Question 1(a): Explain Garbage collection in java. (Marks: 03)

Answer 1(a)

Garbage Collection in Java is an automatic memory management process that:



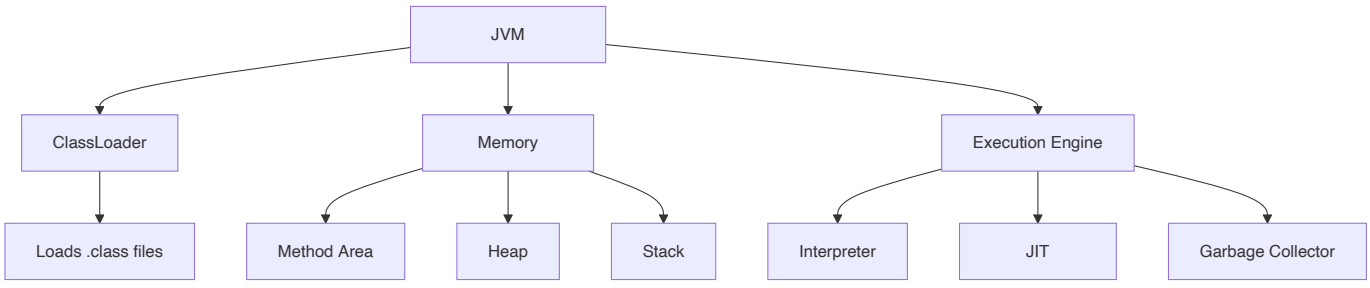
- **Purpose**: Automatically **removes unused objects** from memory
- **Process**:
  - JVM **periodically checks** which objects are no longer referenced
  - **Reclaims memory** occupied by unreferenced objects
  - **Returns memory** to heap for future allocation
- **Trigger**: Occurs when **heap memory is low** or when **explicitly called**

Mnemonic: "**ART**" - Automatic, Reclaims memory, Tracks unused objects

Question 1(b): Explain JVM in detail. (Marks: 04)

Answer 1(b)

Java Virtual Machine (JVM) is the core component of Java's architecture:



Key Components:

- **ClassLoader**: Loads class files into memory
- **Memory Areas**:
  - **Method Area**: Stores class structures
  - **Heap**: Objects storage (garbage collection)
  - **Stack**: Method frames, local variables
- **Execution Engine**:
  - **Interpreter**: Executes bytecode
  - **JIT Compiler**: Optimizes execution
  - **Garbage Collector**: Manages memory

Key Features:

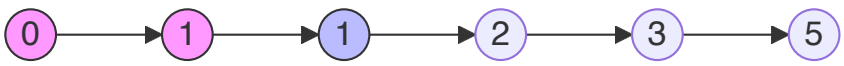
- Provides **platform independence** ("Write Once, Run Anywhere")
- Ensures **security** through sandbox execution
- Manages **memory automatically**

Mnemonic: "**CLME**" - ClassLoader, Memory Areas, Execution Engine

Question 1(c): Write a program in java to print Fibonacci series for N terms. (Marks: 07)

Answer 1(c)

Fibonacci Series: A sequence where each number is the sum of the two preceding ones.



Java Program:

```
import java.util.Scanner;

public class FibonacciSeries {
    public static void main(String[] args) {
        // Create Scanner object for input
        Scanner input = new Scanner(System.in);

        // Get number of terms
        System.out.print("Enter number of terms: ");
        int n = input.nextInt();

        // Initialize first two terms
        int firstTerm = 0;
        int secondTerm = 1;
```

```
        System.out.println("Fibonacci Series for " + n + " terms:");

        // Print first two terms
        if (n >= 1) System.out.print(firstTerm + " ");
        if (n >= 2) System.out.print(secondTerm + " ");

        // Generate remaining terms
        for (int i = 3; i <= n; i++) {
            // Calculate next term
            int nextTerm = firstTerm + secondTerm;
            System.out.print(nextTerm + " ");

            // Update terms
            firstTerm = secondTerm;
            secondTerm = nextTerm;
        }

        input.close();
    }
}
```

Output for n=8:

```
Enter number of terms: 8
Fibonacci Series for 8 terms:
0 1 1 2 3 5 8 13
```

Key Points:

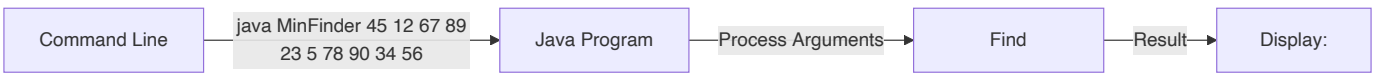
- **Initialize** first two terms (0, 1)
- **Loop** to generate remaining terms
- Each new term = **sum of previous two**
- **Update** variables for next iteration

Mnemonic: "**IFLU**" - Initialize, First two terms, Loop, Update

Question 1(c OR): Write a program in java to find out minimum from any ten numbers using command line argument. (Marks: 07)

Answer 1(c OR)

Command Line Arguments in Java are parameters passed to a program when it's executed.



Java Program:

```java
public class MinimumFinder {
    public static void main(String[] args) {
        // Check if exactly 10 arguments are provided
        if (args.length != 10) {
            System.out.println("Please provide exactly 10 numbers as command line
arguments");
            System.out.println("Example: java MinimumFinder 45 12 67 89 23 5 78 90 34
56");
            return;
        }

        // Initialize min with first number
        int min = Integer.parseInt(args[0]);

        // Find minimum from all arguments
        for (int i = 1; i < args.length; i++) {
            // Convert string argument to integer
            int num = Integer.parseInt(args[i]);

            // Update min if current number is smaller
            if (num < min) {
                min = num;
            }
        }

        // Display result
        System.out.println("Numbers entered:");
        for (String num : args) {
            System.out.print(num + " ");
        }
        System.out.println("\nMinimum value: " + min);
    }
}
```

Execution:

```
> java MinimumFinder 45 12 67 89 23 5 78 90 34 56
Numbers entered:
45 12 67 89 23 5 78 90 34 56
Minimum value: 5
```

Key Points:

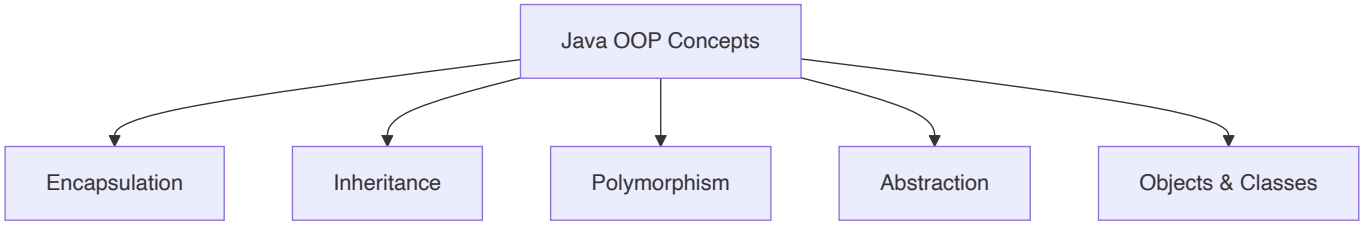
- **Command-line arguments** are passed in `String[] args`
- **Convert** string arguments to integers using `Integer.parseInt()`
- **Initialize** minimum with first number
- **Compare** each number and update minimum if smaller
- **Handle validation** for input arguments

Mnemonic: "**ACCIH**" - Arguments, Convert, Compare, Initialize, Handle validation

Question 2(a): List out basic concepts of Java OOP. Explain any one in details. (Marks: 03)

Answer 2(a)

Basic OOP Concepts in Java:



- **Encapsulation**: Binding data and methods together, hiding implementation
- **Inheritance**: Creating new classes from existing ones
- **Polymorphism**: One interface, multiple implementations
- **Abstraction**: Hiding complex implementation details
- **Objects & Classes**: Basic building blocks

Inheritance Explained:

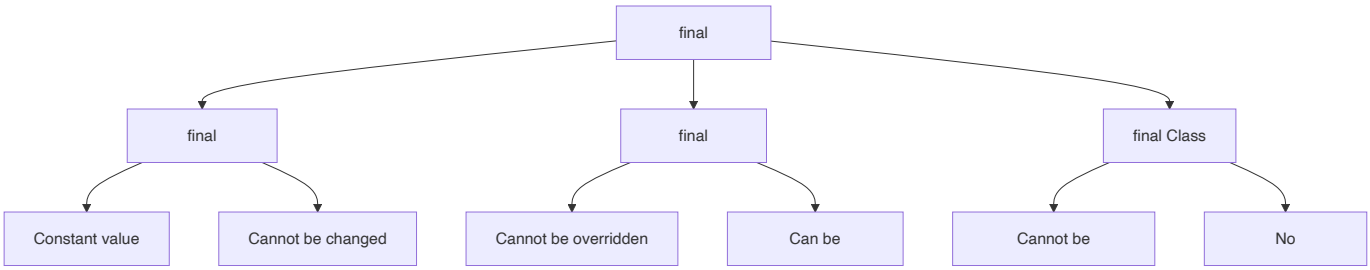
- Inheritance is the mechanism of **creating new classes** from **existing classes**
- The new class (subclass/child) **inherits attributes and behaviors** from existing class (superclass/parent)
- Implemented using the **extends** keyword
- Promotes **code reusability** and establishes **IS-A relationship**
- Example: Car IS-A Vehicle, Dog IS-A Animal

Mnemonic: "**EIOPA**" - Encapsulation, Inheritance, Objects, Polymorphism, Abstraction

Question 2(b): Explain final keyword with example. (Marks: 04)

Answer 2(b)

Final Keyword in Java:



Uses of final keyword:

- **final variable**: Creates constants that cannot be changed
- **final method**: Cannot be overridden in subclasses
- **final class**: Cannot be extended (no inheritance)

Example:

```
public class FinalDemo {
    // final variable (constant)
    final double PI = 3.14159;

    // final method
    final void display() {
        System.out.println("This method cannot be overridden");
    }

    public static void main(String[] args) {
        FinalDemo obj = new FinalDemo();

        // Using final variable
        System.out.println("Value of PI: " + obj.PI);

        // Cannot modify final variable
        // obj.PI = 3.14;  // Compilation error

        // Calling final method
        obj.display();
    }
}

// Final class
final class SecureClass {
    void show() {
        System.out.println("This class cannot be extended");
    }
}

// Cannot extend final class
// class ChildClass extends SecureClass {} // Compilation error
```

Mnemonic: "**VCM**" - Variables (constant), Cannot extend, Methods (no override)

Question 2(c): What is constructor? Explain parameterized constructor with example. (Marks: 07)

Answer 2(c)

Constructor: A special method used to **initialize objects** when created. It has the **same name as the class** and **no return type**.

Characteristics:

- **Same name** as the class
- **No return type**
- **Automatically called** when object is created
- **Initializes** instance variables

Example of Parameterized Constructor:

```
public class Student {
    // Instance variables
    private int rollNo;
    private String name;
    private double percentage;

    // Parameterized constructor
    public Student(int roll, String studentName, double marks) {
        rollNo = roll;
        name = studentName;
        percentage = marks;
    }

    // Method to display student details
    public void displayDetails() {
        System.out.println("Roll No: " + rollNo);
        System.out.println("Name: " + name);
        System.out.println("Percentage: " + percentage + "%");
    }

    public static void main(String[] args) {
        // Creating objects using parameterized constructor
        Student s1 = new Student(101, "Rahul", 85.7);
        Student s2 = new Student(102, "Priya", 92.3);

        // Displaying details
        System.out.println("First Student:");
```

```
        s1.displayDetails();

        System.out.println("\nSecond Student:");
        s2.displayDetails();
    }
}
```

Key Points:

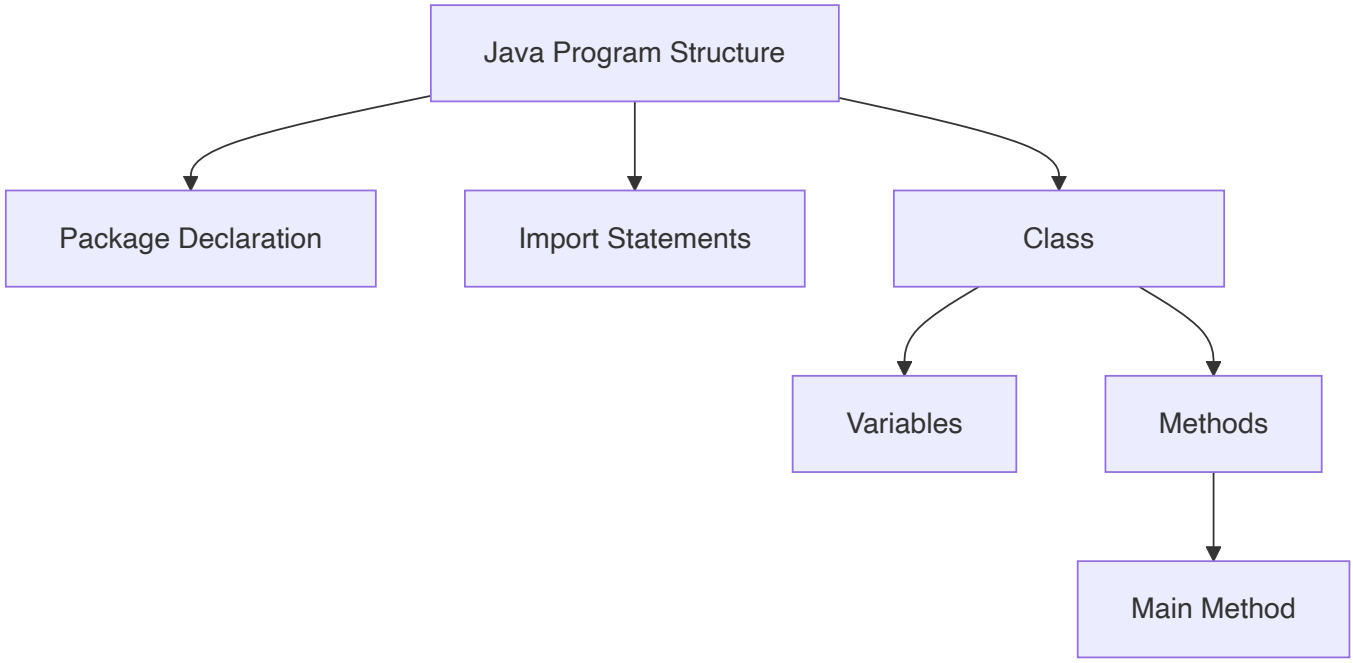
- Allows **initialization with specific values**
- Parameters passed during **object creation**
- Creates **multiple objects with different states**
- **No setter methods** needed to initialize variables

Mnemonic: "**PINS**" - Parameters, Initialize, No return type, Same name

Question 2(a OR): Explain the Java Program Structure with example. (Marks: 03)

Answer 2(a OR)

Java Program Structure:



Components of Java Program:

- **Package Declaration**: (Optional) Organizes related classes
- **Import Statements**: (Optional) Access classes from other packages
- **Class Declaration**: (Required) Container for code
- **Variables**: Store data

- **Methods**: Define behavior, including main method
- **Main Method**: Entry point for program execution

Example:

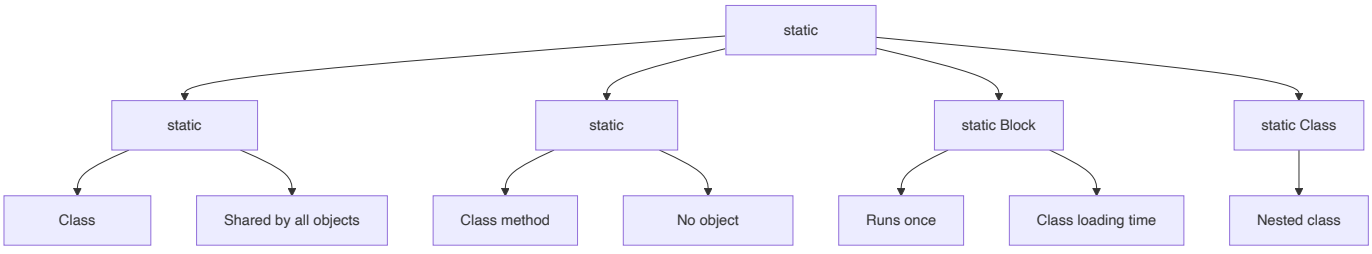
```java
// 1. Package Declaration (Optional)
package com.example;

// 2. Import Statements (Optional)
import java.util.Scanner;

// 3. Class Declaration (Required)
public class HelloWorld {
    // 4. Variables
    String message = "Hello, World!";

    // 5. Methods
    public void displayMessage() {
        System.out.println(message);
    }

    // 6. Main Method (Entry point)
    public static void main(String[] args) {
        // Create object of class
        HelloWorld obj = new HelloWorld();

        // Call method
        obj.displayMessage();
    }
}
```

Mnemonic: "**PICVM**" - Package, Import, Class, Variables, Methods

Question 2(b OR): Explain static keyword with suitable example. (Marks: 04)

Answer 2(b OR)

Static Keyword in Java:



Uses of static:

- **static variable**: Shared across all instances of the class

- **static method**: Can be called without creating objects
- **static block**: Executes when class is loaded
- **static nested class**: Belongs to the class rather than an instance

Example:

```
public class CounterDemo {
    // Static variable - shared by all objects
    static int count = 0;

    // Instance variable - unique to each object
    int instanceNumber;

    // Static block - runs when class is loaded
    static {
        System.out.println("Static block executed");
        count = 10; // Initialize static variable
    }

    // Constructor
    public CounterDemo() {
        count++;          // Increment counter
        instanceNumber = count;  // Assign instance number
    }

    // Static method
    public static void displayCount() {
        System.out.println("Total objects: " + count);
        // Cannot access instance variables directly
        // System.out.println(instanceNumber); // Error!
    }

    // Instance method
    public void displayInfo() {
        System.out.println("This is object #" + instanceNumber);
        System.out.println("Total count: " + count); // Can access static variables
    }

    public static void main(String[] args) {
        // Static method called without object
        CounterDemo.displayCount(); // Output: Total objects: 10

        // Create objects
        CounterDemo obj1 = new CounterDemo();
        CounterDemo obj2 = new CounterDemo();

        // Call instance methods
        obj1.displayInfo(); // Output: This is object #11, Total count: 12
        obj2.displayInfo(); // Output: This is object #12, Total count: 12

        // Call static method again
```

```
        CounterDemo.displayCount(); // Output: Total objects: 12
    }
}
```

Key Points:

- Static members **belong to the class** (not objects)
- They are **loaded into memory** when the class is loaded
- Static methods **cannot access instance variables/methods** directly
- Used for **utility methods**, **constants**, and **counters**

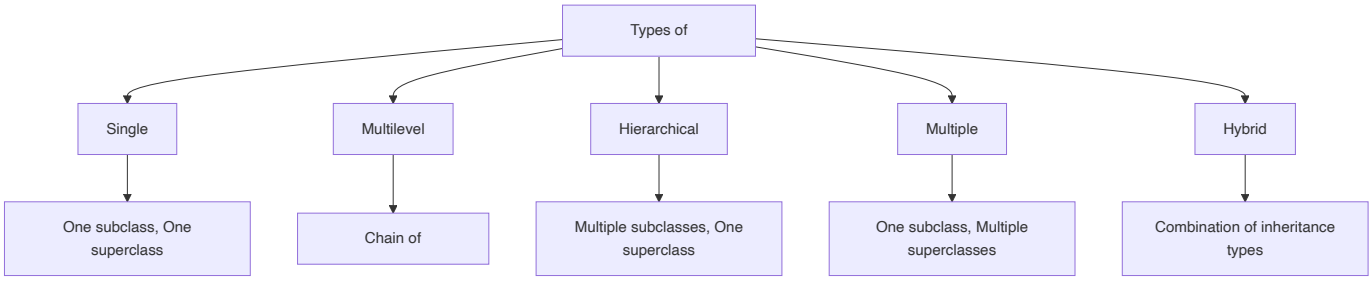
Mnemonic: "**BCCS**" - Belongs to Class, Class-level, Shared memory, Static methods

Question 2(c OR): Define Inheritance. List out types of it. Explain multilevel and hierarchical inheritance with suitable example. (Marks: 07)

Answer 2(c OR)

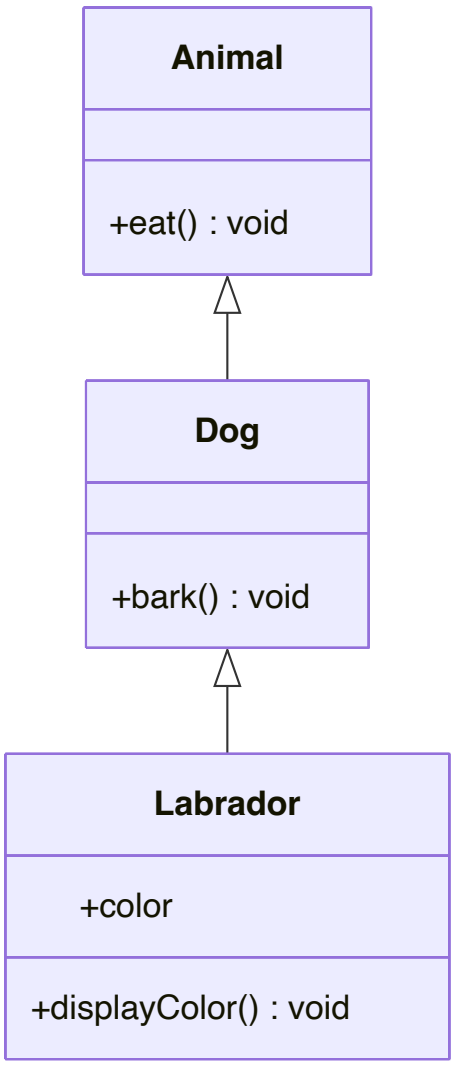
Inheritance: The process where one class acquires the properties and behaviors of another class.

Types of Inheritance:



Type	Description
Single	One subclass inherits from one superclass
Multilevel	Chain of inheritance (A → B → C)
Hierarchical	Multiple classes inherit from one superclass
Multiple	One class inherits from multiple classes (through interfaces in Java)
Hybrid	Combination of multiple inheritance types

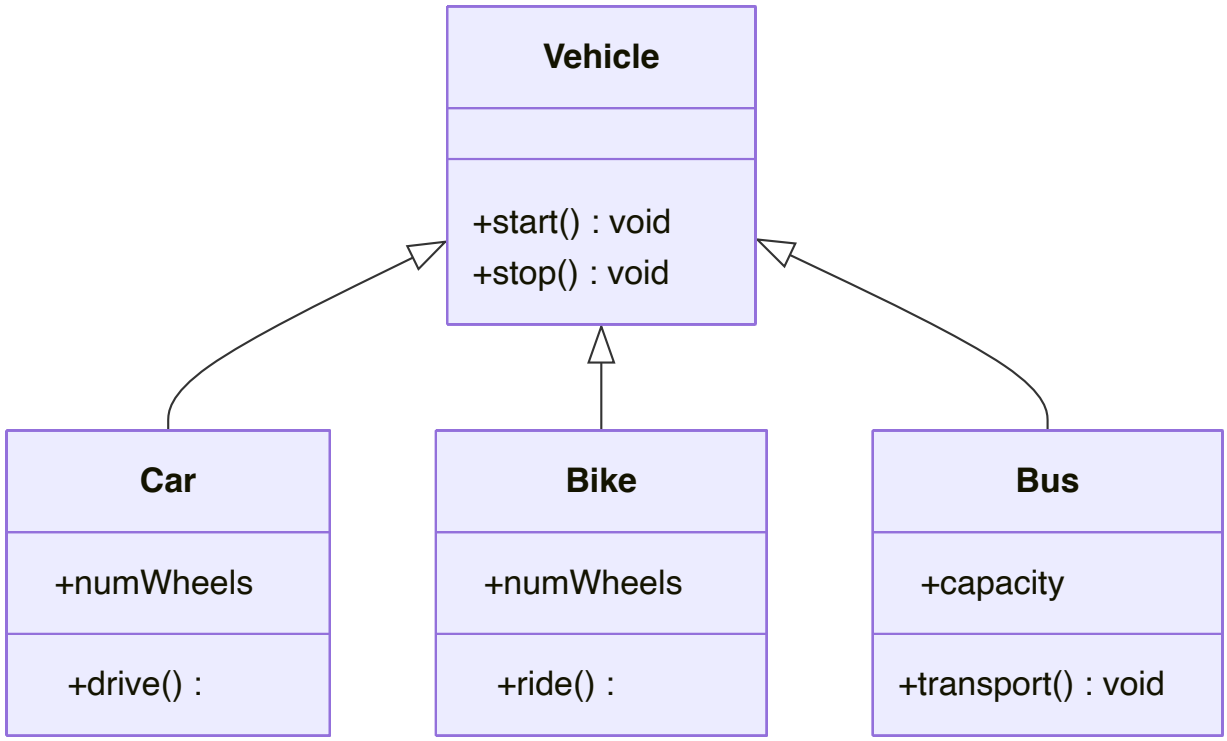
Multilevel Inheritance Example:




```
// Base class
class Animal {
    void eat() {
        System.out.println("Animal is eating");
    }
}

// Intermediate class
class Dog extends Animal {
    void bark() {
        System.out.println("Dog is barking");
    }
}

// Derived class
class Labrador extends Dog {
    String color;

    Labrador(String color) {
        this.color = color;
```

```
    }

    void displayColor() {
        System.out.println("Color is " + color);
    }
}

// Main class
public class MultilevelDemo {
    public static void main(String[] args) {
        Labrador lab = new Labrador("Golden");

        // Methods from Animal class
        lab.eat();

        // Methods from Dog class
        lab.bark();

        // Methods from Labrador class
        lab.displayColor();
    }
}
```

Hierarchical Inheritance Example:




```
// Base class
class Vehicle {
    void start() {
        System.out.println("Vehicle started");
```

```
    }

    void stop() {
        System.out.println("Vehicle stopped");
    }
}

// Derived class 1
class Car extends Vehicle {
    int numWheels = 4;

    void drive() {
        System.out.println("Car is driving with " + numWheels + " wheels");
    }
}

// Derived class 2
class Bike extends Vehicle {
    int numWheels = 2;

    void ride() {
        System.out.println("Bike is riding with " + numWheels + " wheels");
    }
}

// Derived class 3
class Bus extends Vehicle {
    int capacity = 40;

    void transport() {
        System.out.println("Bus is transporting " + capacity + " passengers");
    }
}

// Main class
public class HierarchicalDemo {
    public static void main(String[] args) {
        Car car = new Car();
        Bike bike = new Bike();
        Bus bus = new Bus();

        // Car methods
        car.start();  // From Vehicle
        car.drive();  // From Car
        car.stop();   // From Vehicle

        System.out.println();

        // Bike methods
        bike.start(); // From Vehicle
        bike.ride();  // From Bike
        bike.stop();  // From Vehicle
```

```
        System.out.println();

        // Bus methods
        bus.start();     // From Vehicle
        bus.transport(); // From Bus
        bus.stop();      // From Vehicle
    }
}
```

Key Points:

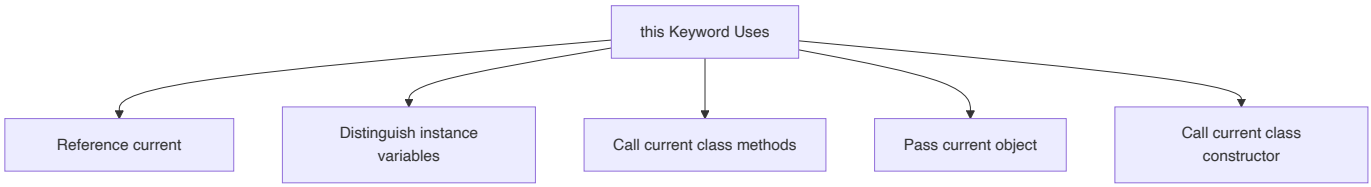
- **Multilevel Inheritance**: Forms a **chain of inheritance** (e.g., Animal → Dog → Labrador)
- **Hierarchical Inheritance**: Multiple classes **inherit from one base class** (e.g., Vehicle → Car/Bike/Bus)
- Both promote **code reusability**
- Java **doesn't support multiple inheritance** with classes (uses interfaces instead)

Mnemonic: "**MASH**" - Multilevel (chain), Acquire properties, Single superclass, Hierarchical (tree)

Question 3(a): Explain this keyword with suitable example. (Marks: 03)

Answer 3(a)

'this' keyword in Java refers to the current object instance.



Main uses of 'this' keyword:

- **Resolve variable shadowing**: Differentiate instance variables from parameters
- **Call constructor**: Call another constructor in same class (`this()`)
- **Return current object**: Return current instance for method chaining
- **Pass current object**: Pass current object as parameter

Example:

```
public class Person {
    // Instance variables
    private String name;
    private int age;

    // Constructor with parameters
    public Person(String name, int age) {
```

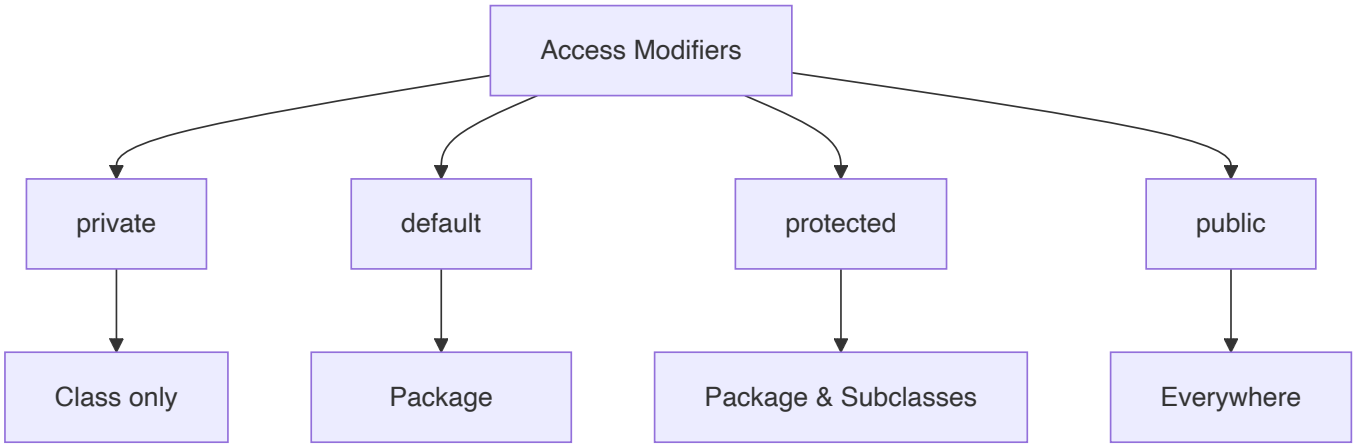
```
        // Use 'this' to refer to instance variables
        this.name = name;  // Without 'this', name would refer to parameter
        this.age = age;    // Without 'this', age would refer to parameter
    }

    // Method that uses 'this' to call another method
    public void display() {
        System.out.println("Name: " + this.name);
        System.out.println("Age: " + this.age);
        this.greet();  // 'this' is optional here
    }

    // Method to be called
    public void greet() {
        System.out.println("Hello from " + this.name);
    }

    public static void main(String[] args) {
        Person person = new Person("John", 25);
        person.display();
    }
}
```

Mnemonic: "**RICP**" - Reference variables, Instance methods, Constructor call, Pass object

Question 3(b): Explain different access controls in Java. (Marks: 04)

Answer 3(b)

Access Modifiers in Java control the accessibility and visibility of classes, methods, and variables.



Java Access Control Levels:

Modifier	Class	Package	Subclass	World
private	Yes	No	No	No
default	Yes	Yes	No	No
protected	Yes	Yes	Yes	No
public	Yes	Yes	Yes	Yes

Example:

```
public class AccessDemo {
    private int privateVar = 10;      // Class only
    int defaultVar = 20;              // Package
    protected int protectedVar = 30;  // Package & subclasses
    public int publicVar = 40;        // Everywhere

    public void showValues() {
        // Can access all variables inside its own class
        System.out.println("Private: " + privateVar);
        System.out.println("Default: " + defaultVar);
        System.out.println("Protected: " + protectedVar);
        System.out.println("Public: " + publicVar);
    }
}
```

Benefits:

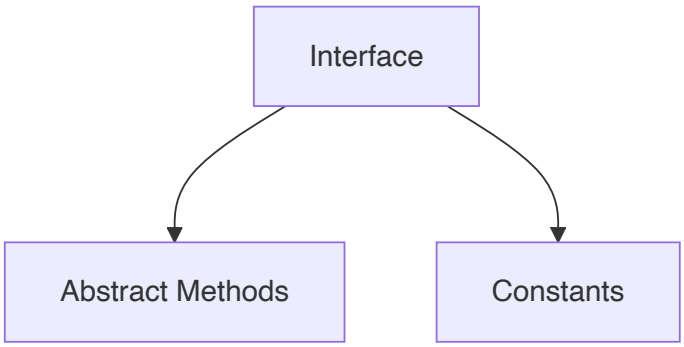
- **Encapsulation**: Hide implementation details
- **Security**: Prevent unauthorized access
- **Maintainability**: Control what can be modified

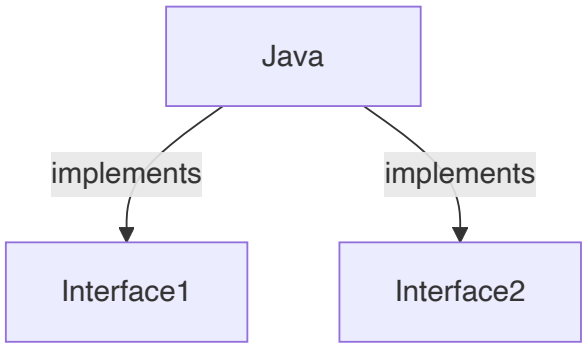
Mnemonic: "**PDPP**" - Private, Default, Protected, Public

Question 3(c): What is interface? Explain multiple inheritance using interface with example. (Marks: 07)

Answer 3(c)

Interface: A blueprint of a class that contains abstract methods and constants.





Key Features:

- Methods are **public** and **abstract** by default
- Variables are **public**, **static**, and **final**
- Class **implements** interface
- Class can implement **multiple interfaces**

Example of Multiple Inheritance:

```
// First interface
interface Drawable {
    void draw();  // Abstract method
    int SIZE = 10;  // Constant
}

// Second interface
interface Colorable {
    void setColor(String color);
    String getColor();
}

// Class implementing multiple interfaces
class Circle implements Drawable, Colorable {
    private String color;

    @Override
    public void draw() {
        System.out.println("Drawing a circle with size " + SIZE);
    }

    @Override
    public void setColor(String color) {
        this.color = color;
        System.out.println("Circle color set to " + color);
    }

    @Override
    public String getColor() {
        return color;
```

```
    }
}

// Main class
public class InterfaceDemo {
    public static void main(String[] args) {
        Circle c = new Circle();

        // Using methods from both interfaces
        c.draw();
        c.setColor("Red");
        System.out.println("Color: " + c.getColor());

        // Polymorphism with interfaces
        Drawable d = new Circle();
        d.draw();  // Can only access Drawable methods

        Colorable col = new Circle();
        col.setColor("Blue");  // Can only access Colorable methods
    }
}
```

Multiple Inheritance with Interfaces:

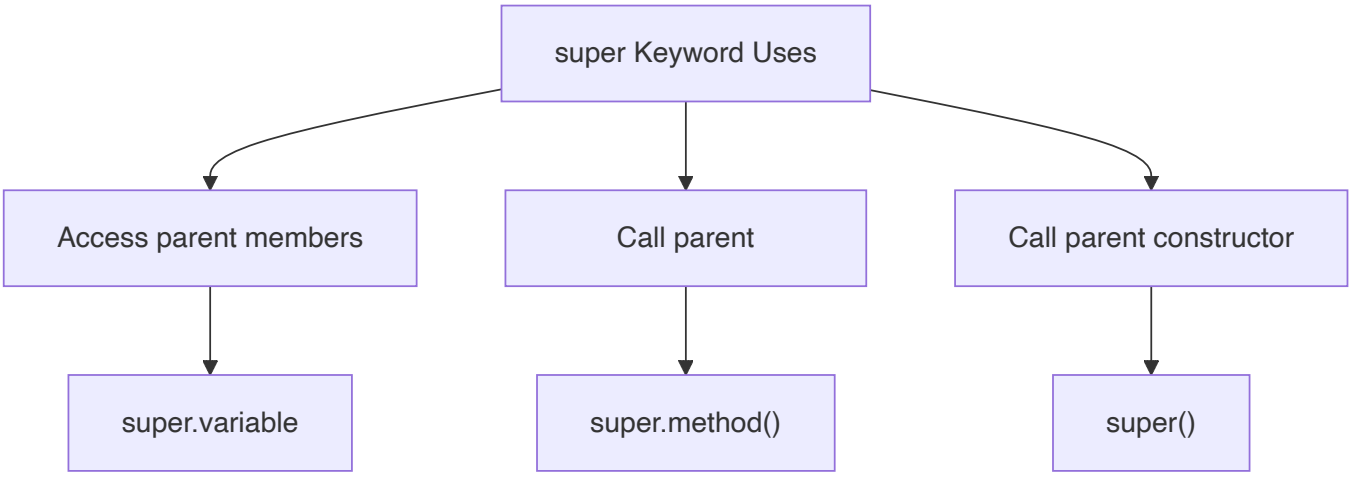
- Java **doesn't allow multiple inheritance** with classes
- Class can **implement multiple interfaces**
- Each interface provides different **behaviors**
- Solves **diamond problem** found in multiple inheritance

Mnemonic: "**CALM**" - Constants, Abstract methods, Like multiple inheritance, Methods without implementation

Question 3(a OR): Explain super keyword with example. (Marks: 03)

Answer 3(a OR)

'super' keyword in Java refers to the parent class (superclass) of the current object.



Main uses of 'super' keyword:

- **Access parent class variables**: `super.variable`
- **Call parent class methods**: `super.method()`
- **Call parent class constructor**: `super()` or `super(parameters)`

Example:

```
// Parent class
class Animal {
    String color = "white";

    void eat() {
        System.out.println("Animal is eating");
    }

    Animal() {
        System.out.println("Animal constructor called");
    }
}

// Child class
class Dog extends Animal {
    String color = "black";

    void printColor() {
        // Access parent variable with same name
        System.out.println("Parent color: " + super.color);
        System.out.println("Child color: " + color);
    }

    void eat() {
        // Call parent method
        super.eat();
        System.out.println("Dog is eating");
    }
```

```
    Dog() {
        // Call parent constructor
        super();
        System.out.println("Dog constructor called");
    }
}

// Main class
public class SuperDemo {
    public static void main(String[] args) {
        Dog dog = new Dog();
        dog.printColor();
        dog.eat();
    }
}
```

Output:

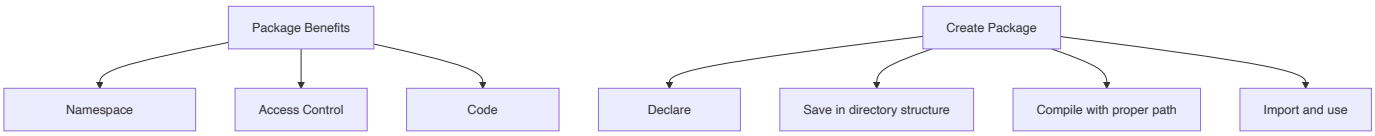
```
Animal constructor called
Dog constructor called
Parent color: white
Child color: black
Animal is eating
Dog is eating
```

Mnemonic: "**VCM**" - Variables (parent), Call methods, Method overriding

Question 3(b OR): What is package? Write steps to create a package and give example of it. (Marks: 04)

Answer 3(b OR)

Package: A namespace that organizes a set of related classes and interfaces.



Steps to Create a Package:

1. **Declare** the package at the beginning of source file
2. **Save** the file in directory structure matching package name
3. **Compile** the file using proper directory structure
4. **Import** and use the package in other classes

Example:

Step 1: Create a class with package declaration

```java
// File: Calculator.java
package com.mymath.util;

public class Calculator {
    // Methods
    public int add(int a, int b) {
        return a + b;
    }

    public int subtract(int a, int b) {
        return a - b;
    }

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

    public double divide(int a, int b) {
        if (b == 0) {
            System.out.println("Cannot divide by zero");
            return 0;
        }
        return (double)a / b;
    }
}
```

Step 2: Save file in proper directory structure

```
project_root/
└── com/
    └── mymath/
        └── util/
            └── Calculator.java
```

Step 3: Compile the file

```
# Navigate to project_root
cd project_root

# Compile
javac com/mymath/util/Calculator.java
```

Step 4: Create a class that uses the package

```java
// File: PackageDemo.java
// Import the package
import com.mymath.util.Calculator;

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

```
        // Create object of the Calculator class
        Calculator calc = new Calculator();

        // Use methods
        System.out.println("10 + 5 = " + calc.add(10, 5));
        System.out.println("10 - 5 = " + calc.subtract(10, 5));
        System.out.println("10 * 5 = " + calc.multiply(10, 5));
        System.out.println("10 / 5 = " + calc.divide(10, 5));
    }
}
```

Step 5: Compile and run the main class

```
# Compile
javac -classpath . PackageDemo.java

# Run
java -classpath . PackageDemo
```

Output:

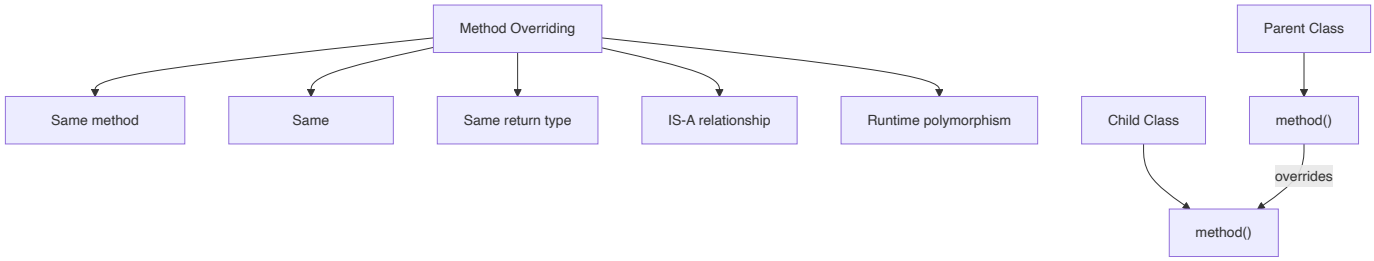
```
10 + 5 = 15
10 - 5 = 5
10 * 5 = 50
10 / 5 = 2.0
```

Mnemonic: "**SCIR**" - Save in structure, Compile with path, Import package, Run with classpath

Question 3(c OR): Define: Method Overriding. List out Rules for method overriding. Write a java program that implements method overriding. (Marks: 07)

Answer 3(c OR)

Method Overriding: Providing a different implementation for a method in a subclass that is already defined in the parent class.



Rules for Method Overriding:

- Method must have **same name** as parent class method
- Method must have **same parameters** (number, type, order)

- Return type must be **same or subtype** of parent method's return type
- Access modifier must be **same or less restrictive** than parent method
- Cannot override **static** methods (method hiding occurs instead)
- Cannot override **final** methods
- Cannot override **private** methods (not visible to subclass)
- Overridden method can throw **same, subtype, or no exceptions** compared to parent

Example of Method Overriding:

```
// Parent class
class Vehicle {
    // Method to be overridden
    public void move() {
        System.out.println("Vehicle is moving");
    }

    // Final method - cannot be overridden
    public final void stop() {
        System.out.println("Vehicle stopped");
    }

    // Method with return type
    public int getMaxSpeed() {
        return 100;
    }

    // Static method - cannot be overridden (can be hidden)
    public static void displayInfo() {
        System.out.println("This is a vehicle");
    }
}

// Child class
class Car extends Vehicle {
    // Overriding move() method
    @Override
    public void move() {
        System.out.println("Car is driving");
    }

    // Cannot override final method
    // public void stop() { } // Error!

    // Overriding with same return type
    @Override
    public int getMaxSpeed() {
        return 200; // Different implementation
    }
```

```
    // Method hiding (not overriding) - static method
    public static void displayInfo() {
        System.out.println("This is a car");
    }
}

// Another child class
class Bike extends Vehicle {
    // Overriding move() method
    @Override
    public void move() {
        // Call parent method first
        super.move();
        System.out.println("Bike is riding");
    }

    // Overriding with covariant return type
    @Override
    public int getMaxSpeed() {
        return 120;
    }
}

// Main class
public class OverridingDemo {
    public static void main(String[] args) {
        // Create parent class object
        Vehicle vehicle = new Vehicle();
        vehicle.move();
        System.out.println("Max speed: " + vehicle.getMaxSpeed());
        Vehicle.displayInfo();

        System.out.println("\n----- Car -----");
        // Create child class object
        Car car = new Car();
        car.move();
        car.stop(); // Using parent's method
        System.out.println("Max speed: " + car.getMaxSpeed());
        Car.displayInfo();

        System.out.println("\n----- Bike -----");
        // Create another child class object
        Bike bike = new Bike();
        bike.move();
        System.out.println("Max speed: " + bike.getMaxSpeed());

        System.out.println("\n----- Runtime Polymorphism -----");
        // Runtime polymorphism (dynamic method dispatch)
        Vehicle v1 = new Car();
        Vehicle v2 = new Bike();

        v1.move(); // Calls Car's move method
```

```
        v2.move(); // Calls Bike's move method

        // Static method called using reference type (not object type)
        v1.displayInfo(); // Calls Vehicle's displayInfo
    }
}
```

Output:

```
Vehicle is moving
Max speed: 100
This is a vehicle

----- Car -----
Car is driving
Vehicle stopped
Max speed: 200
This is a car

----- Bike -----
Vehicle is moving
Bike is riding
Max speed: 120

----- Runtime Polymorphism -----
Car is driving
Vehicle is moving
Bike is riding
This is a vehicle
```

Key Points:

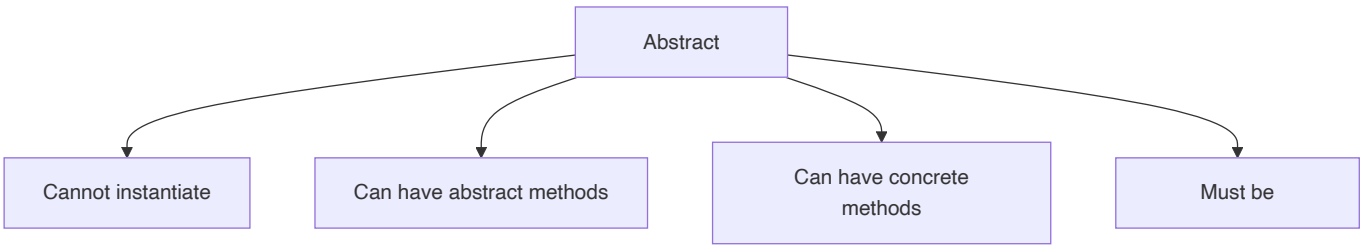
- Method overriding is the basis for **runtime polymorphism**
- The method called is determined by the **actual object type**, not reference type
- `@Override` annotation helps catch errors if method doesn't actually override
- Use `super.methodName()` to call parent method from overriding method

Mnemonic: "**SPAN**" - Same name, Parameters same, Access same/wider, No static/final/private

Question 4(a): Explain abstract class with suitable example. (Marks: 03)

Answer 4(a)

Abstract Class: A class that cannot be instantiated and may contain abstract methods.



Key Features:

- Declared with **abstract** keyword
- May contain **abstract methods** (without implementation)
- Subclasses must **implement all abstract methods**
- Can have **constructors**, **instance variables**, and **concrete methods**

Example:

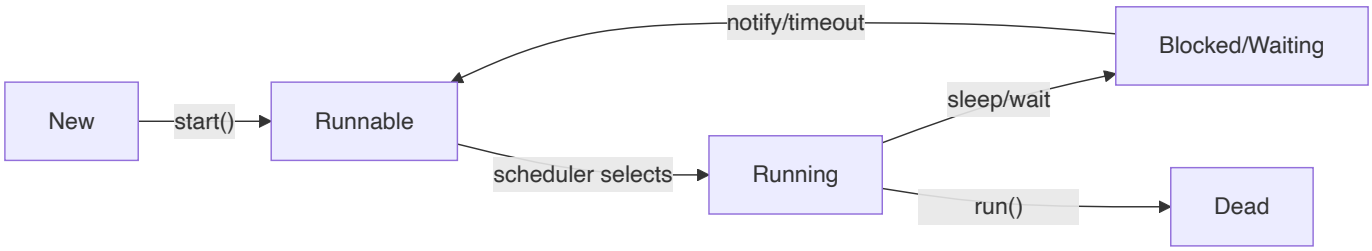
```
// Abstract class
abstract class Shape {
    // Abstract method - no implementation
    abstract double calculateArea();

    // Concrete method
    void display() {
        System.out.println("Area: " + calculateArea());
    }
}

// Concrete subclass
class Circle extends Shape {
    double radius;

    Circle(double radius) {
        this.radius = radius;
    }

    // Implementing abstract method
    @Override
    double calculateArea() {
        return Math.PI * radius * radius;
    }
}
```

Mnemonic: "**CPAI**" - Cannot instantiate, Partial implementation, Abstract methods, Inherited

Question 4(b): What is Thread? Explain Thread life cycle. (Marks: 04)

Answer 4(b)

Thread: A lightweight subprocess that executes a portion of a program concurrently.



Thread Life Cycle Stages:

1. **New**: Thread object created but not started
2. **Runnable**: Thread ready to run, waiting for CPU
3. **Running**: Thread executing in CPU
4. **Blocked/Waiting**: Thread temporarily inactive
    - **sleep()**: Forced inactive for specified time
    - **wait()**: Waiting for notification
    - **join()**: Waiting for another thread to complete
    - **I/O blocking**: Waiting for I/O operation
5. **Dead**: Thread execution completed

Java Thread Methods:

- **start()**: Begin thread execution
- **sleep()**: Pause thread for specified time
- **yield()**: Pause current thread to let others execute
- **join()**: Wait for another thread to complete

Mnemonic: "**NRWBD**" - New, Runnable, Running, Waiting/Blocked, Dead

Question 4(c): Write a program in java that creates the multiple threads by implementing the Thread class. (Marks: 07)

Answer 4(c)

```
// Thread creation by implementing Runnable interface
class CounterThread implements Runnable {
    private String threadName;
    private int counter;

    // Constructor
    public CounterThread(String name, int count) {
        this.threadName = name;
        this.counter = count;
```

```
    }

    // Run method contains the thread logic
    @Override
    public void run() {
        try {
            for (int i = 1; i <= counter; i++) {
                System.out.println(threadName + ": Count " + i);

                // Pause for demonstration
                Thread.sleep(500);
            }

            System.out.println(threadName + " completed.");
        } catch (InterruptedException e) {
            System.out.println(threadName + " interrupted.");
        }
    }
}

// Main class
public class MultiThreadDemo {
    public static void main(String[] args) {
        System.out.println("Creating threads...");

        // Create first thread
        Thread thread1 = new Thread(new CounterThread("Thread-1", 5));

        // Create second thread
        Thread thread2 = new Thread(new CounterThread("Thread-2", 3));

        // Create third thread
        Thread thread3 = new Thread(new CounterThread("Thread-3", 4));

        // Start threads
        thread1.start();
        thread2.start();
        thread3.start();

        System.out.println("Main thread continues...");

        try {
            // Wait for all threads to complete
            thread1.join();
            thread2.join();
            thread3.join();
        } catch (InterruptedException e) {
            System.out.println("Main thread interrupted.");
        }

        System.out.println("All threads completed. Exiting main thread.");
    }
```

```
}
```

Output (will vary due to thread scheduling):

```
Creating threads...
Main thread continues...
Thread-1: Count 1
Thread-2: Count 1
Thread-3: Count 1
Thread-1: Count 2
Thread-2: Count 2
Thread-3: Count 2
Thread-1: Count 3
Thread-2: Count 3
Thread-3: Count 3
Thread-2 completed.
Thread-1: Count 4
Thread-3: Count 4
Thread-1: Count 5
Thread-3 completed.
Thread-1 completed.
All threads completed. Exiting main thread.
```

Key Concepts:

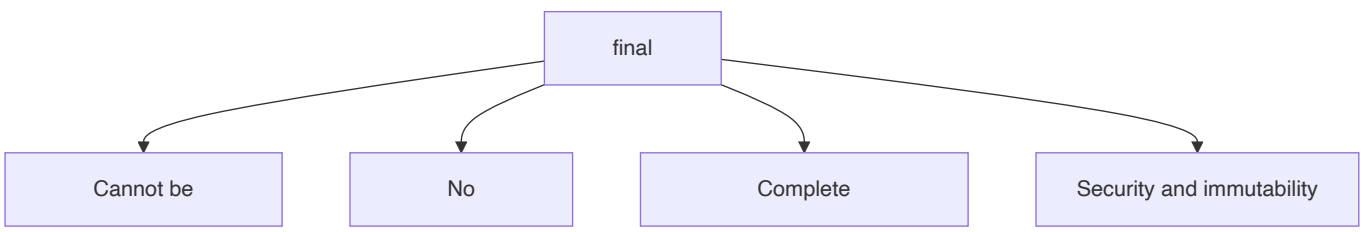
- **Runnable Interface**: Define thread behavior in run() method
- **Thread Object**: Wrapper for runnable task
- **start()**: Begin thread execution
- **join()**: Wait for thread completion
- **sleep()**: Introduce delay between operations

Mnemonic: "**CROSS**" - Create, Runnable, Override run(), Start threads, Sleep for delay

Question 4(a OR): Explain final class with suitable example. (Marks: 03)

Answer 4(a OR)

Final Class: A class that cannot be extended (inherited).



Key Characteristics:

- Declared with **final** keyword
- Cannot have **subclasses**
- Used for **security** and **immutability**
- Common examples: **String**, **Integer**, **Math** classes

Example:

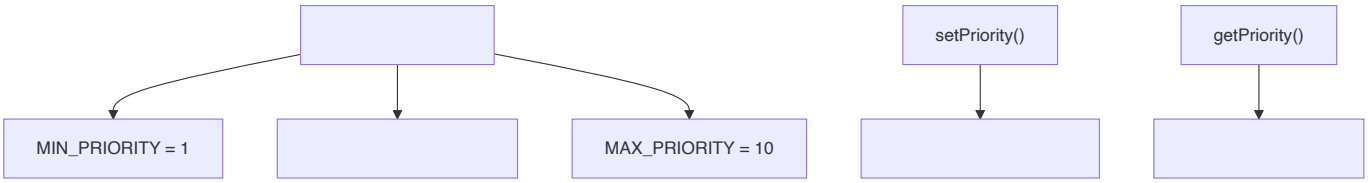
```
// Final class
final class SecureData {
    private String data;

    public SecureData(String data) {
        this.data = data;
    }

    public String getData() {
        return data;
    }

    public void display() {
        System.out.println("Secure data: " + data);
    }
}

// Attempt to extend final class - will cause compilation error
// class DataExtension extends SecureData {
//     DataExtension(String data) {
//         super(data);
//     }
// }

// Main class
public class FinalClassDemo {
    public static void main(String[] args) {
        SecureData sd = new SecureData("Confidential");
        sd.display();
    }
}
```

Mnemonic: "**NICE**" - No inheritance, Immutable design, Complete implementation, Enhanced security

Question 4(b OR): Explain thread priorities with suitable example. (Marks: 04)

Answer 4(b OR)

Thread Priority: A value that influences the order in which threads are scheduled for execution.



Key Points:

- Java thread priorities range from **1 (lowest)** to **10 (highest)**
- Default priority is **5 (normal)**
- Higher priority threads are **preferred** for execution
- Priorities are **hints to scheduler**, not guarantees
- Actual behavior depends on the **operating system**

Example:

```
class PriorityThread extends Thread {
    public PriorityThread(String name) {
        super(name);
    }

    public void run() {
        System.out.println("Running: " + getName() +
                           " with priority: " + getPriority());
        for (int i = 1; i <= 3; i++) {
            System.out.println(getName() + ": " + i);
            try {
                Thread.sleep(100);
            } catch (InterruptedException e) {
                System.out.println(getName() + " interrupted.");
            }
        }
        System.out.println(getName() + " finished.");
    }
}

public class ThreadPriorityDemo {
    public static void main(String[] args) {
        // Create threads
        PriorityThread low = new PriorityThread("Low Priority");
        PriorityThread norm = new PriorityThread("Normal Priority");
        PriorityThread high = new PriorityThread("High Priority");

        // Set priorities
        low.setPriority(Thread.MIN_PRIORITY);     // 1
        // norm uses default priority (5)
        high.setPriority(Thread.MAX_PRIORITY);    // 10

        // Start threads
        low.start();
```

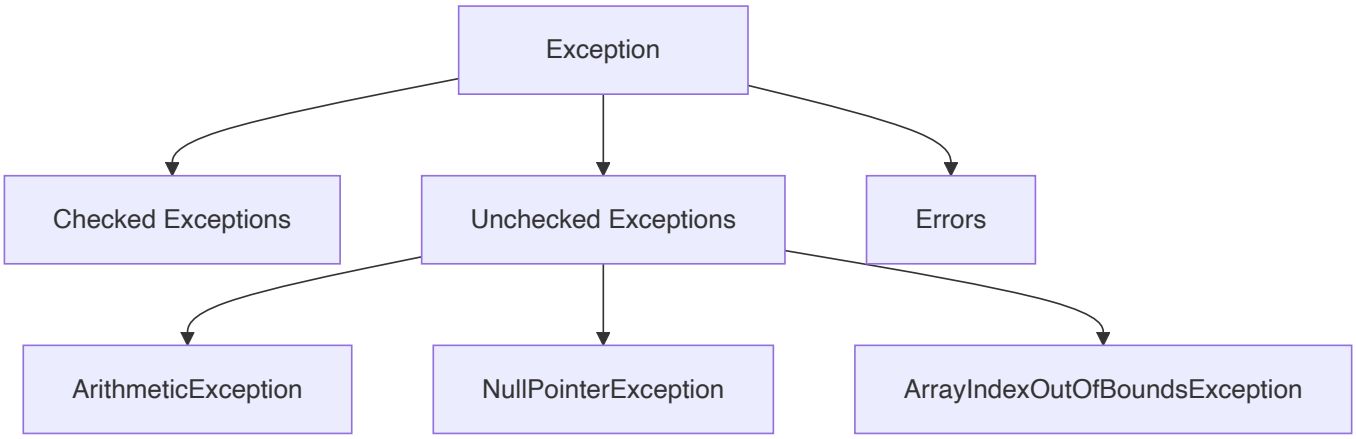
```
        norm.start();
        high.start();
    }
}
```

Mnemonic: "**HOPS**" - Higher values get preference, OS dependent, Priority 1-10, Scheduling hint

Question 4(c OR): What is Exception? Write a program that shows the use of Arithmetic Exception. (Marks: 07)

Answer 4(c OR)

Exception: An event that disrupts the normal flow of program execution.



ArithmeticException: Thrown when an exceptional arithmetic condition occurs, like division by zero.

Program demonstrating ArithmeticException:

```
import java.util.Scanner;

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

        try {
            // Get two numbers from user
            System.out.print("Enter first number: ");
            int num1 = input.nextInt();

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

            // Perform division
            System.out.println("\nPerforming division...");
            int result = divideNumbers(num1, num2);
            System.out.println(num1 + " / " + num2 + " = " + result);

        } catch (ArithmeticException e) {
```

```
            // Handle division by zero
            System.out.println("\nException caught: " + e.getMessage());
            System.out.println("Cannot divide by zero!");

        } catch (Exception e) {
            // Handle other exceptions
            System.out.println("\nError: " + e.getMessage());

        } finally {
            // Clean up resources
            System.out.println("\nFinally block executed.");
            input.close();
        }

        System.out.println("Program completed.");
    }

    // Method that may throw ArithmeticException
    public static int divideNumbers(int a, int b) {
        return a / b;  // Throws ArithmeticException if b is 0
    }
}
```

Sample Output 1 (with valid input):

```
Enter first number: 10
Enter second number: 2

Performing division...
10 / 2 = 5

Finally block executed.
Program completed.
```

Sample Output 2 (with division by zero):

```
Enter first number: 10
Enter second number: 0

Performing division...

Exception caught: / by zero
Cannot divide by zero!

Finally block executed.
Program completed.
```

Key Exception Handling Components:

- **try**: Contains code that might throw exceptions

- **catch**: Handles specific exceptions
- **finally**: Always executes (for cleanup)
- **throw**: Explicitly throw an exception
- **throws**: Declare exceptions a method may throw

Mnemonic: "**ATCF**" - ArithmeticException, Try-catch blocks, Cleanup in finally, Flow control

Question 5(a): Write a Java Program to find sum and average of 10 numbers of an array. (Marks: 03)

Answer 5(a)

```
public class ArraySumAverage {
    public static void main(String[] args) {
        // Declare and initialize array
        int[] numbers = {23, 45, 67, 89, 10, 12, 34, 56, 78, 90};

        // Variables for sum and average
        int sum = 0;
        double average;

        // Calculate sum
        for (int i = 0; i < numbers.length; i++) {
            sum += numbers[i];
        }

        // Calculate average
        average = (double) sum / numbers.length;

        // Display results
        System.out.println("Array elements: ");
        for (int num : numbers) {
            System.out.print(num + " ");
        }
        System.out.println("\nSum: " + sum);
        System.out.println("Average: " + average);
    }
}
```

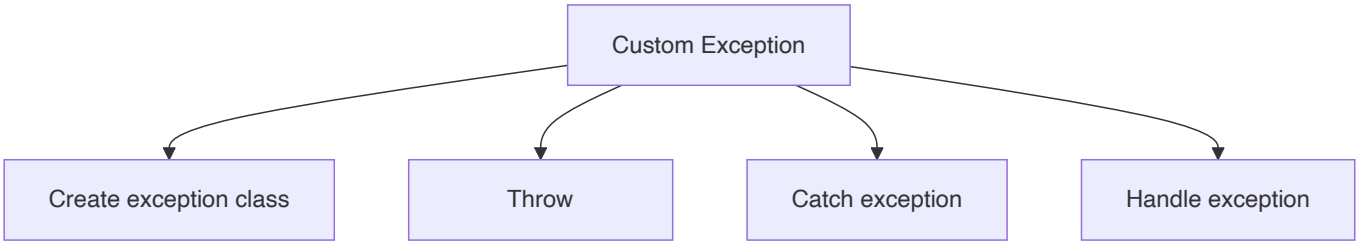
Output:

```
Array elements:
23 45 67 89 10 12 34 56 78 90
Sum: 504
Average: 50.4
```

Mnemonic: "**SALI**" - Sum Array Loop, Initialize array, Iterate through elements

Question 5(b): Write a Java program to handle user defined exception for 'Divide by Zero' error. (Marks: 04)

Answer 5(b)




```java
// Custom exception class
class DivideByZeroException extends Exception {
    public DivideByZeroException(String message) {
        super(message);
    }
}

public class CustomExceptionDemo {
    // Method that throws custom exception
    public static double divide(int a, int b) throws DivideByZeroException {
        if (b == 0) {
            throw new DivideByZeroException("Cannot divide by zero!");
        }
        return (double) a / b;
    }

    public static void main(String[] args) {
        try {
            // Test cases
            System.out.println("10 / 2 = " + divide(10, 2)); // Works fine
            System.out.println("10 / 0 = " + divide(10, 0)); // Throws exception
        } catch (DivideByZeroException e) {
            System.out.println("Error: " + e.getMessage());
        } finally {
            System.out.println("Program completed.");
        }
    }
}
```

Output:

```
10 / 2 = 5.0
Error: Cannot divide by zero!
Program completed.
```

Mnemonic: "**CETH**" - Create exception class, Extend Exception, Throw when condition met, Handle with try-catch

Question 5(c): Write a java program to create a text file and perform read operation on the text file. (Marks: 07)

Answer 5(c)


```
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;

public class FileReadWriteDemo {
    public static void main(String[] args) {
        // File name
        String fileName = "sample.txt";

        try {
            // PART 1: CREATE AND WRITE TO FILE
            System.out.println("Creating and writing to file: " + fileName);

            // Create FileWriter and BufferedWriter
            FileWriter fileWriter = new FileWriter(fileName);
            BufferedWriter bufferedWriter = new BufferedWriter(fileWriter);

            // Write content to file
            bufferedWriter.write("Hello, this is a sample text file.");
            bufferedWriter.newLine();
            bufferedWriter.write("Java File I/O is interesting!");
            bufferedWriter.newLine();
            bufferedWriter.write("End of file.");

            // Close writers
            bufferedWriter.close();
            System.out.println("File created successfully.\n");

            // PART 2: READ FROM FILE
            System.out.println("Reading from file: " + fileName);

            // Create FileReader and BufferedReader
            FileReader fileReader = new FileReader(fileName);
            BufferedReader bufferedReader = new BufferedReader(fileReader);

            // Read and display file content
```

```
            String line;
            System.out.println("--- File Content ---");
            while ((line = bufferedReader.readLine()) != null) {
                System.out.println(line);
            }
            System.out.println("--------------------");

            // Close readers
            bufferedReader.close();

        } catch (IOException e) {
            System.out.println("Error: " + e.getMessage());
        }
    }
}
```

Output:

```
Creating and writing to file: sample.txt
File created successfully.

Reading from file: sample.txt
--- File Content ---
Hello, this is a sample text file.
Java File I/O is interesting!
End of file.
--------------------
```

Key Steps:

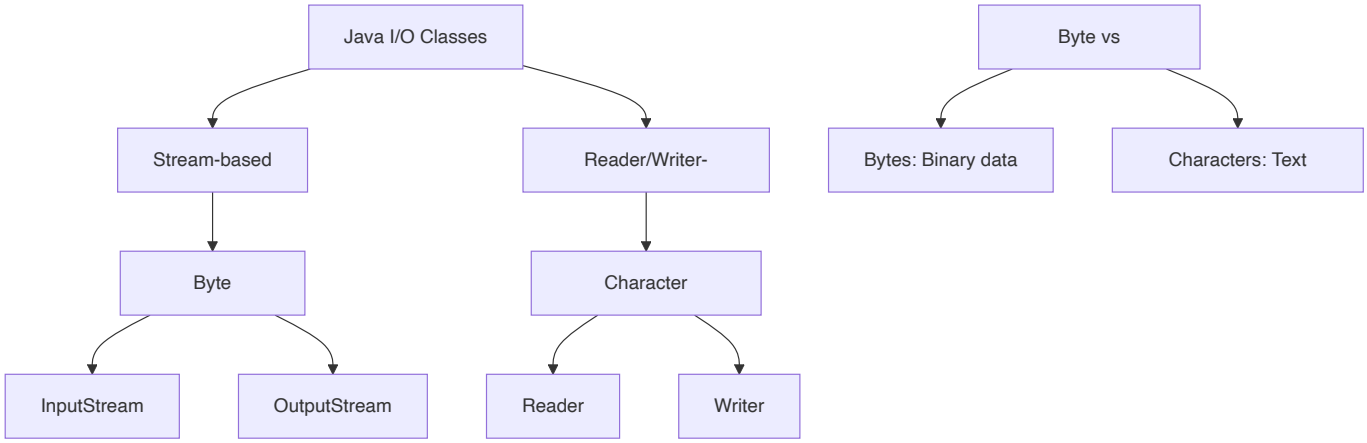
- **Create file**: Use FileWriter/BufferedWriter
- **Write content**: Use write() and newLine() methods
- **Close writer**: Always close streams
- **Read file**: Use FileReader/BufferedReader
- **Process content**: Read line by line with readLine()

Mnemonic: "**CROWN**" - Create file, Read content, Open streams, Write content, Nullify (close) streams

Question 5(a OR): Explain java I/O process. (Marks: 03)

Answer 5(a OR)

Java I/O Process provides classes to handle input and output operations.



Key Components:

- **Streams**: Sequence of data flow between source and destination
- **Two Types**:
  - **Byte Streams**: Handle binary data (images, audio)
  - **Character Streams**: Handle text data (files, documents)
- **Basic Process**:
  1. **Open** connection to data source/destination
  2. **Read/Write** data
  3. **Close** connection to release resources

Common Classes:

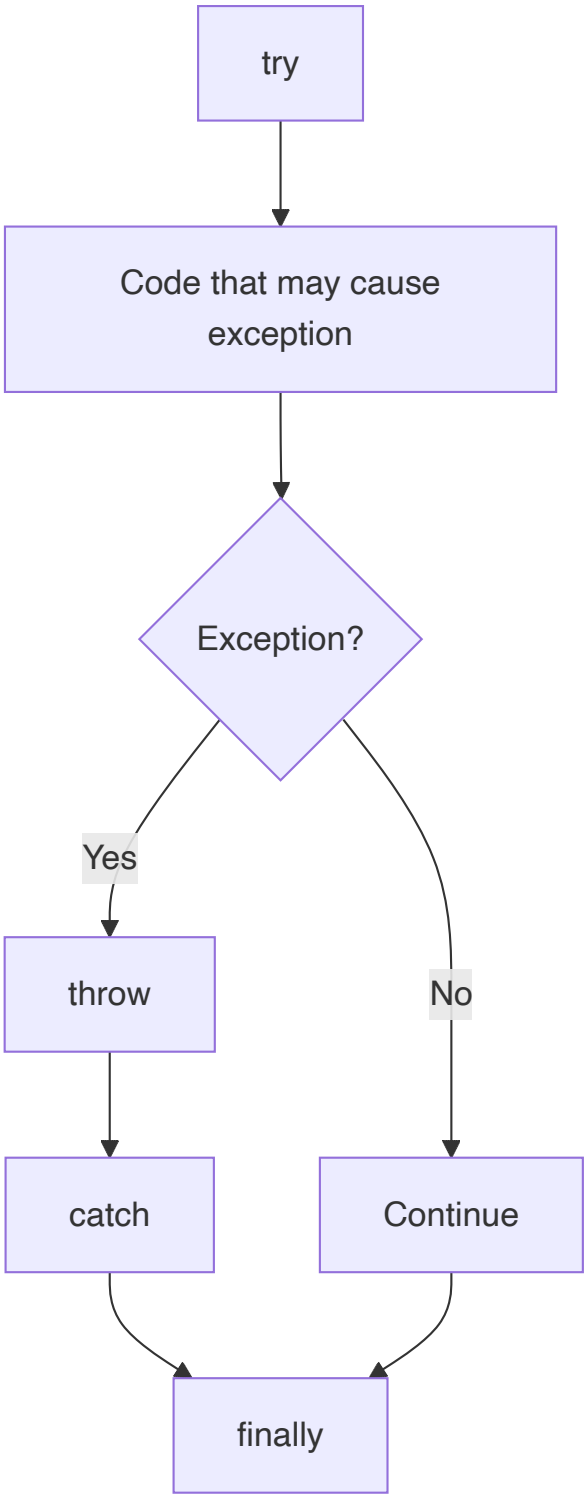
- **Byte Streams**: FileInputStream, FileOutputStream
- **Character Streams**: FileReader, FileWriter
- **Buffered Operations**: BufferedReader, BufferedWriter

Mnemonic: "**IOBC**" - Input/Output, Open connection, Binary/Character streams, Close resources

Question 5(b OR): Explain throw and finally in Exception Handling with example. (Marks: 04)

Answer 5(b OR)

throw: Explicitly throws an exception.
finally: Contains code that always executes regardless of exception.



Example:

```
public class ThrowFinallyDemo {
    public static void main(String[] args) {
        try {
            int age = -5;

            // Validate age
            if (age < 0) {
                // Explicitly throw exception
```

```
                throw new IllegalArgumentException("Age cannot be negative");
            }

            System.out.println("Age is " + age);

        } catch (IllegalArgumentException e) {
            // Handle the exception
            System.out.println("Exception: " + e.getMessage());

        } finally {
            // Always executes
            System.out.println("Finally block executed");
            System.out.println("This runs whether exception occurs or not");
        }

        System.out.println("Program continues...");
    }
}
```

Output:

```
Exception: Age cannot be negative
Finally block executed
This runs whether exception occurs or not
Program continues...
```

Key Points:

- **throw**: Creates a new exception object
- **finally**: Used for cleanup operations
- **finally** block executes even if **return** statement exists in try/catch

Mnemonic: "**CAFE**" - Create exception, Always execute finally, Finish cleanup, Exception propagation

Question 5(c OR): Write a java program to display the content of a text file and perform append operation on the text file. (Marks: 07)

Answer 5(c OR)


```
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;
```

```java
public class FileAppendDemo {
    public static void main(String[] args) {
        // File name
        String fileName = "sample.txt";
        String appendData = "\nThis line was appended later.";

        try {
            // PART 1: CREATE FILE IF IT DOESN'T EXIST
            boolean fileExists = true;
            try {
                FileReader testReader = new FileReader(fileName);
                testReader.close();
            } catch (IOException e) {
                fileExists = false;
                // Create file with initial content
                FileWriter writer = new FileWriter(fileName);
                writer.write("This is a sample file.\nIt contains some text.");
                writer.close();
                System.out.println("File created with initial content.");
            }

            // PART 2: READ AND DISPLAY ORIGINAL CONTENT
            System.out.println("\nOriginal file content:");
            System.out.println("----------------------");
            displayFileContent(fileName);

            // PART 3: APPEND TO FILE
            System.out.println("\nAppending to file...");
            FileWriter fileWriter = new FileWriter(fileName, true); // true = append mode
            BufferedWriter bufferedWriter = new BufferedWriter(fileWriter);

            bufferedWriter.write(appendData);
            bufferedWriter.close();
            System.out.println("Content appended successfully.");

            // PART 4: READ AND DISPLAY UPDATED CONTENT
            System.out.println("\nUpdated file content:");
            System.out.println("----------------------");
            displayFileContent(fileName);

        } catch (IOException e) {
            System.out.println("Error: " + e.getMessage());
        }
    }

    // Method to read and display file content
    public static void displayFileContent(String fileName) throws IOException {
        FileReader fileReader = new FileReader(fileName);
        BufferedReader bufferedReader = new BufferedReader(fileReader);

        String line;
```

```
        while ((line = bufferedReader.readLine()) != null) {
            System.out.println(line);
        }

        bufferedReader.close();
    }
}
```

Output (if file didn't exist previously):

```
File created with initial content.

Original file content:
----------------------
This is a sample file.
It contains some text.

Appending to file...
Content appended successfully.

Updated file content:
----------------------
This is a sample file.
It contains some text.
This line was appended later.
```

Key Points:

- **Append mode**: Use `FileWriter(fileName, true)`
- **Read file**: Use BufferedReader with readLine()
- **Create separate method**: For code reuse
- **Proper error handling**: Use try-catch blocks
- **Close resources**: Always close streams

Mnemonic: "**ARCS**" - Append mode, Read content, Close resources, Separate concerns