Day 106/180

Types of Inheritance 📑

Ques. Take your own example and solve Problem for all the 6 types of inheritance explained in the class. It will make your understanding better.

Inheritance is a mechanism of driving a new class from an existing class. The existing (old) class is known as base class or super class or parent class. The new class is known as a derived class or sub class or child class. It allows us to use the properties and behaviour of one class (parent) in another class (child).

Why Do We Need Java Inheritance?

Code Reusability: The code written in the Superclass is common to all subclasses. Child classes can directly use the parent class code.

Method Overriding: Method Overriding is achievable only through Inheritance. It is one of the ways by which Java achieves Run Time Polymorphism.

Abstraction: The concept of abstract where we do not have to provide all details is achieved through inheritance. Abstraction only shows the functionality to the user.

Access Modifiers in C++

The access modifier specifies the accessibility or scope of a field, method, constructor, or class.

1. Public: All the class members declared under the public specifier will be available to everyone. The data members and member functions declared as public can be accessed by other classes and functions too.

2. Private: The class members declared as private can be accessed only by the member functions inside the class. They are not allowed to be accessed directly by any object or function outside the class.

3. Protected: The protected access modifier is similar to the private access modifier in the sense that it can’t be accessed outside of its class unless with the help of a friend class. The difference is that the class members declared as Protected can be accessed by any subclass (derived class) of that class as well.

Types Of Inheritance

#1) Single Inheritance

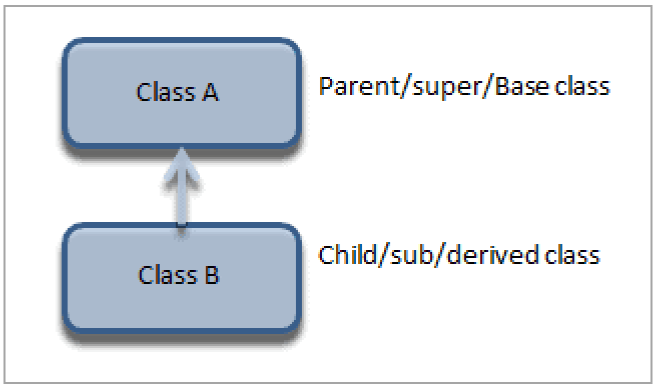
In single inheritance, a class derives from one base class only. This means that there is only one subclass that is derived from one superclass.

Single inheritance is usually declared as follows:

```
class subclassname : accessspecifier superclassname {

        //class specific code;

};
```



Given below is a complete Example of Single Inheritance.

```
#include <iostream>
#include <string>
using namespace std;
class Animal {
    string name = "";

   public:
    int tail = 1;
    int legs = 4;
};
class Dog : public Animal {
   public:
    void voiceAction() { cout << "Barks!!!"; }
};
int main() {
    Dog dog;
    cout << "Dog has " << dog.legs << " legs" << endl;
    cout << "Dog has " << dog.tail << " tail" << endl;
    cout << "Dog ";
    dog.voiceAction();
}
```

Output:

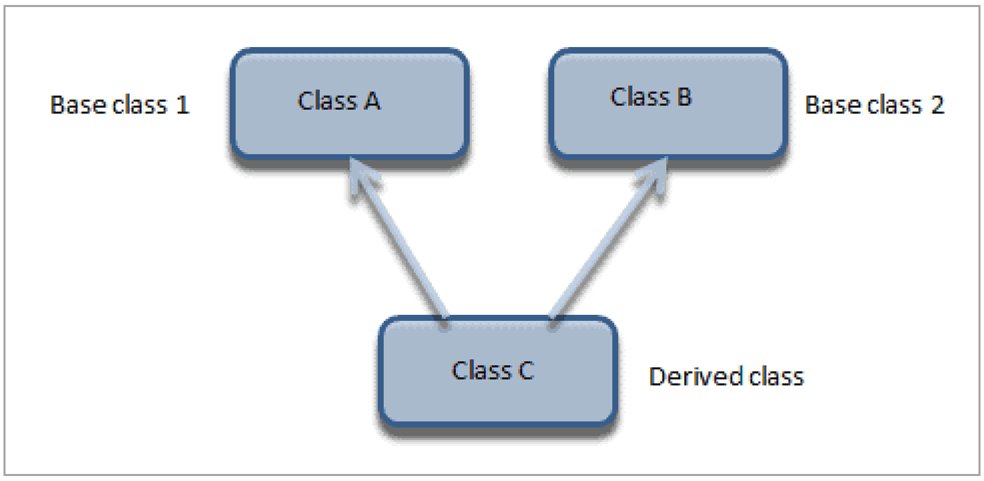
```
Dog has 4 legs
Dog has 1 tail
Dog Barks!!!
```

We have a class Animal as a base class from which we have derived a subclass dog. Class dog inherits all the members of the Animal class and can be extended to include its own properties, as seen from the output.

Single inheritance is the simplest form of inheritance.

#2) Multiple Inheritance

Multiple Inheritance is pictorially represented below.



Multiple inheritance is a type of inheritance in which a class derives from more than one class. As shown in the above diagram, class C is a subclass that has class A and class B as its parent.

In a real-life scenario, a child inherits from their father and mother. This can be considered an example of multiple inheritance.

Given below is a complete Example of Single Inheritance.

```
#include <iostream>
using namespace std;
// multiple inheritance example
class student_marks {
   protected:
    int rollNo, marks1, marks2;

   public:
    void get() {
        cout << "Enter the Roll No.: ";
        cin >> rollNo;
        cout << "Enter the two highest marks: ";
        cin >> marks1 >> marks2;
    }
};
class cocurricular_marks {
   protected:
    int comarks;

   public:
    void getsm() {
        cout << "Enter the mark for CoCurricular Activities: ";
        cin >> comarks;
    }
};

// Result is a combination of subject_marks and cocurricular activities
marks
class Result : public student_marks, public cocurricular_marks {
    int total_marks, avg_marks;

   public:
    void display() {
        total_marks = (marks1 + marks2 + comarks);
        avg_marks = total_marks / 3;
        cout << "\nRoll No: " << rollNo << "\nTotal marks: " <<
total_marks;
        cout << "\nAverage marks: " << avg_marks;
    }
};
int main() {
    Result res;
    res.get();       // read subject marks
    res.getsm();     // read cocurricular activities marks
    res.display();  // display the total marks and average marks
}
```

Output:

```
Enter the Roll No.: 25
Enter the two highest marks: 40 50
Enter the mark for CoCurricular Activities: 30
Roll No: 25
Total marks: 120
Average marks: 40
```

In the above example, we have three classes i.e. student_marks, cocurricular_marks, and Result. The class student_marks reads the subject mark for the student. The class cocurricular_marks reads the student’s marks in co-curricular activities.

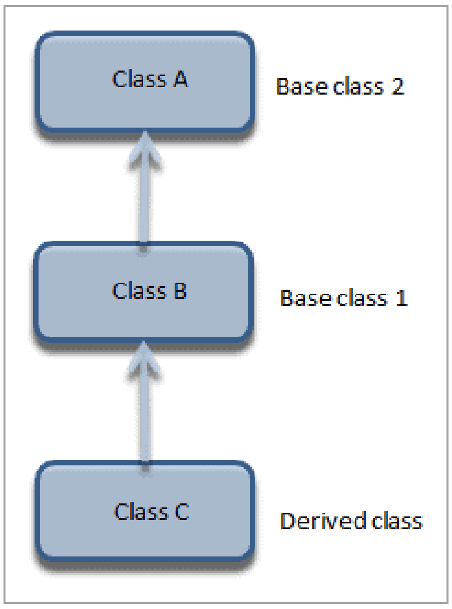
The Result class calculates the total_marks for the student along with the average marks.

In this model, the Result class is derived from student_marks and cocurricular_marks as we calculate results from the subject as well as co-curricular activities marks.

This exhibits multiple inheritances.

#3) Multilevel Inheritance

Multilevel inheritance is represented below.



In multilevel inheritance, a class is derived from another derived class. This inheritance can have as many levels as long as our implementation doesn't go wayward. In the above diagram, class C is derived from Class B. Class B is in turn derived from class A.

Let us see an example of Multilevel Inheritance.

```cpp
#include <iostream>
#include <string>
using namespace std;
class Animal {
    string name = "";

   public:
    int tail = 1;
    int legs = 4;
};
class Dog : public Animal {
   public:
    void voiceAction() { cout << "Barks!!!"; }
};
class Puppy : public Dog {
   public:
    void weeping() { cout << "Weeps!!"; }
};
int main() {
    Puppy puppy;
    cout << "Puppy has " << puppy.legs << " legs" << endl;
    cout << "Puppy has " << puppy.tail << " tail" << endl;
    cout << "Puppy ";
    puppy.voiceAction();
    cout << " Puppy ";
    puppy.weeping();
}
```

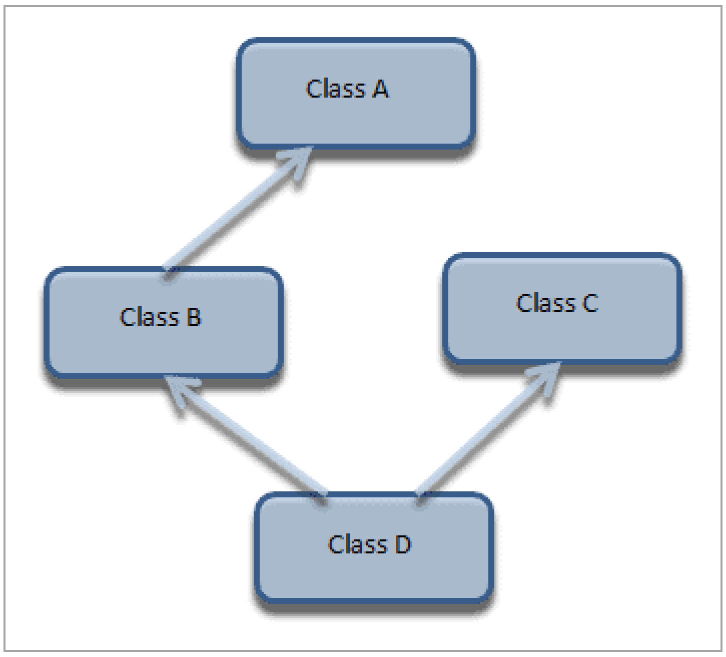
Output:

```
Puppy has 4 legs
Puppy has 1 tail
Puppy Barks!!! Puppy Weeps!!
```

Here we modified the example for Single inheritance such that there is a new class Puppy which inherits from the class Dog that in turn inherits from class Animal. We see that the class Puppy acquires and uses the properties and methods of both the classes above it.

#4) Hybrid Inheritance

Hybrid inheritance is depicted below.



Hybrid inheritance is usually a combination of more than one type of inheritance. In the above representation, we have multiple inheritance (B, C, and D) and multilevel inheritance (A, B, and D) to get a hybrid inheritance.

Let us see an example of Hybrid Inheritance.

```
#include <iostream>
#include <string>
using namespace std;
// Hybrid inheritance = multilevel + multilpe
class student {  // First base Class
    int id;
    string name;

   public:
    void getstudent() {
        cout << "Enter student Id and student name";
        cin >> id >> name;
    }
```

```
};
class marks : public student {  // derived from student
   protected:
    int marks_math, marks_phy, marks_chem;

   public:
    void getmarks() {
        cout << "Enter 3 subject marks:";
        cin >> marks_math >> marks_phy >> marks_chem;
    }
};
class sports {
   protected:
    int spmarks;

   public:
    void getsports() {
        cout << "Enter sports marks:";
        cin >> spmarks;
    }
};
class result : public marks,
               public sports {  // Derived class by multiple
inheritance//
    int total_marks;
    float avg_marks;

   public:
    void display() {
        total_marks = marks_math + marks_phy + marks_chem;
        avg_marks = total_marks / 3.0;

        cout << "Total marks =" << total_marks << endl;
        cout << "Average marks =" << avg_marks << endl;
        cout << "Average + Sports marks =" << avg_marks + spmarks;
    }
};

int main() {
    result res;  // object//
    res.getstudent();
    res.getmarks();
    res.getsports();
    res.display();
    return 0;
}
```

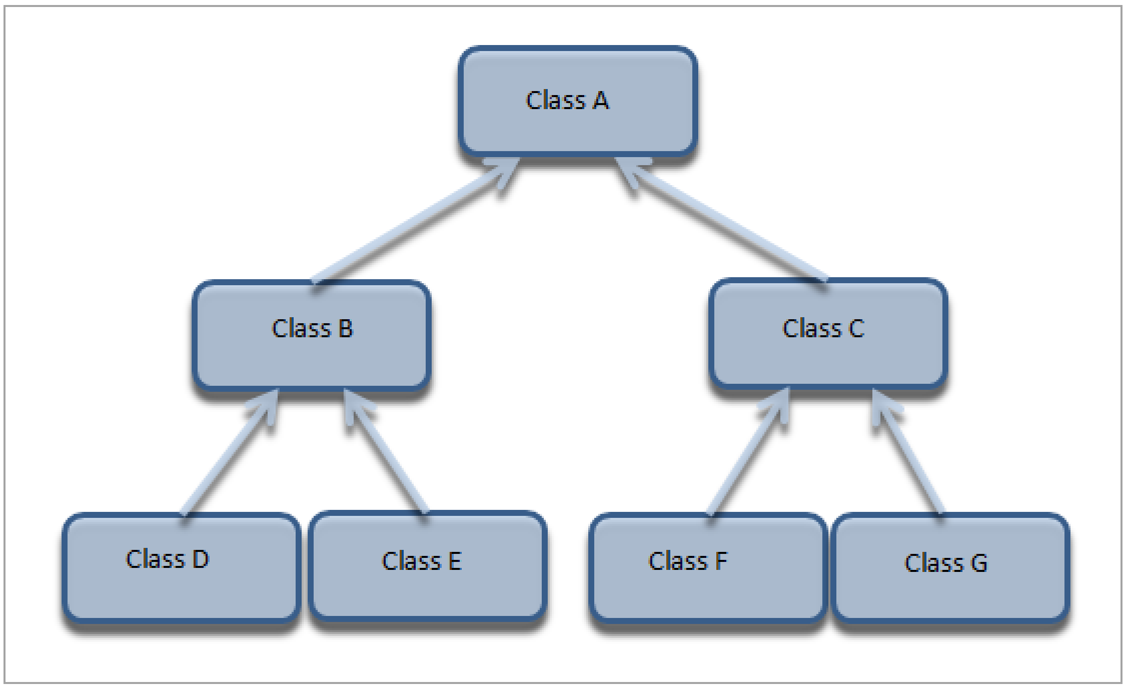
Output:

```
Enter student Id and student name 25 Ved
Enter 3 subject marks:89 88 87
Enter sports marks:40
Total marks =264
Average marks =88
Average + Sports marks =128
```

Here we have four classes i.e. Student, Marks, Sports, and Result. Marks are derived from the student class. The class Result derives from Marks and Sports as we calculate the result from the subject marks as well as sports marks.

The output is generated by creating an object of class Result that has acquired the properties of all three classes.

#5) Hierarchical Inheritance



In hierarchical inheritance, more than one class inherits from a single base class as shown in the representation above. This gives it a structure of a hierarchy.

Given below is the Example demonstrating Hierarchical Inheritance.

```cpp
#include <iostream>
using namespace std;
// hierarchical inheritance example
class Shape  // shape class -> base class
{
   public:
    int x, y;

    void get_data(int n, int m) {
        x = n;
        y = m;
    }
};
class Rectangle : public Shape  // inherit Shape class
{
   public:
    int area_rect() {
        int area = x * y;
        return area;
    }
};
class Triangle : public Shape  // inherit Shape class
{
   public:
    int triangle_area() {
        float area = 0.5 * x * y;
        return area;
    }
};
class Square : public Shape  // inherit Shape class
{
   public:
    int square_area() {
        float area = 4 * x;
        return area;
    }
};
int main() {
    Rectangle r;
    Triangle t;
    Square s;
    int length, breadth, base, height, side;
    // area of a Rectangle
    std::cout << "Enter the length and breadth of a rectangle: ";
    cin >> length >> breadth;
    r.get_data(length, breadth);
    int rect_area = r.area_rect();
    std::cout << "Area of the rectangle = " << rect_area << std::endl;
    // area of a triangle
    std::cout << "Enter the base and height of the triangle: ";
    cin >> base >> height;
    t.get_data(base, height);
    float tri_area = t.triangle_area();
    std::cout << "Area of the triangle = " << tri_area << std::endl;
    // area of a Square
    std::cout << "Enter the length of one side of the square: ";
    cin >> side;
    s.get_data(side, side);
    int sq_area = s.square_area();
    std::cout << "Area of the square = " << sq_area << std::endl;
    return 0;
}
```

Output:

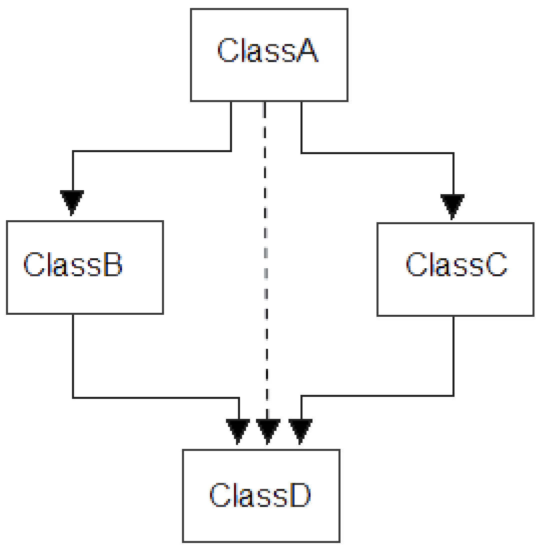
```
Enter the length and breadth of a rectangle: 10 5
Area of the rectangle = 50
Enter the base and height of the triangle: 4 8
Area of the triangle = 16
Enter the length of one side of the square: 5
Area of the square = 20
```

The above example is a classic example of class Shape. We have a base class Shape and three classes i.e. rectangle, triangle, and square are derived from it.

We have a method to read data in the Shape class while each derived class has its own method to calculate area. In the main function, we read data for each object and then calculate the area.

#5) Multipath Inheritance

Multipath Inheritance in C++ is derivation of a class from other derived classes, which are derived from the same base class.This type of inheritance involves other inheritance like multiple, multilevel, hierarchical etc.



Here class D is derived from class B and C.

Class B and C are child of class A.

From the above two points,we can say class D is indirectly derived from class A.

Example Code

```cpp
#include <iostream>
#include <conio>
using namespace std;

class person
{
    public:
    char name[100];
    int code;
    void input()
    {
        cout<<"\nEnter the name of the person : ";
        cin>>name;
        cout<<endl<<"Enter the code of the person : ";
        cin>>code;
    }
    void display()
    {
        cout<<endl<<"Name of the person : "<<name;
        cout<<endl<<"Code of the person : "<<code;
    }
};
```

```cpp
class account:virtual public person
{
    public:
    float pay;
    void getpay()
    {
        cout<<endl<<"Enter the pay : ";
        cin>>pay;

    }
    void display()
    {
        cout<<endl<<"Pay : "<<pay;
    }
};

class admin:virtual public person
{
    public:
    int experience;
    void getexp()
    {
        cout<<endl<<"Enter the experience : ";
        cin>>experience;

    }
    void display()
    {
        cout<<endl<<"Experience : "<<experience;
    }
};
class master:public account,public admin
{
    public:
    char n[100];
    void gettotal()
    {
        cout<<endl<<"Enter the company name : ";
        cin>>n;
    }
    void display()
    {
        cout<<endl<<"Company name : "<<n;
    }
};

int main()
{
    master m1;
    m1.input();
    m1.getpay();
    m1.getexp();
    m1.gettotal();
    m1.person::display();
    m1.account::display();
    m1.admin::display();
    m1.display();
    return 0;
}
```

Output:

```
Enter the name of the person : Chetali
Enter the code of the person : 1224
Enter the pay : 20000
Enter the experience : 2
Enter the company name : Hitech
Name of the person : Chetali
Code of the person : 1224
Pay : 20000
Experience : 2
Company name : Hitech
```

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