While folks are joining

Get you laptops ready and login to your **replit** accounts.

We will be coding away in the session!

Crio Sprint: JAVA-112

OOPs: Polymorphism

Today’s Session Agenda

- Method Overloading (Static Polymorphism)
- Method Overriding (Dynamic Polymorphism)
- Final methods
- Final classes

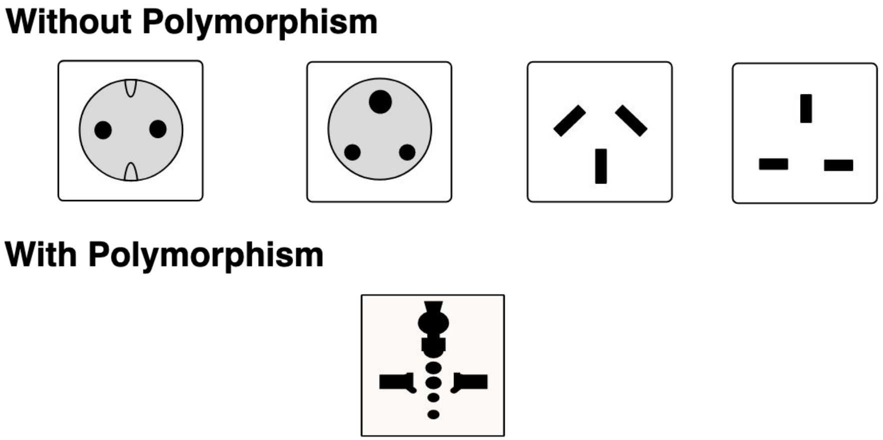
Why Polymorphism? - Scenario #1 Electric Socket

Ever done this while travelling?

You don’t want to pack all these in your travel bag either!

Why Polymorphism ? - Scenario #1 Electric Socket

Wouldn’t it will be better if we had sockets that could accept many different types of plugs.



What is Polymorphism ?

- ***Polymorphism*** means having **many forms**.
- Perform a single action in different ways.
    - Define one interface & have multiple implementations.

"Now Speak!"
"Quack"
"Woof"
"Meow"
arbabwaseer@gmail.com
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Types of Polymorphism

- Compile Time Polymorphism
  - Method Overloading
  - Static Binding
- Runtime Polymorphism
  - Method Overriding
  - Dynamic Binding

Activity 1 - Addition

- Perform the addition of the given numbers. But user can enter any number of arguments.
- Possible Solution:
  - **addTwo(int, int)** method for two parameters
  - **addThree(int,int,int)** for three parameters
  - So on.
- What’s the problem with the above technique?
  - Difficult to understand the behaviour of the method due to strange naming convention.
  - Difficult to track how many such methods are performing addition in the class due to different names.
- Can we avoid this problem?
  - Yes. Method Overloading.

Method Overloading

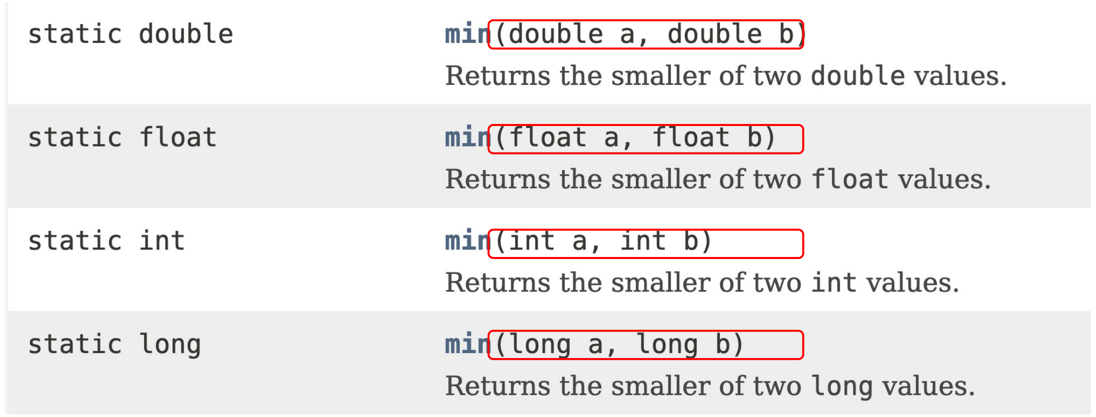
- What is Method Overloading?
  - Multiple methods having the **same name but difference in parameters**.
  - A class can **hold several methods** having the **same name.**
- **Three ways to overload methods:**
  - By changing the number of arguments/parameters.
  - By changing the data type of arguments.
  - By changing the Order of arguments.
- **Solution for Addition Activity**
      - **addition(int, int)**
      - **addition(int,int,int)**

1. By Changing the number of arguments / parameters

```
class SimpleCalculator
{
   int add(int a, int b)
   {
       return a+b;
   }
   int  add(int a, int b, int c)
   {
       return a+b+c;
   }
}
public class Demo
{
  public static void main(String args[])
  {
     SimpleCalculator obj = new SimpleCalculator();
     System.out.println(obj.add(10, 20));
     System.out.println(obj.add(10, 20, 30));
  }
}
```

Activity 2 - Find variations of Math.min()

- In Java's Math class, you will find many examples of overloaded methods.
- min() is overloaded with different data types.



`static double`	`min(double a, double b)` Returns the smaller of two `double` values.
`static float`	`min(float a, float b)` Returns the smaller of two `float` values.
`static int`	`min(int a, int b)` Returns the smaller of two `int` values.
`static long`	`min(long a, long b)` Returns the smaller of two `long` values.

3. By changing the Order of Arguments

```
class Student
{
  public void show(String name, int age)
  {
    System.out.println("Name of person = "+name+ " and age is = "+ age);
  }
  public void show(int age, String name)
  {
    System.out.println("Name of person = "+name+ " and age is = "+ age);
  }
  public static void main (String [] args)
  {
   Student s = new Student();
   // If student providing parameter of String and int  type then first method called
   s.show("Ram", 25);
   // If student providing parameter of int and String type then second method called
   s.show(25, "Ram");
  }
}
```

Curious Cats

- Can we overload main() method in Java?
  - Yes, but JVM calls that main() method that receives string array as an argument only.
- Try running the below code:

```
public class MainMethodOverloadingTest
{
            public static void main(String[] args)
            {
              System.out.println("main(String[] args)");
              main();
            }
           public static void main()
           {
             System.out.println("main without args");
            }
           public static void main(String args)
           {
             System.out.println("main with string args");
            }
}
```

Curious Cats

- How does JVM recognize which overloaded method is called?
  - JVM observers the signature of methods for multiple methods with same name.
  - JVM understands that signatures are different and decides which appropriate method to call.
- Why is method overloading by changing the return type of a method, not possible?
  - Compiler only checks method signature for duplication and not the return type.
- When do we use Static Polymorphism?

Summary - Method Overloading

- When a class has two or more than two methods which are having the **same name but different types of order or number of parameters,** it is known as Method Overloading.
- Method overloading is resolved during **compile time.**
- Three ways to overload methods:
    - By changing the **number of arguments/parameters.**
    - By changing the **data type of arguments.**
    - By changing the **Order of arguments.**
- Changing only return type with same parameters of method is not Method Overloading.

5 minute break

Activity 3 - Bank Interest Rates

Consider a scenario where Bank is a class that provides functionality to get the rate of interest. However, the rate of interest varies according to banks. For example, SBI and ICICI banks could provide 8% and 7% rate of interest.

What would be the output from this program?

- Interest rate will be printed as 5 for every bank.

What can we do to fix it?

- Create new methods in each bank which will give the expected rate.

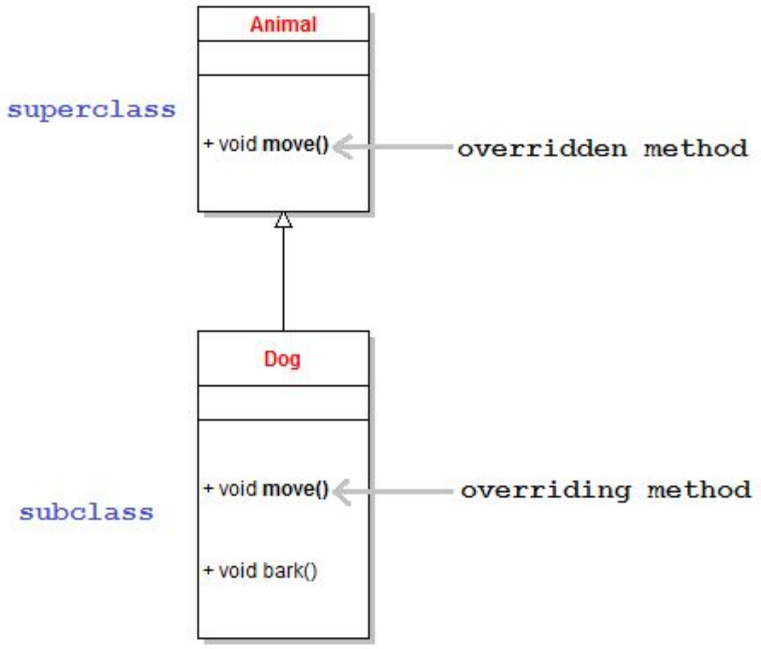
Can we use the same method name - *getRateOfInterest* in each bank subclass?

- Yes. Method Overriding.

```
class Bank{
  int getRateOfInterest(){return 5;}
}
//Creating child classes.
class SBI extends Bank{
}
class ICICI extends Bank{
}

class Test{
  public static void main(String args[]){
    SBI s=new SBI();
    ICICI i=new ICICI();
    System.out.println("SBI Rate of
Interest: "+s.getRateOfInterest());
    System.out.println("ICICI Rate of
Interest: "+i.getRateOfInterest());
  }
}
```

Method Overriding



```
class Bank{
 //Overridden Method
 int getRateOfInterest(){return 5;}
}
//Creating child classes
class SBI extends Bank{
 //Overriding Method
 @Override
  int getRateOfInterest(){return 8;}
}
class ICICI extends Bank{
  //Overriding Method
 @Override
  int getRateOfInterest(){return 7;}
}

class Test{
 public static void main(String args[]){
   SBI s=new SBI();
   ICICI i=new ICICI();
   System.out.println("SBI Rate of Interest"+ s.getRateOfInterest());
   System.out.println("ICICI Rate of Interest: "+i.getRateOfInterest());
 }
}
```

Summary - Rules for Method Overriding

1. **Only inherited methods** can be overridden.
2. The overriding method must have **same argument list**.
3. The overriding method must have **same return type**.
4. The overriding method **must not have more restrictive access modifier**.
   a. If the overridden method has *default* access, then the overriding one must be *default*, *protected* or *public*.
   b. If the overridden method is *protected*, then the overriding one must be *protected* or *public*.
   c. If the overridden method is *public*, then the overriding one must be only *public*.

Activity 3 - How to call an Overridden Method?

Suppose `Base b = new Derived();`

what is the result of the call `b.methodOne();`?

- A subclass might need to call the parent method for some operation to be successful.
- But the parent method is overridden, so how can we still call it?
- Use ***super.method()*** to force the parent's method to be called.
    - Polymorphism - GitLab

Curious Cats

- Can we override a static method?
  - No, static methods cannot be overridden in Java.
  - Static methods are class-based and are called by class directly.
  - They don’t need objects to be invoked at runtime.
  - Hence the static method dispatch is determined by the compiler.
- Can we override final method?
  - A final method means that it cannot be re-implemented by a subclass, thus it cannot be overridden.
- Can we override constructor?
  - No, we cannot override a constructor.
  - Subclasses cannot override a parent class’s constructor as a constructor of two classes cannot be the same.

Curious Cats

- Do we really need to use @Override annotation?
  - Not really but good to have.
  - Makes it human readable to understand that the method is a overriding method.
  - It helps to catch bug at compile time with less effort.

How would you do this in Java?

- A unique mobile (the iPhone Yoda model) has been introduced!
  - Apple wants this to be a one time model that no one replicates.
  - How would they do that?
- There is a counter method which increments count, every time a new instance of the class is created
  - The developer doesn’t want anyone who uses this counter to modify this logic.
  - How would they do that?
- Answer - The **final** keyword
  - **final** class
  - **final** methods

Activity:- Find a Bug

```
public class Calculator{

    public int add(int a, int b){
        return a + b;
    }
    public int substract(int a, int b){
        return a - b;
    }
    public int multiply(int a, int b){
        return a * b;
    }
    public int divide(int a, int b){
        return a / b;
    }
}
```

```
public class ScientificCalculator
extends Calculator{

    @Override
    public int add(int a, int b){
        return a - b;
    }
    @Override
    public int substract(int a, int b){
        return a + b;
    }
    public int square(int a){
        return a * a;
    }
    public double divide(int a){
        return Math.sqrt(a);
    }
    // several other methods
}
```

- What's the issue with ScientificCalculator Class?
- How can we stop overriding the methods?
    - Mark the methods as **final.**
- A method marked as final **cannot be overridden by subclasses** (we will revisit method overriding in detail later).

Curious Cats

- Can we inherit a String Class? Why or Why not?
- It is an immutable class.
    - How can we make a class immutable?
        - Mark the class as **final**.

```
final class String{}
```

- What are the other benefits of final classes?
    - Prevent further inheritance, it cannot be extended

Questions

1. What is polymorphism in Java, and how does it contribute to object-oriented programming?
2. What are the two types of polymorphism in Java?
3. What is method overloading in Java, and how does it work?
4. What is method overriding in Java, and how does it work?
5. Compare method overloading and method overriding in Java, highlighting their differences and use cases.

Session Revision Quiz

[Quiz Link]

Solve this quiz to access your understanding of session’s topics clearly

Take home exercises for the session

- Polymorphism Byte
    - Polymorphism Quiz (Link Present in Byte)

All of these details are also available on the site.

Further Reading

- Java - When NOT to call super() method when overriding? - Stack Overflow

Thank you