HANYANG UNIVERSITY

창의적 소프트웨어 프로그래밍

실습 교재_08

Made by MDB

Abstract Base Classes

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  - Abstract Base Classes
  - Overriding
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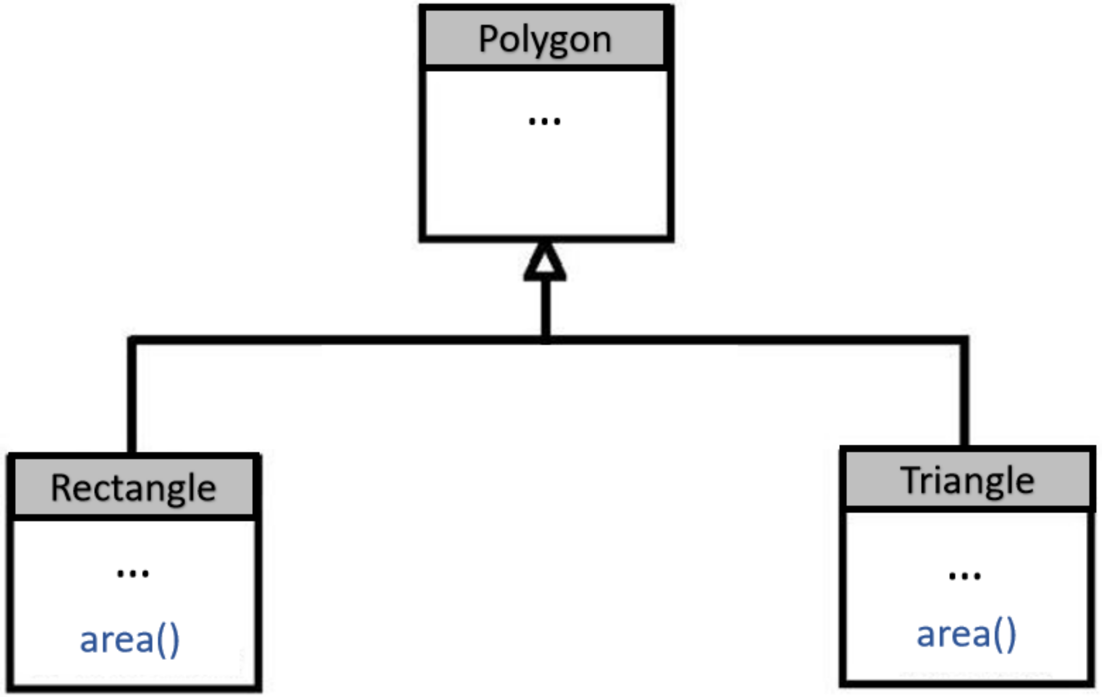
Inheritance & Polymorphism

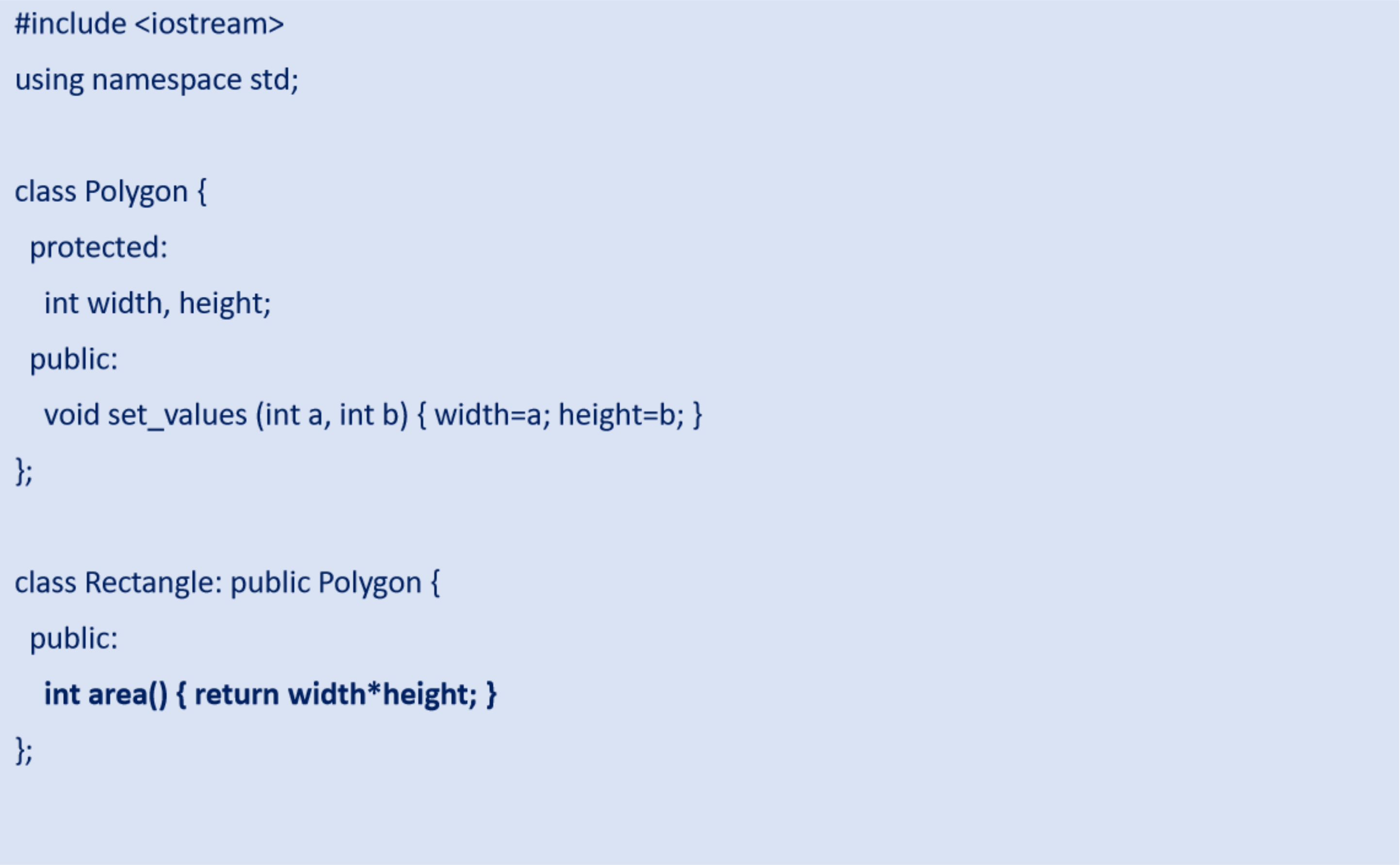
- Inheritance without Polymorphism is possible!
  - Addition or Extension of base class
- Polymorphism without Inheritance is impossible!
  - Treat objects from different classes the same way
  - Needs virtual inheritance
  - class that declares or inherits a virtual function is called polymorphic class

Inheritance & Polymorphism

- Inheritance
    - Addition or Extension of base class

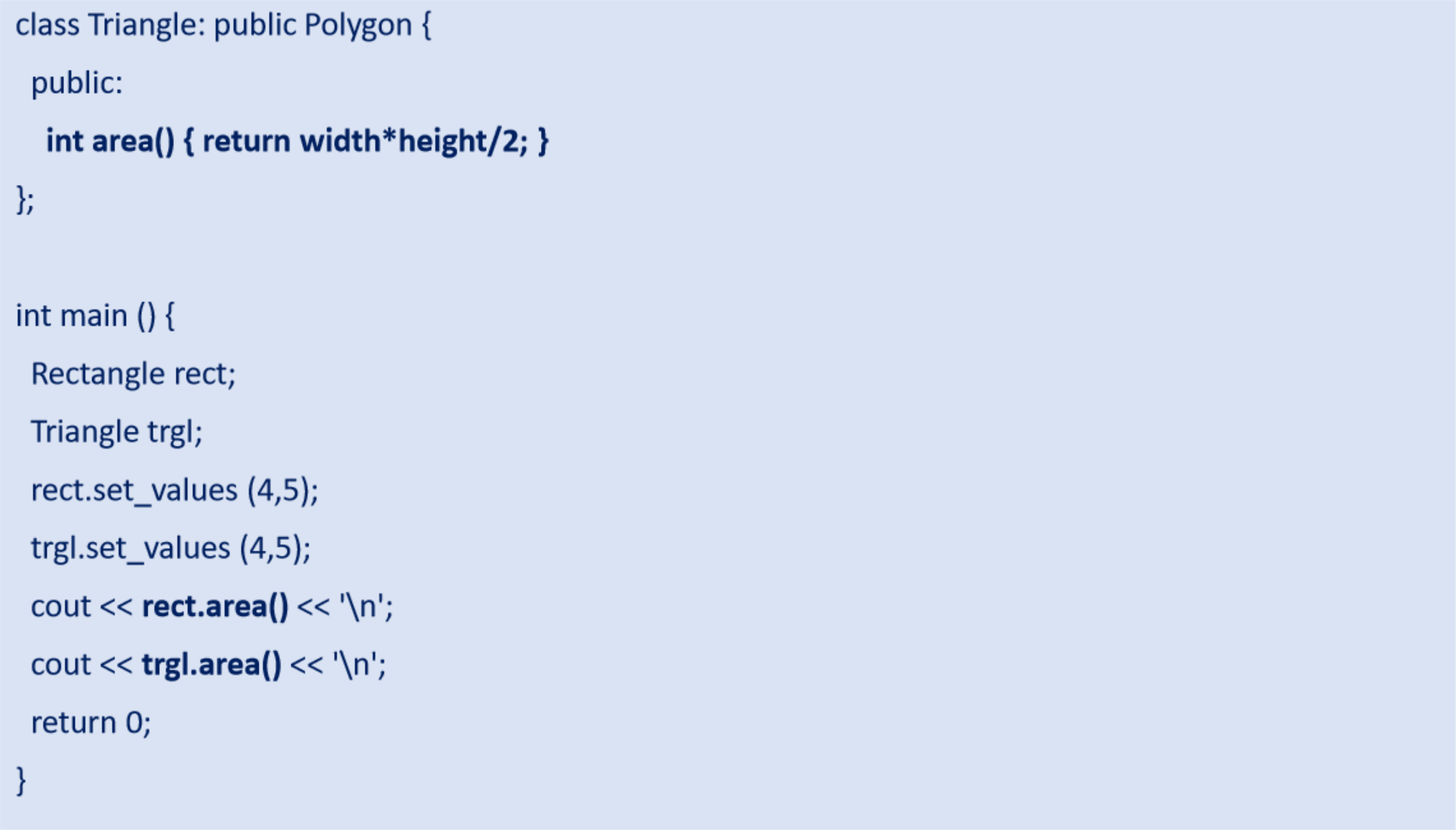


Example



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

class Polygon {
  protected:
    int width, height;
  public:
    void set_values (int a, int b) { width=a; height=b; }
};

class Rectangle: public Polygon {
  public:
    int area() { return width*height; }
};
```

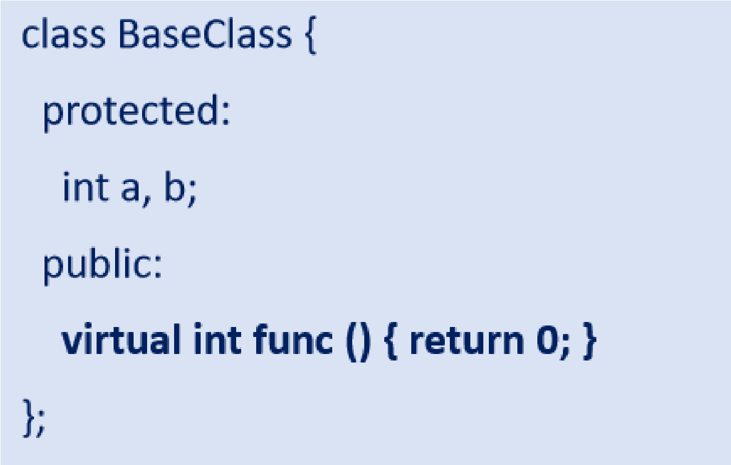
Example (Cont.)



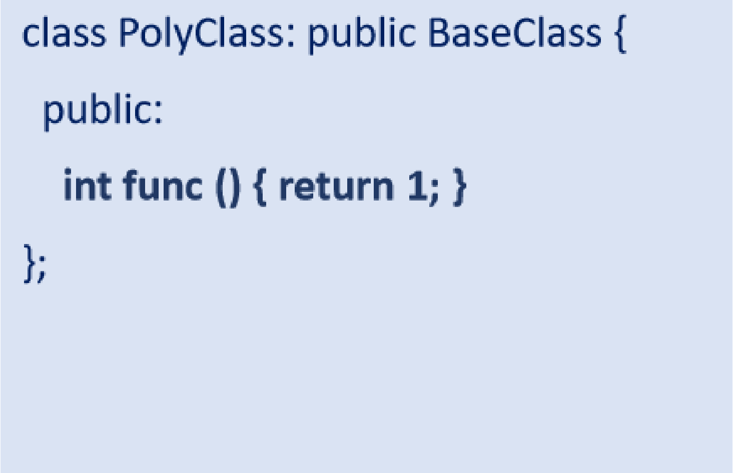
```
class Triangle: public Polygon {
  public:
    int area() { return width*height/2; }
};

int main () {
  Rectangle rect;
  Triangle trgl;
  rect.set_values (4,5);
  trgl.set_values (4,5);
  cout << rect.area() << '\n';
  cout << trgl.area() << '\n';
  return 0;
}
```

Virtual Functions

- Virtual Functions
  - Can be redefined in a derived class
  - Preserve calling properties through references
  - Abstract implementation!



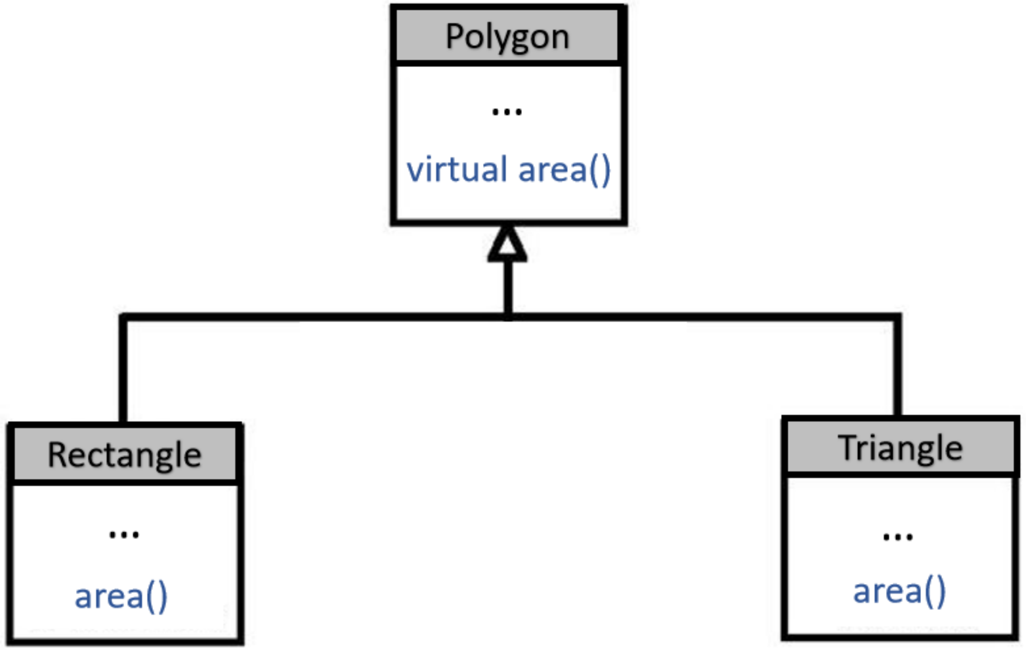
```
class BaseClass {
  protected:
    int a, b;
  public:
    virtual int func () { return 0; }
};
```



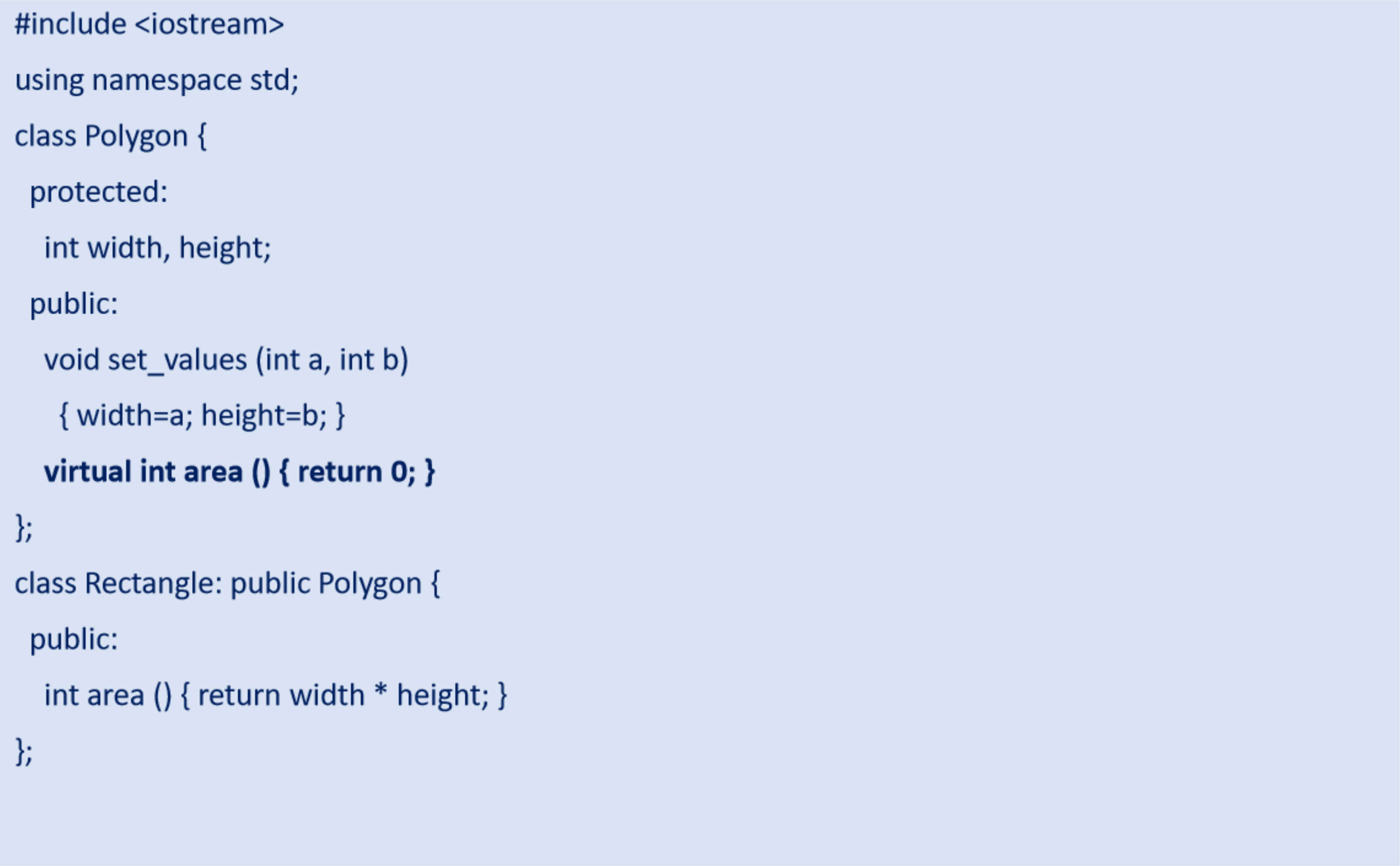
```
class PolyClass: public BaseClass {
  public:
    int func () { return 1; }
};
```

Inheritance & Polymorphism

- Polymorphism
  - Treat objects from different classes the same way
  - Needs virtual inheritance



Example



```
#include <iostream>
using namespace std;
class Polygon {
 protected:
  int width, height;
 public:
  void set_values (int a, int b)
   { width=a; height=b; }
  virtual int area () { return 0; }
};
class Rectangle: public Polygon {
 public:
  int area () { return width * height; }
};
```

Example (Cont.)

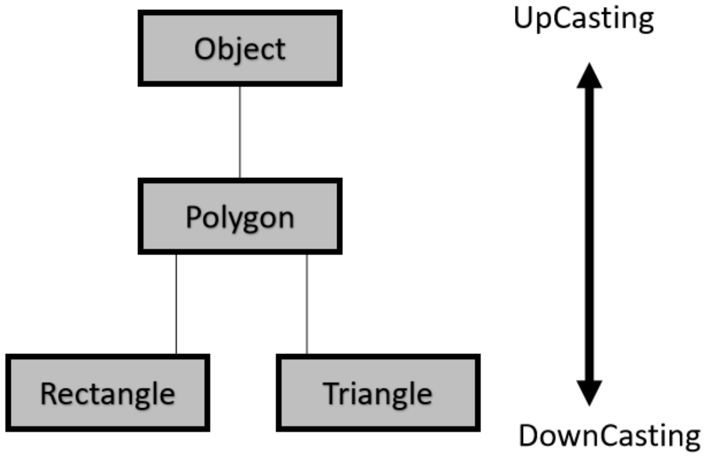
```
class Triangle: public Polygon {
 public:
  int area ()
   { return (width * height / 2); }
};
int main () {
 Rectangle rect;
 Triangle trgl;



 cout << ppoly1->area() << '\n';
 cout << ppoly2->area() << '\n';
return 0;
}
```

Inheritance & Polymorphism

- Key features
  - Pointer to a derived class is type-compatible with a pointer to its base class
  - Can preserve calling properties through references

Casting

- UpCasting
  - Up to Base Class!
  - Possible! Because derived class includes members of base class
  - ABC abc = abcd;
- DownCasting
  - Down to Derived Class!
  - ABCD abcd = abc;



Example

```
#include <iostream>

using namespace std;

class Base {
  public:
    void showBase() { cout << "Base Function" << endl; }
};

class Derived: public Base {
  public:
    void showDerived() { cout << "Derived Function" << endl; }
};
```

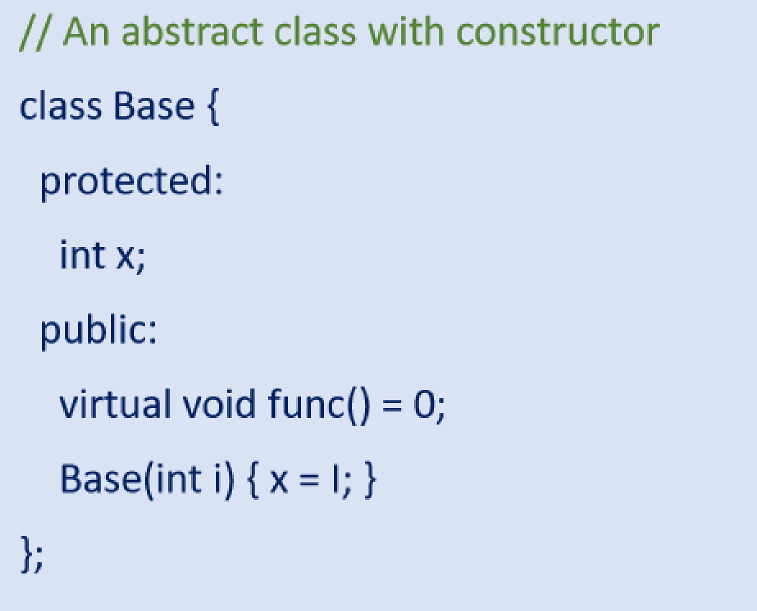
Example

```
int main(void) {
  Derived d2;
  Derived *d1;
  Base *b = &d2;          // UpCasting

  d1 = b;                 // Needs DownCasting


  d1->showDerived();
  d1->showBase();
}
```

```
example3.cpp: In function ‘int main()’:
example3.cpp:21:6: error: invalid conversion from ‘Base*’ to ‘Derived*’ [-fpermissive]
          d1 = b;
             ^
```

Pure Virtual Function

- Pure virtual function
  - virtual functions with no definition
  - Start with `virtual’, ends with `= 0’
  - Can have constructors

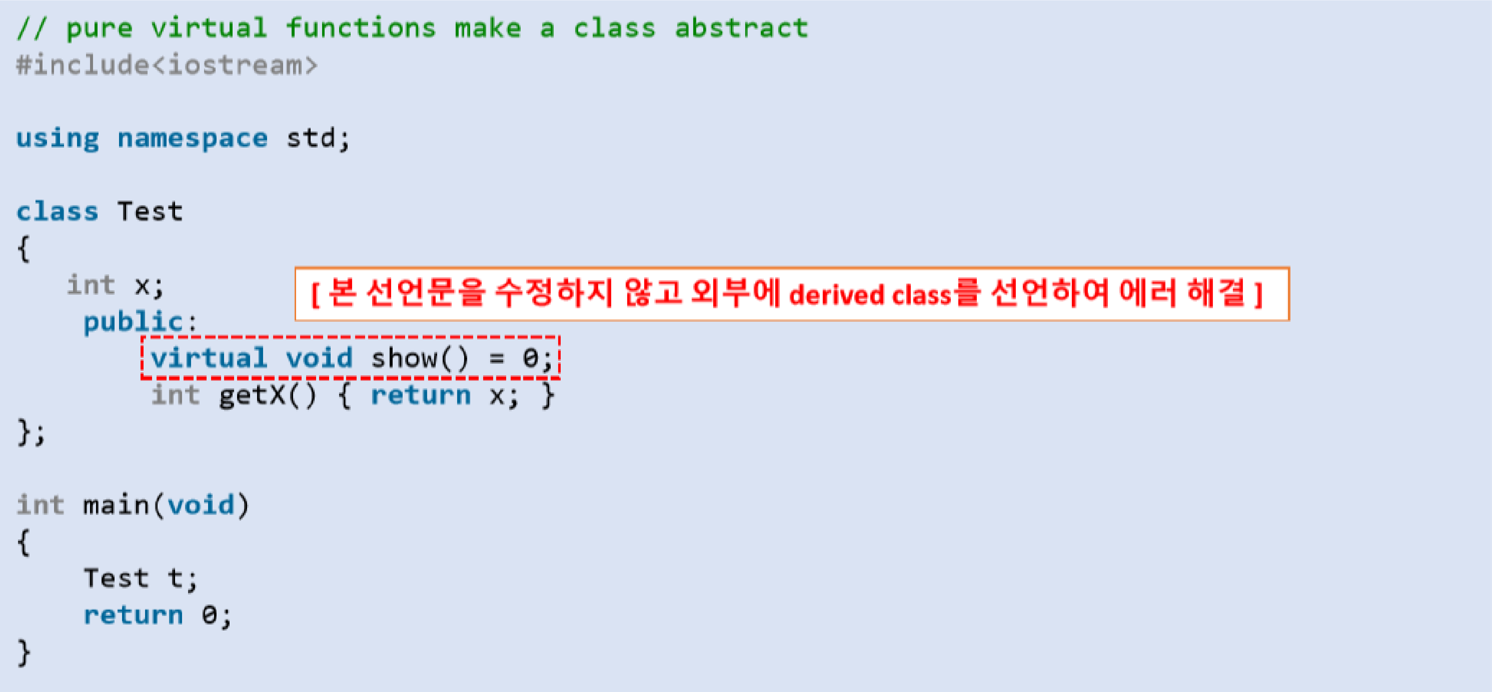


```
// An abstract class with constructor
class Base {
 protected:
   int x;
 public:
   virtual void func() = 0;
   Base(int i) { x = I; }
};
```

Abstract Base Classes

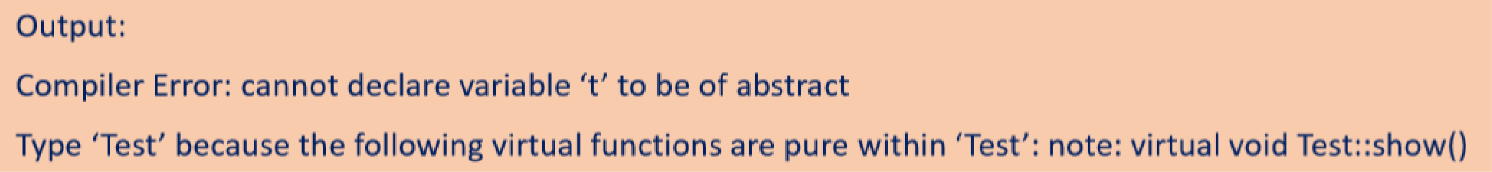
- Abstract Class
  - Have at least one pure virtual function
  - Must implement own version of each derived class

Example



```
// pure virtual functions make a class abstract
#include<iostream>

using namespace std;

class Test
{
   int x;
    public:
        virtual void show() = 0;
        int getX() { return x; }
};

int main(void)
{
    Test t;
    return 0;
}
```

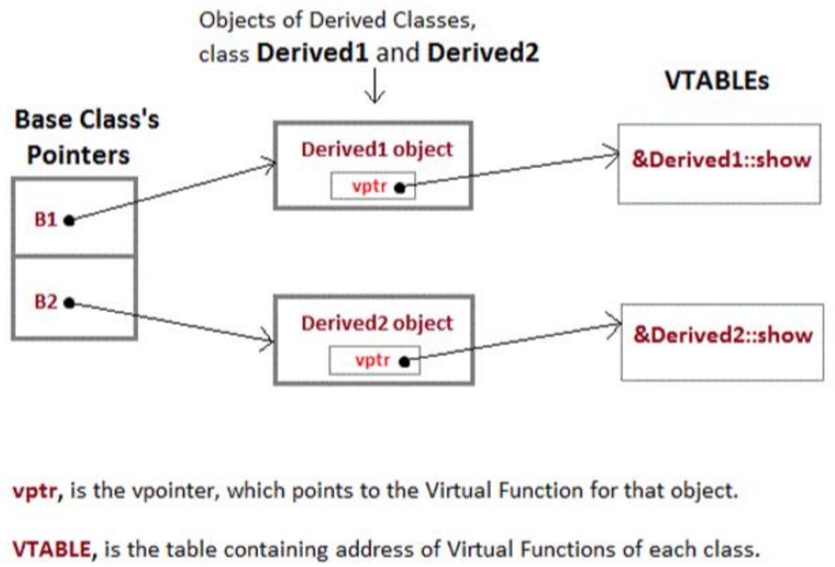
[본 선언문을 수정하지 않고 외부에 derived class를 선언하여 에러 해결]



```
Output:
Compiler Error: cannot declare variable ‘t’ to be of abstract
Type ‘Test’ because the following virtual functions are pure within ‘Test’: note: virtual void Test::show()
```

Abstract Base Classes

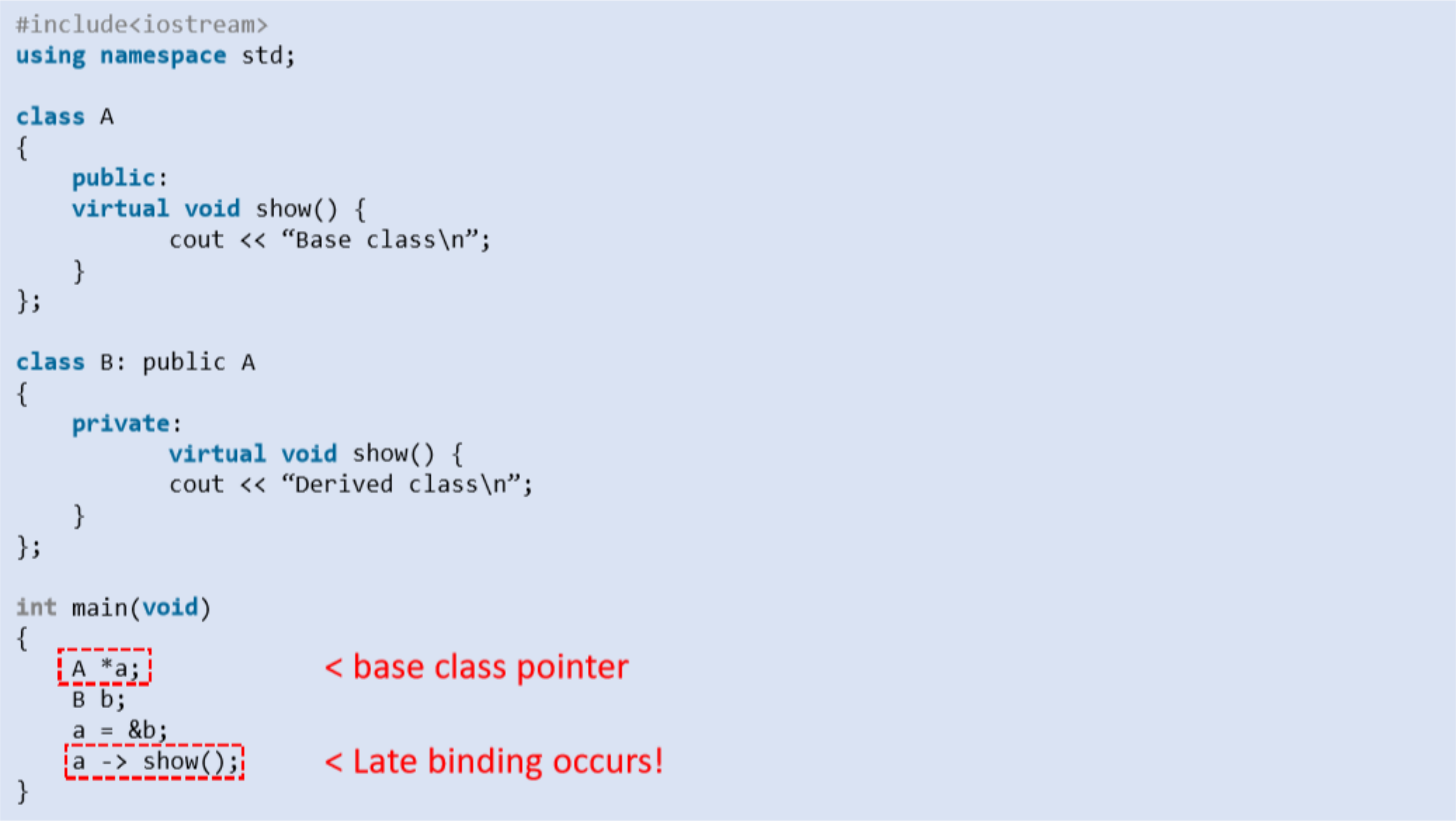
- Why can't we create object of abstract class?
  - Reserve a slot for a function in the VTABLE
  - Doesn't put any address in the slot
  - Incomplete!



vptr, is the vpointer, which points to the Virtual Function for that object.

VTABLE, is the table containing address of Virtual Functions of each class.

Example

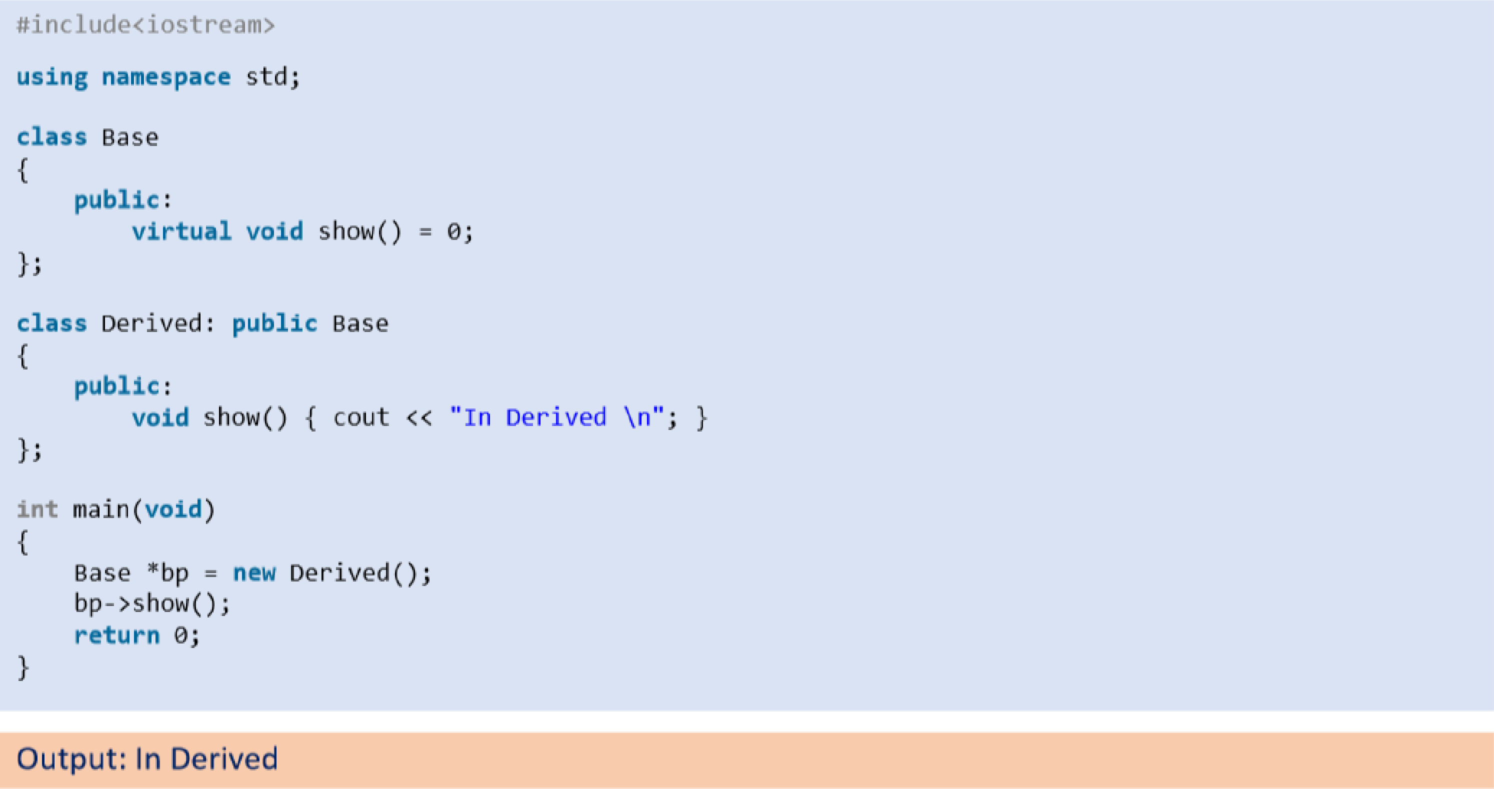


```
#include<iostream>
using namespace std;

class A
{
    public:
    virtual void show() {
            cout << “Base class\n”;
    }
};

class B: public A
{
    private:
            virtual void show() {
            cout << “Derived class\n”;
    }
};

int main(void)
{
    A *a;                < base class pointer
    B b;
    a = &b;
    a -> show();         < Late binding occurs!
}
```

Output: Derived class

Abstract Base Classes

- But can have pointers and references of abstract class



```
#include<iostream>

using namespace std;

class Base
{
    public:
        virtual void show() = 0;
};

class Derived: public Base
{
    public:
        void show() { cout << "In Derived \n"; }
};

int main(void)
{
    Base *bp = new Derived();
    bp->show();
    return 0;
}
```

```
Output: In Derived
```

Overriding

- Similar to redefinition
- If we do not override the pure virtual function, Then derived class also becomes abstract class