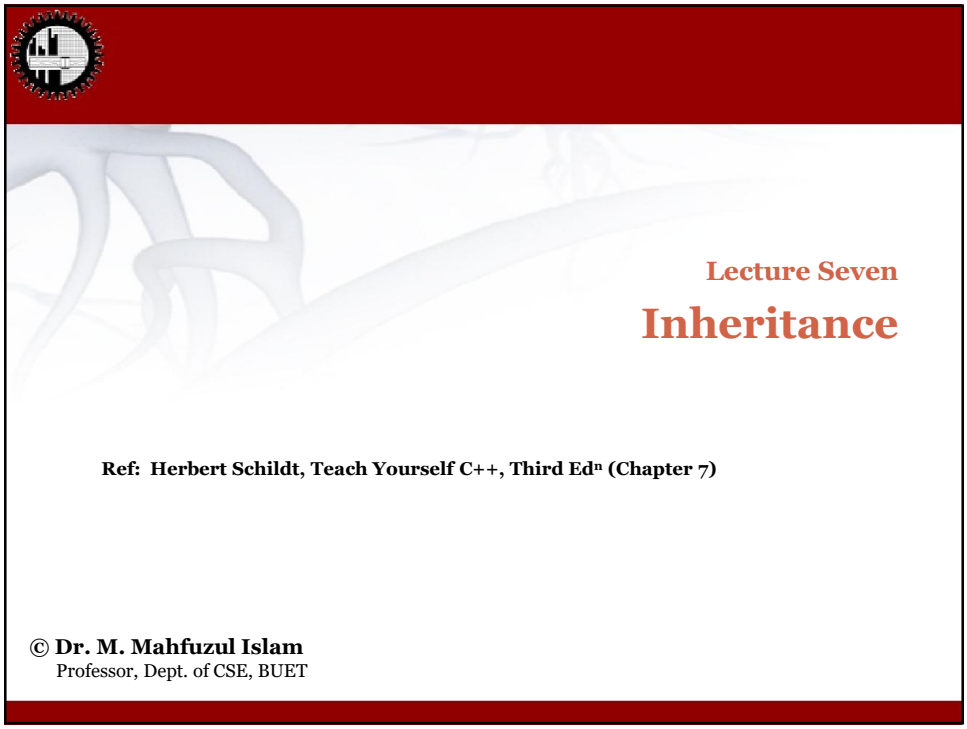

Lecture Seven

Inheritance

Ref: Herbert Schildt, Teach Yourself C++, Third Edn (Chapter 7)

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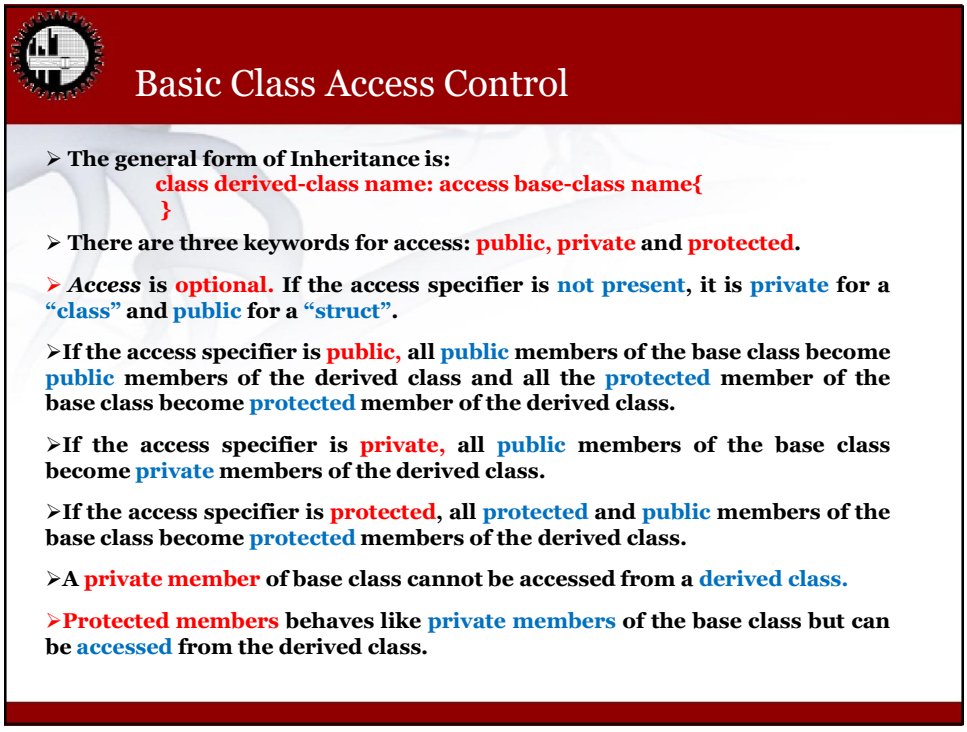


Basic Class Access Control

- The general form of Inheritance is:
  class derived-class name: access base-class name{
  }
- There are three keywords for access: public, private and protected.
- *Access* is optional. If the access specifier is not present, it is private for a "class" and public for a "struct".
- If the access specifier is public, all public members of the base class become public members of the derived class and all the protected member of the base class become protected member of the derived class.
- If the access specifier is private, all public members of the base class become private members of the derived class.
- If the access specifier is protected, all protected and public members of the base class become protected members of the derived class.
- A private member of base class cannot be accessed from a derived class.
- Protected members behaves like private members of the base class but can be accessed from the derived class.

Basic Class Access Control

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

class base {
      int x;
public:
      void setx(int n) { x = n; }
      void showx() { cout << x << '\n'; }
      int getx(){ return x; }
};

class derived: public base {
      int y;
public:
      void sety(int n) { y = n; }
      void showy() {
            cout << y << '\n';
            cout << x+y << '\n';     //Error??
            cout << y+getx() <<'\n';  //ok??
       }
};
```

```
int main(){
      derived ob;

      ob.setx(10);
      ob.sety(20);
      ob.showx();
      ob.showy();

       return 0;
}
```

Basic Class Access Control

➢**If derived inherits base as private, this cause more error within main.**

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

class base {
      int x;
public:
      void setx(int n) { x = n; }
      void showx() { cout << x << '\n'; }
      int getx(){ return x; }
};

class derived: private base {
      int y;
public:
     void sety(int n) { y = n; }
     void showy() {
           cout << y << '\n';
           cout << x+y << '\n';
           cout << y+getx() <<'\n';
      }
};
```

```
int main(){
    derived ob;

    ob.setx(10);        // Error ??
    ob.sety(20);
    ob.showx();         //Error??
    ob.showy();

    return 0;
}
```

Basic Class Access Control

➢**Protected members behaves like private members of the base class but can be accessed from the derived class.**

➢**If the access specifier is public, all public members of the base class become public members of the derived class and all the protected member of the base class become protected member of the derived class.**

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

class base {
      int a;
protected:
      int b;
public:
      int c;
      void setab(int n, int m) { a = n; b = m; }
};

class derived: public base {
public:
    void setc(int n) { c = n; }
    void showabc();
};
```

```
void derived::showabc(){
      cout << a <<" "<< b <<" "<< c<<'\n';
} // Error – a cannot be accessed
  //         – b can be accessed
  //         – c can be accessed

int main(){
      derived ob;

      ob.setab(10, 20);          // ok ??
      ob.setc(20);
      ob.showabc();

      return 0;
}
```

Basic Class Access Control

➢**If the access specifier is protected, all protected and public members of the base class become protected members of the derived class..**

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

class base {
      int a;
protected:
      int b;
public:
      int c;
      void setab(int n, int m) { a = n; b = m; }
};

class derived: protected base {
public:
    void setc(int n) { c = n; }
    void showabc();
};
```

```
void derived::showabc(){
      cout << a <<" "<< b <<" "<< c<<'\n';
} // Error – a cannot be accessed
  //         – b can be accessed
  //         – c can be accessed

int main(){
      derived ob;

      ob.setab(10, 20);          // Error
      ob.setc(20);
      ob.showabc();

      return 0;
}
```

Constructors, Destructors and Inheritance

- **Constructors are executed in order of derivation (i. e., base class constructor is executed first, then derived class constructor is executed) and destructors are executed in reverse order.**
- **For passing arguments to the constructor of base class, a chain of argument passing is necessary from derived class to base class.**
- **The general form of argument passing from derived class to base class is as follows:**

```
Derived-constructor(arg-list): base(arg-list){
}
```

- **Same arguments can be used in both base class and derived class.**
- **Derived class may simply pass the argument to the base class.**

Constructors, Destructors and Inheritance

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

class base {
    int x, y;
public:
    base(int n, int p){
        x = n;
        y = p;
        cout << "Constructing base class\n";
    }
    ~base(){
        cout <<  "destructing base class\n";
    }
    void showxy(){
        cout << x << " " << y << '\n';
    }
};

int main(){
    derived ob(10, 20, 30);

    ob.showxy();
    ob.showij();
    return 0;
}
```

```
class derived: public base {
        int i, j;
public:
        derived(int n, int m, int p): base (n, p){
            i = n;
            j = m;
            cout << "Constructing derived class\n";
        }
       ~derived(){
            cout <<  "destructing derived class\n";
        }
        void showij(){
            cout << i << " " << j << '\n';
        }
};
```

OUTPUT:

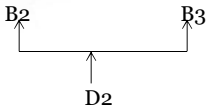
```
Constructing base class
Constructing derived class
10  30
10  20
Destructing derived class
Destructing base class
```

Multiple Inheritances

- There are two ways that a derived class can inherit more than one base class: the hierarchical inheritance and the base inheritance.
- The hierarchical inheritance: a derived class can be used as a base class for another derived class, creating a multilevel class hierarchy.

B1 ← D1 ← D2

- The multiple base inheritances: a derived class can directly inherit more than one base class.



- The general for multiple base inheritance is as follows:

```
derived-constructor(arg-list): base1(arg-list), base2(arg-list), ..., baseN(arg-list){
}
```

- When multiple base classes are inherited, constructors are executed from left to right, and destructors are executed in opposite order.
- When a derived class inherits a hierarchy of classes, each derived class in the chain must pass back to its preceding base any arguments it needs.

Multiple Inheritances

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

```
class B1 {
    int x;
public:
    B1(int i) {
        x = i;
        cout << "Constructing B1\n";
    }
    ~B1(){ cout << "Destructing B1\n";}
    int getx(){ return x;}
};
```

```
class B2 {
    int y;
public:
    B2(int j) {
        y = j;
        cout << "Constructing B2\n";
    }
    ~B2(){ cout << "Destructing B2\n";}
    int gety(){ return y;}
};
```

```
class B3 {
    int z;
public:
    B3(int k) {
        z = k;
        cout << "Constructing B3\n";
    }
    ~B3(){ cout << "Destructing B3\n";}
    int getz(){ return k;}
};
```

```
class D1: public B1 {
public:
    D1(int j):B1(j) {
        cout << "Constructing D1\n";
    }
    ~D1(){ cout << "Destructing D1\n";}
};
```

Multiple Inheritances

```
class D2: public D1, public B2, public B3 {
public:
      D2(int i, int j, int k): D1(i), B2(j),B3(k)  {
            cout << "Constructing D2\n";
      }
      ~D2(){ cout << "Destructing D2\n";}
      void show(){
        cout  << getx() << " " << gety() << " ";
        cout << getz() << '\n';
      }
};
```

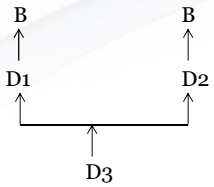
```
int main(){
     D2 ob(10, 20, 30);

     ob.show();
     return 0;
}
```

OUTPUT:

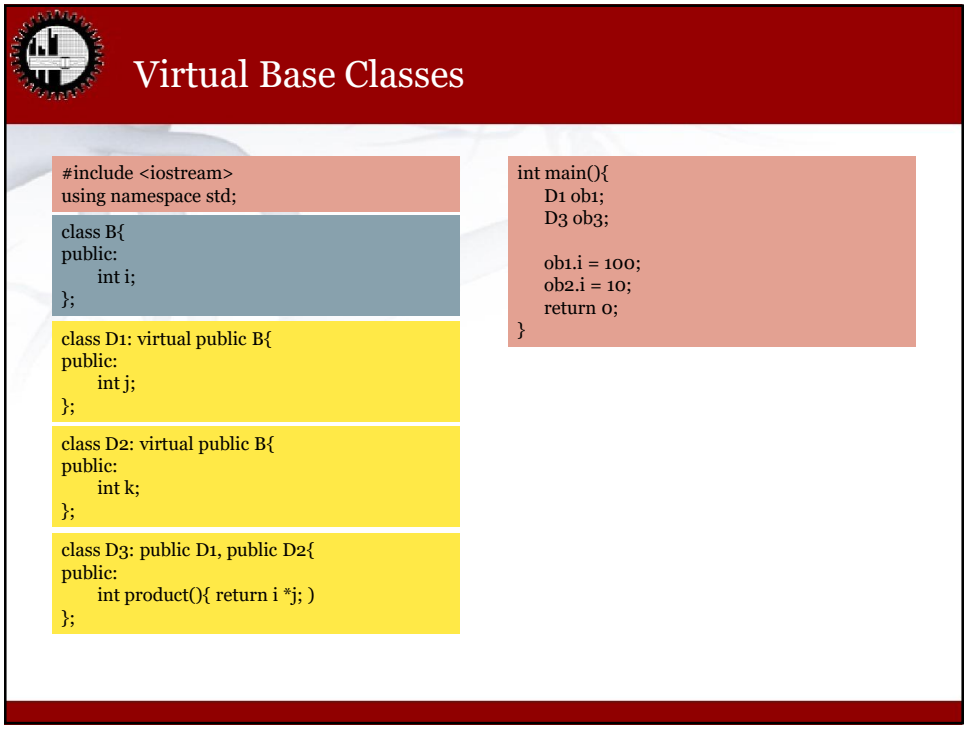
```
Constructing B1
Constructing D1
Constructing B2
Constructing B3
Constructing D2
10 20 30
Destructing D2
Destructing B3
Destructing B2
Destructing D1
Destructing B1
```

Virtual Base Classes

➢**In the following scenario, B is inherited by D1 and D2 and D3 directly inherits D1 and D2. This causes ambiguity (whether calling through D1 or D2) when a member of B is inherited in D3, because two copies of B is included in D3.**



➢**The keyword "virtual" precedes the base class in both cases inherits only one copy in D3.**



Virtual Base Classes

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

class B{
public:
    int i;
};

class D1: virtual public B{
public:
    int j;
};

class D2: virtual public B{
public:
    int k;
};

class D3: public D1, public D2{
public:
    int product(){ return i *j; )
};
```

```
int main(){
    D1 ob1;
    D3 ob3;

    ob1.i = 100;
    ob2.i = 10;
    return 0;
}
```