Advanced Inheritance

C++ Object Oriented Programming

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NTOU CS

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- What can you do with an ABC?
- Pure virtual function

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```
error C2259: 'Person' : cannot instantiate abstract class due to following members:
warning C4259: 'void __thiscall Person::display(void) const' :pure virtual function
                    was not defined
```

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```
Person *database[3];       // heterogeneous container
database[0] = new Undergraduate("Mary", 18);
database[1] = new Graduate("Angela", 25, 6000, "Fairview 2250");
database[2] = new Faculty("Sue", 34, "Fairview 2248", "Professor");
for (int i=0; i<3; i++)
   database[i]->display();
```

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- Abstract classes are sometimes called *partial classes*

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```
void Person::display() const {
    cout << getName() << " is " << getAge() << " years old.\n";
}
void Faculty::display() const {
    Person::display();
    cout << " Her address is " << m_office.getAddress() << ".\n";
    cout << " Her rank is " << m_rank << ".\n\n";
}
```

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class A
deferred function Z()=0

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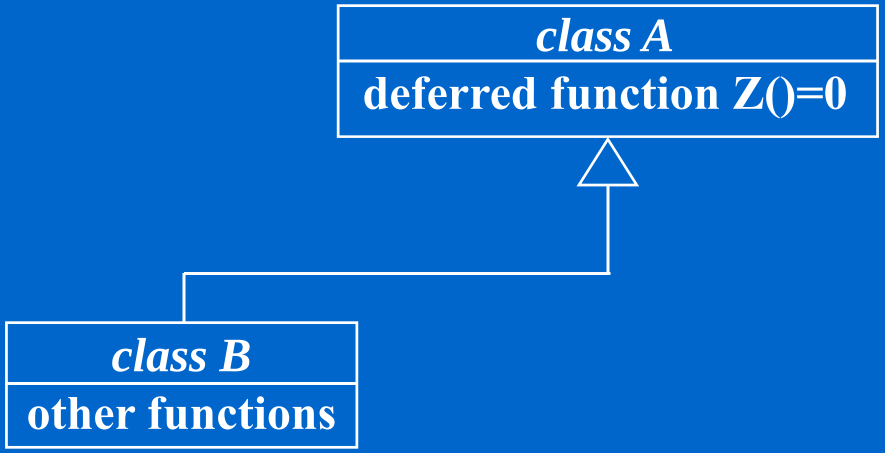

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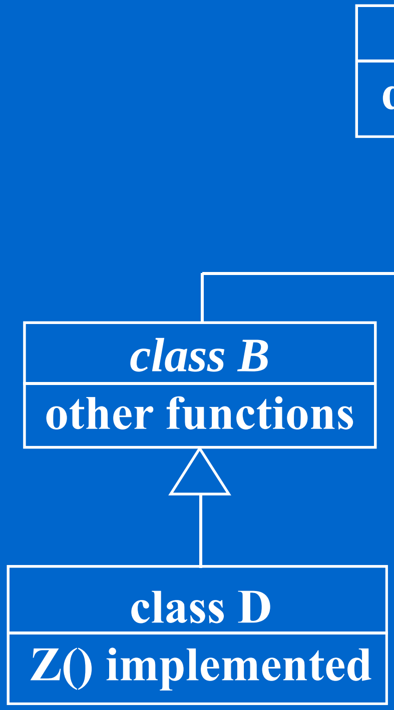

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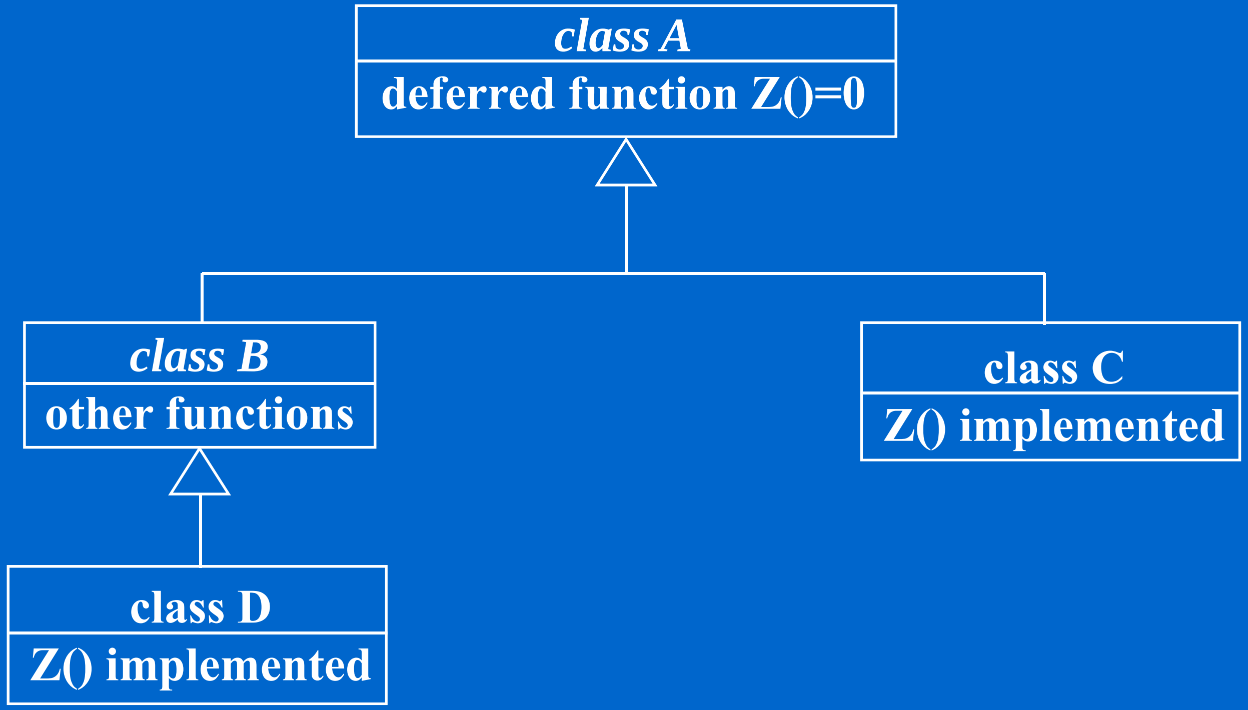

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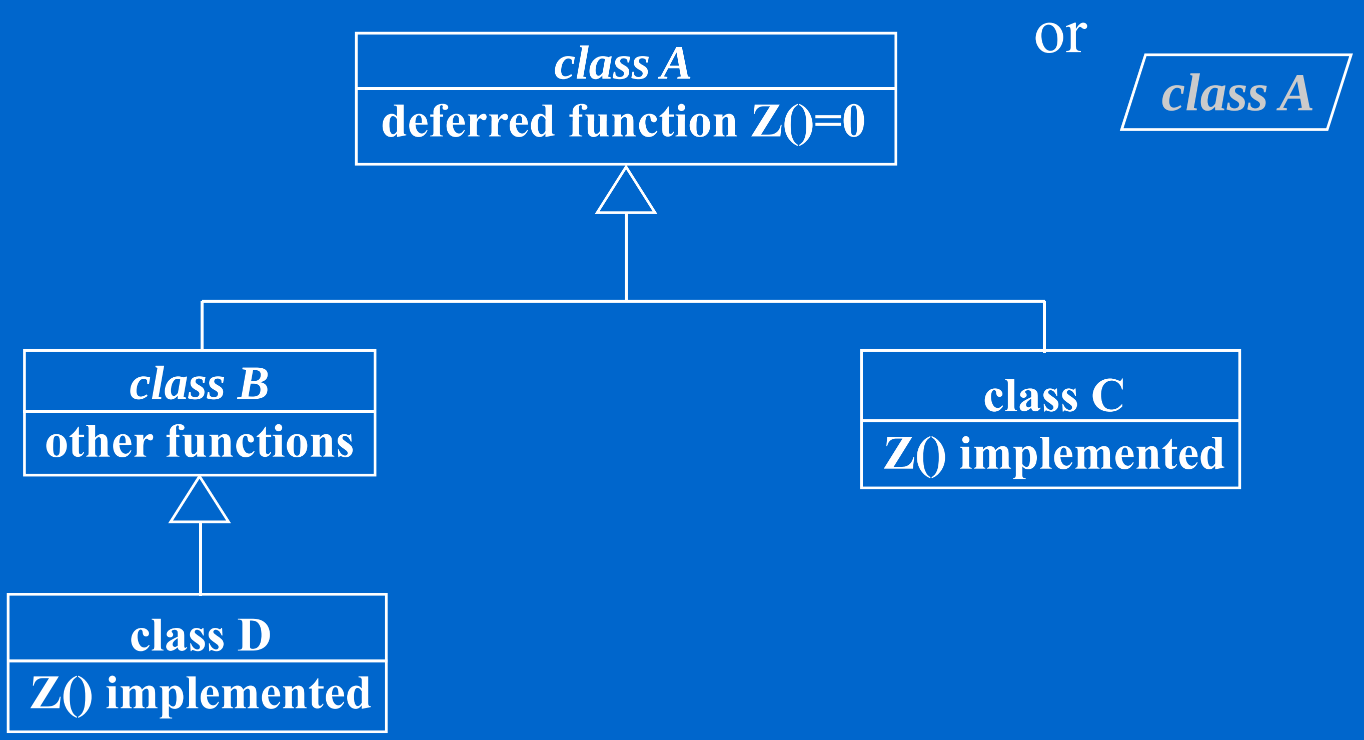

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- An **interface** specifies a particular **role** (we specify a role with a set of operations) for an object that provides some particular functions to other objects. An ABC is frequently an adjective, Ex. Printable, Persistent, … only specify some properties.

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- An **interface** specifies a particular **role** (we specify a role with a set of operations) for an object that provides some particular functions to other objects. An ABC is frequently an adjective, Ex. Printable, Persistent, … only specify some properties.

  A class can have many unrelated abstract specifications. We will discuss this language feature in C++ as multiple inheritance.

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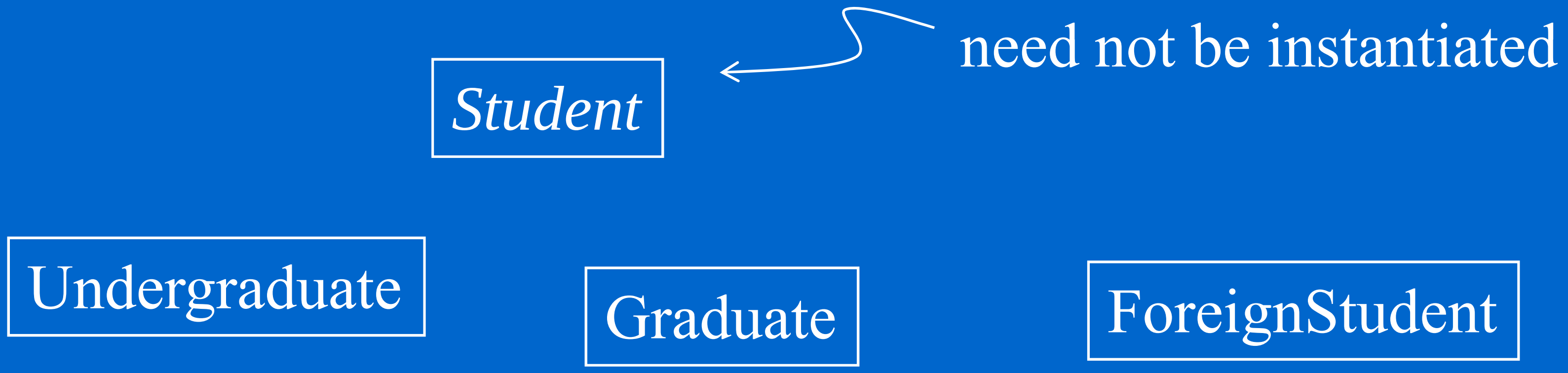
- Two examples (types) of usage:



Why do you need Abstract Classes?

✧ Two examples (types) of usage:

need not be instantiated

Student

Undergraduate

Graduate

ForeignStudent

Printable

Runnable

Observable

only describe some partial property

WorkThread

Multiple Inheritance

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class Predator
{
public:
   Predator(char *prey, char *habitat);
   ~Predator();
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```

```
class Pet
{
public:
   Pet(char *name, char *habitat);
   ~Pet();
   const char *getName() const;
   const char *getHabitat() const;
private:
   char *m_name;
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```

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class Cat: public Predator, public Pet
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public:
    Cat(char *name, char *prey, char *habitat);
    void reduceLives();
    int getLives() const;
private:
    int m_lives;
};
```

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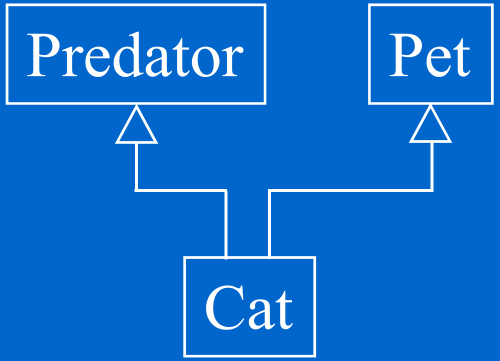
- Class inheritance hierarchy



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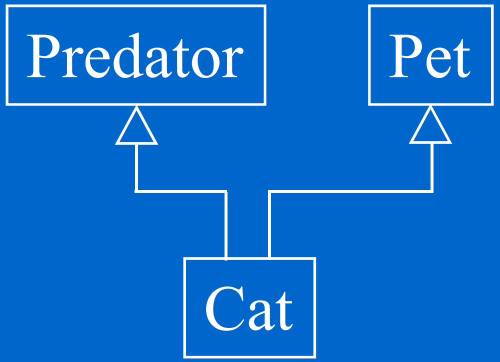

- The Cat constructor

```
Cat::Cat(char *name, char *prey, char *habitat)
   : Predator(prey, habitat), Pet(name, habitat), m_lives(9)
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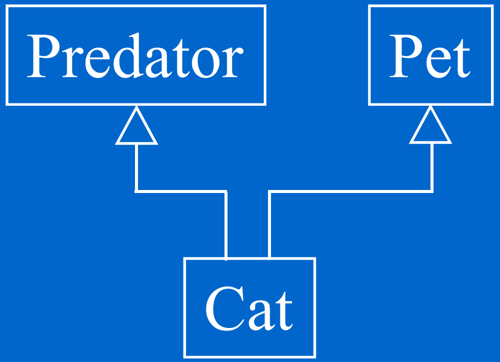

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- Note that getHabitat() and the m_habitat will be inherited twice

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Cat cat("Binky", "mice", "indoors");
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- It is necessary to disambiguate which getHabitat() function we want. In this case, either Predator::getHabitat() or Pet::getHabitat() is a possible candidate.

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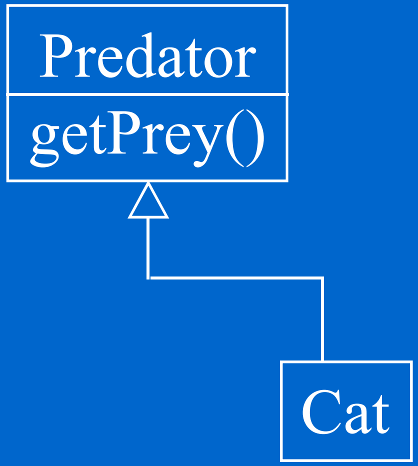

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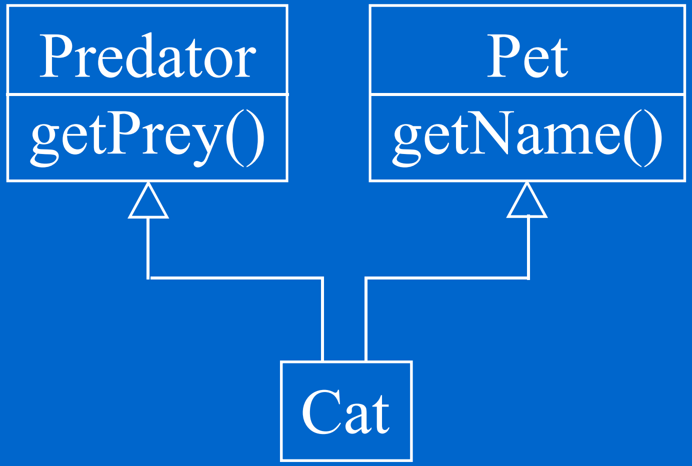

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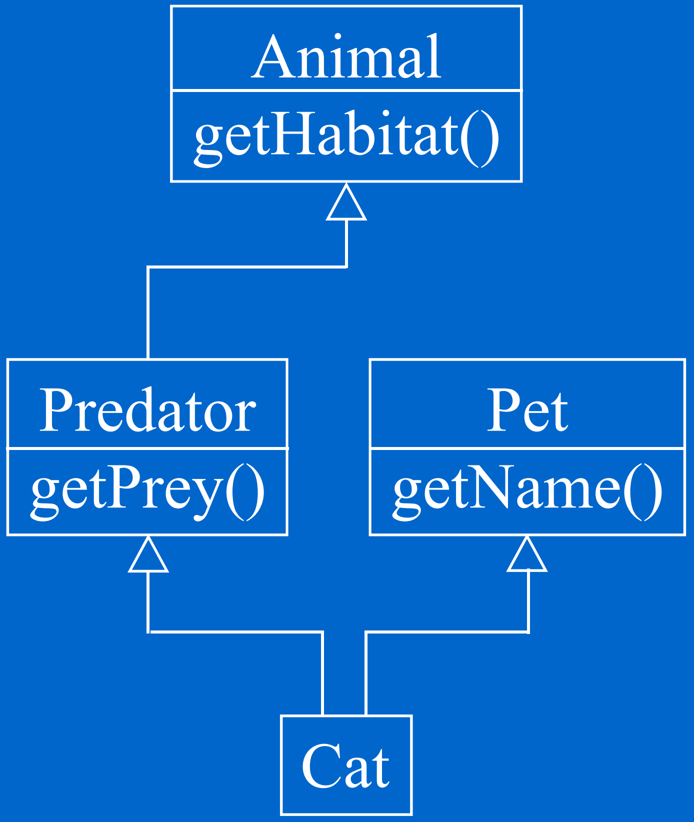

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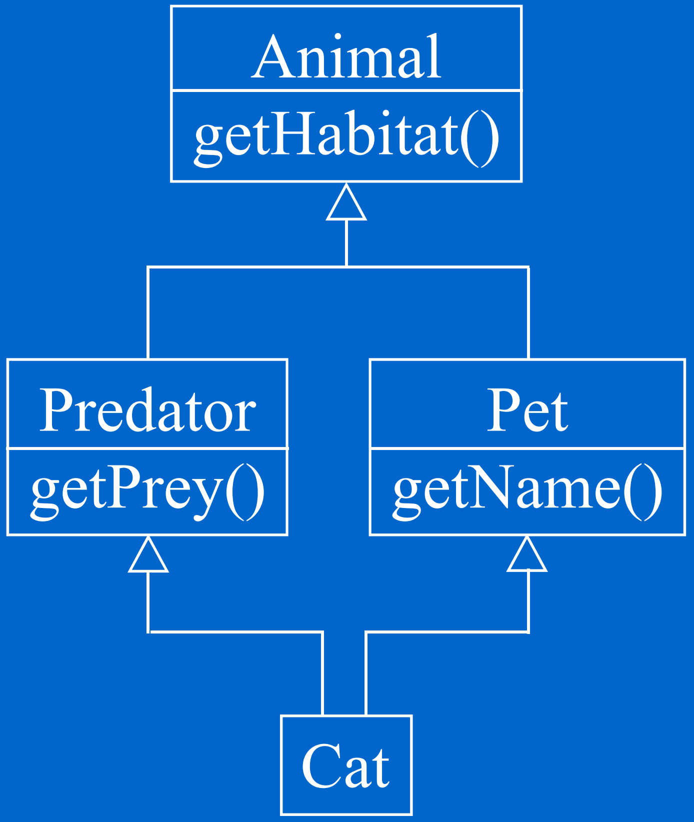

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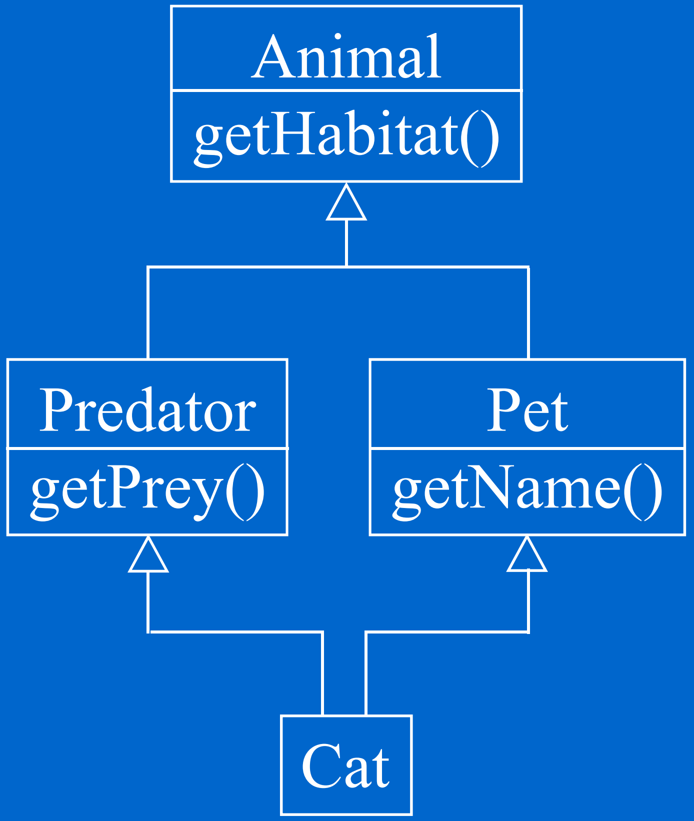

- The base class declaration

```
class Animal {
public:
   Animal(char *habitat);
   virtual ~Animal();
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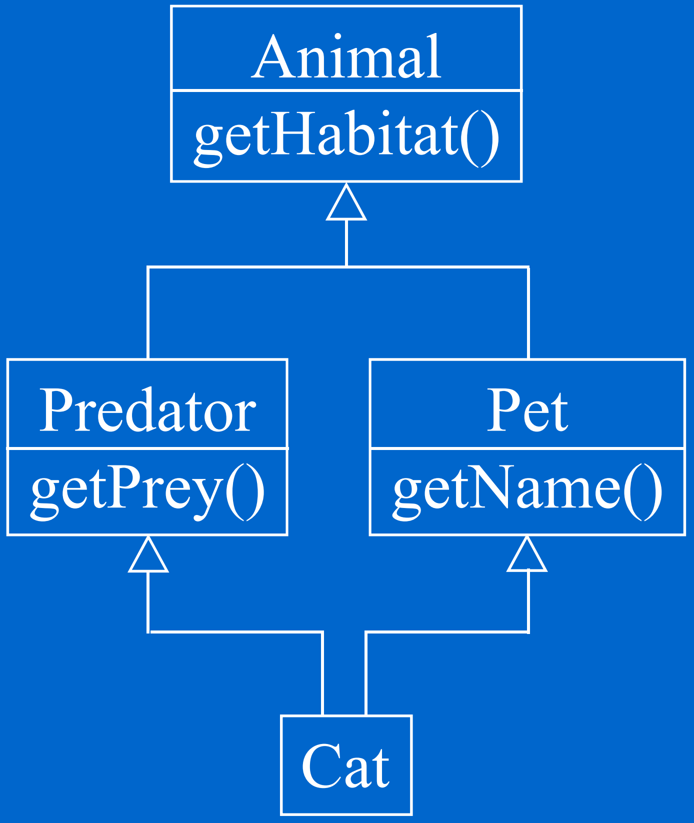

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the 'dreaded diamond'

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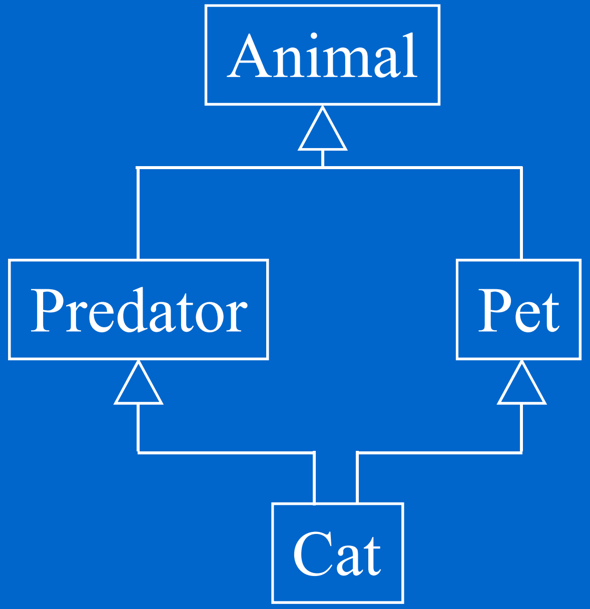

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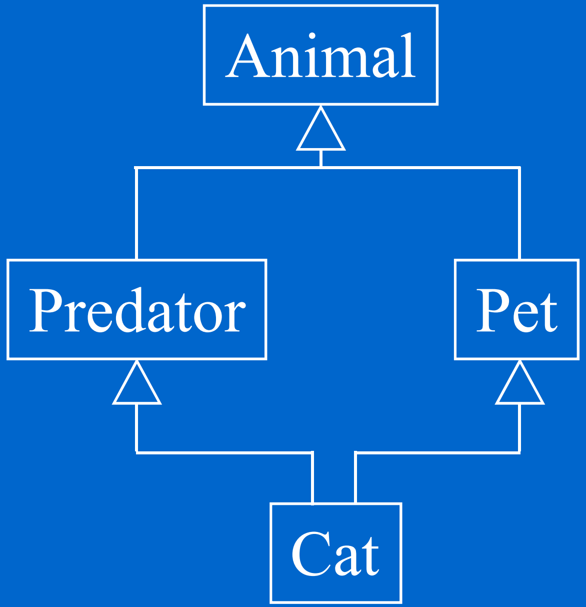

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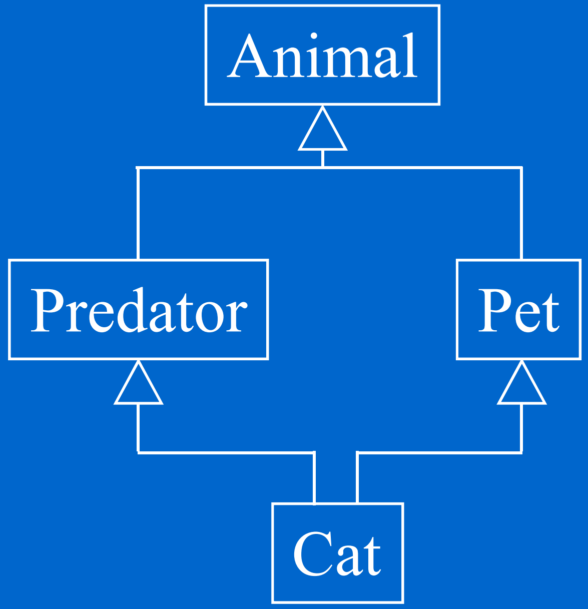

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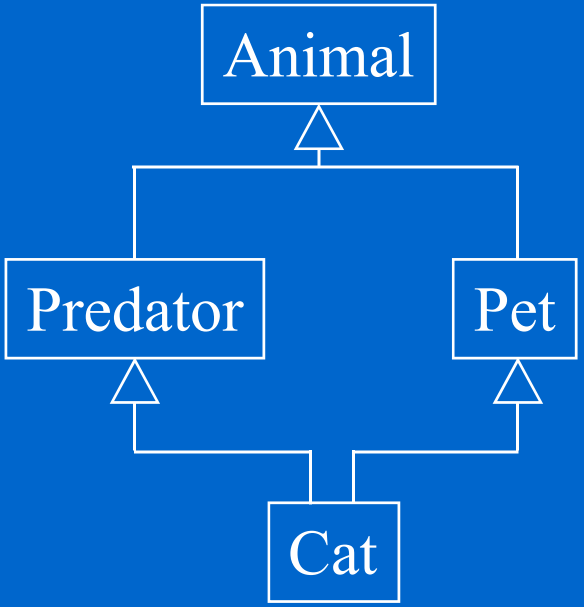

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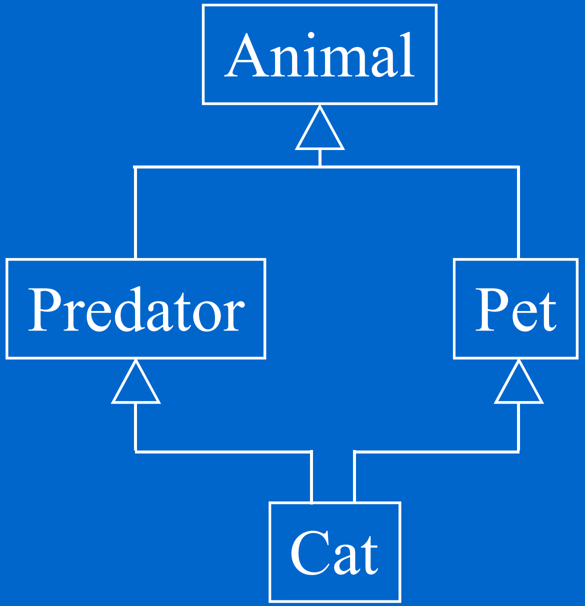

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- Still need to disambiguate these two versions

```
cout << cat.Predator::getHabitat() << "\n";
cout << cat.Pet::getHabitat() << "\n";
```

Virtual Base Class

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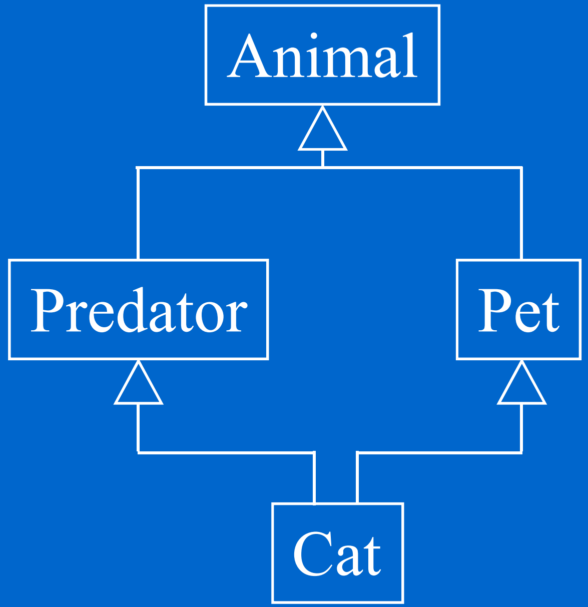

- Cat still has two getHabitat()'s

```
cout << cat.getHabitat();
```

```
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```

- Still need to disambiguate these two versions

```
cout << cat.Predator::getHabitat() << "\n";
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- A better solution is to create a ***virtual base class***.

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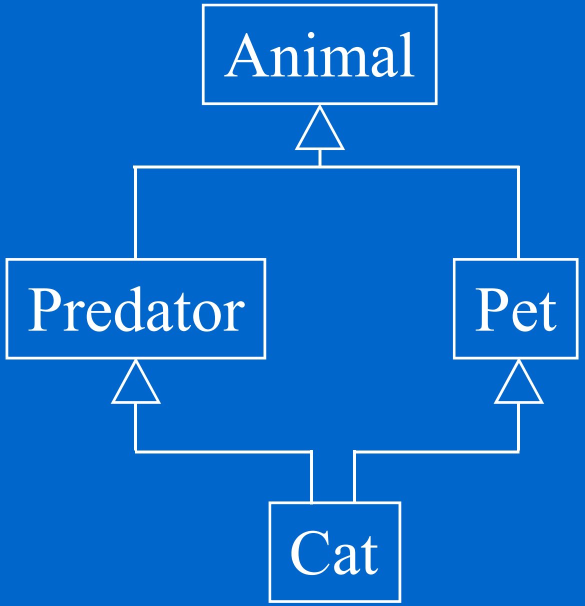

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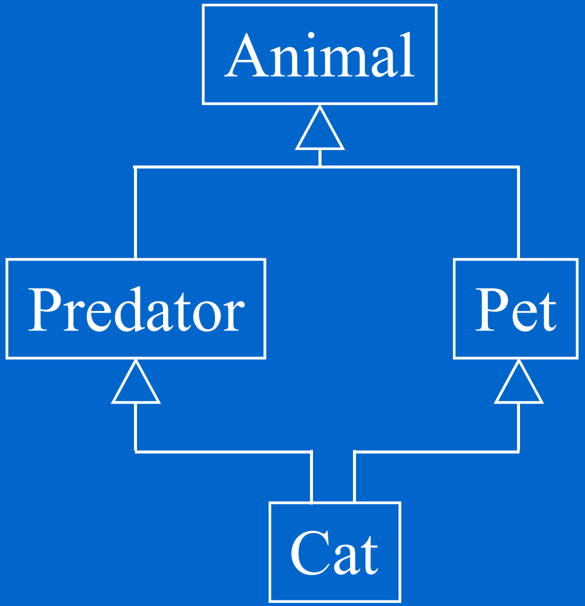

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- A better solution is to create a ***virtual base class***.
- A virtual base class is included only once in all derived classes. In the case of Cat, **all paths** from Animal to Cat must be marked as virtual, but only once.

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```
Cat::Cat(char *name, char *prey, char *habitat)
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Predator::Predator(char *prey, char *habitat) : Animal(habitat) {
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used only in
Predator predator("a", "b");

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Mix-in Inheritance

- Multiple inheritance is sometimes used to combine disparate classes into a single abstraction. This is called *mix-in inheritance*.

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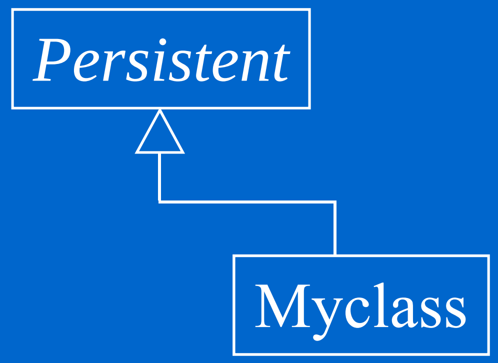

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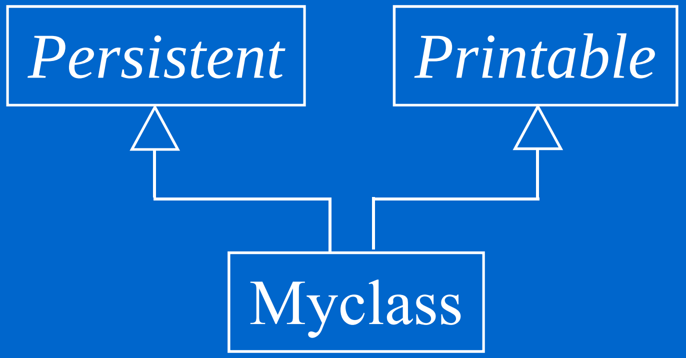

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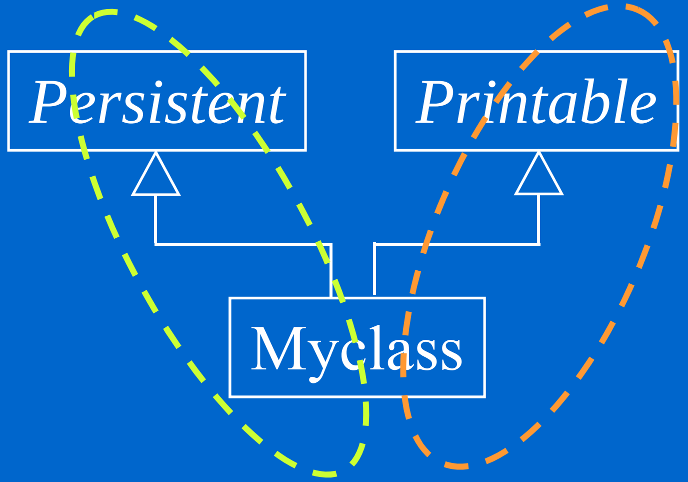

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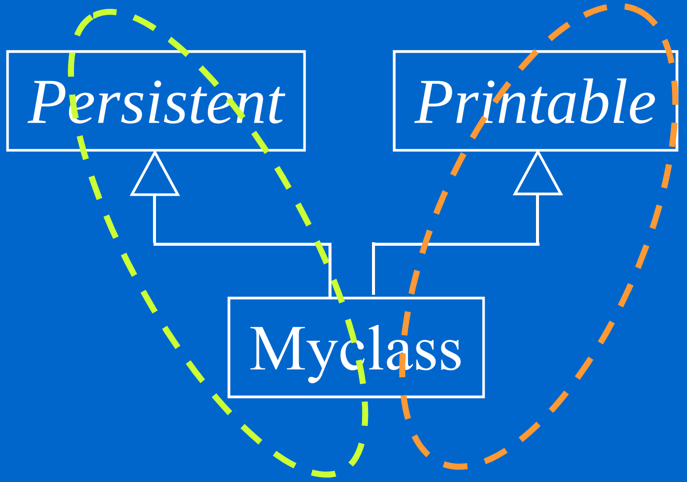
- Many class libraries provide classes with key functionalities such that a new class can inherit required classes.



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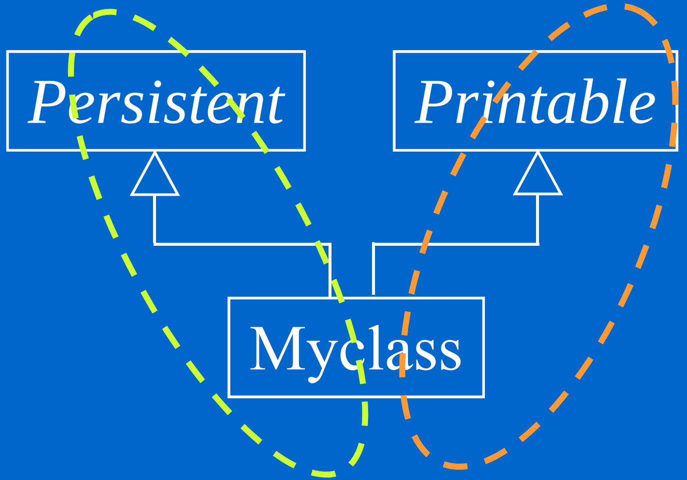

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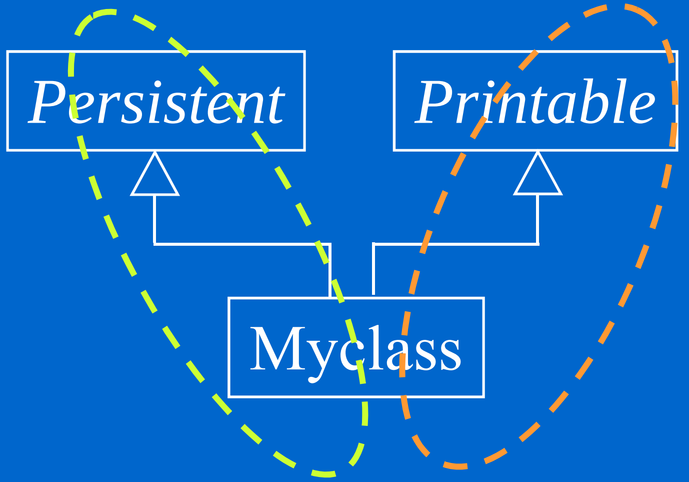

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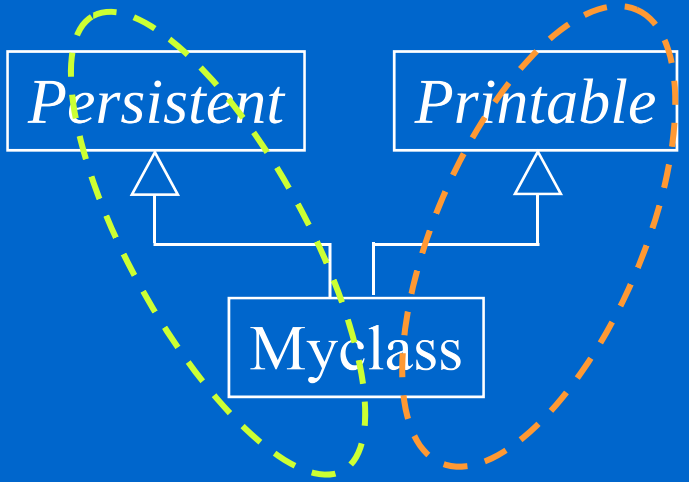

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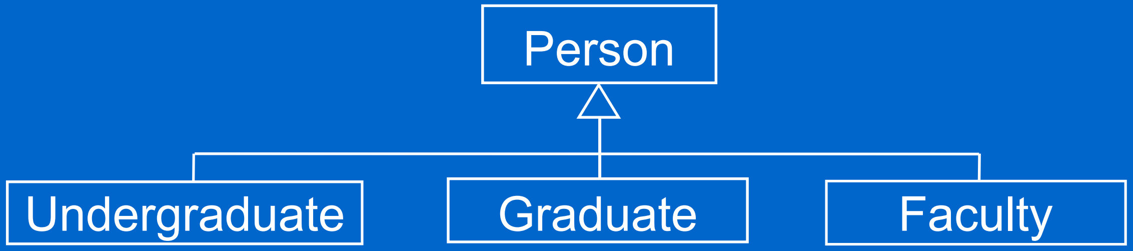

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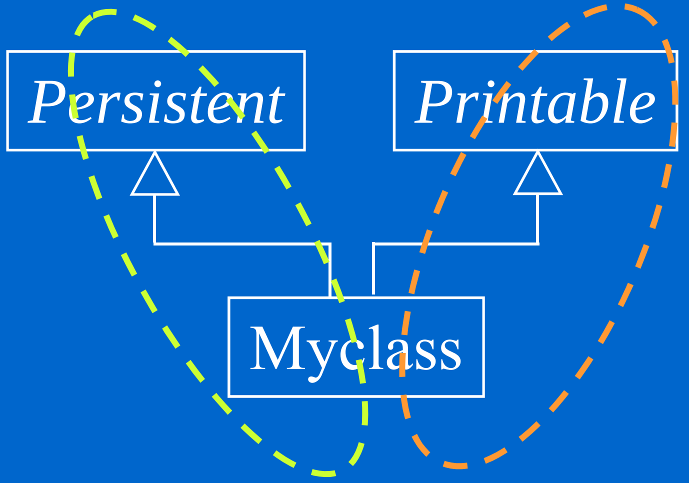

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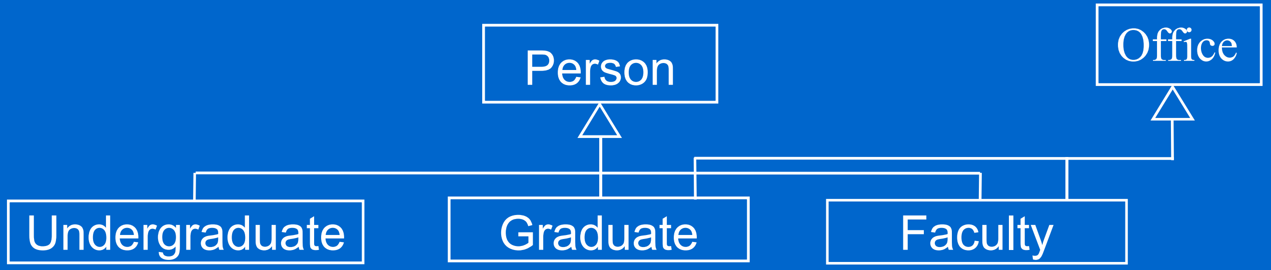

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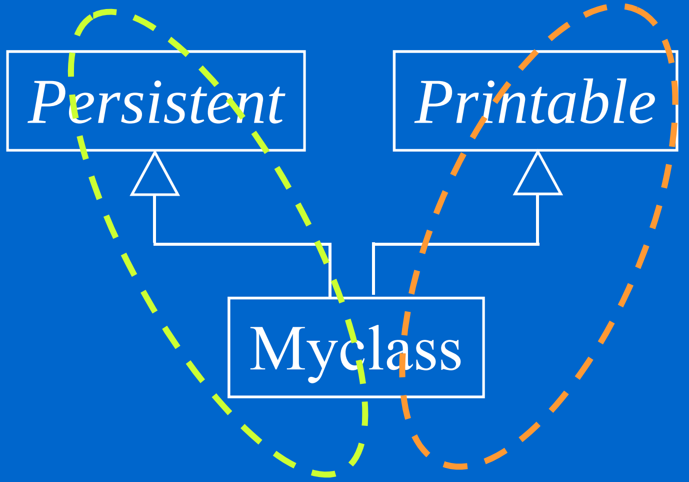

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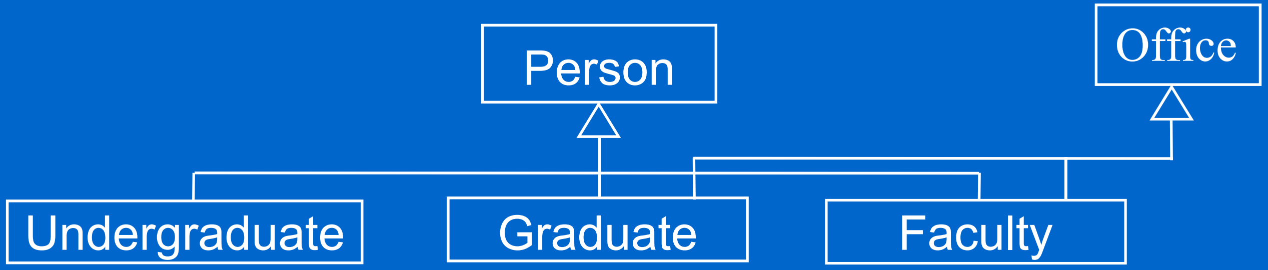

A graduate student is certainly not an office.

Private Inheritance

- Private inheritance

Private Inheritance

✧ Private inheritance

```
class Student {
public:
    Student();
    void setData(char *name, int age);
    int getAge() const;
    const char *getName() const;
private:
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```

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```
class Graduate: private Student {
public:
    Graduate(char *name, int age, int stipend);
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private:
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  Private inheritance is equivalent to a HAS-A relationship. Outside client code cannot see any trace of the base class from a derived class object.

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- Usage

```
Graduate graduateStudent("Angela", 25, 6000);
cout << graduateStudent.getName();
```

Inherit from a Template Class

- Assume you have a templated array class

Inherit from a Template Class

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```
template <class type>
class Array {
public:
    Array(int arraySize);
    ~Array();
    void insertElement(int slot, type element);
    type getElement(int slot) const;
    int getSize() const;
private:
    int m_arraySize;
    type *m_array;
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```

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template <class type>
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```

This derived NewArray class is still a template class.

Inherit from a Template Class

- Constructor

Inherit from a Template Class

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```
template<class type>
NewArray<type>::NewArray(int arraySize): Array<type>(arraySize) {
    for (int i=0; i<arraySize; i++) insertElement(i, 0);
}
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template<class type>
type NewArray<type>::getLargest() {
    type largest = getElement(0);
    for (int i=1; i<getSize(); i++)
        if (getElement(i) > largest)
            largest = getElement(i);
    return largest;
}
```

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- Usage

```
void main() {
    NewArray<double> array(20);
    array.insertElement(0, 4.6);
    array.insertElement(5, 12.6);
    cout << array.getLargest();
}
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Output

```
12.6
```