Day 33 (Fri 04/15)

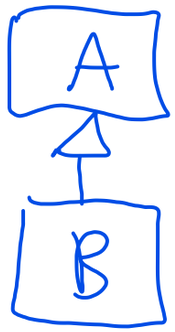
- exercise 32 review
- day 33 recap questions
- exercise 33

- HW7 due Wed 4/20 by 11 pm

- Please register your final project team ASAP!
  - Google form link in (pinned) Piazza post 575
  - You can also use that post to find team member(s)

- Final project has been posted; we will introduce it in detail on Monday
  - But, feel free to start reading it over and working on it

Exercise 32



"is-a"

In B's constructor:

a = 27;

The member variable a is private in the base class A, so B's constructor can't access it directly.

DataLoop& DataLoop::operator+(int x)
{

member function

}

Exercise 32

In main1.cpp:

```
aobj.d = 17.5;   // d is protected in A, main cannot access directly

aptr->setb(15); // even though aptr is pointing to an object of type B,
                // its type is A* (pointer to A), and A does not have a
                // setb member function

bobj = a5;       // B's assignment operator requires an argument of
                // type const B& (reference to const B), but a5's type
                // is A
```

Exercise 32

After making the show() member function virtual in A

Note that additional output is generated

```
--- orig_output.txt     2022-04-14 18:04:14.954391100 -0400
+++ revised_output.txt  2022-04-14 18:04:42.578282600 -0400
@@ -6,10 +6,14 @@

 A is 3
 test A
+B is 2
+test B

 non-virtual display A
 A is 3
 test A
+B is 2
+test B

 A obj killed
 A is 10
```

Exercise 32

A's show() member function:

virtual void show() { std::cout << "A is " << a << std::endl; test(); };

A's display() member function:

void display() { std::cout << "non-virtual display A " << std::endl; show(); };

B's show() member function:

void show() { A::show(); std::cout << "B is " << b << std::endl; test(); };

The call to show() in A::display() now resolves to B::show() when called on a B object. B::show() calls A::show() directly, then prints additional output ("B is _"), then calls test() (which is a non-virtual member function in A, but resolves to B::test(), because B also defines a member function of the same name, and the call is in B::show().)

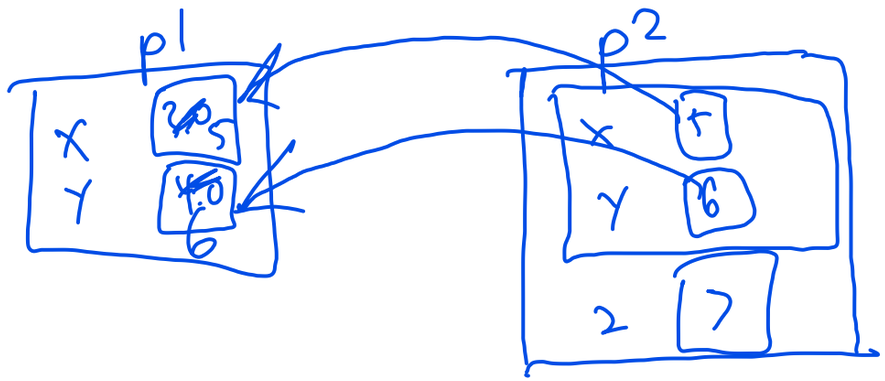
Day 33 recap questions

1. Explain what object slicing is in C++.
2. What is the override specifier in C++?
3. Explain what function hiding is in C++?
4. In C++, how do you make an abstract class?
5. Can we create an object from an abstract class?

1. Explain what object slicing is in C++.

An assignment of a derived class object to a base object will "slice off" the fields of the derived class object, because they can't be stored in the base class object.

E.g.:




```
// assume Point3D derives from Point2D
Point2D p1(3.0, 4.0);
Point3D p2(5.0, 6.0, 7.0);

p1 = p2; // only the x and y values of p2 are copied to p1
```

Value semantics (copying and assigning object contents) tends not to be particularly useful in class hierarchies (where inheritance is used to define "is-a" relationships between classes.)

It is not uncommon for base and derived classes to prohibit the use of the copy constructor and assignment operator by making them private.

2. What is the override specifier in C++?

The override specifier can be used in a derived class to indicate that a member function is intended to override a member function in the base class. If the derived class function (marked with override) does not *actually* override the base class function, the compiler reports an error.

The problem it is designed to solve:

- base class defines a virtual member function

- derived class defines a virtual member function intended to override the base class function, but it messes up somehow (e.g., wrong number or type(s) of parameters), so that the derived class function doesn't actually override the base class function

One reason this could happen is because someone changes the definition of the member function in the base class.

Opinion

Virtual member functions in base classes should be pure virtual (i.e., abstract).

If they are, then the override specifier isn't that necessary, because if a derived class doesn't override all of the pure virtual member functions in the base class, it won't be instantiable.

3. Explain what function hiding is in C++?

Function hiding occurs when a derived class defines a member function with the same name as member function(s) in the base class.

This "hides" the identically named functions in the base class.

Note that those functions could still be called using the scope resolution operator (::). E.g.

```
Base::foobar(123, 'a'); // if functions called "foobar" in Base would normally
                        // be hidden, this would call Base::foobar(int, char)
```

4. In C++, how do you make an abstract class?

A class that has at least one pure virtual function is an abstract class.

E.g.:

```
class Animal {
public:
  virtual ~Animal() { }
  virtual void vocalize() = 0; // pure virtual function
};
```

Opinion: virtual functions in base classes should always be pure virtual. The reason is that if derived classes will be overriding the function to implement varying behavior, then there is probably nothing useful that the base class can do to define functionality for the member function.

5. Can we create an object from an abstract class?

No. Example:

```
class Animal {
public:
  virtual ~Animal() { }
  virtual void vocalize() = 0;
};

class Dog : public Animal {
  virtual ~Dog() {}
  virtual void vocalize()
    { std::cout << "woof\n"; }
};
```

```
Animal *a = new Animal(); // compile error
  Dog *d = new Dog(); // fine
```

```
Animal *a = new Dog;
    ⋮
delete a;
```

.