National University of Computer & Emerging Sciences, Karachi
Computer Science Department
Spring 2022, Lab Manual - 06

Course Code: CL-1004	Course : Object Oriented Programming Lab

Lab # 06

Outline:

- Introduction to Inheritance
- Single Level Inheritance
- Visibility Modes
- Multilevel Inheritance
- Hierarchical Inheritance

INTRODUCTION TO INHERITANCE

Inheritance is one of the key features of Object-oriented programming in C++. It allows us to create a new class (derived class) from an existing class (base class).

Base Class:

- A base class is the class from which features are to be inherited into another class.

Derived Class:

- A derived class is the one which inherits features from the base class. It can have additional properties and methods that are not present in the parent class that distinguishes it and provides additional functionality.

Real World Example:

- A real-world example of inheritance constitutes the concept that children inherit certain features and traits from their parents. In addition, children also have their unique features and traits that distinguishes them from their parents.

Basic syntax for Inheritance:

```
class derived-class-name : access base-class-name {
// body of class
};
```

Advantages of Inheritance:

The main advantage of inheritance is **code reusability.** You can reuse the members of your base class inside the derived class, without having to rewrite the code.

TYPES OF INHERITANCE BASED ON BASE CLASS ACCESS CONTROL

There are three types of inheritance with respect to base class access control:

- Public
- Private
- Protected

Public Inheritance:

- With public inheritance, every object of a derived class is also an object of that derived class's base class. However, base class objects are not objects of their derived classes.

Is – A Relationship:

- Inheritance is represented by an is-a relationship which means that an object of a derived class also can be treated as an object of its base class for example, a Car is a Vehicle, so any attributes and behaviors of a Vehicle are also attributes and behaviors of a Car.

Syntax for public Inheritance:

```
Class (name of the derived class) : public (name of the base class)
Class Car : public Vehicle
```

Base Class Access Control for Public, Private and Protected:

Visibility of Base Class Members	**Types of Inheritance**		
	Public Inheritance	***Private Inheritance***	***Protected Inheritance***
Public	Public in derived class	Private in derived class	Protected in derived class
Private	Hidden in derived class	Hidden in derived class	Hidden in derived class
Protected	Protected in derived class	Hidden in derived class	Protected in derived class

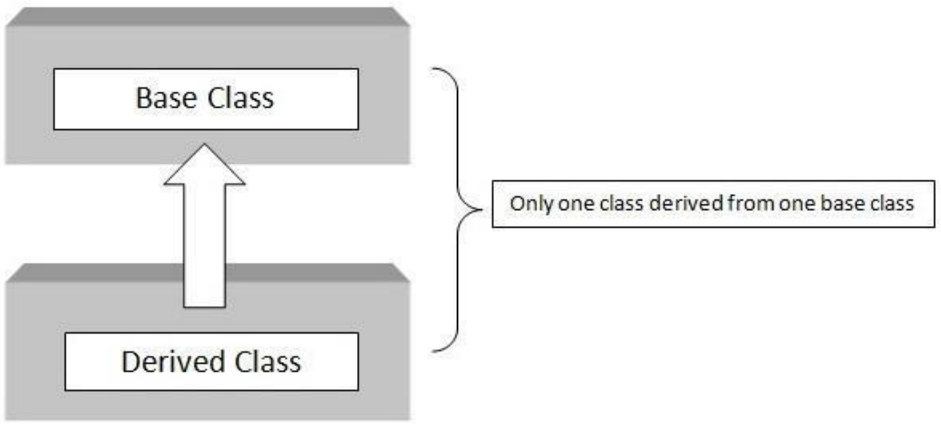
TYPES OF INHERITANCE BASED ON DERIVED CLASSES

Inheritance based on derived classes can be categorized as follows:

- Single Inheritance
- Multiple Inheritance
- Multilevel Inheritance
- Hierarchical Inheritance
- Hybrid Inheritance

Single Inheritance:

- In this type of inheritance there is one base class and one derived class.
- As shown in the figure below, in single inheritance only one class can be derived from the base class. Based on the visibility mode used or access specifier used while deriving, the properties of the base class are derived.



Syntax for single Inheritance:

```
class A   // base class
{
  // body of the class
};
class B : acess_specifier A   // derived class
{
   // body of the class
};
```

Example code for single Inheritance:

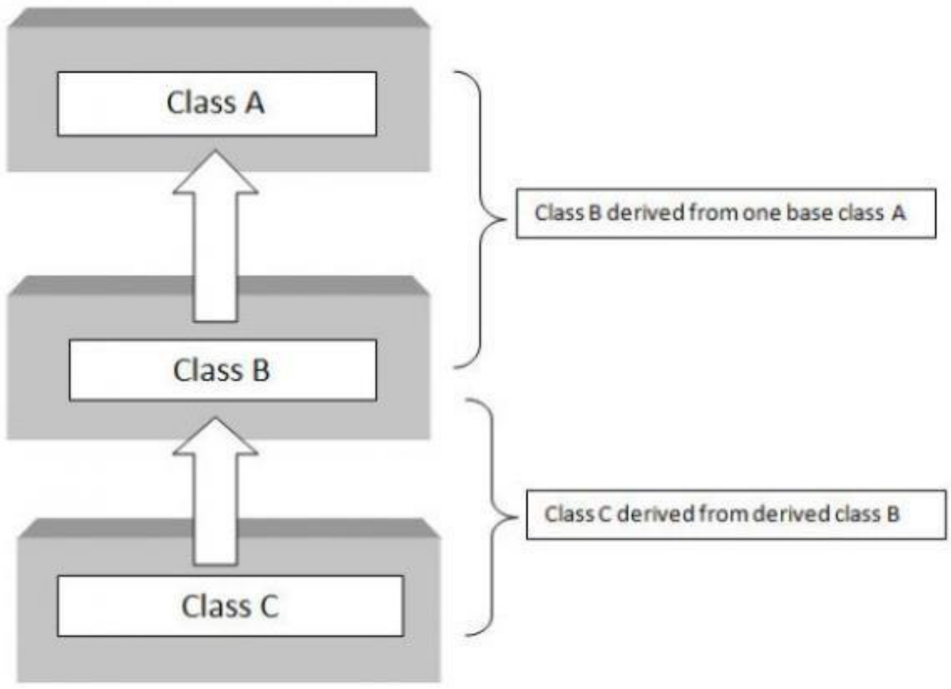
```
#include <iostream>
using namespace std;
class base    //single base class
{
  public:
    int x;
  void getdata()
  {
    cout << "Enter the value of x = "; cin >> x;
  }
 };
class derive : public base    //single derived class
{
  private:
  int y;
  public:
  void readdata()
  {
    cout << "Enter the value of y = "; cin >> y;
  }
  void product()
  {
    cout << "Product = " << x * y;
  }
 };

 int main()
 {
   derive a;    //object of derived class
   a.getdata();
   a.readdata();
   a.product();
   return 0;
 }       //end of program
```

Sample Run

```
Enter the value of x = 3
Enter the value of y = 4
Product = 12
```

Multilevel Inheritance:

- If a class is derived from another derived class then it is called multilevel inheritance, so in multilevel inheritance, a class has more than one parent class.
- As shown in the figure below, class C has class B and class A as parent classes.
- ecifier used. ecifier can be


Class A
Class B
Class C
Class B derived from one base class A
Class C derived from derived class B

Syntax for multilevel Inheritance:

```
class A   // base class
{
  // body of the class
};
class B : acess_specifier A // derived class
{
  // body of the class
};
class C : acess_specifier B     // derived from class B
{
    // body of the class
};
```

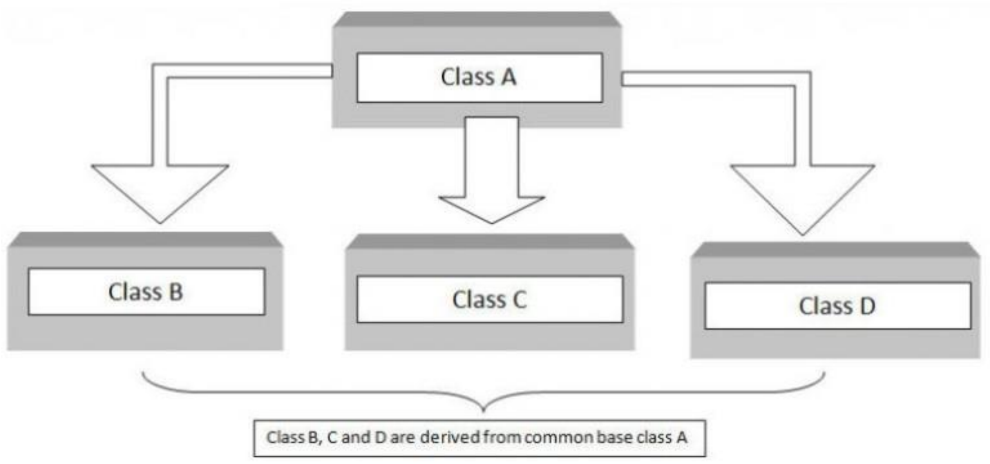
Example code for multilevel Inheritance:

```
#include <iostream>
using namespace std;
class base //single base class
{
    public:
    int x;
    void getdata()
    {
    cout << "Enter value of x= "; cin >> x;
    }
};
class derive1 : public base // derived class from base class
{
    public:
    int y;
    void readdata()
    {
       cout << "\nEnter value of y= "; cin >> y;
    }
};
class derive2 : public derive1   // derived from class derive1
{
    private:
    int z;
    public:
    void indata()
    {
    cout << "\nEnter value of z= "; cin >> z;
    }
    void product()
    {
       cout << "\nProduct= " << x * y * z;
    }
};
int main()
{
   derive2 a;      //object of derived class
   a.getdata();
   a.readdata();
   a.indata();
   a.product();
   return 0;
}            //end of program
```

```
Sample Run
Enter value of x= 2
Enter value of y= 3
Enter value of z= 3
Product= 18
```

Hierarchical Inheritance:

- When several classes are derived from a common base class it is called as hierarchical inheritance.
- In C++ hierarchical inheritance, the feature of the base class is inherited onto more than one sub-class.
- For example, a car is a common class from which Audi, Ferrari, Maruti etc can be derived.
- As shown in the figure below, in C++ hierarchical inheritance all the derived classes have a common base class. The base class includes all the features that are common to derived classes.



Syntax for hierarchical Inheritance:

```
class A   // base class
{
  // body of the class
};
class B : acess_specifier A // derived class from A
{
  // body of the class
};
class C : acess_specifier A    // derived class from A
{
   // body of the class
};
class D : acess_specifier A    // derived class from A
{
   // body of the class
};
```

Example code for hierarchical Inheritance:

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

class A //single base class
{
    public:
      int x, y;
      void getdata()
      {
          cout << "\n Enter value of x and y:\n"; cin >> x >> y;
      }
};
class B : public A //B is derived from class base
{
    public:
      void product()
      {
          cout << "\n Product= " << x * y;
      }
};
class C : public A //C is also derived from class base
{
    public:
      void sum()
      {
        cout << "\n Sum= " << x + y;
      }
};
int main()
{
    B obj1;         //object of derived class B
    C obj2;         //object of derived class C
    obj1.getdata();
    obj1.product();
    obj2.getdata();
    obj2.sum();
    return 0;
}  //end of program
```

Sample Run

```
Enter value of x and y:
2
```

```
3
Product= 6
Enter value of x and y:
2
3
Sum= 5
```

Task - 00:

Create a base class with the following members:

- Private integer privateInt
- Protected integer protectedInt
- Public integer publicInt
- Create getters and setters for each of these variables

Derive 3 classes from the base class with the three types of inheritance based on visibility(public, protected, private). You can name these classes as **publicChild**, **privateChild** and **protectedChild**.

After doing this, try and figure out which member you can access publicly or through getters and setters. Then print out the way that you were able to access them.
For example, if you did private inheritance, you could not be able to access the members in the child classes, and would need to use their getters or setters.

LAB TASKS:

Task - 01:

Create a class **Student** with the following **private** attributes:

- Name
- Age
- Institute

Derive three classes from it that has the following names: **TrackAndFieldMember, BasketBallMember, FootballMember**
These classes should have the following members:

- Sports Name (Possible values can be "Track and field", "Basketball", "Football", set these at object creation time via Member Initializer List – this is not taken as input from user. **A BasketBallMember object will always have the sports name as basketball**)
- Shirt Number (for example, 1, 2, 3, etc. set these at object creation time via Member Initializer List)

Create proper accessors and mutators for the attributes.
Create objects for each of the classes and display the values. You can ask the user to input the values (except sports name)

Task - 02:

In this task, you are required to show how multilevel inheritance will be performed in this scenario:

```
Vehicle -----> Automobile ----> Car ------> SuzukiAlto
        |                           ------> SuzukiMehran
        |
        ---> PulledVehicle
```

Task - 03:

A restaurant is making a program to calculate the bills for each of their customers. The items in the restaurant are categorized as follows:

Item:

- Name
- Quantity

Pakistani Foods: (derived from item)

- Discount = 10%

Karahi: (derived from Pakistani Foods)

- Price = 600

Biryani: (derived from Pakistani Foods)

- Price = 200

Non-Pakistani Foods (derived from item)

- Discount = 7%

Pasta: (derived from Non-Pakistani Foods)

- Price = 800

Drinks: (derived from item)

- Discount = 5%
- Price = 100

In your main function, ask a restaurant cahier to input the items and their quantities and calculate the bill accordingly. Your program should display and menu, and let the user input as many items as they want. Assume that duplicate items cannot be entered, and instead only take their quantities as input.