

## W8.1 Continuing Classes

- **friend Functions and friend Classes**
- **Using the this Pointer**
- **Cascading Function Calls**

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## 7.4 friend Functions and friend Classes

- **friend function and friend classes**
  - Can access **private** and **protected** members of another class
  - **friend** functions are not member functions of class
    - Defined outside of class scope
- **Properties of friendship**
  - Friendship is granted, not taken
  - Not symmetric (if **B** a **friend** of **A**, **A** not necessarily a **friend** of **B**)
  - Not transitive (if **A** a **friend** of **B**, **B** a **friend** of **C**, **A** not necessarily a **friend** of **C**)

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## When to Use a **friend**

- Using **friend** functions can enhance performance.
- **friend** functions may be used to overload operators for classes and to create iterator classes.
  - Objects of iterator class used to successively select items or perform an operation on items in a container class (Ch.7.9)
  - Objects of container classes are capable of storing items.
- Using **friend** functions is appropriate when member function cannot be used (operator overloading, see Ch.8.4, later)

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## 7.4 **friend** Functions and **friend** Classes

- **friend** declarations
  - To declare a **friend** function
    - Type **friend** before the function prototype in the class that is giving friendship
 

```
friend int myFunction( int x );
```

 should appear in the class giving friendship
  - To declare a **friend** class
    - Type **friend class Classname** in the class that is giving friendship
      - if **ClassOne** is granting friendship to **ClassTwo**,
 

```
friend class ClassTwo;
```

 should appear in **ClassOne**'s definition

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```

1 // Fig. 7.5: fig07_05.cpp
2 // Friends can access private members of a class.
3 #include <iostream>
4
5 using std::cout;
6 using std::endl;
7
8 // Modified Count class
9 class Count {
10     friend void setX( Count &, int ); // friend declaration
11 public:
12     Count() { x = 0; } // constructor
13     void print() const { cout << x << endl; } // output
14 private:
15     int x; // data member
16 };
17
18 // Can modify private data of Count because
19 // setX is declared as a friend function of
20 void setX( Count &c, int val )
21 {
22     c.x = val; // legal: setX is a friend of Count
23 }
24
25 int main()
26 {
27     Count counter;
28
29     cout << "counter.x after instantiation: ";
30     counter.print();

```

**setX** a friend of class **Count** (can access **private** data).

**setX** is defined normally  
and is not a member  
function of **Count**.

Changing **private** variables allowed.

## Outline

### 1. Class definition

#### 1.1 Declare function a friend

#### 1.2 Function definition

#### 1.3 Initialize Count object

5

```

31     cout << "counter.x after call to setX friend function: ";
32     setX( counter, 8 ); // set x with a friend
33
34     counter.print();
35 }

```

## Outline

### 2. Modify object

#### 3. Print results

6

counter.x after instantiation: 0  
counter.x after call to setX friend function: 8

## Program Output

**private** data was changed.

```

1 // Fig. 7.6: fig07_06.cpp
2 // Non-friend/non-member functions cannot access
3 // private data of a class.
4 #include <iostream>
5
6 using std::cout;
7 using std::endl;
8
9 // Modified Count class
10 class Count {
11 public:
12     Count() { x = 0; }                                // constructor
13     void print() const { cout << x << endl; } // output
14 private:
15     int x; // data member
16 };
17
18 // Function tries to modify private data of Count,
19 // but cannot because it is not a friend of Count.
20 void cannotSetX( Count &c, int val )
21 {
22     c.x = val; // ERROR: 'Count::x' is not accessible
23 }
24
25 int main()
26 {
27     Count counter;
28
29     cannotSetX( counter, 3 ); // cannotSetX is not a friend
30     return 0;
31 }

```

cannotSetX is not a **friend**  
of class **Count**. It cannot access  
**private** data.

## Outline

(Previous program  
without **friend**  
declared)

cannotSetX tries to  
modify a **private**  
variable...

```

Compiling...
Fig07_06.cpp
D:\books\2000\cpphtp3\examples\Ch07\Fig07_06\Fig07_06.cpp(22) :
    error C2248: 'x' : cannot access private member declared in
    class 'Count'
    D:\books\2000\cpphtp3\examples\Ch07\Fig07_06\
    Fig07_06.cpp(15) : see declaration of 'x'
Error executing cl.exe.

test.exe - 1 error(s), 0 warning(s)

```

Expected compiler error - cannot  
access **private** data

## Outline

### Program Output

## 7.5 Using the `this` Pointer

- `this` pointer
  - Allows objects to access their own address
  - Not part of the object itself
  - Implicit first argument on non-static member function call to the object
  - Implicitly reference member data and functions
  - The type of the `this` pointer depends upon the type of the object and whether the member function using `this` is `const`
  - In a non-`const` member function of `Employee`, `this` has type  
`Employee * const`
    - Constant pointer to an `Employee` object
  - In a `const` member function of `Employee`, `this` has type  
`const Employee * const`
    - Constant pointer to a constant `Employee` object

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## 7.5 Using the `this` Pointer

- Examples using `this`
  - For a member function print data member `x`, either
 

```
    this->x
        or
        ( *this ).x
```
- Cascaded member function calls
  - Function returns a reference pointer to the same object
 

```
    { return *this; }
```
  - Other functions can operate on that pointer
  - Functions that do not return references must be called last

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## 7.5 Using the this Pointer

- Example of cascaded member function calls
  - Member functions **setHour**, **setMinute**, and **setSecond** all return **\*this** (reference to an object)
  - For object **t**, consider
    - t.setHour(1).setMinute(2).setSecond(3);**
    - Executes **t.setHour(1)**, returns **\*this** (reference to object) and the expression becomes  
**t.setMinute(2).setSecond(3);**
    - Executes **t.setMinute(2)**, returns reference and becomes  
**t.setSecond(3);**
    - Executes **t.setSecond(3)**, returns reference and becomes  
**t;**
    - Has no effect

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```

1 // Fig. 7.7: fig07_07.cpp
2 // Using the this pointer to refer to object members.
3 #include <iostream>
4
5 using std::cout;
6 using std::endl;
7
8 class Test {
9 public:
10    Test( int = 0 );           // default constructor
11    void print() const;      // ( ) around *this
12 private:
13    int x;
14 };
15
16 Test::Test( int a ) { x = a; } // constructor
17
18 void Test::print() const // ( ) around *this
19 {
20    cout << "      x = " << x
21    << "\n this->x = " << this->x
22    << "\n(*this).x = " << (*this).x << endl;
23 }
24
25 int main()
26 {
27    Test testObject( 12 );
28
29    testObject.print();
30
31    return 0;
32 }
```

Outline

1. Class definition

1.1 Function definition

1.2 Initialize object

2. Function call

Printing **x** directly.

Print **x** using the arrow **->** operator off the **this** pointer.

Printing **x** using the dot **(.)** operator. Parenthesis required because dot operator has higher precedence than **\***. Without, interpreted incorrectly as **\*this.x**.



```
x = 12
this->x = 12
(*this).x = 12
```

All three methods have  
the same result.

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## Outline

### 1. Class definition

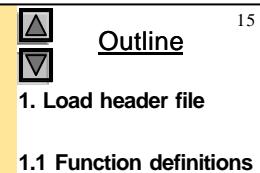
```
1 // Fig. 7.8: time6.h
2 // Cascading member function calls.
3
4 // Declaration of class Time.
5 // Member functions defined in time6.cpp
6 #ifndef TIME6_H
7 #define TIME6_H
8
9 class Time {
10 public:
11     Time( int = 0, int = 0, int = 0 ); // default constructor
12
13     // set functions
14     Time & setTime( int, int, int ); // set hour, minute, second
15     Time & setHour( int ); // set hour
16     Time & setMinute( int ); // set minute
17     Time & setSecond( int ); // set second
18
19     // get functions (normally declared const)
20     int getHour() const; // return hour
21     int getMinute() const; // return minute
22     int getSecond() const; // return second
23
24     // print functions (normally declared const)
25     void printMilitary() const; // print military time
26     void printStandard() const; // print standard time
27 private:
28     int hour; // 0 - 23
29     int minute; // 0 - 59
30     int second; // 0 - 59
31 };
32
33 #endif
```

Notice the **Time &**-function  
returns a reference to a **Time**  
object. Specify object in  
function definition.

```

34 // Fig. 7.8: time.cpp
35 // Member function definitions for Time class.
36 #include <iostream>
37
38 using std::cout;
39
40 #include "time6.h"
41
42 // Constructor function to initialize private data.
43 // Calls member function setTime to set variables.
44 // Default values are 0 (see class definition).
45 Time::Time( int hr, int min, int sec )
46     { setTime( hr, min, sec ); }
47
48 // Set the values of hour, minute, and second.
49 Time &Time::setTime( int h, int m, in
50 {
51     setHour( h );
52     setMinute( m );
53     setSecond( s );
54     return *this; // enables cascading
55 }
56
57 // Set the hour value
58 Time &Time::setHour( int h )
59 {
60     hour = ( h >= 0 && h < 24 ) ? h : 0;
61
62     return *this; // enables cascading
63 }
64

```



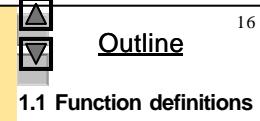
Returning `*this` enables  
cascading function calls



```

65 // Set the minute value
66 Time &Time::setMinute( int m )
67 {
68     minute = ( m >= 0 && m < 60 ) ? m : 0;
69
70     return *this; // enables cascading
71 }
72
73 // Set the second value
74 Time &Time::setSecond( int s )
75 {
76     second = ( s >= 0 && s < 60 ) ? s : 0;
77
78     return *this; // enables cascading
79 }
80
81 // Get the hour value
82 int Time::getHour() const { return hour; }
83
84 // Get the minute value
85 int Time::getMinute() const { return minute; }
86
87 // Get the second value
88 int Time::getSecond() const { return second; }
89
90 // Display military format time: HH:MM
91 void Time::printMilitary() const
92 {
93     cout << ( hour < 10 ? "0" : "" ) << hour << ":"
94         << ( minute < 10 ? "0" : "" ) << minute;

```



Returning `*this` enables  
cascading function calls



```

95 }
96
97 // Display standard format time: HH:MM:SS AM (or PM)
98 void Time::printStandard() const
99 {
100    cout << ( ( hour == 0 || hour == 12 ) ? 12 : hour % 12 )
101    << ":" << ( minute < 10 ? "0" : "" ) << minute
102    << ":" << ( second < 10 ? "0" : "" ) << second
103    << ( hour < 12 ? " AM" : " PM" );
104}
105// Fig. 7.8: fig07_08.cpp
106// Cascading member function calls together
107// with the this pointer
108#include <iostream>
109
110using std::cout;
111using std::endl;
112
113#include "time6.h"
114
115int main()
116{
117    Time t;
118
119    t.setHour( 18 ).setMinute( 30 ).setSecond( 22 );
120    cout << "Military time: ";
121    t.printMilitary();
122    cout << "\nStandard time: ";
123    t.printStandard();
124
125    cout << "\n\nNew standard time: ";
126    t.setTime( 20, 20, 20 ).printStandard();

```

**printStandard** does not return a reference to an object.

Notice cascading function calls.

Cascading function calls. **printStandard** must be called after **setTime** because **printStandard** does not return a reference to an object.  
**t.printStandard().setTime();** would cause an error.

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## Outline

### 1.1 Function definitions

#### 1. Load header

#### 1.1 Initialize Time object

#### 2. Function calls

#### 3. Print values

```

127    cout << endl;
128
129    return 0;
130}

```

18

## Outline

### Program Output

```

Military time: 18:30
Standard time: 6:30:22 PM
New standard time: 8:20:20 PM

```