C/C++ Programming Language

CS205 Spring

Feng Zheng

Week 10

南方科技大学

SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Content

- Brief Review
- Objects and classes
  - Two programming styles
  - Classes in C++
  - Access control
  - Function implementations
  - Constructors and destructors
  - This pointer
  - Class scope
- Summary

Brief Review

Review

- A header file
- Header File Management (guarding scheme)
- Scope and Linkage
- 1. Automatic Storage Duration
- 2. Static Duration Variables:
  - External, Internal and No Linkage
  - Specifiers and Qualifiers
  - Functions Linkage
- 3. Storage Schemes and Dynamic Allocation

Objects and Classes

Procedural and Object-Oriented Programming

- Procedural Programming
  - Firstly concentrate on the procedures you will follow
  - Then think about how to represent the data
  - Put the functions together
- Object-Oriented Programming
  - Begin by thinking about the data
    - ✓Concentrate on the object as the user perceives it
    - ✓Describe the object and the operations that will describe the user's interaction with the data
    - ✓Decide how to implement the interface and data storage
  - Put together a program to use your new design

What Is a Type?

- Specifying a basic type does three things
  - It determines how much memory is needed for a data object
  - It determines how the bits in memory are interpreted (long vs. float)
  - It determines what operations, or methods, can be performed using the data object (integer vs. pointer)
- For built-in types
  - The information about operations is built in to the compiler
- For user-defined types in C++
  - Have to provide the same kind of information yourself

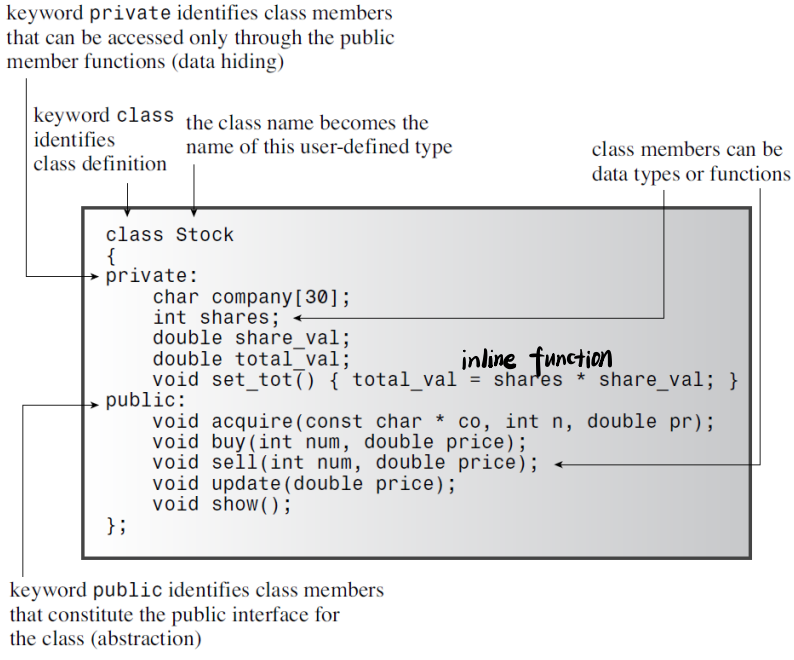
Classes in C++

- A class is a C++ vehicle for translating an abstraction to a user-defined type
  - Include data representation
  - Include methods for manipulating that data
- A class specification has two parts
  - A class declaration, which describes the data component, in terms of data members, and the public interface, in terms of member functions, termed methods
  - The class method definitions, which describe how certain class member functions are implemented

Access Control

protect data
encapsulation 封装.

- Describe access control for class members
  - Any program that uses an object of a particular class can access the public portions directly
  - A program can access the private members of an object only by using the public member functions



Components

- Abstraction component: the public interface
- Encapsulation component: gather the implementation details and separate them from the abstraction
  - Data hiding: insulation of data from direct access by a program is called
  - Data hiding is an instance of encapsulation
    - ✓ Prevent you from accessing data directly
    - ✓ Absolve you from needing to know how the data is represented
    - ✓ By default, the members are private (in structure type: public by default)

Implementing Class Member Functions

- Provide code for those member functions represented by a prototype in the class declaration
  - Use the **scope-resolution operator** (::) to identify the class to which the function belongs
  - Access the private components of the class
  - Has class scope (the same name for multi-class)
- Inline function:
  - Any function with a definition in the class declaration automatically
  - Define a member function outside the class declaration and still make it inline

```
class Stock
{
private:
    ...
    void set_tot();  // definition kept separate
public:
    ...
};
```

member function

```
inline void Stock::set_tot()  // use inline in definition
{
    total_val = shares * share_val;
}
```

Which Object Does a Method Use?

- Contain storage for its own internal variables, the class members
- But all objects of the same class share the same set of class methods, with just one copy of each method

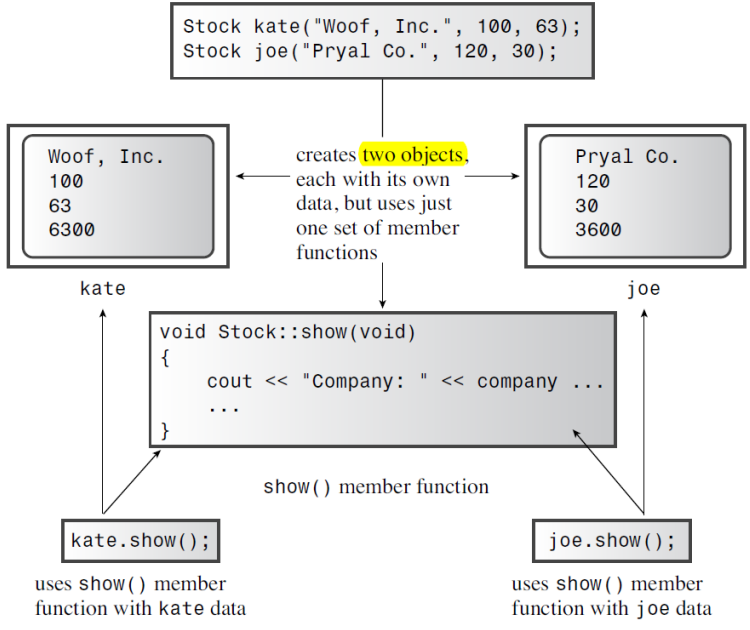
所有实例共享

- Questions?
  - What about a static variable for member functions of a class?
  - What about a static member of a class?
  - What about a static member function of a class?

Using Classes

- A program example: create and use objects of a class

- Run stock00.h, stock00.cpp, usestck0.cpp



Reviewing Our Story to Date

- Specify a class design is to provide a class declaration
- Specify a class design is to implement the class member functions
- Create an object, which is a particular example of a class

Constructor Declaration and Definition

- A program automatically invokes the constructor when it declares an object
  - Have NO return value and has NO declared type
  - Avoid confusion: between member variables and arguments
- Using constructors
  - Call the constructor explicitly 显式
    ```
    Stock food = Stock("World Cabbage", 250, 1.25);
    ```
  - Call the constructor implicitly
    ```
    Stock garment("Furry Mason", 50, 2.5);
    ```
  - Constructors are used differently from the other class methods

Default Constructors

- Do you remember the default functions?
- Create an object when you don't provide explicit initialization values
  - Have the members been initialized?
- How to provide default constructors
  - One is to provide default values for all the arguments to the existing constructor
  - The second is to use function overloading to define a second constructor, one that has no arguments
  - You can have only one default constructor

Destructors

- When program expires, when the program exits the block of code in which an object is defined or when you use delete to free the memory dynamically allocated for an object
  - Destructor: a special member function is called
  - Clean up all variables
  - Use new to create variables in constructor and use delete to free them
- Destructor form
  - Be formed from the class name preceded by a tilde (~)
  - Have NO return value and has NO declared type
  - Must have NO arguments

~Stock( );

- Run stock01.h, stock01.cpp, usestok01.cpp

Initialization and const

- C++11 list initialization (followed program 2)
  - Match the argument list of a constructor

```
Stock hot_tip = {"Derivatives Plus Plus", 100, 45.0};
Stock jock {"Sport Age Storage, Inc"};
Stock temp {};
```

- const member functions
  - A function promises NOT to modify the invoking object

```
void show() const;          // promises not to change invoking object

void stock::show() const    // promises not to change invoking object
```

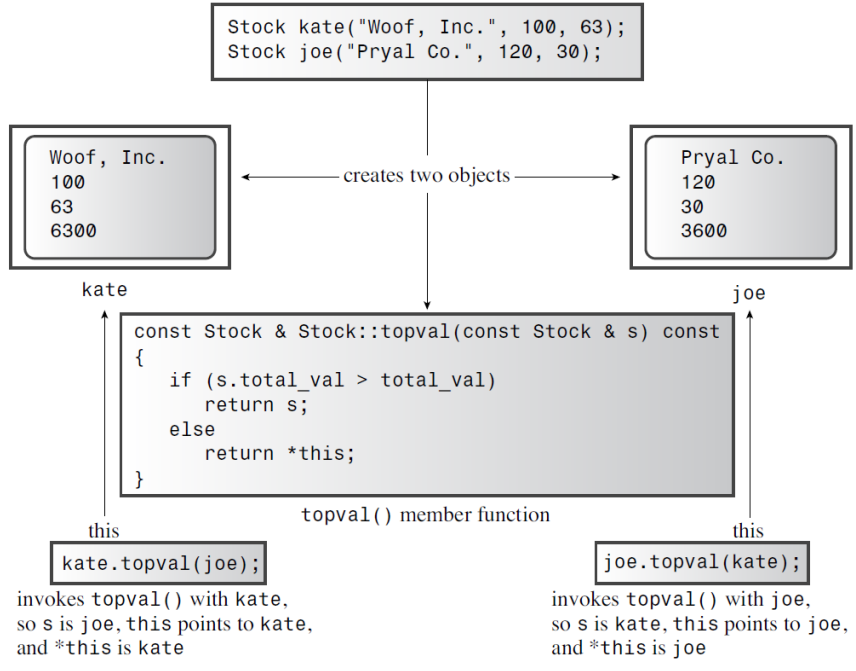
```
#define VALUE 100

const int value = 100;

const int * p_int;
int const * p_int;

int * const p_int;

void func(const int *);
void func(const int &);
```

Review of Constructors and Destructors

- Constructor (special member function of the same name)
  - Have more than one constructor with the same name, provided that each has its own signature
  - Have NO declared type
  - Have NO arguments for a default constructor
- Destructor (special member function of the name preceded by a tilde)
  - Invoke a destructor when an object is destroyed
  - You can have only one destructor per class
  - Have no return type (not even void) and no arguments
  - Use delete become necessary when class constructors use new

Knowing Your Objects: The this Pointer

- The this pointer points to the object used to invoke a member function
- In **general**, all class methods have a this pointer set to the address of the object that invokes the method
  - Why is it general and what is special?



An Array of Objects

- Create several objects of the same class
  - Declare an array of objects the same way you declare an array of any of the standard types
    - ✓ Either: the class explicitly defines no constructors at all, in which case the implicit do-nothing default constructor is used
    - ✓ Or: an explicit default constructor be defined
    - ✓ More: use a constructor to initialize the array elements

- Run

stock02.h, stock02.cpp, usestok02.cpp

```
const int STKS = 4;
Stock stocks[STKS] = {
    Stock("NanoSmart", 12.5, 20),
    Stock("Boffo Objects", 200, 2.0),
    Stock("Monolithic Obelisks", 130, 3.25),
    Stock("Fleep Enterprises", 60, 6.5)
    };
```

Class Scope

- Review scope
  - Global (or file) scope
  - Local (or block) scope
  - Function names can have global scope but they never have local scope

can be seen but can't be used

- Class scope applies to names defined in a class
  - The names of class data members
  - Class member functions
  - Can't directly access members of a class from the outside world
    - ✓ Direct membership operator (.)
    - ✓ Indirect membership operator (->)
    - ✓ Scope-resolution operator (::)

Class Scope Constants

- Constants in class
  - Problem: until you create an object, there's no place to store a value
- Solution
  - A symbolic constant: declare an enumeration within a class
  - A constant within a class—using the keyword static

```
class Bakery
{
private:
    const int Months = 12;    // declare a constant? FAILS
    double costs[Months];
    ...
```

```
class Bakery
{
private:
    static const int Months = 12;
    double costs[Months];
    ...
```

```
class Bakery
{
private:
    enum {Months = 12};
    double costs[Months];
    ...
```

1. Constants: symbol and literal
2. Defining Constants: macos
3. Enumerated Constants

Scoped Enumerations (C++11)

- Problem: enumerators from two different enum definitions can conflict
- Have class scope for its enumerators

```
enum egg {Small, Medium, Large, Jumbo};
enum t_shirt {Small, Medium, Large, Xlarge};
```

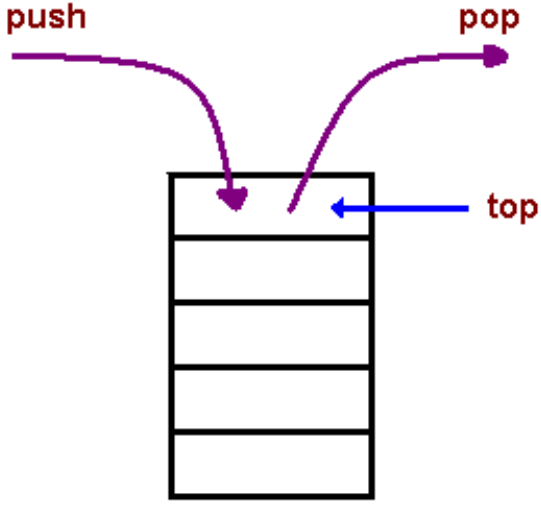
```
enum class egg {Small, Medium, Large, Jumbo};
enum class t_shirt {Small, Medium, Large, Xlarge};
```

```
enum egg_old {Small, Medium, Large, Jumbo};        // unscoped
enum class t_shirt {Small, Medium, Large, Xlarge}; // scoped
egg_old one = Medium;                              // unscoped
t_shirt rolf = t_shirt::Large;                     // scoped
int king = one;      // implicit type conversion for unscoped
int ring = rolf;     // not allowed, no implicit type conversion
if (king < Jumbo)    // allowed
    std::cout << "Jumbo converted to int before comparison.\n";
if (king < t_shirt::Medium)   // not allowed
    std::cout << "Not allowed: < not defined for scoped enum.\n";
```

Abstract Data Types

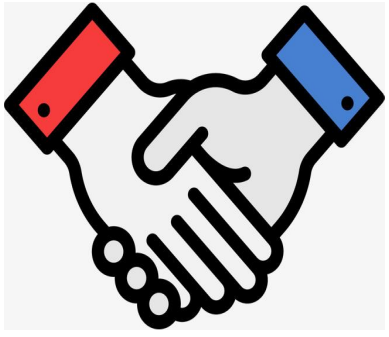
- An example: stack
  - Create an empty stack
  - Add an item to the top of a stack
  - Remove an item from the top
  - Check whether the stack is full
  - Check whether the stack is empty

- Run stack.h, stack.cpp, stacker.cpp



Summary

- Objects and classes
  - Two programming styles
  - Classes in C++
  - Access control
  - Function implementations
  - Constructors and destructors
  - this pointer
  - Class scope
  - Abstract data type: stack



Thanks

zhengf@sustech.edu.cn