**National University of Computer & Emerging Sciences, Karachi**

**Computer Science Department**

**Spring 2023, Lab Manual - 11**

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| **Course Code: CL-1004** | **Course : Object Oriented Programming Lab** |
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# 

**Lab # 11**

# Outline:

1. Friend Functions
2. Friend Classes
3. Advantages of Friend Functions
4. Disadvantages of Friend Functions
5. Operator overloading with member functions
6. Operator overloading with non member functions
7. Lab Tasks

# INTRODUCTION TO FRIEND FUNCTIONS:

In object-oriented programming, we have feature of hiding the data through access specifiers. Two of those access specifiers are private and protected. Private members cannot be accessed from outside of class while protected members can only be accessed through derived classes and cannot be accessed from outside of the class. Let’s have an example:

class MyClass {

private:

int member1;

};

int main() {

MyClass obj;

// Error! Cannot access private members from here.

obj.member1 = 5;

}

In C++, friend functions are exception to this rule and these functions allow us to access member functions from outside of the class as well. The friend declaration can be placed anywhere in the class declaration.

## Friend Functions in C++:

A **friend function** can access the **private** and **protected** data of a class. We declare a friend function using the friend keyword inside the body of the class.

class className {

... .. ...

friend returnType functionName(arguments);

... .. ...

}

## Example Code for Friend Functions:

// C++ program to demonstrate the working of friend function

#include <iostream>

using namespace std;

class Distance {

private:

int meter;

// friend function

friend int addFive(Distance);

public:

Distance()

{meter = 0;}

};

// friend function definition

int addFive(Distance d) {

//accessing private members from the friend function

d.meter += 5;

return d.meter;

}

int main() {

Distance D;

cout << "Distance: " << addFive(D);

return 0;

}

**Sample Run:**

Distance: 5

## Example Code for Friend Functions:

// Add members of two different classes using friend functions

#include <iostream>

using namespace std;

// forward declaration

class ClassB;

class ClassA {

private:

int numA;

public:

// constructor to initialize numA to 12

ClassA() : numA(12) {}

// friend function declaration

friend int add(ClassA, ClassB);

};

class ClassB {

public:

// constructor to initialize numB to 1

ClassB() : numB(1) {}

private:

int numB;

// friend function declaration

friend int add(ClassA, ClassB);

};

// access members of both classes

int add(ClassA objectA, ClassB objectB) {

return (objectA.numA + objectB.numB);

}

int main() {

ClassA objectA;

ClassB objectB;

cout << "Sum: " << add(objectA, objectB);

return 0;

}

**Sample Run:**

Sum: 13

In this program, ClassA and ClassB have declared **add()** as a friend function. Thus, this function can access **private** data of both classes. One thing to notice here is the friend function inside ClassA is using the ClassB. However, we haven't defined ClassB at this point.

// inside classA

friend int add(ClassA, ClassB);

For this to work, we need a forward declaration of ClassB in our program:

// forward declaration

class ClassB;

## Friend Classes in C++:

class ClassB;

class ClassA {

// ClassB is a friend class of ClassA

friend class ClassB;

... .. ...

}

class ClassB {

... .. ...

}

When a class is declared a friend class, all the member functions of the friend class become friend functions.

Since ClassB is a friend class, we can access all members of ClassA from inside ClassB.

However, we cannot access members of ClassB from inside ClassA.

## Example Code for Friend Classes:

#include <iostream>

using namespace std;

class Square;

class Rectangle {

int width, height;

public:

Rectangle(int w, int h){

width=w; height=h;

}

void display() {

cout << "Rectangle: " << width \* height << endl;

};

void morph(Square &);

};

class Square {

int side;

public:

Square(int s)

{side=s;}

void display() {

cout << "Square: " << side \* side << endl;

};

friend class Rectangle;

};

void Rectangle::morph(Square &s) {

width = s.side;

height = s.side;

}

int main () {

Rectangle rec(5,10);

Square sq(5);

cout << "Before:" << endl;

rec.display();

sq.display();

rec.morph(sq);

cout << "\nAfter:" << endl;

rec.display();

sq.display();

return 0;

}

**Sample Run:**

Before:

Rectangle: 50

Square: 25

After:

Rectangle: 25

Square: 25

We declared **Rectangle** as a friend of **Square** so that **Rectangle** member functions could have access to the private member, **Square::side** In our example, **Rectangle** is considered as a friend class by **Square** but **Rectangle** does not consider **Square** to be a friend, so **Rectangle** can access the private members of **Square** but not the other way around.

## Advantages/Applications of Friend Functions:

• Windows will have many functions that should not be publicly accessible but that can be needed by a related class like WindowsManager so friend functions can be used.

• You want to operate on objects of two different classes then friend function can be useful as we observed in above examples otherwise without friend function in this situation, your code will be long, complex and hard.

## Disadvantages of Friend Functions:

• One of the distinguishing features of C++ is encapsulation i.e., bundling of data and functions operating on that data together so that no outside function or class can access the data. But by allowing the friend functions or class to access the private members of another class, we actually compromise the encapsulation feature.

• In order to prevent this, we should be careful about using friend functions or class. We should ensure that we should not use too many friend functions and classes in our program which will totally compromise on the encapsulation.

## **Operator Overloading:**

In C++, the purpose of operator overloading for an operator is to specify more than one meaning in one scope. It gives special meaning of an operator for a user-defined data type.

You can redefine most of the C++ operators with the help of operator overloading. To perform multiple operations using one operator, you can also use operator overloading.

## **Syntax for operator overloading:**

## To overload a C++ operator, you should define a special function inside the Class as follows:

class class\_name

{

... .. ...

public

return\_type operator symbol (argument(s))

{

... .. ...

}

... .. ...

};

Here is an explanation for the above syntax:

* The return\_type is the return type for the function.
* Next, you mention the operator keyword.
* The symbol denotes the operator symbol to be overloaded. For example, +, -, <, ++.
* The argument(s) can be passed to the operator function in the same way as functions.

### **Example :**

#include <iostream>

using namespace std;

class TestClass {

private:

int count;

public:

TestClass()

{

count=5;

}

void operator --() {

count = count - 3;

}

void Display() {

cout << "Count: " << count; }

};

int main() {

TestClass tc;

--tc;

tc.Display();

return 0;}

**Output:**

[https://www.guru99.com/images/2/100520_1216_COperatorOv1.png](https://www.guru99.com/images/2/100520_1216_COperatorOv1.png)

## **C++ Operators that cannot be Overloaded**

There are four C++ operators that can't be overloaded.

They include:

* :: Scope resolution operator
* ?: ternary operator.
* . member selection operator
* .\* member selection through a pointer to function operator.

## **C++ Operators that can be Overloaded**

* Following is the list of operators which can be overloaded −

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| + | - | \* | / | % | ^ |
| & | | | ~ | ! | , | = |
| < | > | <= | >= | ++ | -- |
| << | >> | == | != | && | || |
| += | -= | /= | %= | ^= | &= |
| |= | \*= | <<= | >>= | [] | () |
| -> | ->\* | new | new [] | delete | delete [] |

**Unary Operators Overloading:**

The unary operators operate on a single operand and following are the examples of Unary operators −

* [The increment (++) and decrement (--) operators](https://www.tutorialspoint.com/cplusplus/increment_decrement_operators_overloading.htm).
* The unary minus (-) operator.
* The logical not (!) operator.

The unary operators operate on the object for which they were called and normally, this operator appears on the left side of the object, as in !obj, -obj, and ++obj but sometime they can be used as postfix as well like obj++ or obj--.

Following example explain how minus (-) operator can be overloaded for prefix as well as postfix usage.

#include <iostream>

using namespace std;

class Distance {

private:

int feet; // 0 to infinite

int inches; // 0 to 12

public:

// required constructors

Distance() {

feet = 0;

inches = 0;

}

Distance(int f, int i) {

feet = f;

inches = i;

}

// method to display distance

void displayDistance() {

cout << "F: " << feet << " I:" << inches <<endl;

}

// overloaded minus (-) operator

Distance operator- () {

feet = -feet;

inches = -inches;

return Distance(feet, inches);

}

};

int main() {

Distance D1(11, 10), D2(-5, 11);

-D1; // apply negation

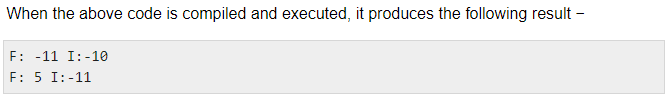
D1.displayDistance(); // display D1

-D2; // apply negation

D2.displayDistance(); // display D2

return 0;

}



Another way of calling unary operator overloading function is to call like a normal member function as follows,

D1.operator- ( );

Hope above example makes your concept clear and you can apply similar concept to overload Logical Not Operators (!).

The increment (++) and decrement (--) operators are two important unary operators available in C++. Following example explain how increment (++) operator can be overloaded for prefix as well as postfix usage. Similar way, you can overload operator (--).

// Overload ++ when used as prefix and postfix

#include <iostream>

using namespace std;

class Count {

private:

int value;

public:

// Constructor to initialize count to 5

Count() : value(5) {}

// Overload ++ when used as prefix

void operator ++ () {

++value;

}

// Overload ++ when used as postfix

void operator ++ (int) {

value++;

}

void display() {

cout << "Count: " << value << endl;

}

};

int main() {

Count count1;

// Call the "void operator ++ (int)" function

count1++;

count1.display();

// Call the "void operator ++ ()" function

++count1;

count1.display();

return 0;

}

**Binary Operators Overloading:**

The binary operators take two arguments and following are the examples of Binary operators. You use binary operators very frequently like addition (+) operator, subtraction (-) operator and division (/) operator.

Following example explains how addition (+) operator can be overloaded. Similar way, you can overload subtraction (-) and division (/) operators.

#include <iostream>

using namespace std;

class Box {

double length; // Length of a box

double breadth; // Breadth of a box

double height; // Height of a box

public:

double getVolume(void) {

return length \* breadth \* height;

}

void setLength( double len ) {

length = len;

}

void setBreadth( double bre ) {

breadth = bre;

}

void setHeight( double hei ) {

height = hei;

}

// Overload + operator to add two Box objects.

Box operator+(const Box& b) {

Box box;

box.length = this->length + b.length;

box.breadth = this->breadth + b.breadth;

box.height = this->height + b.height;

return box;

}

};

// Main function for the program

int main() {

Box Box1; // Declare Box1 of type Box

Box Box2; // Declare Box2 of type Box

Box Box3; // Declare Box3 of type Box

double volume = 0.0; // Store the volume of a box here

// box 1 specification

Box1.setLength(6.0);

Box1.setBreadth(7.0);

Box1.setHeight(5.0);

// box 2 specification

Box2.setLength(12.0);

Box2.setBreadth(13.0);

Box2.setHeight(10.0);

// volume of box 1

volume = Box1.getVolume();

cout << "Volume of Box1 : " << volume <<endl;

// volume of box 2

volume = Box2.getVolume();

cout << "Volume of Box2 : " << volume <<endl;

// Add two object as follows:

Box3 = Box1 + Box2;

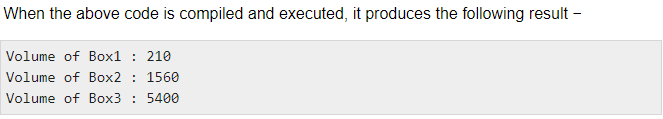
// volume of box 3

volume = Box3.getVolume();

cout << "Volume of Box3 : " << volume <<endl;

return 0;

}



In statement 1, Left object Box1 will invoke operator+() function and right object Box2 is passing as argument.

Another way of calling binary operator overloading function is to call like a normal member function as follows,

Box3 = Box1.operator+ ( Box2 );

**Relational Operators Overloading:**

There are various relational operators supported by C++ language like (<, >, <=, >=, ==, etc.) which can be used to compare C++ built-in data types.

You can overload any of these operators, which can be used to compare the objects of a class.

Following example explains how a < operator can be overloaded and similar way you can overload other relational operators.

#include <iostream>

using namespace std;

class Distance {

private:

int feet; // 0 to infinite

int inches; // 0 to 12

public:

// required constructors

Distance() {

feet = 0;

inches = 0;

}

Distance(int f, int i) {

feet = f;

inches = i;

}

// method to display distance

void displayDistance() {

cout << "F: " << feet << " I:" << inches <<endl;

}

// overloaded < operator

bool operator <(const Distance& d) {

if(feet < d.feet) {

return true;

}

if(feet == d.feet && inches < d.inches) {

return true;

}

return false;

}

};

int main() {

Distance D1(11, 10), D2(5, 11);

if( D1 < D2 ) {

cout << "D1 is less than D2 " << endl;

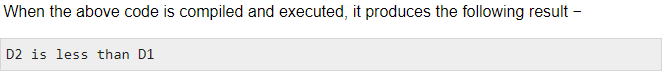
} else {

cout << "D2 is less than D1 " << endl;

}

return 0;

}



**Assignment Operator Overloading:**

You can overload the assignment operator (=) just as you can other operators and it can be used to create an object just like the copy constructor.

Following example explains how an assignment operator can be overloaded.

#include <iostream>

using namespace std;

class Distance {

private:

int feet; // 0 to infinite

int inches; // 0 to 12

public:

// required constructors

Distance() {

feet = 0;

inches = 0;

}

Distance(int f, int i) {

feet = f;

inches = i;

}

void operator = (const Distance &D ) {

feet = D.feet;

inches = D.inches;

}

// method to display distance

void displayDistance() {

cout << "F: " << feet << " I:" << inches << endl;

}

};

int main() {

Distance D1(11, 10), D2(5, 11);

cout << "First Distance : ";

D1.displayDistance();

cout << "Second Distance :";

D2.displayDistance();

// use assignment operator

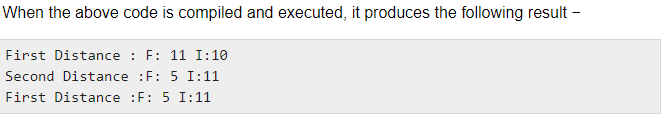
D1 = D2;

cout << "First Distance :";

D1.displayDistance();

return 0;

}



## **Operator Overloading for Non-Member Functions**

A non-member function does not have access to private members of the class that it is being overloaded for. To overload the operator in this case, you have to make the operator overloading function a friend of the class.

In the following example, we can see how a friend function is used for operator overloading:

#include <iostream>

using namespace std;

class Distance {

public:

int feet, inch;

Distance() {

this->feet = 0;

this->inch = 0; }

Distance(int f, int i) {

this->feet = f;

this->inch = i; }

friend Distance operator+(Distance, Distance); // Declaring friend function using friend keyword

};

Distance operator+(Distance d1, Distance d2) // Implementing friend function with two parameters

{

Distance d3; // Create an object to return

d3.feet = d1.feet + d2.feet;

d3.inch = d1.inch + d2.inch;

return d3;

}

int main()

{

Distance d1(8, 9);

Distance d2(10, 2);

Distance d3;

d3 = d1 + d2;

cout << "\nTotal Feet & Inches: " << d3.feet << "'" << d3.inch;

return 0;

}

Another way of calling binary operator overloading with friend function is to call like a non member function as follows,

d3 =operator+ ( d1,d2 );

## **Things to remember for Operator Overloading:**

Here are rules for Operator Overloading:

* At least one of the operands in overloaded operators must be user-defined, which means we cannot overload the minus operator to work with one integer and one double. However, you could overload the minus operator to work with an integer and a mystring.
* We can only overload the operators that exist and cannot create new operators or rename existing operators.
* You can make the operator overloading function a friend function if it needs to access the private and protected class members.
* Some operators cannot be overloaded using a friend function. However, such operators can be overloaded using member function. Eg. Assignment overloading operator = and function call() operator etc.

# LAB TASKS:

## Task - 01:

Create a class named **LoneClass** with the following private members:

* A string called **loneObjName**
* An integer called **loneObjID**

Create a **global** **friend function** by the name of **friendOfLoneClass** which takes an object of a lone class as parameter.

The friend function should display the following: “I am friend of this Lone Class with ObjName = <object name> and ObjID = <object ID>”

## Task - 02:

Create a class called **ShapeDetails** with these private attributes:

* Area
* Parameter

**Do not** make any getters and setter for these, as we will be observing how friend classes will be used.

Create two classes called **Square** and **Circle** which will be friends of the class.

Class **Square** will have the following attributes:

* Side\_length

Class **Circle** will have the following attributes:

* Radius\_length

Both classes will have these two functions that take an object of **ShapeDetails** as input:

* Calculate\_Perimeter
* Calculate\_Area

In you main program you will have to make two objects for **ShapeDetails** and one object each of **Square**  and **Circle**

Your task is to demonstrate how you will store the values of perimeter and area in the **ShapeDetails** object by using objects of **Square** and **Circles**

## Task - 03:

**Calculate Area of Triangle the one class is acute angle(less than 90**

**degree) and another one is obtuse angle (greater than 90 degree) both**

**class wants to access only one function which is “Area of Triangle”**

**which is independent of all classes.**

## Task - 04:

Create a class called Distance (similar to the previous Distance example). It should have two private variables called **feet** and **inches.**

* Overload the post-increment operator such that it increments inches by 1.
* Overload the post-decrement operator such that it decrements inches by 1.

You should make sure that inches do not exceed 11, as 12 inches = 1 foot. You should also make sure the the value for inches does not become negative.

**For example:**

* If you increment 5’11” by one, it should become 6’0”
* If you decrement 5’0” by one, it should become 4’11”

## Task - 05:

Create a class called Box with the following attributes and functions:

* Number of sides
* Area
* A display function that displays the number of sides and area of the box

Write a program to overload the binary operators + and – for the class. Create three objects named **box1**, **box2** and **resultantBox**.

* Overload **+** to return a Box type object which contain the sum of sides and areas for the two box objects **box1** and **box2**. Store the result in **resultantBox** and then display the result
* Overload **-** to return a Box type object which contain the difference of sides and areas for the two box objects **box1** and **box2**. Store the result in **resultantBox** and then display the result