Agenda

- Operator Overloading
- Function Object
- Conversion Function

Operator Overloading

- operator is token in C/C++.
- It is used to generate expression.
- operator is keyword in C++.
- Types of operator:
    1. Unary operator
    2. Binary Operator
    3. Ternary operator
- Unary Operator:
    - If operator require only one operand then it is called unary operator.
    - example : Unary(+,-,*) , &, !, ~, ++, --, sizeof, typeid etc.
- Binary Operator:
    - If operator require two operands then it is called binary operator.
    - Example:
        1. Arithmetic operator
        2. Relational operator
        3. Logical operator
        4. Bitwise operator
        5. Assignment operator
- Ternary operator:
    - If operator require three operands then it is called ternary operator.
    - Example:
        - Conditional operator(? :)
- In C/C++, we can use operator with objects of fundamental type directly.(No need to write extra code).

```
int num1 = 10; //Initialization
int num2 = 20; //Initialization
int num3 = num1 + num2; //OK
```

- In C++, also we can not use operator with objects of user defined type directly.
- If we want to use operator with objects of user defined type then we should overload operator.

```
class Point
{
    int x;
    int y;
};
```

```
int main( void )
{
    struct Point pt1 = { 10,20};
    struct Point pt2 = { 30,40};
    struct Point pt3;
    pt3 = pt1 + pt2; //Not OK
    //pt3.x = pt1.x + pt2.x;
    //pt3.y = pt1.y + pt2.y;
return 0;
}
```

- If we want to use operator with objects of user defined type then we should overload operator.
- To overload operator, we should define operator function.
- We can define operator function using 2 ways
  1. Using member function
  2. Using non member function.
- By defining operator function, it is possible to use operator with objects of user defined type. This process of giving extension to the meaning of operator is called operator overloading.
- Using operator overloading we can not define user defined operators rather we can increase capability of existing operators.

Limitations of operator overloading

- We can not overloading following operator using member as well as non member function:
  1. dot/member selection operator(.)
  2. Pointer to member selectiion 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
- We can not overload following operators using non member function:
  1. Assignment operator(=)
  2. Subscript / Index operator([])
  3. Function Call operator[()]
  4. Arrow / Dereferencing operator(->)
- Using operator overloading, we can change meaning of operator.
- Using operator overloading, we can not change number of parameters passed to the operator function.

Operator overloading using member function(operator function must be member function)

- If we want to overload, binary operator using member function then operator function should take only one parameter.
- Using operator overloading, we can not change, precedance and associativity of the operator.
- If we want to overload unary operator using member function then operator function should not take any parameter.

```
c3 = c1 + c2; //c3 = c1.operator+(c2);

c4 = c1 + c2 + c3; //c4 = c1.operator+( c2 ).operator+( c3 );
```

Operator overloading using non member function(operator function must be global function)

- If we want to overload binary operator using non member function then operator function should take two parameters.
- If we want to overload unary operator using non member function then operator function should take only one parameters.

```
c3 = c1 + c2; //c3 = operator+(c1,c2);

c4 = c1 + c2 + c3; //c4 = operator+(operator+(c1,c2),c3);

c2 = ++ c1; //c2=operator++( c1 );
```

Overloading Insertion Operator(<<)

-cout is an external object of ostream class which is declared in std namespace.

- ostream class is typdef of basic_ostream class.
- If we want print state of object on console(monitor) then we should use cout object and insertion operator(<<).
- Copy constructor of ostream class is private hence we can not copy of cout object inside our program
- If we want to avoid copy then we should use reference.
- If we want to print state of object(of structure/class) on console then we should overload insertion operator.

```
//ostream out = cout; // NOT OK
ostream &out = cout; //OK
```

```
1. cout<<c1; //cout.operator<<( c1 );
2. cout<<c1; //operator<<(cout, c1 );
```

- According to first statement, to print state of c1 on console, we should define operator<<( ) function inside ostream class. But ostream class is library defined class hence we should not modify its implementation.
- According to second statement, to print state of c1 on console, we should define operator<<() function globally. Which possible for us. Hence we should overload operator<<( ) using non member function.

```
class ClassName
{
  friend ostream& operator<<( ostream &cout, ClassName &other );
};

ostream& operator<<( ostream &cout, ClassName &other )
{
  //TODO : print state of object using other
  return cout;
}
```

Overloading Extraction Operator(>>)

- cin stands for character input. It represents keyboard.
- cin is external object of istream class which is declared in std namespace.
- istream class is typedef of basic_istream class.
- If we want to accept data/state of the variable/object from console/keyboard then we should use cin object and extraction operator.
- Copy constructor of istream class is private hence, we can not create copy of cin object in out program.
- To avoid copy, we should use reference.

```
istream in = cin; // NOT OK
istream &in = cin; // OK
```

- If we want to accept state of object (of structure/class) from console(keyboard) then we should overload extraction operator.

```
1. cin>>c1; //cin.operator>>( c1 )

2. cin>>c1;//operator>>( cin, c1 );
```

- According to first statement, to accept state of c1 from console, we should define operator>>( ) function inside istream class. But istream class is library defined class hence we should not modify its implementation.
- According to second statement, to accept state of c1 from console, we should define operator>>( ) function globally. Which possible for us. Hence we should overload operator>>( ) using non member function.

```
class ClassName
{
  friend istream& operator>>( istream &cin, ClassName &other );
};
istream& operator>>( istream &cin, ClassName &other )
{
  //TODO : accept state of object using other
  return cin;
}
```

Index/Subscript Operator Overloading

- If we want to overcome limitations of array then we should encapsulate array inside class and we should perform operations on object by considering it array.
- If we want to consider object as a array then we should overload sub script/index operator.

```
//Array *const this = &a1
int& operator[]( int index )throw( ArrayIndexOutOfBoundsException )
{
  if( index >= 0 && index < SIZE )
    return this->arr[ index ];
  throw ArrayIndexOutOfBoundsException("ArrayIndexOutOfBoundsException");
}

//If we use subscript operator with object at RHS of assignment operator then
expression must return value from array.

Array a1;
cin>>a1; //operator>>( cin, a1 );
cout<<a1; //opeator<<( cout, a1 );
int element = a1[ 2 ]; //int element = a1.operator[]( 1 );

// If we want to use sub script operator with object at LHS of assignment operator
then expression should not return a value rather it should return either address /
reference of memory location.

Array a1;
cin>>a1; //operator>>( cin, a1 );
a1[ 1 ] = 200; //a1.operator[]( 1 ) = 200;
cout<<a1; //opeator<<( cout, a1 );
```

Overloading assignment operator.

- If we initialize newly created object from existing object of same class then copy constructor gets called.
- If we assign, object to the another object then assignment operator function gets called.

```
Complex c1(10,20);
Complex c2 = c1; //On c2 copy ctor will call
Complex c1(10,20);
Complex c2;
c2 = c1; //c2.operator=( c1 )
```

```
class ClassName
{
public:
  ClassName& operator=( const ClassName &other )
{
  //TODO : Shallow/Deep Copy
  return *this;
}
};
```

- If we do not define assignment operator function inside class then compiler generates default assignment operator function for the class. By default it creates shallow Copy.
- During assignment, if there is need to create deep copy then we should overload assignment operator function.

Overloading Call / Function Call operator:

- If we want to consider any object as a function then we should overload function call operator.

```
class Complex
{
private:
    int real;
    int imag;

public:
    Complex(int real = 0, int imag = 0)
    {
        this->real = real;
        this->imag = imag;
    }
    void operator()(int real, int imag)
    {
        this->real = real;
        this->imag = imag;
    }
    void printRecord(void)
    {
        cout << "Real Number :" << this->real << endl;
        cout << "Imag Number :" << this->imag << endl;
    }
};
int main(void)
{
    Complex c1;
    c1(10, 20); // c1.operator()( 10, 20 );
    c1.printRecord();
    return 0;
}
```

- If we use any object as a function then such object is called function object or functor.
- In above code, c1 is function object.

Conversion Function

It is a member function of a class which is used to convert state of object of fundamental type into user defined type or vice versa. Following are conversion functions in C++

1. Single Parameter Constructor

```
int main( void )
{
int number = 10;
Complex c1 = number; //Complex c1( number );
c1.printRecord();
return 0;
}
```

- In above code, single parameter constructor is responsible for converting state of number into c1 object. Hence single parameter constructor is called conversion function.

2. Assignment operator function

```
int main( void )
{
int number = 10;
Complex c1;
c1 = number;//c1 = Complex( number );
//c1.operator=( Complex( number ) );
c1.printRecord();
return 0;
}
```

- In above code, assignment operator function is responsible for converting state of number into c1 object hence it is considered as converion function.
- If we want to put restriction on automatic instantiation then we should declare single parameter constructor explicit.
- "explicit" is a keyword in C++.
- We can use it with any constructor but it is designed to use with single parameter constructor.

3. Type conversion operator function.

```
int main( void )
{
Complex c1(10,20);
int real = c1; //real = c1.operator int( )
cout<<"Real Number : "<<real<<endl;
return 0;
}
```

- In above code, type conversion operator function is responsible for converting state of c1 into integer variable(real). Hence it is considered as conversion function.