CS2141 – Software Development using C/C++

Class Definitions

Visibility Modifiers

- Permissions for data members and member functions:
  - **`private`**: Can only be accessed by that class
  - **`protected`**: Can be accessed by subclasses
  - **`public`**: Can be accessed by anyone
- Class members are **`private`** by default
- Cannot be applied to the whole class:

```
public class A;     // Don't do this!
protected class B; // Or this!
```

Example

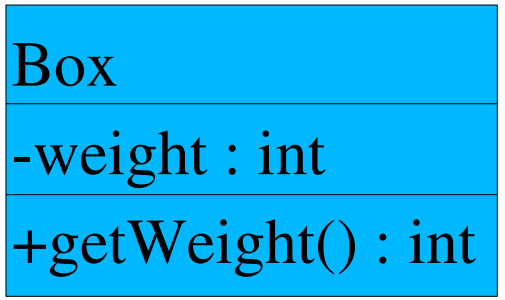
```
class Box   // Class name
{
   public:  // Public members section

      Box( int w ) { weight = w; }
      int getWeight( ) const { return weight; }

   private: // Private members section

      int weight;
};             // Notice the semicolon
```

Example in UML



- Always 3 sections
  - Name
  - Data members
  - Member functions
- Visibility modifiers
  - Public (+)
  - Private (-)
  - Protected (#)

Inline Methods

- A method that is implemented inside the class definition is called an *inline method*.
- The compiler may choose to expand the body of the method at the point of call.
  - The compiled code executes faster since it avoids the overhead of a function call.
  - Inlining can make the compiled code larger and more complex (usually not desirable properties).
- Use inlining only for very short methods.
- Never use them with loops or recursive calls.

Class Interface

- Usually the class definition is in an *interface* (or *header*) file, and the implementation in an *implementation* (or *source*) file.
  - Interface files usually have a .h extension.
  - Implementation files can have a .cpp, .c++, or .C.
  - The filename does not have to match the class name.
- A `#include` statement is used to include the class definition into the implementation file:

```
#include “myclass.h”
```

Fully Qualified Names

- Use a `#ifndef` ... `#define` ... `#endif` in the header file to avoid including the class definition more than once.
- Methods implemented in the source file use a *fully qualified* function name.
  - This avoids conflicts with other classes that have a method with the same name.
  - A fully qualified name consists of the class name, a double colon, and the method name:

```
... ClassName::methodName ...
```

Example

- box.h

```
#ifndef BOX_H
#define BOX_H

class Box
{
  public:
  Box( int w );
  int getWeight( ) const;

  private:
  int weight;
};

#endif
```

- box.c

```
#include “box.h”

Box::Box( int w )
{
    weight = w;
}

int Box::getWeight( ) const
{
    return weight;
}
```

Forward Declaration

- A class must be defined before it is used
  - If a class name is used in another class definition, the first class must be defined prior to the use
  - This could be a problem if the first class also uses the name of the second class
- A *forward declaration* is used to declare the name of a class
  - Permits pointers to the class to be declared
  - Cannot invoke methods in the class (since they're not defined yet)

Example 1

```
class Chicken;

class Egg
{
   public:
   Chicken * parent;
};

class Chicken
{
   public:
   Egg * children;
}
```

Example 2

```
class Link;

class List {
   public:
   ...
   private:

   Link * head;
};
```

```
class Link {
   Public:
   int value;
   Link * next;
   Link * prev;

   Link( int v,
         Link  * n,
         Link * p );

   void addBefore( int val,
                   List * );
};
```

Constructors

- Constructors serve two purposes: they create and initialize an object
- A constructor is a method with the **same name** as the class, and does **not** have a return type
- There are three types of constructors:
  - A **default** constructor takes no arguments
  - An **ordinary** constructor has some arguments
  - A **copy** constructor is used to make copies (clone)

Copy Constructor

- A copy constructor is used to make a copy of an object value.
  - It takes an instance of the same class as a constant reference argument:

```
Box( const Box & b );
```

  - A copy constructor is often called implicitly, such as when passing by value:

```
Box a;              // Default constructor gets
                    // called implicitly, too.
doStuff( a ); // Copy constructor called.
```

Example

```
class Box {
   public:
   Box( )                  // Default constructor
   { weight = 0; }

   Box( int w )          // Ordinary constructor
   { weight = w; }

   Box( const Box & b )  // Copy constructor
   { weight = b.weight; }

   private:
   int weight;
};
```

Initializers

- Data members can be initialized by an assignment in the constructor, or by an *initializer*:

```
class Box {
   public:
   Box( ) : v( 0 ) { }
   Box( int v ) : val( v ) { }
   ...
};
```

- Use initializers whenever possible to avoid initializing a value twice (first by the default constructor, then by the ordinary constructor).

Double initialization

```
class Box {
   public:
   Box( int w )
   { weight = w; }

   private:
   int weight;
};
```

- The default constructor for **`weight`** is called before the function body of the constructor
- Then **`weight`** is changed

Order of Initialization

- Class members are initialized in the order they are declared in the class body rather than in the order of the initializers

```
// This class is broken
class Order {
   public:
   Order( int i ) : one( i ), two( one ) { }
   int test( ) const { return two; }

   private:
   int two;  // initialized first
   int one;  // initialized second
};
```

Example

- Correct class definition:

```
class Order {
   public:
   Order( int i ) : one( i ), two( one ) { }
   int test( ) const { return two; }

   private:
   int one;  // initialized first
   int two;  // initialized second
};
```

Combining Constructors

- It is not allowed to call one constructor from another constructor:

```
class Box {
   public:
   Box( int a ) : val1( a ) { }
   Box( int a, int b ) : val2( b )
   {
      Box::Box( a ); // This will not work!
   }
   private:
   int val1, val2;
};
```

Solution 1

- Use *default arguments*:

```
class Box
{
   public:
   Box(int a, int b=7) : val1(a),val2(b) { }

   private:
   int val1, val2;
};
```

- Even though only one constructor is defined, it can be used with one or two arguments.

Solution 2

- Put the common initialization code in a separate private function:

```
class Box {
   public:
   Box( int a ) { initialize( a ); }
   Box( int a, int b )
   {
      initialize( a );
      ...
   }
   private:
   int initialize( int c );
};
```

Destructors

- The *destructor* is implicitly called when an object is deleted
  - Object may have been explicitly deleted using delete
  - An object could also be automatically deleted at the end of a function if the object is stack-resident
  - The destructor is **never** called directly
- The destructor is defined using a tilde followed by the class name and takes no arguments:

```
~Box( );
```

Destructors cont.

- The destructor usually deletes any heap-resident memory the object may have allocated:

```
class Storage {
   public:
   Storage( int s ) { space = new int[s]; }
   int & operator[]( int i )
   { return space[i]; }

   ~Storage( ) { delete [] space; }

   private:
   int * space;
};
```

The keyword `this`

- Every method has a pointer named **`this`** which points to the object the method was invoked on

```
class Box {
   public:
   Box( int w ) : weight( w ) { }

   Box & doStuff( ) {
      this->weight = 73;
      return *this;
   }

   private:
   int weight;
};
```

Nested Classes

- One class can be defined within another class.
  - If the nested class is defined in the private section, only the outer class will know it exists.
  - To access a nested class from outside the outer class, a fully qualified name must be used (suppose Link is public):

```
List::Link * l;
```

```
class List
{
   private:
   class Link
   {
      int value;
      Link * next;
   };
   Link * head;

   public:
   ...
};
```

Friends

- A class can have *friends* that are allowed to access its private data members and functions:

```
class Box {
   public:
   Box( int w ) : weight( w ) { }

   // Allow access for global function operator<<
   friend ostream & operator<<( ostream & out );

   // Allow class Crate to access val
   friend class Crate;

   private:
   int weight;
};
```