Polymorphism in Java

Polymorphism in Java is a concept by which we can perform a *single action in different ways*. Polymorphism is derived from 2 Greek words: poly and morphs. The word "poly" means many and "morphs" means forms. So polymorphism means many forms.

There are two types of polymorphism in Java: compile-time polymorphism and runtime polymorphism. We can perform polymorphism in java by method overloading and method overriding.

If you overload a static method in Java, it is the example of compile time polymorphism. Here, we will focus on runtime polymorphism in java

Runtime Polymorphism in Java

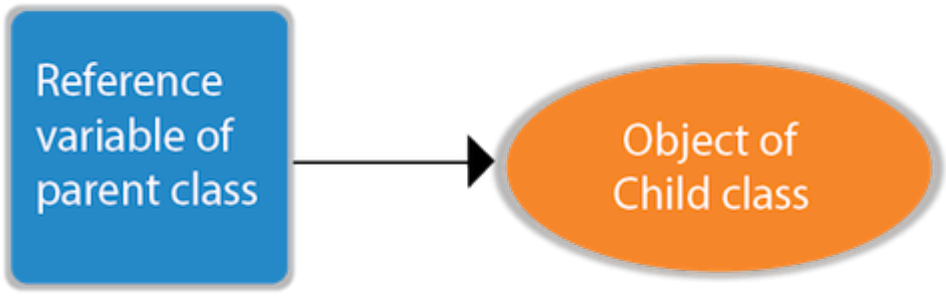
Runtime polymorphism or **Dynamic Method Dispatch** is a process in which a call to an overridden method is resolved at runtime rather than compile-time.

In this process, an overridden method is called through the reference variable of a superclass. The determination of the method to be called is based on the object being referred to by the reference variable.

Let's first understand the upcasting before Runtime Polymorphism.

Upcasting

If the reference variable of Parent class refers to the object of Child class, it is known as upcasting. For example:




```
class A{}
```

```
class B extends A{}

A a=new B();//upcasting
```

For upcasting, we can use the reference variable of class type or an interface type. For Example:

```
interface I{}

class A{}

class B extends A implements I{}
```

Here, the relationship of B class would be:

```
B IS-A A
B IS-A I
B IS-A Object
```

Since Object is the root class of all classes in Java, so we can write B IS-A Object

Example of Java Runtime Polymorphism

In this example, we are creating two classes Bike and Splendor. Splendor class extends Bike class and overrides its run() method. We are calling the run method by the reference variable of Parent class. Since it refers to the subclass object and subclass method overrides the Parent class method, the subclass method is invoked at runtime.

Since method invocation is determined by the JVM not compiler, it is known as runtime polymorphism.

```
class Bike{
  void run(){System.out.println("running");}
}
class Splendor extends Bike{
  void run(){System.out.println("running safely with 60km");}

  public static void main(String args[]){
   Bike b = new Splendor();//upcasting
```

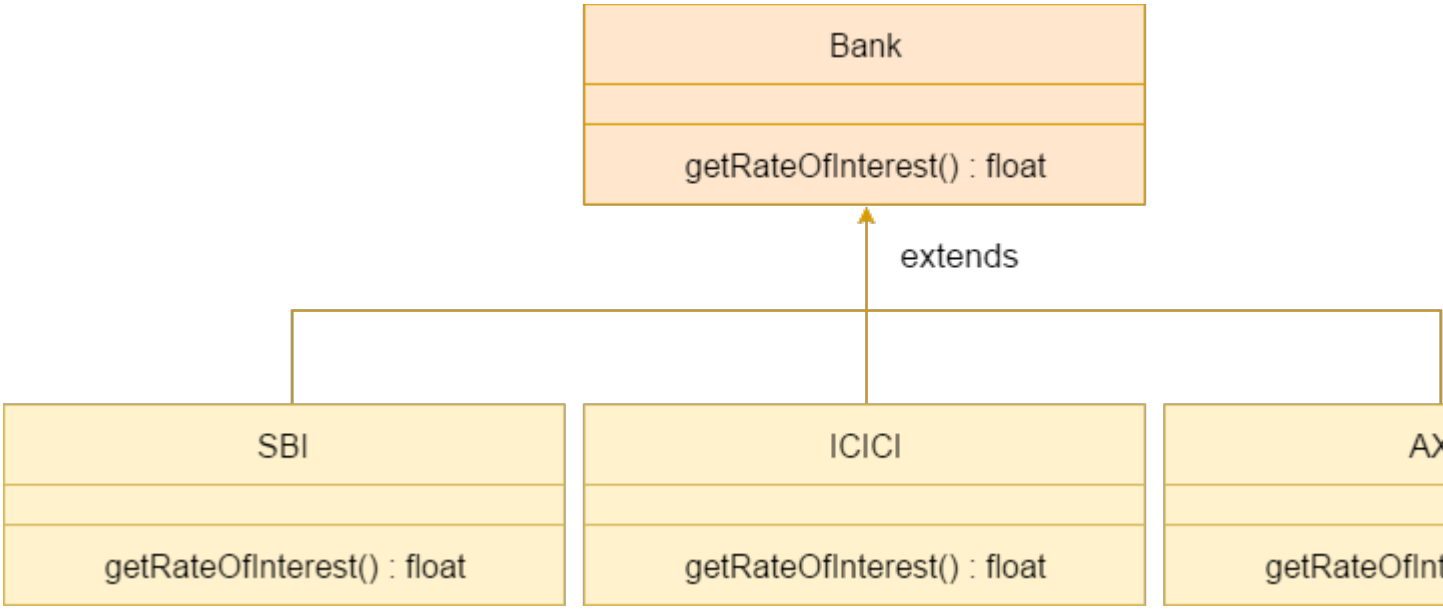
```
    b.run();
  }
}
```

Output:

```
running safely with 60km.
```

Java Runtime Polymorphism Example: Bank

Consider a scenario where Bank is a class that provides a method to get the rate of interest. However, the rate of interest may differ according to banks. For example, SBI, ICICI, and AXIS banks are providing 8.4%, 7.3%, and 9.7% rate of interest.



Note: This example is also given in method overriding but there was no upcasting.

```
class Bank{
float getRateOfInterest(){return 0;}
}
class SBI extends Bank{
float getRateOfInterest(){return 8.4f;}
}
```

```
class ICICI extends Bank{
float getRateOfInterest(){return 7.3f;}
}
class AXIS extends Bank{
float getRateOfInterest(){return 9.7f;}
}
class TestPolymorphism{
public static void main(String args[]){
Bank b;
b=new SBI();
System.out.println("SBI Rate of Interest: "+b.getRateOfInterest());
b=new ICICI();
System.out.println("ICICI Rate of Interest: "+b.getRateOfInterest());
b=new AXIS();
System.out.println("AXIS Rate of Interest: "+b.getRateOfInterest());
}
}
```

Output:

```
SBI Rate of Interest: 8.4
ICICI Rate of Interest: 7.3
AXIS Rate of Interest: 9.7
```

Java Runtime Polymorphism Example: Shape

```
class Shape{
void draw(){System.out.println("drawing...");}
}
class Rectangle extends Shape{
void draw(){System.out.println("drawing rectangle...");}
}
class Circle extends Shape{
void draw(){System.out.println("drawing circle...");}
```

```
}
class Triangle extends Shape{
void draw(){System.out.println("drawing triangle...");}
}
class TestPolymorphism2{
public static void main(String args[]){
Shape s;
s=new Rectangle();
s.draw();
s=new Circle();
s.draw();
s=new Triangle();
s.draw();
}
}
```

Output:

```
drawing rectangle...
drawing circle...
drawing triangle...
```

Java Runtime Polymorphism Example: Animal

```
class Animal{
void eat(){System.out.println("eating...");}
}
class Dog extends Animal{
void eat(){System.out.println("eating bread...");}
}
class Cat extends Animal{
void eat(){System.out.println("eating rat...");}
}
class Lion extends Animal{
```

```
void eat(){System.out.println("eating meat...");}

}

class TestPolymorphism3{

public static void main(String[] args){

Animal a;

a=new Dog();

a.eat();

a=new Cat();

a.eat();

a=new Lion();

a.eat();

}}
```

Output:

```
eating bread...
eating rat...
eating meat...
```

Java Runtime Polymorphism with Data Member

A method is overridden, not the data members, so runtime polymorphism can't be achieved by data members.

In the example given below, both the classes have a data member speedlimit. We are accessing the data member by the reference variable of Parent class which refers to the subclass object. Since we are accessing the data member which is not overridden, hence it will access the data member of the Parent class always.

> ***Rule: Runtime polymorphism can't be achieved by data members.***

```
class Bike{

int speedlimit=90;

}

class Honda3 extends Bike{
```

```
int speedlimit=150;


public static void main(String args[]){
  Bike obj=new Honda3();
  System.out.println(obj.speedlimit);//90
}
```

Output:

```
90
```

Java Runtime Polymorphism with Multilevel Inheritance

Let's see the simple example of Runtime Polymorphism with multilevel inheritance.

```
class Animal{
void eat(){System.out.println("eating");}
}
class Dog extends Animal{
void eat(){System.out.println("eating fruits");}
}
class BabyDog extends Dog{
void eat(){System.out.println("drinking milk");}
public static void main(String args[]){
Animal a1,a2,a3;
a1=new Animal();
a2=new Dog();
a3=new BabyDog();
a1.eat();
a2.eat();
a3.eat();
```

```
}

}
```

Output:

```
eating
eating fruits
drinking Milk
```

Try for Output

```
class Animal{

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

}

class Dog extends Animal{

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

}

class BabyDog1 extends Dog{

public static void main(String args[]){

Animal a=new BabyDog1();

a.eat();

}}
```

Output:

```
Dog is eating
```

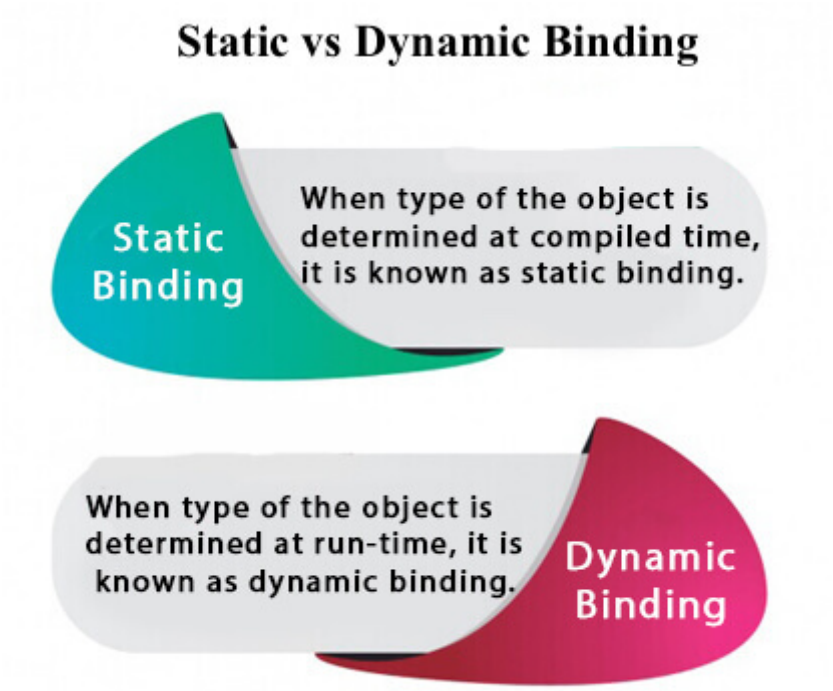
Since, BabyDog is not overriding the eat() method, so eat() method of Dog class is invoked.

Static Binding and Dynamic Binding

Connecting a method call to the method body is known as binding.

There are two types of binding

1. Static Binding (also known as Early Binding).
2. Dynamic Binding (also known as Late Binding).



Understanding Type

Let's understand the type of instance.

1) variables have a type

Each variable has a type, it may be primitive and non-primitive.

```
int data=30;
```

Here data variable is a type of int.

2) References have a type

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

```
 Dog d1;//Here d1 is a type of Dog
 }
}
```

3) Objects have a type

An object is an instance of particular java class,but it is also an instance of its superclass.

```
class Animal{}


class Dog extends Animal{
 public static void main(String args[]){
  Dog d1=new Dog();
 }
}
```

Here d1 is an instance of Dog class, but it is also an instance of Animal.

static binding

When type of the object is determined at compiled time(by the compiler), it is known as static binding.

If there is any private, final or static method in a class, there is static binding.

Example of static binding

```
class Dog{
 private void eat(){System.out.println("dog is eating...");}


 public static void main(String args[]){
  Dog d1=new Dog();
  d1.eat();
 }
}
```

Dynamic binding

When type of the object is determined at run-time, it is known as dynamic binding.

Example of dynamic binding

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


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


 public static void main(String args[]){
  Animal a=new Dog();
  a.eat();
 }
}
```

```
Output:dog is eating...
```

In the above example object type cannot be determined by the compiler, because the instance of Dog is also an instance of Animal.So compiler doesn't know its type, only its base type.