

UEE 1303(1069): Object-Oriented Programming

Lab #6: Advanced Topics of Class

In this laboratory session you will:

- learn the advance topics of object-oriented programming using class.
- learn how to use operator overloading, which are important functionality provided by C++.

Lab 6-1: Static Member

- ✓ static member can be taken as a global member for this class and all objects own the same copy (or value) of the member.

```
// lab6-1.cpp
#include <iostream>
class Point2D
{
public:
    Point2D();
    void assignPoint2D(int x, int y);
    void displayPoint2D();
    static void setValue(double v);
    // only static member function can access static member
private:
    int x;
    int y;
    static const double limit = 10.0; // const static member
    can be init.
    static double value; // indicates that all object's
    value are the same
};
Point2D::Point2D()
{
    x = 0;
    y = 0;
}
void Point2D::assignPoint2D(int n1, int n2)
{
```

```
x = n1;
y = n2;
}
void Point2D::displayPoint2D()
{
    std::cout << "(" << x << "," << y << ") = ";
    std::cout << value << std::endl;
}
void Point2D::setValue(double v)
{
    if (v < limit)
        value = v;
    else
        value = limit;
}
double Point2D::value = 0.0;
// It needs to initialize static member
int main()
{
    Point2D ptArray[10];
    ptArray[0].setValue(1.1);
    // modify the static member by static member function
    for (int i = 0; i < 10; i++)
    {
        ptArray[i].assignPoint2D(i, i+2);
        ptArray[i].displayPoint2D();
    }
    return 0;
}
```

- Remark the line `double Point2D::value = 0.0;` and compile the program again. Try to explain the error message.
- Remove `static` in `static const double limit = 10.0;` and compile the program again.
- Remove `const` in `static const double limit = 10.0;` and compile the program again.
- Try to modify `ptArray[0].setValue(1.1);` as `ptArray[0].setValue(30.1);` and execute the program again.

Lab 6-2: this Pointer

- ✓ this pointer is an implicit private member to store the address of the object for a class.

```
// original version in lab5-2.cpp
PointND::PointND()
{
    value = 0.0;
    coord = new int [num];
    for (int i = 0; i < num; i++) coord[i] = 0;
}
```

```
// modify version in lab6-2.cpp
PointND::PointND()
{
    this->value = 0.0;
    this->coord = new int [num];
    for (int i = 0; i < num; i++) this->coord[i] = 0;
}
```

- ✓ this pointer includes the address of the object, so it can be used to compare the addresses between different objects.

```
// lab6-2.cpp
#include <iostream>
/* class PointND declares and defines in lab 5-2 with copy
constructor*/
/* add declaration of member function: copyPoint2D() to
class PointND */
void PointND::copyPointND(const PointND &pt)
{
    if (this != &pt)
    {
        value = pt.value;
        coord = new int [num];
        for (int i = 0; i < num; i++) coord[i] = pt.coord[i];
    }
}
```

```
int main()
{
    int *vec = new int [num];
    for (int i = 0; i < num; i++) vec[i] = i;

    PointND pt1;
    pt1.assignValue(4.3);
    pt1.assignCoord(vec, num);
    pt1.displayPointND();
    PointND pt2;
    pt2.copyPointND(pt1);
    pt2.displayPointND();
    PointND pt3;
    pt3.copyPointND(pt3);
    pt3.displayPointND();
    delete []vec;

    return 0;
}
```

Lab 6-3: Overloaded Functions as Member Functions

- ✓ In this example, there are three overloaded constructors and two overloaded member functions.

```
// lab6-3.cpp
#include <iostream>
class Point2D
{
public:
    Point2D();
    Point2D(int n1, int n2);
    Point2D(int n1, int n2, double v);
    void assignPoint2D(int n1, int n2);
    void assignPoint2D(int n1, int n2, double v);
    void displayPoint2D() const;
private:
    int x;
    int y;
```

```
    double value;
};
Point2D::Point2D()
{
    x = 0;
    y = 0;
    value = 0;
}
Point2D::Point2D(int n1, int n2)
{
    assignPoint2D(n1, n2, 0.0);
}
Point2D::Point2D(int n1, int n2, double v)
{
    assignPoint2D(n1, n2, v);
}
void Point2D::assignPoint2D(int n1, int n2)
{
    assignPoint2D(n1, n2, value);
}
void Point2D::assignPoint2D(int n1, int n2, double v)
{
    x = n1;
    y = n2;
    value = v;
}
void Point2D::displayPoint2D() const
{
    std::cout << "(" << x << "," << y << ") = ";
    std::cout << value << std::endl;
}
int main()
{
    Point2D pt1(3,4,3.9);
    Point2D pt2;
    pt1.displayPoint2D();
    pt2.displayPoint2D();
}
```

```
std::cout << "after assignment " << std::endl;
pt1.assignPoint2D(1,3);
pt2.assignPoint2D(2,3,1.1);
pt1.displayPoint2D();
pt2.displayPoint2D();
return 0;
}
```

Lab 6-4: Overloaded Functions as Friend Functions

- ✓ Friend functions can be also overloaded.

```
// lab6-4.cpp
#include <iostream>
#include <cmath>
/* class Point2D declares and defines in lab6-3 */
/* add two overloaded functions as friend */
double distPoint2D(const Point2D &pt1, const Point2D
&pt2)
{
    return sqrt((pt1.x - pt2.x)*(pt1.x - pt2.x) + (pt1.y
- pt2.y)*(pt1.y - pt2.y));
}
double distPoint2D(const Point2D &pt1, const Point2D
&pt2, const Point2D &pt3)
{
    double n1 = distancePoint2D(pt1, pt2);
    double n2 = distancePoint2D(pt1, pt3);
    double n3 = distancePoint2D(pt2, pt3);
    return (n1 + n2 + n3);
}
int main()
{
    Point2D pt1(3,4);
    Point2D pt2(1,2);
    Point2D pt3(0,0);
    std::cout << "total distance: " <<
distePoint2D(pt1,pt2,pt3) << std::endl;
    return 0;
}
```

```
}
```

- How to choose the type of function? Is it better to set `distPoint2D()` as a common function or a member of the class object?
- There is no absolute answer. The type of function is depended on the functionality of this function. For example, `Point2D` is a class object, but `distPoint2D` is operated on the object `Point2D` instead of the object's property.

Exercise 6-1 (DATE)

- ✓ Write a class `Date` to have the following capabilities.
 - Output the date in multiple formats such as
DDD YYYY
MM/DD/YY
June 14, 1992
 - Use overloaded constructors to create `Date` objects initialized with dates of the formats as described.
 - Create a `Date` constructor that reads the system date, using the standard library functions of the `<ctime>` header, and sets the `Date` members.
- ✓ Hints:
 - There are four constructors for this class: a default constructor that sets the date to the current date, using `<ctime>`; a constructor that takes a date in the form (DDD, YYYY); where DDD represents the day of the year, a constructor that takes a date in the form (MM, DD, YY) and a constructor which takes the month name, day and year. Use a `char*` and two `ints` for the last constructor.
 - In addition to the four constructors, include functions for setting the month, day and year. No other data members are necessary.
 - Write three different printing member functions. You may find it necessary to implement helper member functions that perform the following tasks:
 - ◆ Return the name of a month (as a `char*`).
 - ◆ Return the number of days in a month.
 - ◆ Test for a leap year. A year is a leap year if it is divisible 400 or divisible by four and not by 100.
 - ◆ Return the name of a month.
 - ◆ Convert DDD to MM DD.
 - ◆ Convert MM DD to DDD.
 - ◆ Convert from month name to MM.
- ✓ The main function is defined as follows

```
// ex6-1.cpp
// Driver program for class Date.
#include <iostream>
using std::cout;
using std::endl;
#include "Date.h" // include Date class definition
int main()
{
    Date date1( 256, 1999 ); // initialize using ddd yyyy
format
    Date date2( 3, 25, 04 ); // initialize using mm/dd/yy
format
    Date date3( "September", 1, 2000 ); // "month" dd, yyyy
format
    Date date4; // initialize to current date with default
constructor
    // print Date objects in default format
    date1.print();
    date2.print();
    date3.print();
    date4.print();
    cout << endl;
    // print Date objects in 'ddd yyyy' format
    date1.printDDDYYYY();
    date2.printDDDYYYY();
    date3.printDDDYYYY();
    date4.printDDDYYYY();
    cout << endl;
    // print Date objects in 'mm/dd/yy' format
    date1.printMMDDYY();
    date2.printMMDDYY();
    date3.printMMDDYY();
    date4.printMMDDYY();
    cout << endl;
    // print Date objects in '"month" d, yyyy' format
    date1.printMonthDDYYYY();
    date2.printMonthDDYYYY();
```



```
date3.printMonthDDYYYY();  
date4.printMonthDDYYYY();  
cout << endl;  
return 0;  
} // end main
```

✓ The sample output is

```
9/13/1999  
3/25/2004  
9/1/2000  
4/10/2013  
  
256 1999  
85 2004  
245 2000  
100 2013  
  
09/13/99  
03/25/04  
09/01/00  
04/10/13  
  
September 13, 1999  
March 25, 2004  
September 1, 2000  
April 10, 2013  
  
Date object destructor for date 4/10/2013  
Date object destructor for date 9/1/2000  
Date object destructor for date 3/25/2004  
Date object destructor for date 9/13/1999
```

✓ The class Data is defined as

```
// Date.h  
#ifndef DATE_H  
#define DATE_H  
#include <string>
```

```
using std::string;

class Date
{
public:
    Date(); // default constructor uses <ctime> functions to set date
    Date( int, int ); // constructor using ddd yyyy format
    Date( int, int, int ); // constructor using dd/mm/yy format
    Date( string, int, int ); // constructor using Month dd, yyyy format
    void setDay( int ); // set the day
    void setMonth( int ); // set the month
    void print() const; // print date in month/day/year format
    void printDDDDYYYY() const; // print date in ddd yyyy format
    void printMMDDYY() const; // print date in mm/dd/yy format
    void printMonthDDYYYY() const; // print date in Month dd, yyyy
format
    ~Date(); // provided to confirm destruction order
private:
    int month; // 1-12 (January-December)
    int day; // 1-31 based on month
    int year; // any year
    int checkDay( int ) const; // check if day is proper for month
and year
    int daysInMonth( int ) const; // returns number of days in given
month
    bool isLeapYear() const; // indicates whether date is in a leap
year
    int convertDDToDDD() const; // get 3-digit day based on month and
day
    void setMMDDFromDDD( int ); // set month and day based on 3-digit
day
    string convertMMToMonth( int ) const; // convert mm to month name
    void setMMFromMonth( string ); // convert month name to mm
    int convertYYYYToYY() const; // get 2-digit year based on 4-digit
    void setYYYYFromYY( int ); // set year based on 2-digit year
}; // end class Date
#endif
```