Oops concepts  
**Object-Oriented Programming (OOP) Concepts Explained with Answers to Interview Questions**

**OOP Concepts**

**1. Encapsulation**

Encapsulation bundles data (variables) and methods (functions) that operate on the data into a single unit (class) and restricts direct access to data members using access modifiers.

**Example**:

public class BankAccount {

private double balance;

public BankAccount(double initialBalance) {

this.balance = initialBalance;

}

public void deposit(double amount) {

if (amount > 0) {

balance += amount;

}

}

public double getBalance() {

return balance;

}

}

**Q&A**:  
**Q: What is encapsulation? How is it implemented?**  
**A:** Encapsulation is the mechanism of wrapping data and methods in a single unit, ensuring controlled access using access modifiers like private, public, or protected. It is implemented by making class variables private and providing public getter and setter methods for controlled access.

**2. Inheritance**

Inheritance allows a class (child) to acquire properties and behaviors from another class (parent), promoting code reusability.

**Example**:

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 dog = new Dog();

dog.eat(); // Inherited method

dog.bark(); // Method specific to Dog

}

}

**Q&A**:  
**Q: What is inheritance? What are its types?**  
**A:** Inheritance is the process by which one class acquires the properties and methods of another class.

* **Single inheritance**: One class inherits from another.
* **Multilevel inheritance**: A class inherits from a derived class.
* **Hierarchical inheritance**: Multiple classes inherit from a single base class.  
  (Note: Java does not support multiple inheritance with classes to avoid ambiguity; it uses interfaces instead.)

**3. Polymorphism**

Polymorphism means "many forms" and allows methods to perform differently based on the object or input.

**Method Overloading (Compile-Time Polymorphism):**

class Calculator {

int add(int a, int b) {

return a + b;

}

double add(double a, double b) {

return a + b;

}

}

**Method Overriding (Run-Time Polymorphism):**

class Animal {

void sound() {

System.out.println("This animal makes a sound.");

}

}

class Cat extends Animal {

@Override

void sound() {

System.out.println("The cat meows.");

}

}

**Q&A**:  
**Q: What is polymorphism? How is it achieved?**  
**A:** Polymorphism allows the same method or operator to behave differently. It is achieved through:

* **Compile-Time Polymorphism**: Using method overloading (methods with the same name but different parameters).
* **Run-Time Polymorphism**: Using method overriding (subclass method overrides the superclass method).

**4. Abstraction**

Abstraction hides implementation details and exposes only the essential features.

**Abstract Class Example:**

abstract class Shape {

abstract void draw(); // Abstract method

}

class Circle extends Shape {

void draw() {

System.out.println("Drawing a circle.");

}

}

**Interface Example:**

interface Vehicle {

void start();

}

class Car implements Vehicle {

public void start() {

System.out.println("Car starts with a key.");

}

}

**Q&A**:  
**Q: What is abstraction? How is it implemented?**  
**A:** Abstraction is the process of hiding implementation details while exposing only functionality. It is implemented using:

* **Abstract Classes**: Define abstract methods that subclasses must implement.
* **Interfaces**: Define a contract that implementing classes must follow.

**Level-Wise Interview Questions and Answers**

**Beginner Level**

1. **Q: What is Object-Oriented Programming? What are its advantages?**  
   **A:** OOP is a programming paradigm that uses objects and classes to structure software. Its advantages include:
   * Reusability through inheritance.
   * Improved code readability and maintainability via encapsulation.
   * Flexibility using polymorphism.
2. **Q: What are classes and objects?**  
   **A:**
   * A **class** is a blueprint for objects (e.g., Car).
   * An **object** is an instance of a class (e.g., Car myCar = new Car();).
3. **Q: What is the difference between method overloading and method overriding?**  
   **A:**
   * **Overloading** occurs within the same class, using the same method name with different parameters.
   * **Overriding** occurs in different classes (subclass overrides a method in its parent class).

**Intermediate Level**

1. **Q: How does inheritance work in OOP?**  
   **A:** Inheritance allows a subclass to inherit methods and variables from a superclass, enabling code reuse. For example:
2. class Parent { void display() { } }
3. class Child extends Parent { }
4. **Q: What is the difference between an abstract class and an interface?**  
   **A:**
   * **Abstract class**: Can have abstract and concrete methods; supports constructors.
   * **Interface**: Only abstract methods (until Java 8), multiple inheritance supported.
5. **Q: Explain access modifiers in OOP.**  
   **A:**
   * **Private**: Accessible only within the same class.
   * **Default**: Accessible within the same package.
   * **Protected**: Accessible within the same package and subclasses.
   * **Public**: Accessible everywhere.

**Advanced Level**

1. **Q: What is the diamond problem in inheritance? How is it resolved in Java?**  
   **A:**
   * The diamond problem occurs in multiple inheritance when a class inherits from two classes with the same method, causing ambiguity.
   * In Java, it is resolved by using interfaces instead of classes. If a conflict arises, you must explicitly specify which method to use.
2. **Q: What is the difference between composition and inheritance? Which is preferred?**  
   **A:**
   * **Inheritance**: A "is-a" relationship (e.g., Dog is an Animal).
   * **Composition**: A "has-a" relationship (e.g., Car has an Engine).
   * **Preferred**: Composition is preferred for flexibility and reduced coupling.
3. **Q: Explain SOLID principles in OOP.**  
   **A:**
   * **S**: Single Responsibility Principle - A class should have one reason to change.
   * **O**: Open/Closed Principle - Classes should be open for extension but closed for modification.
   * **L**: Liskov Substitution Principle - Subtypes must be substitutable for their base types.
   * **I**: Interface Segregation Principle - Prefer smaller, specific interfaces over one large interface.
   * **D**: Dependency Inversion Principle - High-level modules should not depend on low-level modules but on abstractions.

This explanation combines theoretical explanations, practical examples, and answers to commonly asked interview questions for each OOP concept, structured for beginner, intermediate, and advanced levels.

1,what is interface?

A,

An **interface**

It specifies a set of methods that a class must provide but does not include any implementation details. Interfaces are a key part of object-oriented programming and are used to achieve abstraction and enforce a consistent structure across different classes.

**Key Features of Interfaces**

1. **Abstraction**: Interfaces provide a way to define abstract methods (methods without a body) that must be implemented by a class.
2. **No Implementation**: Methods in an interface do not have bodies (implementation); only the method signatures are defined.
3. **Multiple Inheritance**: Interfaces allow a class to implement multiple interfaces, enabling multiple inheritance-like behavior in languages that don't support it directly.
4. **Polymorphism**: Interfaces enable polymorphism by allowing different classes to be accessed through the same interface type.
5. **Standardization**: Interfaces ensure a consistent structure across classes, making it easier to maintain and extend code.

In below code eat added in interface only bit it can be called when a class is instatntiated also.

Ex:eat().

Code:

// Define the interface

public interface Animal {

void makeSound(); // Abstract method

void eat();

}

// Implement the interface in the Dog class

public class Dog implements Animal {

@Override

public void makeSound() {

System.out.println("Woof!");

}

@Override

public void eat() {

System.out.println("Dog is eating.");

}

}

// Implement the interface in the Cat class

public class Cat implements Animal {

@Override

public void makeSound() {

System.out.println("Meow!");

}

@Override

public void eat() {

System.out.println("Cat is eating.");

}

}

// Test the interface and its implementations

public class Main {

public static void main(String[] args) {

Animal dog = new Dog(); // Polymorphism

Animal cat = new Cat();

dog.makeSound(); // Output: Woof!

dog.eat(); // Output: Dog is eating.

cat.makeSound(); // Output: Meow!

cat.eat(); // Output: Cat is eating.

}

}

2,what is abstract class?

A, An **abstract class**

It serves as a blueprint for other classes and can contain both abstract methods (methods without implementation) and concrete methods (methods with implementation). Subclasses must provide implementations for the abstract methods.

Code:

// Define an abstract class

abstract class Animal {

// Abstract method (no body)

abstract void makeSound();

// Concrete method (has a body)

void eat() {

System.out.println("This animal is eating.");

}

}

// Subclass Dog extends the abstract class Animal

class Dog extends Animal {

@Override

void makeSound() {

System.out.println("Woof!");

}

}

// Subclass Cat extends the abstract class Animal

class Cat extends Animal {

@Override

void makeSound() {

System.out.println("Meow!");

}

}

// Test the abstract class and its subclasses

public class Main {

public static void main(String[] args) {

Animal dog = new Dog(); // Polymorphism

Animal cat = new Cat();

dog.makeSound(); // Output: Woof!

dog.eat(); // Output: This animal is eating.

cat.makeSound(); // Output: Meow!

cat.eat(); // Output: This animal is eating.

}

3,if we use static or default methos in interface it is equal to abstraction then what is difference ?

A,

**Key Differences Between Interface and Abstract Class**

| **Feature** | **Abstract Class** | **Interface** |
| --- | --- | --- |
|  |  |  |
|  |  |  |
| **Inheritance** | A class can inherit only one abstract class (single inheritance). | A class can implement multiple interfaces (multiple inheritance). |
|  |  |  |
| **Constructors** | Can have constructors. | Cannot have constructors. |
|  |  |  |
|  |  |  |
| **When to Use** | Use when you want to share code among related classes. | Use to define a contract or capability for unrelated classes. |
| **State (Fields)** | Can maintain state (fields that are non-final). | Cannot maintain state (fields are constants). |
|  |  |  |

**15,comparable vs comparator in interface ?**

**A, 1. Comparable Interface**

* **Definition: Belongs to the java.lang package.**
* **Purpose: Used to define the natural ordering of objects in a class.**
* **How to Use:**
  + **The class itself implements Comparable.**
  + **It overrides the compareTo method to define the default comparison logic.**

**Key Features of Comparable:**

1. **Single Sorting Logic:**
   * **Can only define one default sorting order for a class.**
2. **Modify the Class:**
   * **Requires modification of the class whose objects need to be sorted.**

**class Employee implements Comparable<Employee> {**

**int id;**

**String name;**

**public Employee(int id, String name) {**

**this.id = id;**

**this.name = name;**

**}**

**@Override**

**public int compareTo(Employee other) {**

**return this.id - other.id; // Natural order by id**

**}**

**}**

**// Usage**

**List<Employee> employees = new ArrayList<>();**

**employees.add(new Employee(2, "Alice"));**

**employees.add(new Employee(1, "Bob"));**

**Collections.sort(employees); // Sorts by id**

**Comparator Interface**

* **Definition: Belongs to the java.util package.**
* **Purpose: Used to define custom sorting logic outside of the class.**
* **How to Use:**
  + **Create a separate class (or use a lambda/anonymous class) that implements Comparator.**
  + **It overrides the compare method to define the custom comparison logic.**

**class Employee {**

**int id;**

**String name;**

**public Employee(int id, String name) {**

**this.id = id;**

**this.name = name;**

**}**

**}**

**// Custom Comparator**

**class NameComparator implements Comparator<Employee> {**

**@Override**

**public int compare(Employee e1, Employee e2) {**

**return e1.name.compareTo(e2.name); // Custom order by name**

**}**

**}**

**// Usage**

**List<Employee> employees = new ArrayList<>();**

**employees.add(new Employee(2, "Alice"));**

**employees.add(new Employee(1, "Bob"));**

**Collections.sort(employees, new NameComparator()); // Sorts by name**

23,what is binding in polymorphism?

A, Binding in Polymorphism

Binding refers to the process of associating a method call with the method definition or implementation. In the context of polymorphism, it determines which method will be executed at runtime or compile-time.

Types of Binding

1. Static Binding (Early Binding):

• Occurs at compile-time.

• The method to be invoked is determined based on the reference type of the object.

• It is used for method overloading, private, static, and final methods since these methods cannot be overridden.

• Example:

class Demo {

void show() {

System.out.println("Static Binding Example");

}

}

public class Test {

public static void main(String[] args) {

Demo obj = new Demo();

obj.show(); // Resolved at compile-time

}

}

2. Dynamic Binding (Late Binding):

• Occurs at runtime.

• The method to be executed is determined based on the actual object (not the reference type).

• It is used for method overriding, allowing polymorphic behavior.

• Example:

class Animal {

void sound() {

System.out.println("Animal makes a sound");

}

}

class Dog extends Animal {

void sound() {

System.out.println("Dog barks");

}

}

public class Test {

public static void main(String[] args) {

Animal obj = new Dog(); // Reference type is Animal, but object is Dog

obj.sound(); // Resolved at runtime, output: "Dog barks"

}

}

Key Differences Between Static and Dynamic Binding

Aspect Static Binding Dynamic Binding

Timing Compile-time Runtime

Methods involved private, static, and final methods Overridden methods

Polymorphism Type Compile-time polymorphism Runtime polymorphism

Decision based on Reference type Object type

Polymorphism and Binding in Action

class Shape {

void draw() {

System.out.println("Drawing a shape");

}

}

class Circle extends Shape {

@Override

void draw() {

System.out.println("Drawing a circle");

}

}

class Test {

public static void main(String[] args) {

Shape s = new Circle(); // Polymorphism

s.draw(); // Dynamic binding, resolved at runtime

}

}

Output:

Drawing a circle

In the example above:

• The reference s is of type Shape.

• At runtime, the actual object Circle determines which draw() method to call.

Conclusion

• Binding in polymorphism is a mechanism that allows dynamic method invocation based on the object at runtime.

• Static binding supports method overloading, while dynamic binding supports method overriding.

Some more oops interview questions?

A,  
**Q8. What is meant by static polymorphism?** Static polymorphism, also known as compile-time polymorphism, is achieved through method overloading or operator overloading. It allows the same method to have different implementations based on the parameters passed to it. The method to be invoked is determined at compile time.

**Q9. What is meant by dynamic polymorphism?** Dynamic polymorphism, or runtime polymorphism, is achieved through method overriding. It allows a subclass to provide a specific implementation of a method that is already defined in its superclass. The method to be invoked is determined at runtime based on the object type.

**Q10. What is the difference between overloading and overriding?**

* **Overloading**: This is a compile-time polymorphism where multiple methods have the same name but different parameters (method signature).
* **Overriding**: This is a runtime polymorphism where a subclass provides a specific implementation of a method that is already defined in its superclass.

**Q11. What is method hiding?** Method hiding occurs when a subclass defines a static method with the same name and signature as a static method in its superclass. The method in the superclass is hidden by the method in the subclass.

**Q12. What is variable hiding?** Variable hiding happens when a subclass declares a variable with the same name as a variable in its superclass. The variable in the superclass is hidden by the variable in the subclass.

**Q13. What is an abstract class?** An abstract class is a class that cannot be instantiated and is meant to be subclassed. It can contain abstract methods (methods without implementation) that must be implemented by subclasses, as well as concrete methods (methods with implementation).

**Q14. What is an interface?** An interface is a reference type in Java that can contain only constants, method signatures, default methods, static methods, and nested types. Interfaces cannot contain instance fields. The methods in interfaces are abstract by default.

**Q15. Advantages and disadvantages of using Abstraction?**

* **Advantages**:
  + Reduces complexity by hiding implementation details.
  + Increases code reusability and maintainability.
  + Enhances security by exposing only necessary details.
* **Disadvantages**:
  + Can lead to performance overhead due to additional layers of abstraction.
  + May increase the complexity of the codebase if overused.

**Q16. Is it possible for a single class to implement two different interfaces?** Yes, a single class can implement multiple interfaces in Java. This allows the class to inherit the abstract methods of multiple interfaces and provide implementations for them.

**Q17. Why are default methods allowed in interfaces?** Default methods were introduced in Java 8 to allow the addition of new methods to interfaces without breaking the existing implementations. They provide a default implementation that can be overridden by implementing classes.

**Q18. Inheritance - We have 3 classes A, B, and C. Class C extends Class B, and Class B extends Class A. Each class has a method add(). Is there a way to call A's add() method from class C?** Yes, you can call A's add() method from class C using the super keyword. Here is an example:

class A {

void add() {

System.out.println("A's add()");

}

}

class B extends A {

void add() {

System.out.println("B's add()");

}

}

class C extends B {

void add() {

super.add(); // Calls B's add()

((A)this).add(); // Calls A's add()

}

}

**Q21. What is the difference between composition and inheritance?**

* **Composition**: A design principle where a class is composed of one or more objects of other classes, allowing for flexible code reuse. It represents a "has-a" relationship.
* **Inheritance**: A mechanism where a new class inherits properties and behavior from an existing class, representing an "is-a" relationship.

**Q22. What are the differences between an abstract class and an interface?**

* **Abstract Class**:
  + Can have both abstract and concrete methods.
  + Can have instance variables.
  + Can provide constructors.
  + Supports single inheritance.
* **Interface**:
  + Can only have abstract methods (until Java 8, which introduced default and static methods).
  + Cannot have instance variables.
  + Cannot provide constructors.
  + Supports multiple inheritance.

**Q23. What is the use of the default keyword in interfaces?** The default keyword in interfaces allows the definition of default methods, which provide a default implementation that can be overridden by implementing classes. This helps in adding new methods to interfaces without breaking existing implementations.

**Q24. Polymorphism - In an online shopping system, you have different types of users such as customers and admins. Both users need to log in but have different post-login actions.** In this scenario, you can use polymorphism to define a common interface or abstract class for users with a login method. Each user type (customer, admin) can then provide its own implementation of the post-login actions.

**Q25. Composition - Design a system for a car dealership where cars can have different engines (e.g., petrol engine, electric engine). You want to model cars and engines such that engines can be easily replaced without needing to modify the car class.** In this scenario, you can use composition to design the system. Define an Engine interface with different implementations (PetrolEngine, ElectricEngine). The Car class will have an Engine object, allowing the engine to be replaced easily.

interface Engine {

void start();

}

class PetrolEngine implements Engine {

public void start() {

System.out.println("Petrol engine starting...");

}

}

class ElectricEngine implements Engine {

public void start() {

System.out.println("Electric engine starting...");

}

}

class Car {

private Engine engine;

public Car(Engine engine) {

this.engine = engine;

}

public void setEngine(Engine engine) {

this.engine = engine;

}

public void startCar() {

engine.start();

}

}

Some missing questions in oops?

Here are some additional object-oriented programming (OOP) interview questions that are missing from the list you provided, which can help in further understanding OOP concepts:

**1. What is the difference between deep copy and shallow copy in OOP?**

* **Answer**:
  + **Shallow Copy**: A shallow copy creates a new object but does not recursively copy nested objects. Instead, it just copies references to the original nested objects.
  + **Deep Copy**: A deep copy creates a new object and recursively copies all nested objects, ensuring that the copy is completely independent of the original.

**2. What is the use of the super keyword in Java?**

* **Answer**:
  + The super keyword in Java is used to refer to the superclass (parent class) of the current object. It can be used to call superclass methods, access superclass constructors, or reference superclass fields.

**3. What is method overloading and how does it differ from method overriding?**

* **Answer**:
  + **Method Overloading**: Occurs when two or more methods in the same class have the same name but different parameters (different number of parameters or parameter types). It is resolved at compile time (static polymorphism).
  + **Method Overriding**: Happens when a subclass provides its specific implementation of a method that is already defined in its superclass. It is resolved at runtime (dynamic polymorphism).

**4. What is the difference between a class and an object?**

* **Answer**:
  + **Class**: A class is a blueprint or template for creating objects. It defines the properties (attributes) and behaviors (methods) that the objects created from the class will have.
  + **Object**: An object is an instance of a class. It is created based on the class template and can hold specific values for its attributes and can invoke methods defined in the class.

**5. What is the purpose of the final keyword in OOP?**

* **Answer**:
  + **Final Variable**: A variable that cannot be reassigned after its initial value is set.
  + **Final Method**: A method that cannot be overridden by subclasses.
  + **Final Class**: A class that cannot be subclassed.

**6. What is the difference between this and super keywords in Java?**

* **Answer**:
  + **this**: Refers to the current instance of the class. It is used to access instance variables, methods, and constructors within the class.
  + **super**: Refers to the superclass (parent class) and is used to call the superclass’s methods, constructors, and fields.

**7. What is an inner class in Java?**

* **Answer**:
  + An inner class is a class defined within another class. It has access to the outer class's private members. Inner classes can be used for logical grouping of classes, to enhance encapsulation, or to implement event listeners.

**8. What is the difference between static and non-static methods in OOP?**

* **Answer**:
  + **Static Methods**: Belong to the class rather than to instances of the class. They are invoked without creating an object and can access only static variables and methods.
  + **Non-Static Methods**: Belong to instances of the class. They require an object to be invoked and can access both static and non-static variables.

**9. What is the concept of "has-a" and "is-a" relationship in OOP?**

* **Answer**:
  + **"is-a" Relationship**: Represents inheritance, where a subclass is a type of its superclass. For example, a Dog "is-a" Animal.
  + **"has-a" Relationship**: Represents composition, where a class contains references to other objects as its members. For example, a Car "has-a" Engine.

**10. What is the purpose of the instanceof operator in Java?**

* **Answer**:
  + The instanceof operator is used to test whether an object is an instance of a specific class or subclass. It returns true if the object is an instance of the class or any subclass of that class, and false otherwise.

**11. What is the difference between the equals() method and the == operator in Java?**

* **Answer**:
  + **== Operator**: Compares memory references (whether two references point to the same object).
  + **equals() Method**: Compares the actual contents of two objects. It is overridden in many classes (like String) to compare the actual values rather than the memory references.

**12. What is an anonymous class in Java?**

* **Answer**:
  + An anonymous class is a class defined without a name, usually used to instantiate a class for a single use. It is commonly used to implement interfaces or extend classes in a concise manner.

**13. What is a singleton class in OOP?**

* **Answer**:
  + A singleton class ensures that only one instance of the class is created during the entire runtime of the application. It provides a global point of access to that instance.

**14. What are the differences between composition and aggregation?**

* **Answer**:
  + **Composition**: Represents a "has-a" relationship, but the lifecycle of the contained objects is controlled by the container object. If the container object is destroyed, the contained objects are also destroyed.
  + **Aggregation**: Also represents a "has-a" relationship, but the contained objects can exist independently of the container object. The container object does not manage the lifecycle of the contained objects.

**15. What is method hiding in OOP?**

* **Answer**:
  + Method hiding occurs when a subclass defines a static method with the same signature as a static method in its superclass. The method in the superclass is hidden by the method in the subclass, and it is not an example of method overriding because static methods cannot be overridden.

**16. What is the clone() method in Java and how does it work?**

* **Answer**:
  + The clone() method is used to create a copy of an object. It is part of the Object class, and classes can override it to perform deep copying if needed. By default, the clone() method creates a shallow copy of the object.

**17. What is the difference between a constructor and a method in OOP?**

* **Answer**:
  + **Constructor**: Special method used to initialize an object when it is created. It has the same name as the class and does not have a return type.
  + **Method**: A function defined in a class to perform some operations. It can have a return type and may be called after an object is created.

**18. What are the advantages of using OOP?**

* **Answer**:
  + Code reusability via inheritance.
  + Modular structure due to encapsulation.
  + Easier to maintain and scale due to abstraction.
  + Flexibility in programming via polymorphism.
  + Improved code organization and readability.

**19. Can we have an abstract class with a constructor?**

* **Answer**: Yes, abstract classes can have constructors. While an abstract class cannot be instantiated, its constructor is called when an object of a subclass is created, allowing initialization of fields in the abstract class.

**20. What is the difference between this() and super() in constructors?**

* **Answer**:
  + **this()**: Refers to the current class's constructor and is used to call another constructor in the same class.
  + **super()**: Refers to the superclass's constructor and is used to call a constructor in the parent class.

These additional questions cover a wide range of topics in OOP and will help deepen your understanding for interviews or general knowledge of OOP principles.