Object Oriented Programming Using C++

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Operator Overloading

- In C/C++, we can use operator with the variable fundamental type directly.
- In C language, we can not use operator with objects of user defined type directly/indirectly.
- In C++ language, we can not use operator with objects of user defined type(struct/class) directly.
- In C++, if we want to use operator with objects of user defined type then we should overload operator.
- Overloading operator means defining operator function.
- operator is keyword in C++.
- We can define operator function using 2 ways:
    1. Member function
    2. Non member function.
- By defining operator function, it is possible to use operator with the objects of user defined type. This process of giving extension to the meaning of the operator is called operator overloading

Operator Overloading

- Operator overloading using member function:

```
class Complex{
    int real, imag;
public:
    Complex operator+( Complex other ){
        Complex result;
        result.real = this->real + other.real;
        result.imag = this->imag + other.imag;
        return result;
    }
}
c3 = c1 + c2;    //c3 = c1.operator+( c2 );
```

Operator Overloading

- Operator overloading using non member function:

```
class Complex{
    int real, imag;
public:
    friend Complex operator+( Complex c1, Complex c2 );
}
Complex operator+( Complex c1, Complex c2 ){
    Complex result;
    result.real = c1.real + c2.real;
    result.imag = c1.imag + c2.imag;
    return result;
}
c3 = c1 + c2;    //c3 = operator+( c1, c2 );
```

Limitations Of Operator Overloading

- We can not overload following operators using member function as well as non member function:
    1. Dot / Member selection operator(.)
    2. Pointer to member selcetion operator(.*)
    3. Scope resolution operator(::)
    4. Ternary / Conditional operator(? :)
    5. sizeof operator
    6. typeid operator
    7. static_cast operator
    8. dynamic_cast operator
    9. const_cast operator
    10. reinterpret_cast operator

Limitations Of Operator Overloading

- We can not overloading following operators using non member function.
    1. Assignment operator(=)
    2. Index / subscript operator([ ])
    3. Call / function call operator[( )]
    4. Arrow operator(->)
- Using operator overloading, we can change meaning of the operator.
- We can not change number of parameters passed to the operator function.

Template

- If we want to write generic code in C++, then we should use template.
- Objective
    1. Not to reduce code size
    2. Not to reduce execution time
    3. To reduce developers effort.
- It is possible by passing data type as a argument.
- Types of template:
    1. Function template
    2. Class Template

Function Template

```
//template<typename T>     //T => Type Parameter.
template<class T>    //T => Type Parameter.
void swap_object( T &obj1, T &obj2 ){
    T temp = obj1;
    obj1 = obj2;
    obj2 = temp;
}
```

```
int main( void ){
    int x = 10;
    int y = 20;
    ::swap_object<int>(x, y);    //OK //int => Type argument
    ::swap_object(x, y);     //OK
    cout<<"X    :    "<<x<<endl;
    cout<<"Y    :    "<<y<<endl;
    return 0;
}
```

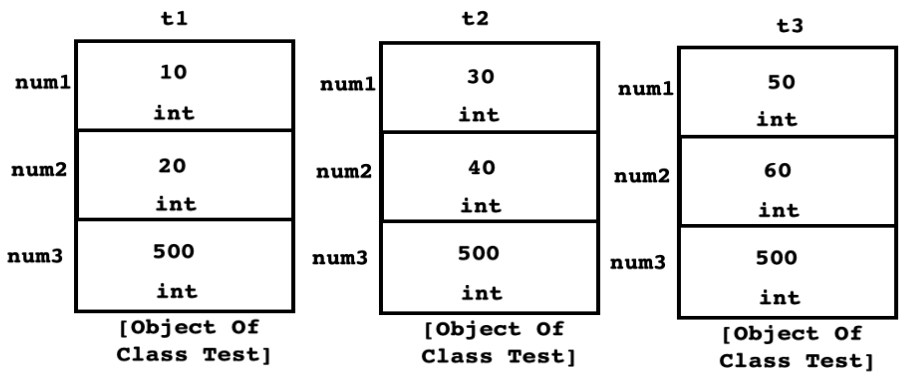
Template

- An ability of compiler to detect and pass type of argument implicitly to the function is called type inference.
- Template is mainly designed for data structure and algorithm.
- By passing data type as a argument, we can define generic code in C++. Hence parametrized type is called template.

Static Data Member

- Member function(static/non static) do not get space inside object. Hence size of object depends on size of all the data members declared inside class.

```
class Test{
private:
   int num1;
   int num2;
   int num3;
public:
   Test( void ){
      this->num1 = 0;
      this->num2 = 0;
      num3 = 500;
   }
   Test( int num1, int num2 ){
      this->num1 = num1;
      this->num2 = num2;
      num3 = 500;
   }
};
int main( void ){
   Test t1( 10, 20 );
   Test t2( 30, 40 );
   Test t3( 50, 60 );
     return 0;
```



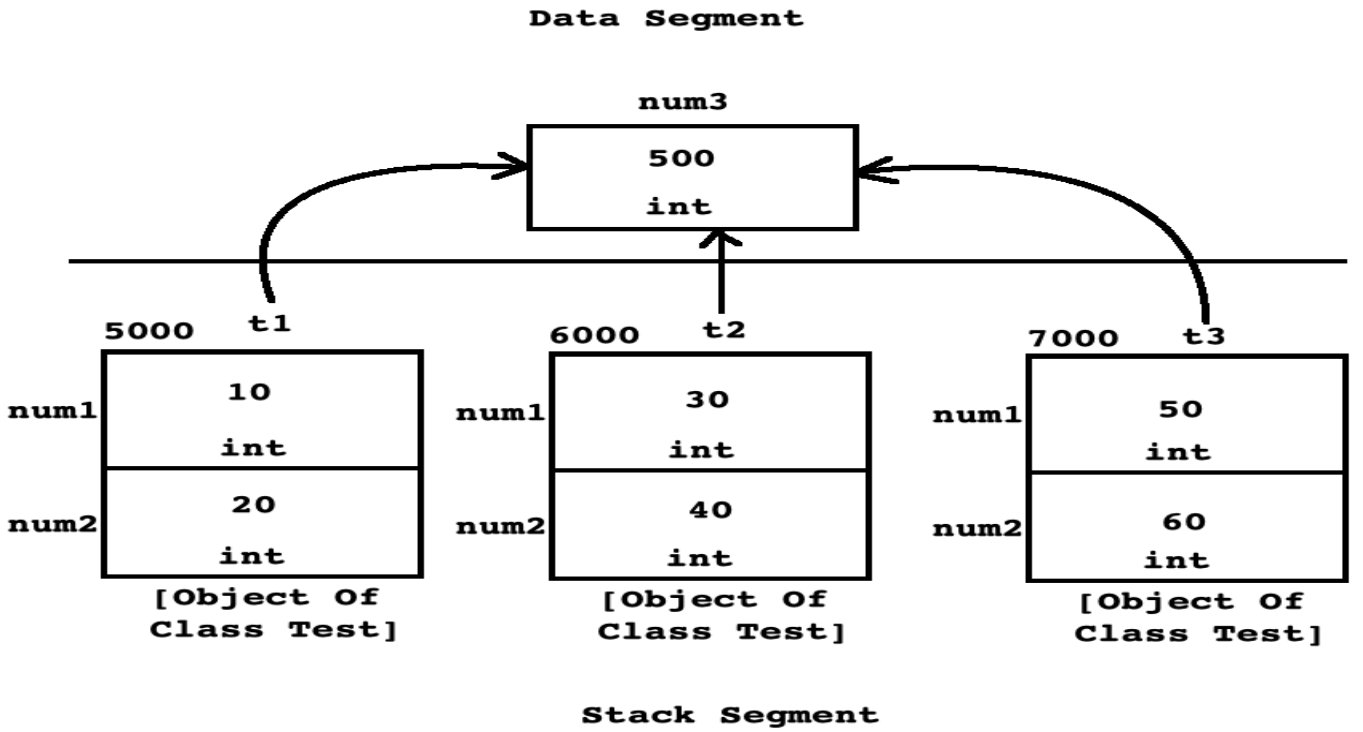
Static Data Member

- **Instance Variable** : A data member of a class which get space inside object is called instance variable. In short, non static data member declared inside class is called instance variable.
- **Instance Method** : A member function of a class, which is designed to call on object is called instance method. In short, non static member function defined inside class is called instance method.
- **Concrete Method** : A member function of a class, which is having body is called concrete method.
- **Concrete Class** : A class from which we can create object is called concrete class. In other words, we can instantiate concrete class.
- **Revision of some oops concepts**:
    1. Data member declared inside class get space once per object according to their declaration inside class.
    2. If we call non static member function on object then non static member function get this pointer.
    3. With the help of this pointer, all the objects of same class share single copy of member function.

Static Data Member

- If we want to share value of any data member inside all the objects of same class then we should declare data member static.

```
class Test{
private:
    int num1; //Instance Variable
    int num2; //Instance Variable
    static int num3; //Class level Variable
public:
    Test( void ){
        this->num1 = 0;
        this->num2 = 0;
    }
    Test( int num1, int num2 ){
        this->num1 = num1;
        this->num2 = num2;
    }
    //Test *const this = &t1
    void printRecord( void ){
        cout<<"Num1   :   "<<this->num1<<endl;
        cout<<"Num2   :   "<<this->num2<<endl;
        cout<<"Num3   :   "<<Test::num3<<endl;
    }
};
int Test::num3 = 500;   //Global Definition
int main( void ){
    Test t1( 10, 20 );
    t1.printRecord( );
     return 0;
}
```



Static Data Member

- Static data member do not get space inside object. Rather all the objects of same class share single copy of it. Hence size of object is depends on size of all the non static data members declared inside class.
- A data member of a class which get space inside object is called instance variable.
- Instance variable is designed to access using object or pointer/reference of object.
- A data member of a class which do not get space inside object is called class level variable.
- Class level variable is designed to access using class name and scope resolution operator.
- If we declare data member static then we must provide global definition for it. Otherwise linker will generate error.
- Non static data member get space once per object. But static data member get space once per class.

Static Data Member

- Only non static data member get space inside object. To initialize object we define constructor inside class. In other words, we should use constructor to initialize non static data member which get space inside object.
- Since static data member do not get space inside object, we should not initialize static data member inside constructor.

Static Member Function

- In C++, we can declare global function as well as member function static.

- If we want to access non static members of the class then member function should be non static and if we want to access static members of the class then member function should be static.

- Non static member function get this pointer. Hence inside non static member function, we can access static as well as non static members.

- Why static member function do not get this pointer?
  - If we call non static member function on object then non static member function get this pointer. In other words, non static member functions are designed to call on object.
  - Static member function is designed to call on class name.
  - **Since static member function is not designed to call on object, it doesn't get this pointer.**

Static Member Function

- Since static member function do not get this pointer, we can not access non static members inside static member function. In other words, static member function, can access only static members of the class directly.

- Using object, we can use non static members inside static member function.

- **Inside member function, if we are going to use this pointer then member function should be non static otherwise it should be static.**
- **We can not declare static member function:**
    1. **constant**
    2. **volatile**
    3. **Virtual**

Advantages of OOPS

1. To achieve simplicity
2. To achieve data hiding and data security.
3. To minimize the module dependency so that failure in single part should not stop complete system.
4. To achieve reusability so that we can reduce development time/cost/efforts.
5. To reduce maintenance of the system.
6. To fully utilize hardware resources.
7. To maintain state of object on secondary storage so that failure in system should not impact on data.

Major and Minor pillars of oops

- 4 Major pillars
    1. Abstraction
    2. Encapsulation
    3. Modularity
    4. Hierarchy

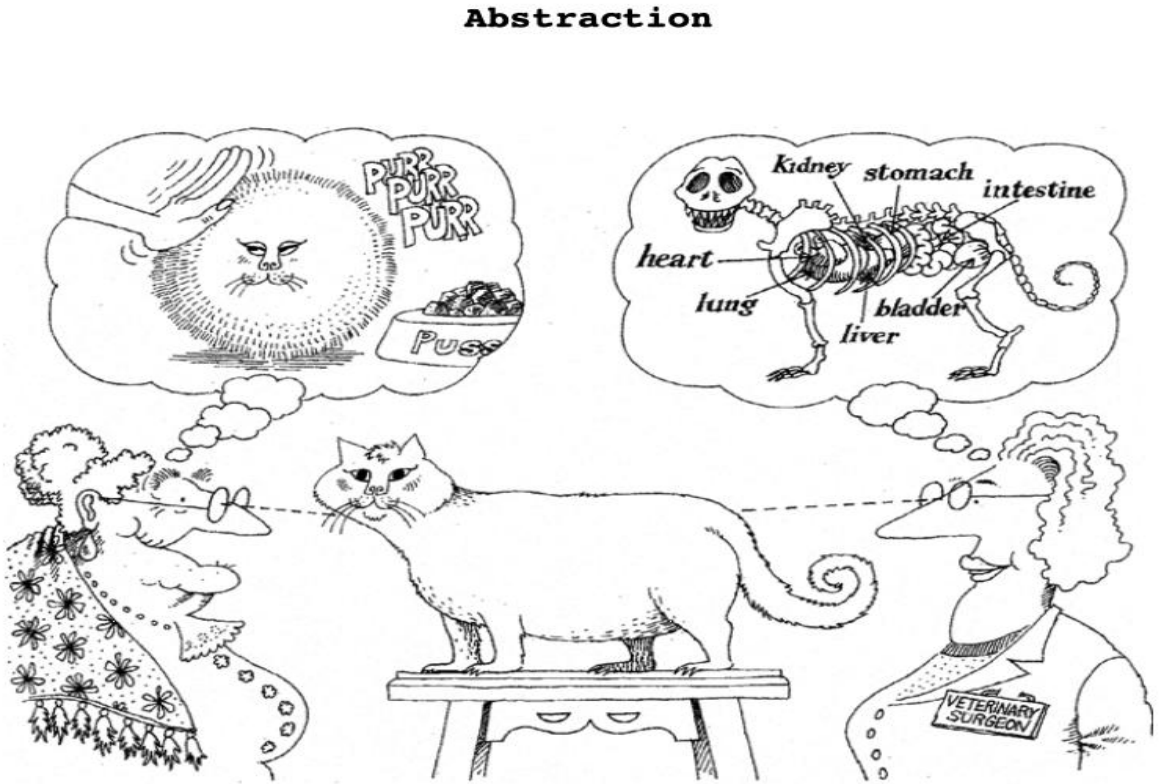
- 3 Minor Pillars
    1. Typing
    2. Concurrency
    3. Persistence

Abstraction

- It is a major pillar of oops.
- **It is a process of getting essential things from object.**
- It describes outer behaviour of the object.
- Abstraction focuses on some essential characteristics of object relative to the perspective of viewer. In other words, abstraction changes from user to user.
- **Using abstraction, we can achieve simplicity.**
- Abstraction in C++

```
Complex c1;
c1.acceptRecord( );
c1.printRecord( );
```

Abstraction



Abstraction focuses on the essential characteristics of some object, relative to the perspective of the viewer.

Encapsulation

- It is a major pillar of oops.

- Definition:
    1. **Binding of data and code together is called encapsulation.**
    2. To achieve abstraction, we should provide some implementation. It is called encapsulation.

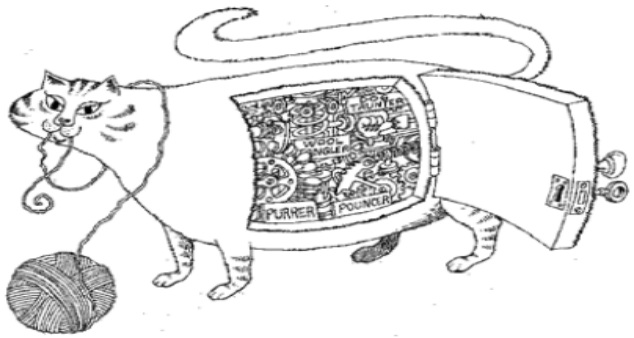
- Encapsulation represents, internal behaviour of the object.

- **Using encapsulation we can achieve data hiding.**

- Abstraction and encapsulation are complementary concepts: **Abstraction focuses on the observable behaviour** of an object, whereas **encapsulation focuses on the implementation** that gives rise to this behaviour.

Encapsulation

Encapsulation



Encapsulation hides the details of the implementation of an object.

Abstraction and encapsulation are complementary concepts: Abstraction focuses on the observable behavior of an object, whereas encapsulation focuses on the implementation that gives rise to this behavior.

Encapsulation

Encapsulation using C++.

```
class Complex{
private:
     int real;
     int imag;
public:
     Complex( void ){
     }
     void acceptRecord( void ){
     }
     void printRecord( void ){
     }
};
```

Modularity

- It is a major pillar of oops.
- It is the process of developing complex system using small parts.
- **Using modularity, we can reduce module dependency.**
- We can implement modularity by creating library files.
    - .lib/.a, .dll / .so files
    - .jar/.war/.ear in java

Hierarchy

- It is a major pillar of oops.
- **Level / order / ranking of abstraction is called hierarchy.**
- Main purpose of hierarchy is **to achieve reusability**.
- Advantages of code reusability
    1. We can reduce development time.
    2. We can reduce development cost.
    3. We can reduce developers effort.
- Types of hierarchy:
    1. **Has-a** / Part-of => Association
    2. **Is-a** / Kind-of => Inheritance / Generalization
    3. **Use-a** => Dependency
    4. **Creates-a** => Instantiation

Typing

- It is a minor pillar of oops.
- Typing is also called as polymorphism.
- Polymorphism is a Greek word. Polymorphism = Poly(many) + morphism(forms).
- **An ability of object to take multiple forms is called polymorphism.**
- **Using polymorphism, we can reduce maintenance of the system.**
- Types of polymorphism:
    - **Compile time polymorphism**
        - It is also calling static polymorphism / **Early binding** / Weak Typing / False polymorphism.
        - We can achieve it using:
            1. **Function Overloading**
            2. **Operator Overloading**
            3. **Template**
    - **Run time polymorphism**
        - It is also calling dynamic polymorphism / **Late binding** / Strong Typing / True polymorphism.
        - We can achieve it using:
            1. **Function Overriding.**

Concurrency

- It is a minor pillar of oops.
- In context of operating system, it is called as multitasking.
- It is the process of executing multiple task simultaneously.
- Main purpose of concurrency is to utilise CPU efficiently.
- In C++, we can achieve concurrency using thread.

Persistence

- It is a minor pillar of oops.
- It is process of maintaining state of object on secondary storage.
- In C++, we can achieve Persistence using file and database.

Thank you