

# **Object Oriented Programming Using C++**

## **Handwritten Notes**

## OOPS in C++ AND ITS FEATURES

The main aim of OOP is to bind together the data and the functions that operate on them so that no other part of the code can access this data except this function.

**Class :** It is a user defined data types, which holds its own data members and member functions, which can be accessed and used by creating an instance of that class.

**Object :** When a class is defined no memory is allocated but when it is instantiated (i.e., object is created) memory is allocated.

**Encapsulation :** In OOP, Encapsulation is defined as binding together the data and the functions that manipulate them.

**Abstraction :** Abstraction means displaying only essential information and hiding the details.

- Abstraction using classes
- Abstraction using Header files (`math.h → pow()`)

**Polymorphism :** In simple words, we can define polymorphism as the ability of a message to be displayed in more than one form.

- Operator overloading
- Function overloading

↳ `int sum(10, 20, 30)`

`int sum(10, 20)`

Inheritance : The capability of a class to derive properties and characteristics from another class is called Inheritance.

- SubClass
- SuperClass
- Reusability

Dynamic Binding : In dynamic binding, the code to be executed in response to function calls is decided at run time.

Constructors : A constructor is a member function of a class which initializes objects of a class. In C++ constructor is automatically called when the object creates.

It has same name as class itself.  
Constructor don't have a return type.

1. Default Constructor (No parameter passed)
2. Parametrized Constructors
3. Copy Constructors

Destructors in C++ : Derived class destructor will be invoked first, then the base class destructor will be invoked.

Access Modifiers :  
Public :- can be accessed by any class.  
Private :- can be accessed only by a function in a class (inaccessible outside the class).

Protected :- It is also inaccessible outside the class but can be accessed by subclasses of that class.

Note : If we do not specify any access modifier inside the class then by default the access modifier for the member will be private.

Friend class : A friend class can access private and protected members of other class in which it is declared as friend.

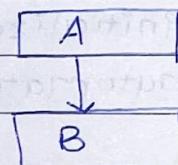
Ex-: friend class B ;

#### • Inheritance

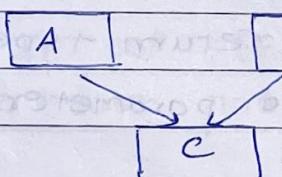
Class      Subclass      access mode      base class

of      not      ?      —

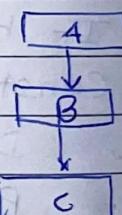
#### 1. Single inheritance



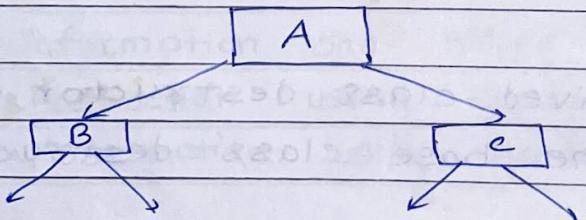
#### 2. Multiple inheritance



#### 3. Multilevel inheritance



#### 4. Hierarchical inheritance



5. Hybrid inheritance  
Combination of one or more type.

#### • Polymorphism

→ Compile time Poly

→ Run time Poly

Operator overloading

Function overloading

↳ function overriding occurs when a derived class has a definition of one or more members of base class.

## Advantages of Data Abstraction

- Avoid code duplication and inc. reusability.
- can change internal implementation of class independently.

Structure Vs class : Most important difference is security.

A structure is not secure and cannot hide its member function and variable while class is secure and can hide its programming & designing details.

Local Classes in C++ : A class declared inside a function becomes local to that function and is called local class.

All the methods of local class must be defined inside the class only.

## Virtual Function and Runtime Polymorphism :

A virtual function is a member function which is declared within a base class and redefined (overridden) by derived class.

Functions are declared with Virtual Keyword in base class.

## Exception Handling in C++ :

try : represent a block of code that can throw an exception.

catch : represent a block of code that get executed when error is thrown.

throw : Used to throw an exception.

There is a special catch block  $\rightarrow$  to catch(...)  
It catches all types of errors.

- Inline Function

$\rightarrow$  inline is a request not command.

If is function that is expanded in line when it is called. When the inline function is called, whole code get inserted or substituted at the point of inline function call.

```
inline return-type func()
```

- Function Overloading is a feature in C++ where two or more functions can have same name but different parameters.

```
void print(int i)
```

```
{ cout << "Here is int" << i << endl;
```

```
void print(float i)
```

```
{ cout << "Here is float" << i << endl;
```

```
int main
```

```
{ print(10);
```

```
print(10+12);
```

```
}
```

## Differences b/w C and C++

C

++ is known as hybrid language, because it supports both procedural and object oriented programming.

- 1. C supports procedural prog. • C++ is known as hybrid language, because it supports both procedural and object oriented programming.
- 2. As C does not support the OOPS concept so it has no support for polymorphism, encapsulation and inheritance.
- 3. C is a subset of C++ • C++ is superset of C
- 4. C contains ~ 32 keywords • C++ contains 52 keywords (public, private, protected, try, catch, throw...)
- 5. C is a function driven language • C++ is an object driven language.
- 6. Function and operator overloading is not supported in C. • C++ supports function & operator overloading.
- 7. C does not support exception handling. • C++ does not support exception handling using try and catch

- Structure is a collection of dissimilar elements

- Static Members in C++

- Static variable in a function : When a variable is declared as static, space for it gets allocated for the lifetime of the program. (default initialized to 0)

Even if the function is called multiple times, the space for it is allocated once.

- Static variable in a class :

- Declared inside the class body.

- Also known as class member variable.

- They must be defined outside the class.

- Static variable doesn't belong to any object, but to the whole class.

- There will be only one copy of static member variable for the whole class.

Ex: class Account

private:

int balance;

static float roi;

public:

void SetBalance(int b)

{ balance = b; }

}

// initialised outside class

float Account::roi = 3.5f;

void main

{ Account a;

}

- Object can also be declared as static.

```
static Account a1;
```

- Static function in a Class

Static member functions are allowed to access only the static data members or other static member functions.

- Constructors :

- Constructors is a special member function of the class. It is automatically invoked when an object is created.
- It has no return type.
- Constructor has same name as class itself.
- If we do not specify, then C++ compiler generates a default constructor for us.

<u>Constructor</u>	Default	Parameterized	COPY
Class_name()		Class_name(parameters)	Class_name (const Class_name&)
update()	update(int x, int y)	update(const update& p2)	
a = 10; b = 20;	a = x; b = y;	p2.a = p2.a; p2.b = p2.b;	

Compiler generates two constructor by itself.

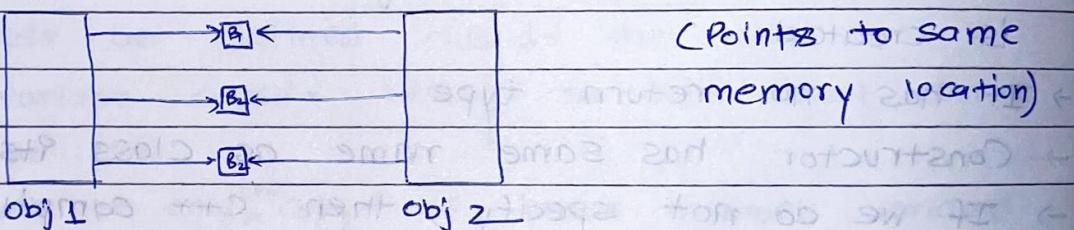
1. Default Constructor

2. Copy Constructor

But if any of the constructor is created by user, then default constructor will not be created by compiler.

Construction overloading can be done just like function overloading.

Default (Compiler's) Copy constructor can be done only shallow copy.



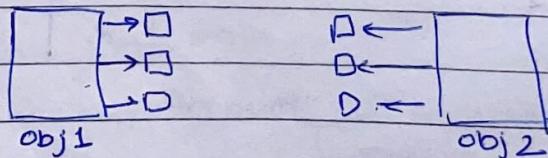
Deep copy is possible only with user defined constructors.

In user defined copy constructor, we make sure that pointers of copied object points to new memory location.

Can we make Copy Constructor private? Yes

Why argument to Copy constructor must be passed as a reference?

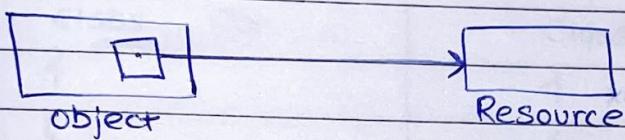
Because if we pass value, then it would made to call copy constructor which becomes non-terminating.



Deep Copy

## • Destructor

- Destructor is a member function which destroys or deletes an object.
- Constructors don't take any argument and don't have any return type.
- Only one constructor is possible.
- Constructors cannot be static.
- Actually destructor doesn't destroy object, it is the last function that is invoked before object destroy.



Destructor is used, so that before deletion of obj we can free space allocated for this resource. B/c if obj gets deleted then space allocated for obj will be free but resource doesn't.

## • Operator Overloading

(C++ have the ability to provide special meaning to the operator.)

```
class Complex
```

```
{  
    Complex operator + (Complex &c1)  
    {  
        Complex res;  
        res.a = c1.a;  
        res.b = c1.b;
```

```
}
```

```
int main()
```

```
{  
    c = c1 + c2  
}
```

As '+' can't add complex nos directly. So we can define a function with name + but we need write operator keyword before it. So, we can use @ operator like this.

### Friend Class

A friend class can access the private and protected members of other classes in which it is declared as friend.

There can be friend class and friend function.

Ex:

class Box

{ private :

double width;

public :

friend void printWidth(Box box);

void setWidth(double Wid);

}

void Box::setWidth(Box double Wid)

{ width = Wid; }

void printWidth(Box box)

{ cout << box.width; }

int main()

{ Box box;

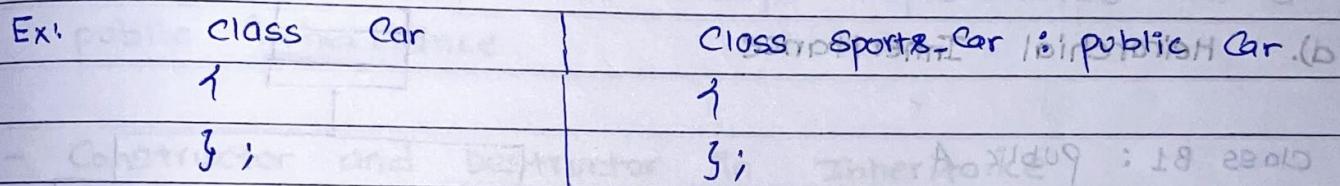
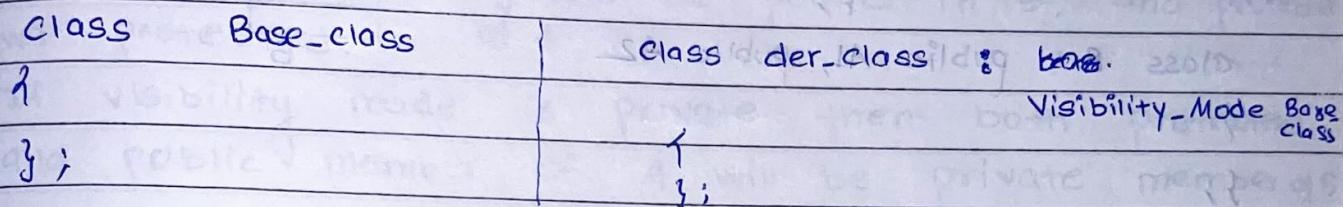
box.setWidth(14);

printWidth(box);

}

## Inheritance

It is a process of inheriting properties and behaviour of existing class into a new class.



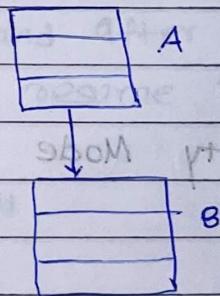
### Types of Inheritance:

#### a). Single Inheritance:

class B : public A

{

};



#### b). Multilevel Inheritance:

class B : public A

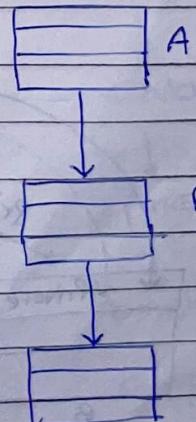
{

};

class C : public B

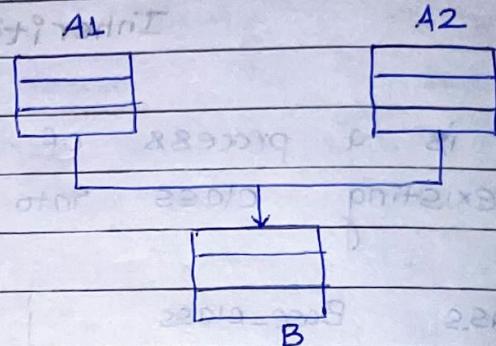
{

};



### c). Multiple Inheritance

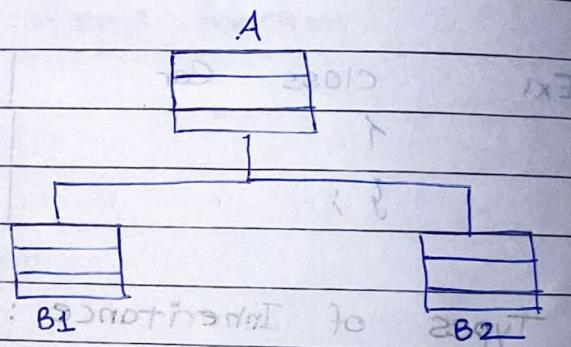
class A1  
};  
class A2  
};  
class B : public A1, public A2  
};



### d). Hierarchical Inheritance

class B1 : public A  
};

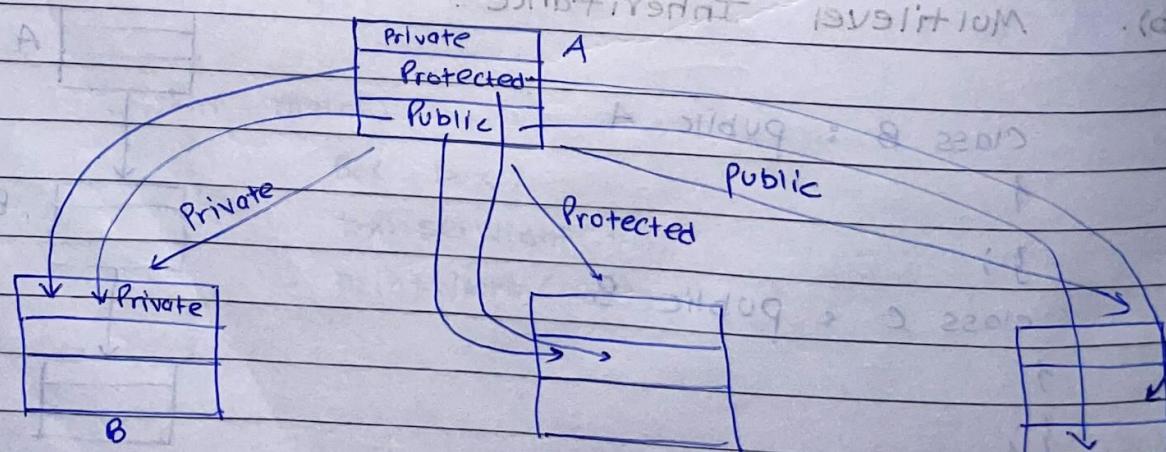
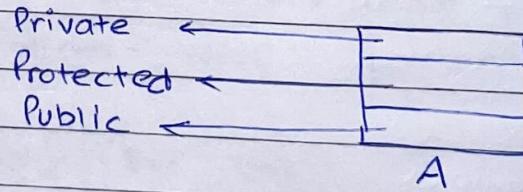
class B2 : public A  
};



### → Visibility Mode :

A - base class

B - Sub class



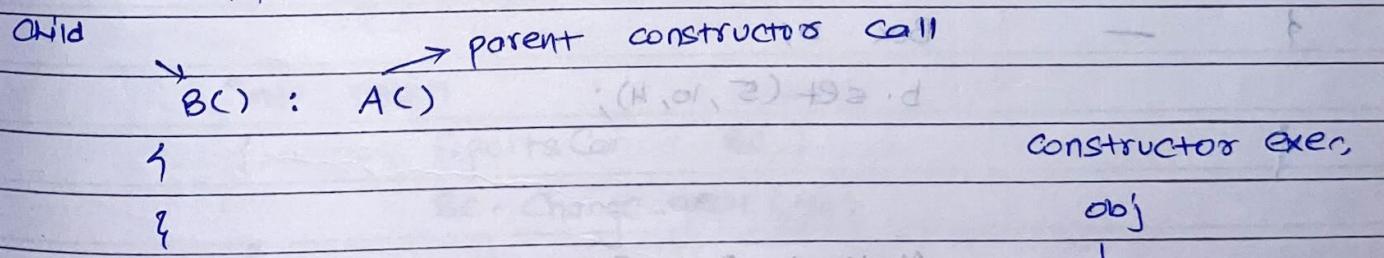
If B is subclass and visibility mode is public.  
class A: [public] B ++;

then public member will be public in B, and protected will be protected.

If visibility mode is private then both protected and public member of A will be private members of B

- Is a Relationship is always implemented as a public inheritance.
- Constructor and Destructor in Inheritance

First child class constructor will run during creation of object of child class, but as soon as obj is created child class constructor runs and it will call constructor of its parent class and after the execution of parent class constructor it will resume its constructor execution.



While in case of destructor, first child destructor exec, then parent desc. executed, parent const complete parent, complete child

this pointer

Every object in C++ has access to its own address through an important pointer called this pointer.

Friend function doesn't have this pointer, b/c friends are not members of a class. Only member function have this pointer.

Class Box

```
class Box {  
private:  
    int l, b, h;  
public:
```

```
void set (int l, int b, int h);
```

```
    this->l = l;
```

```
    this->b = b;
```

```
    this->h = h;
```

```
int main ()
```

```
{
```

```
    Box b;
```

```
    b.set (5, 10, 4);
```

Method Overriding

(Achieved at run time)

It is the redefinition of base class function in its derived class, with same return type and same parameters.

while method Overloading is achieved at compile time.

Ex:

Class Car

{ private:

int gearno;

public:

void change-gear(int gear)

{

gear++;

// Late Binding

Class SportsCar : public Car

{

void change-gear(int gear)

{

if (gear > 5)

gear++;

}

{

int main

{

SportsCar sc;

sc.change-gear(4);

}

function of sports car class will be called.

While calling change-gear(), first it check if any function with this name exist in base class, otherwise it goes to base class.

Useful: Like we have change-gear for all cars except one car which have unique method of gearchange.

## Virtual Function

A virtual function is a member function which is declared with a 'virtual keyword' in the base class and redeclared (overridden) in a derived class.

When you refer to an object of derived class using pointer to a base class, you can call a virtual function of that object and execute the derived class's version of the function.

- They are used to achieve Run time Polymorphism.
- Virtual Function cannot be static and also cannot be friend function of another class.

### Compile-time (Early binding) Vs Run-time (late Binding)

```
class base {  
public:  
    virtual void print() {  
        cout << "This is base print" << endl;  
    }  
    void show() {  
        cout << "Base show fun" << endl;  
    }  
}  
  
class derived : public base {  
public:  
    void print() {  
        cout << "derived Print" << endl;  
    }  
    void show() {  
        cout << "derived Show fun" << endl;  
    }  
}
```

```

int main()
{
    base *bptr ;
    derived der;
    bptr = &der;

    bptr->print();           // Run time execution
    bptr->show();            // Compile time
}

```

**Output:**

```

derived print          // Late Binding
This Base show fun    // Early binding

```

As during compiler time bptr behaviour judged on the bases of which class it belongs, so bptr represent base class.

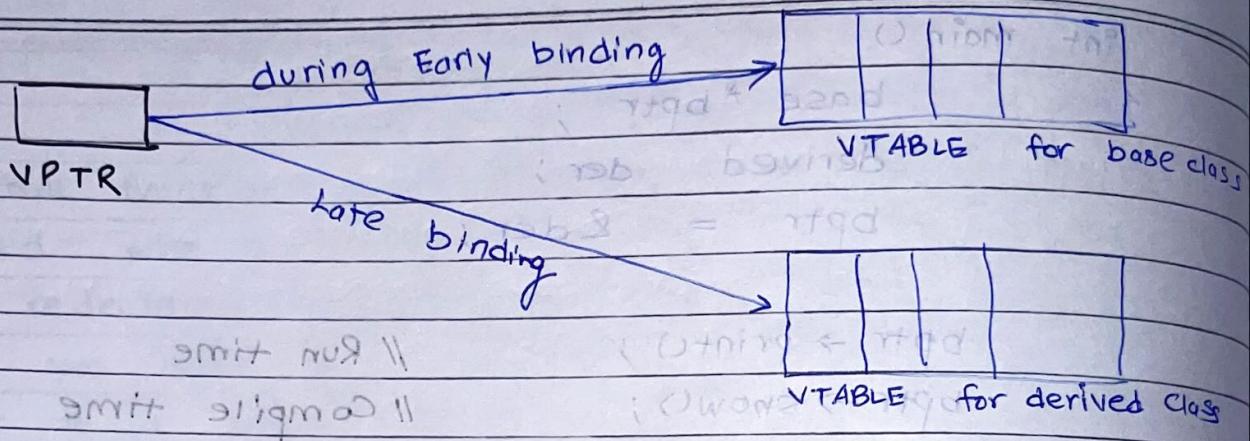
If the function is not virtual then it will allow binding at compile time and print fun of base class will get binded b/c bptr represent base class.

But at run time bptr points to the object of class derived, so it will bind function of derived at run time.

### Working of Virtual Function (VTable & Vptr)

If a class contains virtual function then compiler itself does two things:

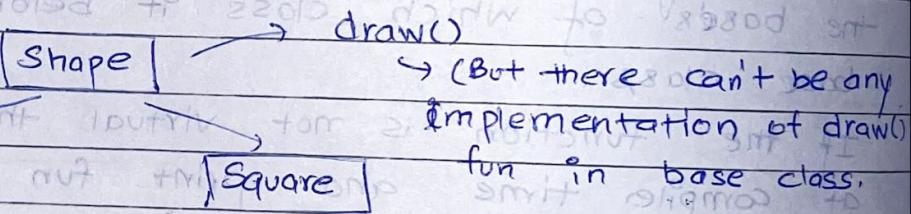
1. A virtual pointer (VPTR) is created every time obj is created for that class which contains virtual function.
2. Irrespective of object is created or not, static array of pointer called VTABLE where each cell points to each virtual function created, in base class and derived class.



## Pure Virtual Function

And Abstract Class

Sometimes implementation of all function cannot be provided in the base class. Such a class is called abstract class.



A pure virtual function in C++ is a virtual function for which derived classes don't have any implementation, we only declare it.

// Abstract class

```

class Test {
public:
    virtual void fun() = 0; // Pure Virtual function
};
  
```

1. A class is abstract if it has at least one pure virtual function

We cannot declare objects of abstract class.

Ex: Test(); will show error

2. We can have pointer or references of abstract class.
3. We can access the other functions except virtual by object of its derived class.
4. If we don't override the pure virtual function in derived class then it becomes abstract.
5. An abstract class can have constructors.

(Read from GFG)

Template in C++

```
template <class X> void check (int a, X b)
{
    if (a > b)
        return a;
    else
        return b;
}
```

It does just help in data type. So that we can write generic function that can be used for different data type.

Dynamic Constructor

When allocation of memory is done dynamically using dynamic memory allocator 'new' in constructor.

class geeks

```
{ public:
```

```
    void fun() { p = new char[6]; }
```

}

int main()

```
{     geeks g = new geeks(); }
```

}