CSE 220 : OOP with Java

Inheritance

Instructor

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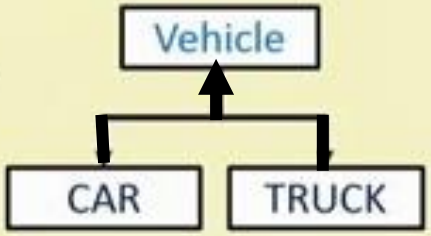
Inheritence

What is Inheritance?

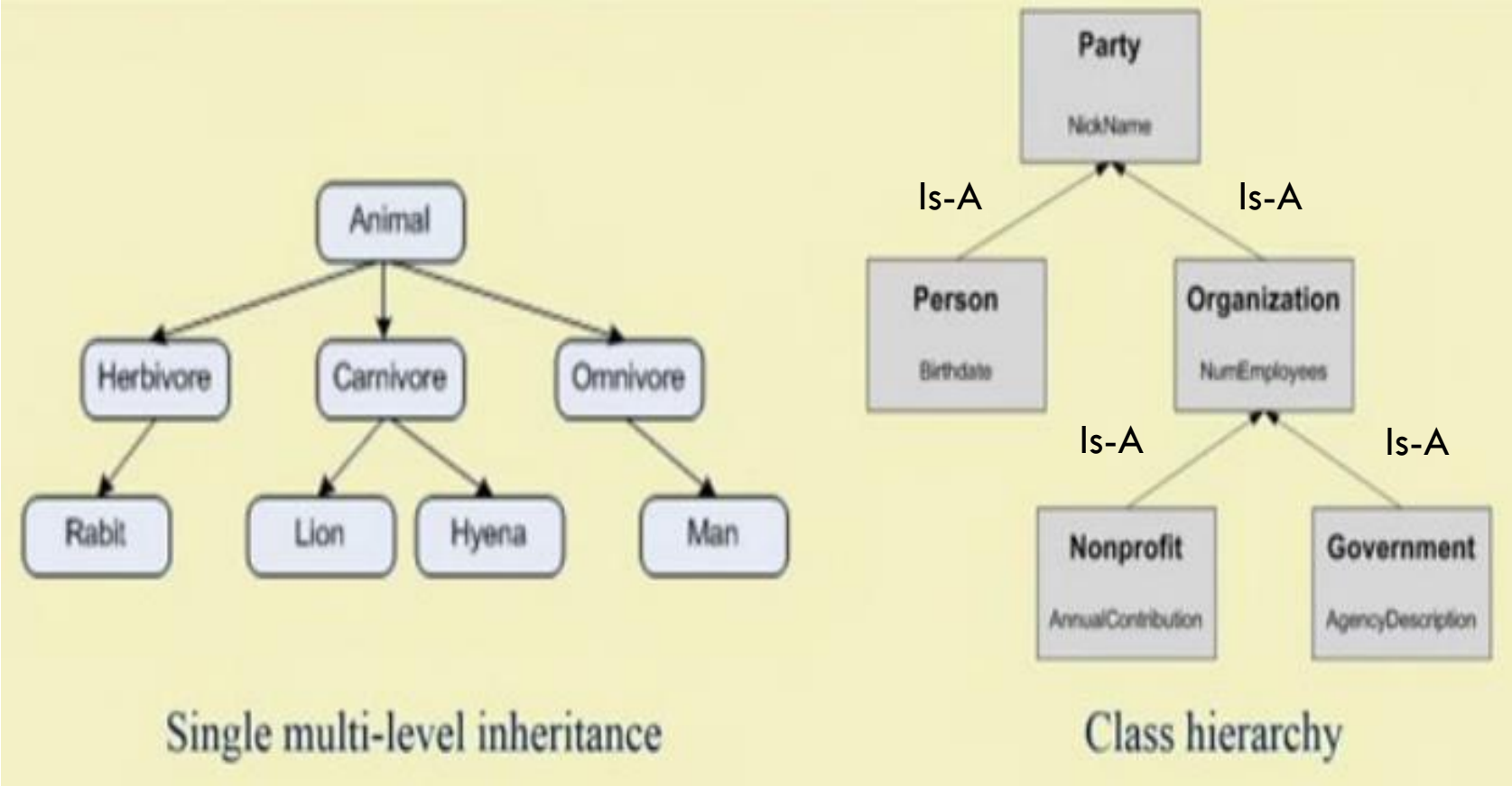
Inheritance is a mechanism in which one class acquires the property of another class. For example, a child inherits the traits of his/her parents.

General to Specific

- Inheritance is one of the cornerstone of object-oriented programming because it allows the creation of hierarchical classification.
- Using inheritance, one can create a general class that include some common set of items.
- This class then can be used to create more specific classes which has all the items from the base class, in addition to some items of its own.

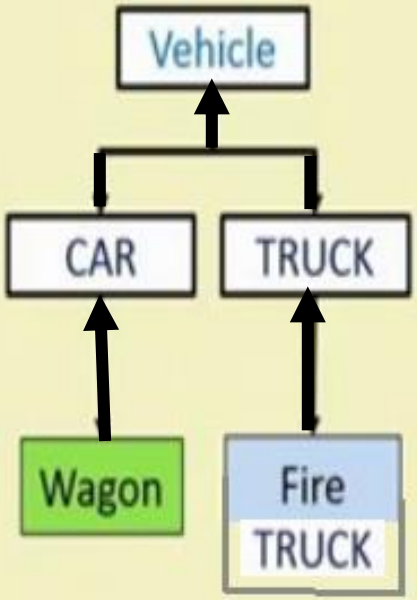


Inheritance in Java



Superclass and subclass relationship

- **Superclass:** A class that is inherited is called a superclass.
- **Subclass:** The class that does inheriting is called a subclass.
  - A subclass is a specialized version of a superclass
  - It inherits all of the instance variables and methods defined by the superclass and add its own, unique elements (i.e., variables and methods)
- **Reusability:** It is a mechanism which facilitates you to reuse the data and methods of the existing class when one create a new class.
  - One can use the same data and methods already defined in the previous class.



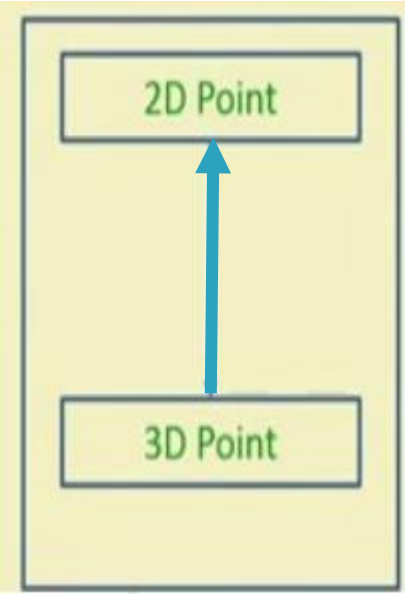
Inheritance in Java

- The **extends** keyword is used to define a new class that derives from an existing class. The meaning of "extends" is to increase the functionality.

```
class  Class_Name   [extends SuperClassName ]
                    [ implements Interface ] {
                        [declaration of member elements ]
                        [ declaration of methods ]
        }
```

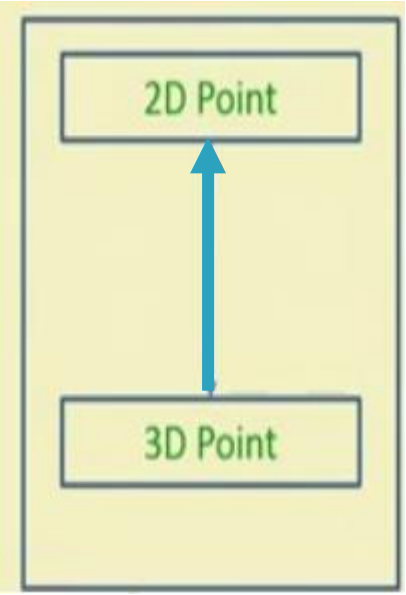
Those are included with [...] are optional. Member elements will be declared with usual convention as in C++ with the following syntax :

Inheritance in Java



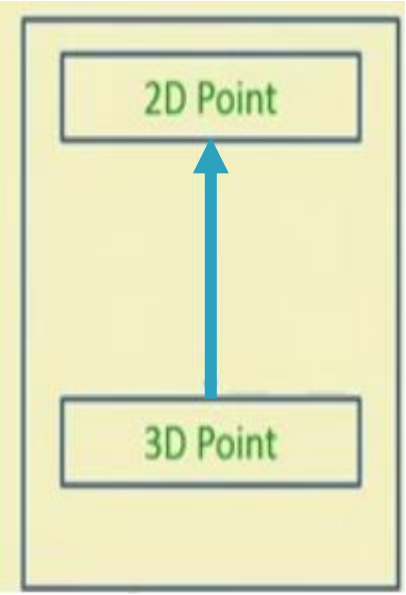

```
class Point2D
{
        int x;  int y;

          void setValue(int i, int j)   {
          x=i;  y=j;  }

          void display() {
           System.out.println("x= "+ x + "     y= "+y); }

        void who() {
         System.out.println("From Base Class"); }
}
```

Inheritance in Java



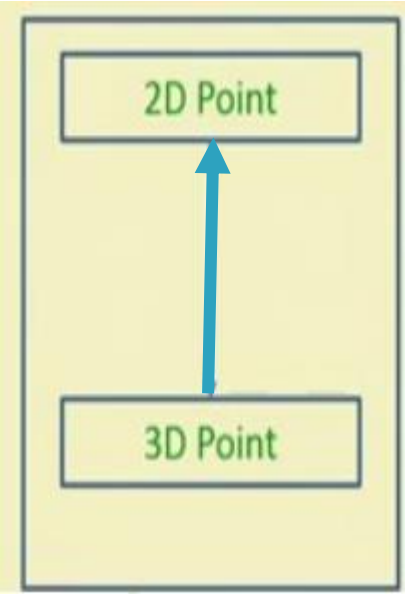

```
class Point3D extends Point2D
{
        int z;

            void setValue(int i, int j, int k)  {
             x=i;  y=j; z=k; }

             void display() {
             System.out.println("x= "+ x + "     y= "+y+"   z= "+z);
             }

            void who() {
            System.out.println("From Derived Class"); }
}
```

Inheritance in Java



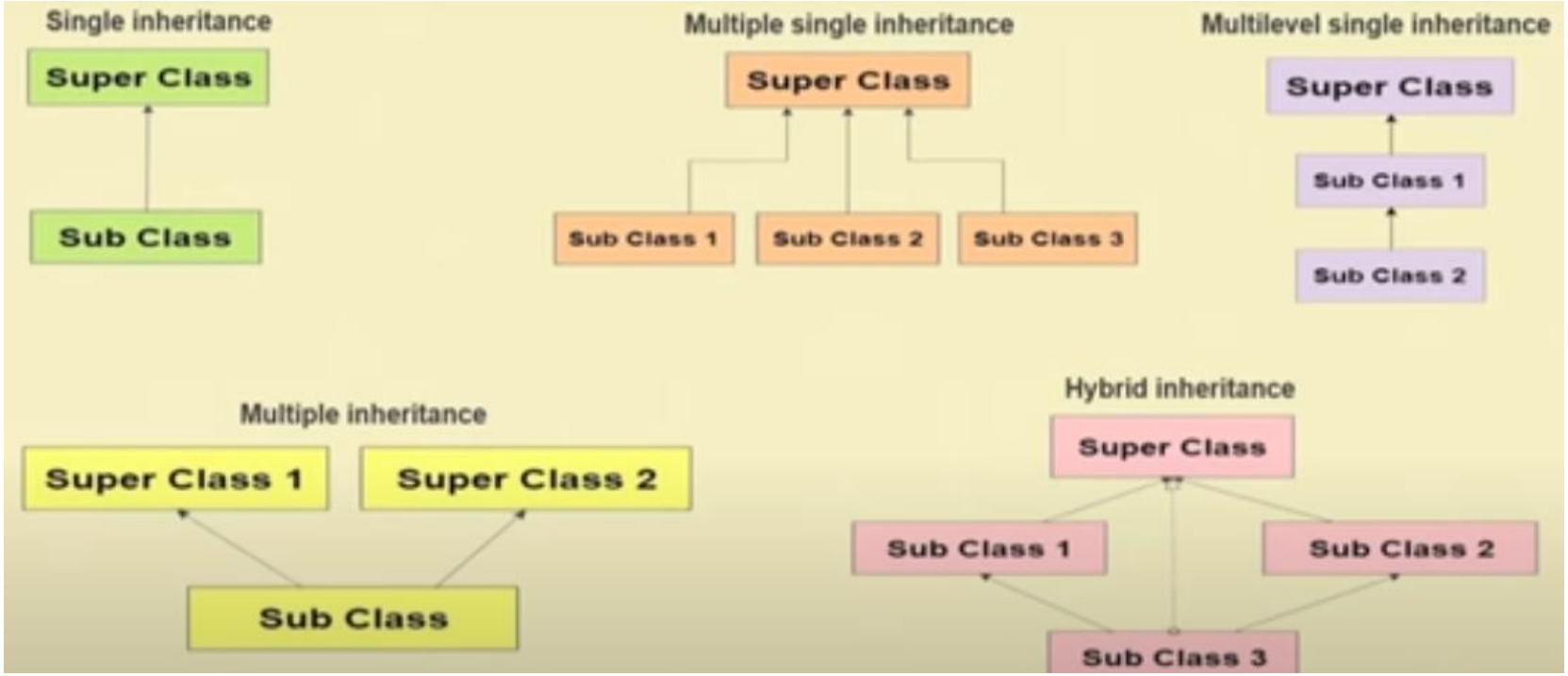

```
public class Test_Inheritance
{
        public static void main(String[] args)
        {
        Point2D p= new Point2D();
        Point3D q= new Point3D();

         p.setValue(10,10);
         q.setValue(20,30,40);

        p.display();
       q.display();

         p.who();
         q.who();

        }

}
```

Inheritance in Java

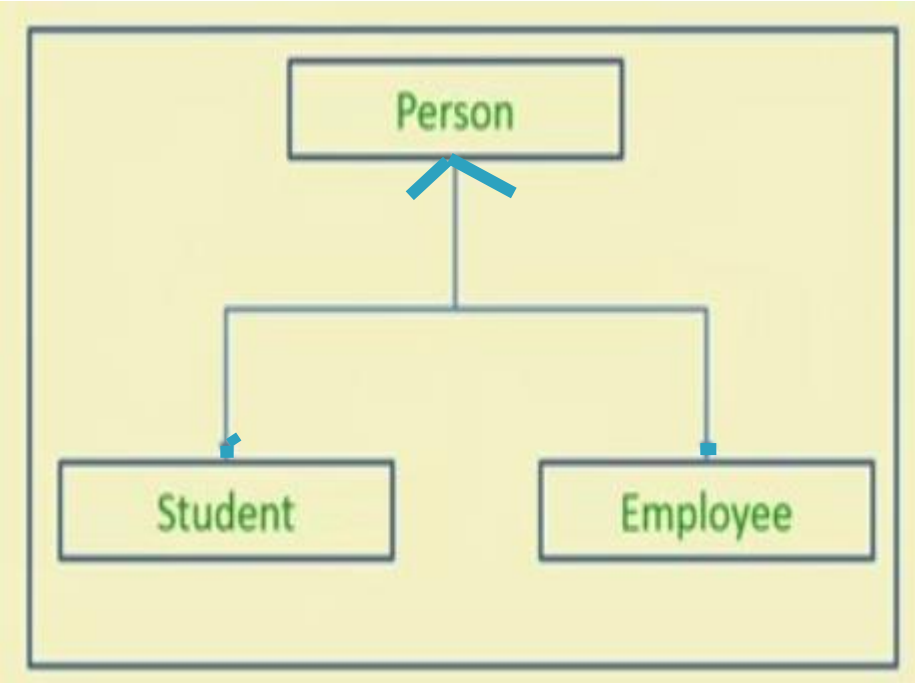



```
run:
x= 10     y= 10
x= 20     y= 30   z= 40
From Base Class
From Derived Class
```

Inheritance Types in Java



Simple Inheritance



Single Inheritance


```
class Person
{
            String name;
            int birthYear;

           public Person(String nm, int byear)
           {
             name = nm;
             birthYear =byear;
           }

           public void  show_data()
           {
             System.out.println( "name=  "+name+"  Birth Year=  "+birthYear);
           }

}
```

Single Inheritance


```
class Student extends Person
{
        private String dept;

        public Student(String nm, int byear, String dt)
        {
         super(nm, byear);
         dept = dt;
        }

        public void show_data()
              {
                System.out.println( "name=  "+name+"  Birth Year=  "+ birthYear+"  Dept=
              "+ dept);
              }

}
```

Single Inheritance


```
//Employee.java
class Employee extends Person
{
        private int salary;

        public Employee(String nm, int byear, int sal)
    {
    super(nm, byear);
    salary = sal;
    }

    public void show_data()
        {
          System.out.println( "name=  "+ name +" Birth Year=  "+birthYear+ "
        Salary= "+ salary);
        }

}
```

Single Inheritance


```
//PersonTester.java
public class PersonTester
{
  public static void main(String[] args)
  {
    Person   a = new Person("Rakib",2000);
    Student  b = new Student("Nafis",1998,"CSE");
    Employee c = new Employee ("Faisal", 1990,50000);
    a.show_data();
    b.show_data();
    c.show_data();
  }
}
```

```
run:
name=  Rakib  Birth Year=  2000
name=  Nafis Birth Year=  1998  Department= CSE
name=  Faisal Birth Year=  1990  Salary= 50000
```

Method Overriding

Usage of Java Method Overriding

- Method overriding is used to provide the specific implementation of a method which is already provided by its superclass.
- Method overriding is used for runtime polymorphism

Rules for Java Method Overriding

- The method must have the same name as in the parent class
- The method must have the same parameter as in the parent class.
- There must be an IS-A relationship (inheritance).

Method Overriding


```
public class Override_Test//class Point2D and
                          //Point3D previously defined
{
        public static void main(String[] args)
        {
                Point2D p= new Point2D();
                Point3D q= new Point3D();
                p.setValue(10,10);
                q.setValue(20,30,40);

                p.display();
                q.display();  //q has another inherited
                              //display method
                 p.who();
                 q.who();

                Point2D x=(Point2D) q; // cast q to an instance of class Point2D
                x.display();
        }
```

Method Overloading

Method Overridding

This is basically up casting; that means, q is a point of 3D, but we can cast into 2D using this kind of special features

```
run:
x= 10     y= 10
x= 20     y= 30   z= 40
From Base Class
From Derived Class
x= 20     y= 30   z= 40)
```

Method Overriding: C++


```
class Base
{
... .. ...
public:
  void getData();
  {
    ... .. ...
  }
};

class Derived: public Base
{
  ... .. ...
  public:
    void getData();
    {
    ... .. ...
    }
};

int main()
{
  Derived obj;
  obj.getData();
}
```

This function will not be called

Function call

Method Overriding and Overloading: Java

Methods of superclass defined in subclass with same name and signature

Multiple methods with same name within a class

Overriding

```
class Dog{
    public void bark(){
        System.out.println("woof ");
    }
}
class Hound extends Dog{
    public void sniff(){
        System.out.println("sniff ");
    }

    public void bark(){
        System.out.println("bowl");
    }
}
```

Same Method Name, Same parameter

Overloading

```
class Dog{
    public void bark(){
        System.out.println("woof ");
    }

    //overloading method
    public void bark(int num){
        for(int i=0; i<num; i++)
            System.out.println("woof ");
    }
}
```

Same Method Name, Different Parameter

Accessing supre class members and methods from subclass

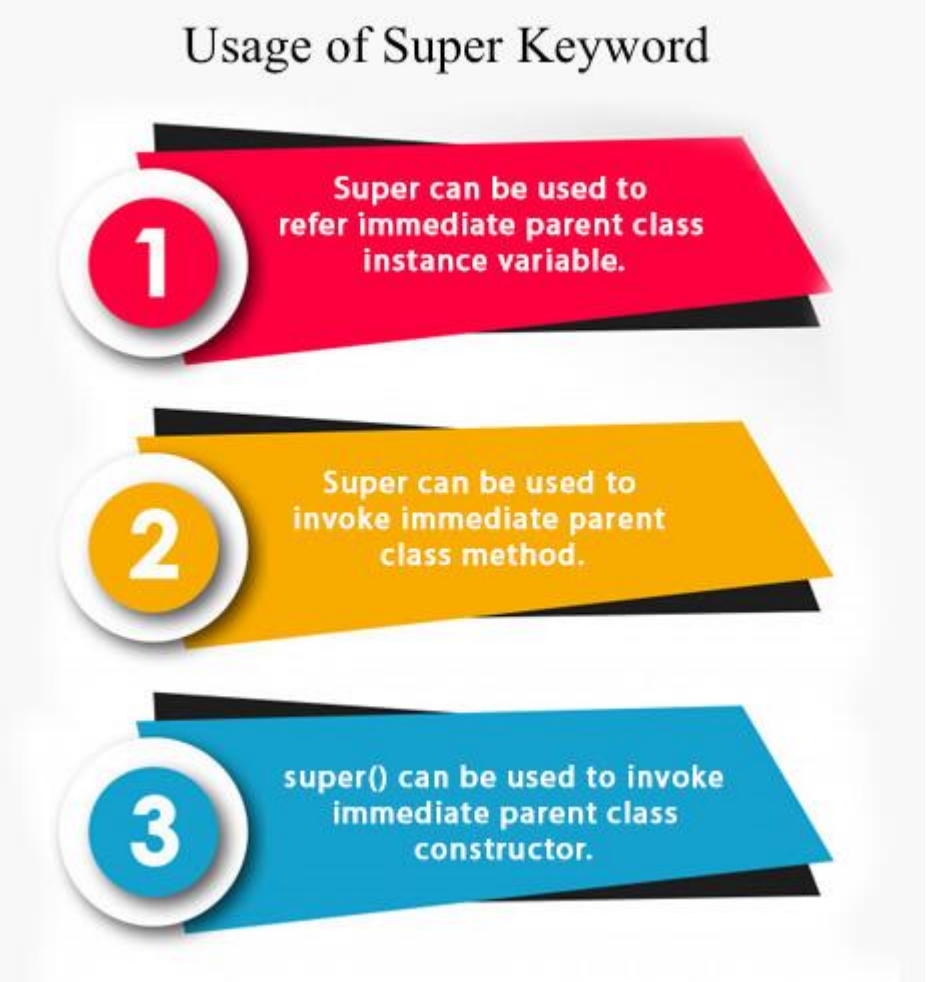
- A sub class object can reference a super class variable or method if it is not overridden.
- A super class object cannot reference a variable or method which is explicit to the sub class object.

Super keyword

The **super** keyword in Java is a reference variable which is used to refer immediate parent class members.

Whenever you create an instance of a sub class, an instance of its parent class is created implicitly, which is referred by **super** keyword.

Super keyword



Super keyword

1) super is used to refer immediate parent class instance variable.

```
class Animal{
String color="white";
}
class Dog extends Animal{
String color="black";
void printColor(){
System.out.println(color);//prints color of Dog class
System.out.println(super.color);//prints color of Animal class
}
}
class TestSuper1{
public static void main(String args[]){
Dog d=new Dog();
d.printColor();
}}
```

```
black
white
```

Super keyword

2) super can be used to invoke parent class method

```
class Animal{
void eat(){System.out.println("eating...");}
}
class Dog extends Animal{
void eat(){System.out.println("eating bread...");}
void bark(){System.out.println("barking...");}
void work(){
super.eat();
bark();
}
}
class TestSuper2{
public static void main(String args[]){
Dog d=new Dog();
d.work();
}}
```

```
eating...
barking...
```

Super keyword

3) super is used to invoke parent class constructor.

```
class Animal{
Animal(){System.out.println("animal is created");}
}
class Dog extends Animal{
Dog(){
super();
System.out.println("dog is created");
}
}
class TestSuper3{
public static void main(String args[]){
Dog d=new Dog();
}}
```

```
animal is created
dog is created
```

Super keyword:real use


```
class Person{
int id;
String name;
Person(int id,String name){
this.id=id;
this.name=name;
}
}

class Emp extends Person{
float salary;
Emp(int id,String name,float salary){
super(id,name);//reusing parent constructor
this.salary=salary;
}
void display(){System.out.println(id+" "+name+"
"+salary);}
}
```

```
class TestSuper{
public static void main(String[] args){
Emp e1=new Emp(1,“Babar",50000f);
e1.display();
}}
```

Runtime Polymorphism in Java

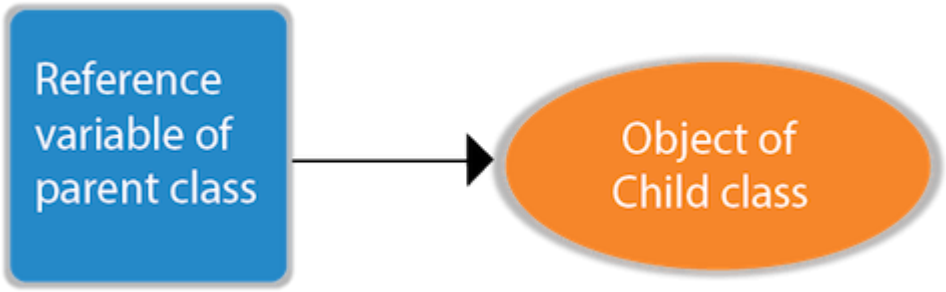
Dynamic method dispatch is a process in which a call to an overridden method is resolved at runtime rather than compile-time. Also, it is called Runtime polymorphism.

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

Runtime Polymorphism in Java

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
```

Runtime Polymorphism in Java

Upcasting

```
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();
  }
}
```

running safely with 60km.

Runtime Polymorphism in Java


```
class A {
        void callMe ( ) {
                System.out. println ( "I am from A ") ;
                }
        }
class B  extends A {
        void callMe ( ) {
        System.out.println ( "I am from B ");
        }
}
public class Who {
        public static void main(String args [ ] ) {
                A  a = new B ( ) ;
                a.callMe (  );
        }
}
```

```
I am from B
I am from B
```

Access Specifier

Public : Member elements and methods can be marked as public and then they can be accessed from any other method in Java Programs.

The public modifier can be applied to classes as well as methods and variables. It then allows to make a class accessible to other classes in other Packages.

The public access specification is automatic, in the sense that, if no access specifier is mentioned then by default it is having public accessibility.

Access Specifier

Private : Member elements and methods marked private can be used only marked private can be used only from inside their class. A private element / method is not visible in any other class, including subclasses . Also, a subclass cannot override a non-private method and make the new method private.

Protected : Member elements and methods marked protected can be used only from inside their class or in subclasses of that class. A subclass can still override a protected method or variable.

Access Specifier

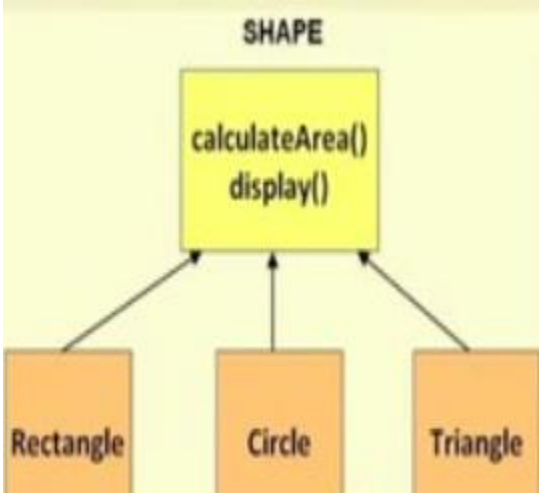
Modifiers	Within Same Class	Within same package	Outside the package-(Subclass)	Outside the package-(Global)
Public	Yes	Yes	Yes	Yes
Protected	Yes	Yes	Yes (only to derrived class)	No
Default	Yes	Yes	No	No
Private	Yes	No	No	No

Access Specifier


```
/* Example-1 : Private access modifier */

public class A{
        private int data = 40;
        public void msg(){
        System.out.println("Class A: Hello Java!");
        }
}

public class Demonstration {
        public static void main(String args[]){
        A obj = new A();            //OK : Class A is public
        System.out.println(obj.data); //Compile Time Error : data is private
        obj.msg();                  //OK : msg is public
        }
}
```

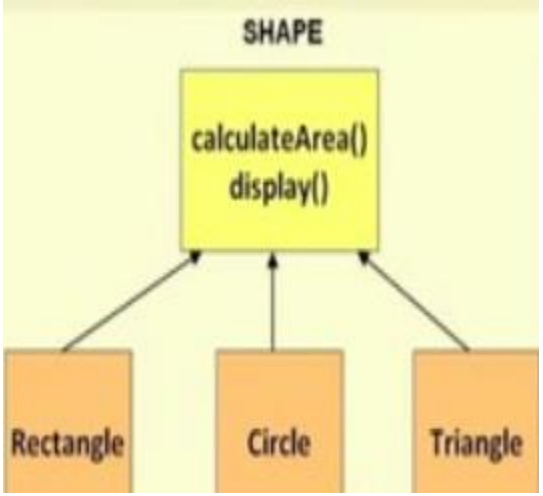
Abstract class

- Abstraction is a process of hiding the implementation details and showing only functionality to the user.
- Abstraction lets you focus on what the object does instead of how it does it.
- A class which is declared with the **abstract** keyword is known as an abstract class in Java. It can have abstract and non-abstract methods (i.e., method with the body only without its definition).



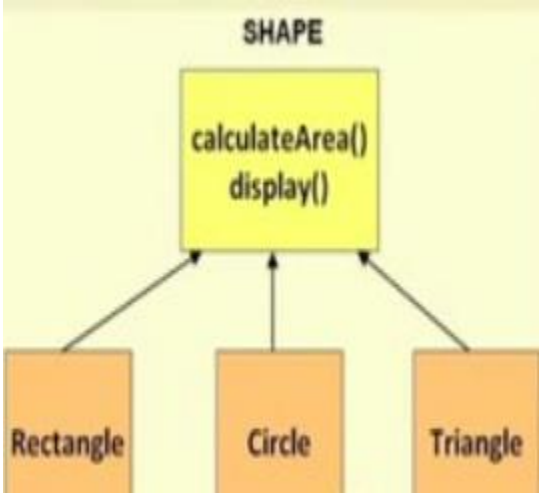
Abstract class


```
// An example abstract class in Java
abstract class Shape {
    int color;

    // An abstract function (like a pure virtual
function in C++)
    abstract void draw();
}
```



Abstract class


```
abstract class Base {
    abstract void fun();
}
class Derived extends Base {
    void fun() { System.out.println("Derived fun()
called"); }
}
class Main {
    public static void main(String args[]) {

        // Uncommenting the following line will
cause compiler error as the
        // line tries to create an instance of
abstract class.
        // Base b = new Base();

        // We can have references of Base type.
        Base b = new Derived();
        b.fun();
    }
}
```



Abstract class

Points to remember

- An abstract class must be declared with an `abstract` keyword.
- It can have abstract and non-abstract methods.
- It cannot be instantiated.
- It can have constructors and static methods also.
- It can have final methods which will force the sub class not to change the body of the method.

final keyword

The final keyword in Java is used to restrict the access of an item from its super class to a sub class. The Java `final` keyword can be used in many context.

- Variable : a variable cannot be accessed in sub class
- Method : a method cannot called from a sub class object
- Class : a class cannot be sub classed.

final keyword


```
// Final Class Inheritance  An Example

final class Bike{}

class Honda1 extends Bike{
   void run(){
     System.out.println("Running safely with 100kmph");
   }
}


final class Demonstration_611 {
   public static void main(String args[]){
                          Honda1 honda = new Honda1();
                          honda.run();
  }
}
```

References

Courtesy:

Object-Oriented Programming with C++ and Java- Debasis Samanta and course slides

References:
The Complete Reference Java 2: Herbert Schildt

Web materials