Object Oriented Programming by C++

Software Component (1/2)

Basic of Class and Object

2017. 8.

Sungwon Lee / Professor

Email: drsungwon@khu.ac.kr
Web: http://mobilelab.khu.ac.kr/

Modified & taught by Jinwoo Choi
in 2023 Spring
Email: jinwoochoi@khu.ac.kr
Webpage: https://sites.google.com/site/jchoivision/

Contents

- Remind: Pointer and Array Notation
- Software Component
  - Class
  - Object
- Class Example 1
- Class Definition
- More about Class Definition
- Encapsulation
- Class Example 2
- FYI: auto

Remind

Pointer and Array Notation

when p is a pointer,

p[i] is *(p+i)

p[j][i] is *(*(p+j)+i)

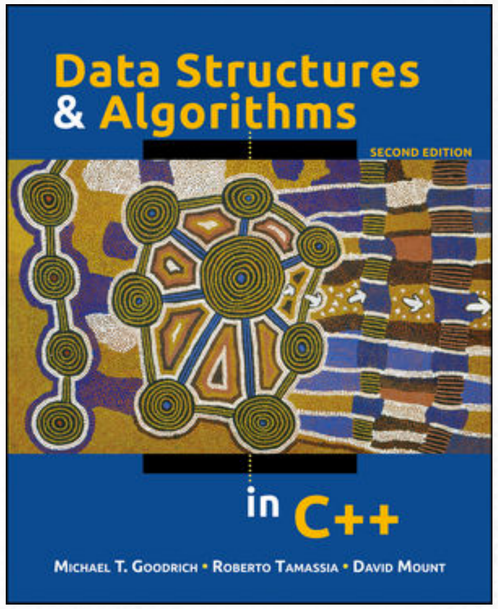
Remind

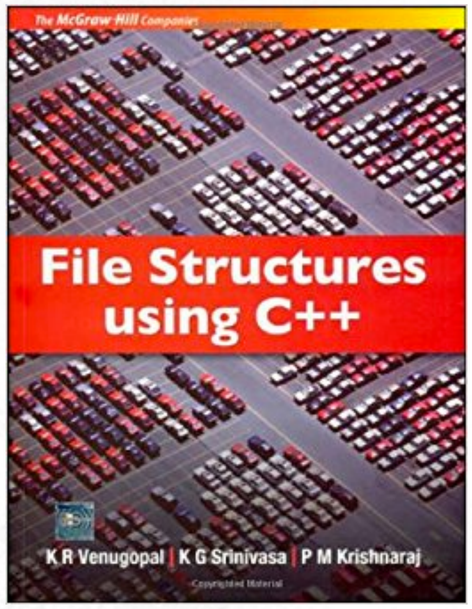
References

Managing File Intelligently: *FILE STRUCTURE*

Sorting and Searching: *ALGORITHM*

Managing Information Intelligently: *DATA STRUCTURE*





Software Component = Data + Function

- We already used:
  - cin, cout
  - string
  - fstream, ifstream, ofstream

- Software Component includes:
  - Data: file itself in fstream
  - Function: operations (open, close, etc,.) for file in fstream

Class and Object

- Class
  - Design document (not a real thing)
  - Example: ***fstream***

fstream myFile;

- Object
  - Realization of a Class (real thing with specific information)
  - Example: fstream ***myFile***;

- *Object* is an instance of a *Class*
  - ***A class is a programmer-defined type***
  - ***An object is an instance of a class***
    - The terms object and instance may be used interchangeably.

How can we make Class?

1. ***Specifying the data*** that constitute an object's state,
2. ***Defining the code to be executed on an object***'s behalf that provides services to clients that use the object,
3. ***Defining code that automatically initializes a newly-created object*** ensuring that it begins its life in a well-defined state, and
4. ***Specifying*** which parts of objects are ***visible to clients*** and which parts are ***hidden from clients***.

Class Example 1

Point Class (with data only = *member data*)

```
class Point {
public:
    double x;
    double y;
};
```

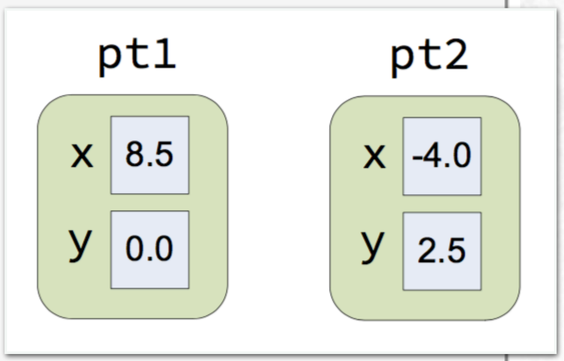
Listing 14.1: mathpoints.cpp

```
#include <iostream>

// The Point class defines the structure of software
// objects that model mathematical, geometric points
class Point {
public:
    double x;   // The point's x coordinate
    double y;   // The point's y coordinate
};

int main() {
    // Declare some point objects
    Point pt1, pt2;
    // Assign their x and y fields
    pt1.x = 8.5; // Use the dot notation to get to a part of the object
    pt1.y = 0.0;
    pt2.x = -4;
    pt2.y = 2.5;
    // Print them
    std::cout << "pt1 = (" << pt1.x << "," << pt1.y << ")\n";
    std::cout << "pt2 = (" << pt2.x << "," << pt2.y << ")\n";
    // Reassign one point from the other
    pt1 = pt2;
    std::cout << "pt1 = (" << pt1.x << "," << pt1.y << ")\n";
    std::cout << "pt2 = (" << pt2.x << "," << pt2.y << ")\n";
    // Are pt1 and pt2 aliases?  Change pt1's x coordinate and see.
    pt1.x = 0;
    std::cout << "pt1 = (" << pt1.x << "," << pt1.y << ")\n";
    // Note that pt2 is unchanged
    std::cout << "pt2 = (" << pt2.x << "," << pt2.y << ")\n";

}
```




```
pt1.x = pt2.x;
pt1.y = pt2.y;
```

```
pt1 = pt2;
```

Account Class (with vector and sorting)

```
class Account {
public:
    std::string name;   // The name of the account's owner
    int id;             // The account number
    double balance;     // The current balance
};
```

```
std::vector<Account> accounts(5000);
```

Let's see Listing 14.2

Class Definition

Account Class (with member function)

- Member Function
  - Function inside Class
  - Manipulate member data
  - '.' notation is not required to access member data *in same Object*
  - *ObjectName.DataName* is required to access member data *in other Object*
  - Member function definition can be *inside or outside of Class declaration*

Listing 14.3: newaccount.cpp

```
class Account {
    // String representing the name of the account's owner
    string name;
    // The account number
    int id;
    // The current account balance
    double balance;
public:
    /*********************************************************
     *  deposit(amt)
     *     Adds amount amt to the account's balance.
     *
     *     Author: Sam Coder
     *     Date: April 17, 2017
     *********************************************************/
    void deposit(double amt) {
        balance += amt;
    }

    /*********************************************************
     *  withdraw(amt)
     *     Deducts amount amt from the account's balance,
     *     if possible.
     *     Returns true if successful; otherwise, it returns false.
     *     A call can fail if the withdraw would
     *     cause the balance to fall below zero
     *
     *     amt:  funds to withdraw
     *
     *     Author: Sam Coder
     *     Date: April 17, 2017
     *********************************************************/
    bool withdraw(double amt) {
        bool result = false;  // Unsuccessful by default
        if (balance - amt >= 0) {
            balance -= amt;
            result = true;  // Success
        }
        return result;
    }
};
```

Account Class (member function calling)

Listing 14.3: newaccount.cpp

```
class Account {
    // String representing the name of the account's owner
    string name;
    // The account number
    int id;
    // The current account balance
    double balance;
public:
    /**********************************************************
     *  deposit(amt)
     *     Adds amount amt to the account's balance.
     *
     *     Author: Sam Coder
     *     Date: April 17, 2017
     **********************************************************/
    void deposit(double amt) {
        balance += amt;
    }

    /**********************************************************
     *  withdraw(amt)
     *     Deducts amount amt from the account's balance,
     *     if possible.
     *     Returns true if successful; otherwise, it returns fa
     *     A call can fail if the withdraw would
     *     cause the balance to fall below zero
     *
     *     amt:  funds to withdraw
     *
     *     Author: Sam Coder
     *     Date: April 17, 2017
     **********************************************************/
    bool withdraw(double amt) {
        bool result = false;  // Unsuccessful by default
        if (balance - amt >= 0) {
            balance -= amt;
            result = true;  // Success
        }
        return result;
    }
};
```

Same usage with standard Classes (fstream, string, etc)

```
// Affects the balance field of acct1 object
acct1.withdraw(100.00);
// Affects the balance field of acct2 object
acct2.withdraw(25.00);
```

Account myAccount;

Account Class (enhance with Constructor - 1/3)

- How can we make sure *the fields of an object have reasonable initial values* before a client begins using the object?
  - A class may define a ***constructor*** that ensures an object will begin in a well-defined sate.
  - A constructor definition *looks similar to a method definition*.
  - The code within a constructor executes on behalf of an object *when a client creates the object*.
  - For some classes, the client can provide information for the constructor to use when initializing the object.
  - ***A constructor has the same name as the class.***
  - ***A constructor has no return type, not even void.***

Account Class (enhance with Constructor - 2/3)

Listing 14.4: bankaccountmethods.cpp

```
#include <iostream>
#include <iomanip>
#include <string>

class Account {
    // String representing the name of the account's owner
    std::string name;
    // The account number
    int id;
    // The current account balance
    double balance;
public:
    // Initializes a bank account object
    Account(const std::string& customer_name, int account_number,
            double amount):
            name(customer_name), id(account_number), balance(amount) {
        if (amount < 0) {
            std::cout << "Warning: negative account balance\n";
            balance = 0.0;
        }
    }

    // Adds amount amt to the account's balance.
    void deposit(double amt) {
        balance += amt;
    }
```

Initialization list, explained later

```
Name: Joe, ID: 2312, Balance: 1000
Name: Moe, ID: 2313, Balance: 500.29
--------------------
Name: Joe, ID: 2312, Balance: 200
Name: Moe, ID: 2313, Balance: 522.29
```

Class Definition

Account Class (enhance with Constructor - 3/3)

```
    // Deducts amount amt from the account's balance,
    // if possible.
    // Returns true if successful; otherwise, it returns false.
    // A call can fail if the withdraw would
    // cause the balance to fall below zero
    bool withdraw(double amt) {
        bool result = false;  // Unsuccessful by default
        if (balance - amt >= 0) {
            balance -= amt;
            result = true;  // Success
        }
        return result;
    }

    // Displays information about the account object
    void display() {
        std::cout << "Name: " << name << ", ID: " << id
                  << ", Balance: " << balance << '\n';
    }
};


int main() {
    Account acct1("Joe", 2312, 1000.00);
    Account acct2("Moe", 2313, 500.29);
    acct1.display();
    acct2.display();
    std::cout << "--------------------" << '\n';
    acct1.withdraw(800.00);
    acct2.deposit(22.00);
    acct1.display();
    acct2.display();
}
```

int x = 10;

```
Name: Joe, ID: 2312, Balance: 1000
Name: Moe, ID: 2313, Balance: 500.29
--------------------
Name: Joe, ID: 2312, Balance: 200
Name: Moe, ID: 2313, Balance: 522.29
```

More about Constructor (1/3)

- If you do not define a constructor for your class,
  - the compiler automatically will create one for you—a default constructor that accepts no parameters
  - The compiler-generated constructor does not do anything to affect the state of newly created instances.
  - Example: `Account acct1; // Legal, do nothing.`

- If you define any constructor for your class,
  - the compiler will not provide a default constructor
  - Example: ***if you define your own constructor as in previous slide***

```
Account acct1; // Illegal, you should define
               // your own constructor.
```

More about Constructor (2/3)

- If multiple Constructor is defined, C++ selects approprate one.

```
class S {
    int n;

public:

    S(int) // constructor definition.
    {
        n = 1;
    }

    S() // constructor definition.
    {
        n = 0;
    }
};

int main()
{
    S s; // calls S::S()
    S s2(10); // calls S::S(int)
}
```

More about Constructor (3/3)

- With constructors, unlike with normal methods, we can use curly braces in place of parentheses, as in

```
// Client creating two Account objects
Account acct1{"Joe", 2312, 1000.00};
Account acct2{"Moe", 2313, 500.29};
```

- Which is same with

```
// Client creating two Account objects
Account acct1("Joe", 2312, 1000.00);
Account acct2("Moe", 2313, 500.29);
```

Strongly Recommended

Member Function definition out of Class

- If multiple Constructor is defined, C++ selects approprate one.

```
class S {
   int n;

public:

   S(int); // constructor declaration.

   S() // constructor definition.
   { n = 0; }
};

S::S(int) // constructor definition.
{
    n = 1;
{

int main()
{
   S s; // calls S::S()
   S s2(10); // calls S::S(int)
}
```

S::S(int)

function S(int)
in Class S

Initialization List

- Easy way to initialize member data in Constructor

```
class S {
   int n;

public:

   S(int); // constructor declaration.

   S() : n(0) // set member 'n' as '0'
   {} // constructor definition.
};

S::S(int) // constructor definition.
{
    n = 1;
{

int main()
{
   S s; // calls S::S()
   S s2(10); // calls S::S(int)
}
```

What is different?

OK

```
#include <iostream>
using namespace std;

class Adder {
  public:
    // constructor
    Adder(int i = 0) {
      total = i;
    }

    // interface to outside world
    void addNum(int number) {
      total += number;
    }

    // interface to outside world
    int getTotal() {
      return total;
    };

  private:
    // hidden data from outside world
    int total;
};

int main() {
  Adder a;

  a.addNum(10);
  a.addNum(20);
  a.addNum(30);

  cout << "Total " << a.getTotal() <<endl;
  return 0;
}
```

Fail

```
#include <iostream>
using namespace std;

class Adder {
  public:
    // constructor
    Adder(int i = 0) {
      total = i;
    }

    // interface to outside world
    void addNum(int number) {
      total += number;
    }

    // interface to outside world
    int getTotal() {
      return total;
    };

  private:
    // hidden data from outside world
    int total;
};

int main() {
  Adder a;

  a.addNum(10);
  a.addNum(20);
  a.addNum(30);

  cout << "Total " << a.total <<endl;
  return 0;
}
```

Hided Data and Codes

- **private:**
  - The variables *length*, *breadth*, and *height* are private
  - This means that **they can be accessed only by other members of the Box class**, and not by any other part of your program
  - This is one way ***encapsulation*** is achieved
  - C++'s ***default*** mode

```
class Box {
  public:
    double getVolume(void) {
      return length * breadth * height;
    }

  private:
    double length;     // Length of a box
    double breadth;    // Breadth of a box
    double height;     // Height of a box
};
```

Opened Data and Codes

- **public:**
  - you must declare them (*getVolume()*) after the public keyword
  - All variables or functions defined after the public specifier are **accessible by all other functions in your program**.

```
class Box {
  public:
    double getVolume(void) {
      return length * breadth * height;
    }

  private:
    double length;     // Length of a box
    double breadth;    // Breadth of a box
    double height;     // Height of a box
};
```

Opened Data and Codes, but not today…

- **protected:**
  - ***explained in Week.12***

Why Encapsulation?

- Software that is more flexible and resilient to change,
- Software that is more robust and reliable, and
- a software development process that programmers can more easily comprehend and manage.

Simple but Powerful Rule

A good rule of thumb in class design is this: make data `private`, and make methods that provide a service to clients `public`.

A good rule of thumb in class design is this: make data `private`, and make methods that provide a service to clients `public`.

A good rule of thumb in class design is this: make data `private`, and make methods that provide a service to clients `public`.

Class Example 2

Code Review

Let's see Listing 14.5

For Your Information

auto

- The auto keyword allows the compiler to ***automatically deduce the type of a variable*** if it is initialized when it is declared:

```
auto count = 0;
auto ch = 'Z';
auto limit = 100.0;
```

- The auto keyword ***may not be used without an accompanying initialization***; for example, the following declaration is illegal, because the compiler cannot deduce x's type.

```
auto x;
```

Automatic type inference is supported only by compilers that comply with the latest C++11 standard. Programmers using older compilers must specify a variable's exact type during the variable's declaration.

Required

CODE REVIEW

Code Review is the best way to understand Class & Object.

Please “Step into” your own software component using Visual Studio.

{ Recommended example codes are Listing 14.1 to 14.5 in Textbook }

Object Oriented Programming by C++

Sungwon Lee / Professor

Email: drsungwon@khu.ac.kr

Web: http://mobilelab.khu.ac.kr/