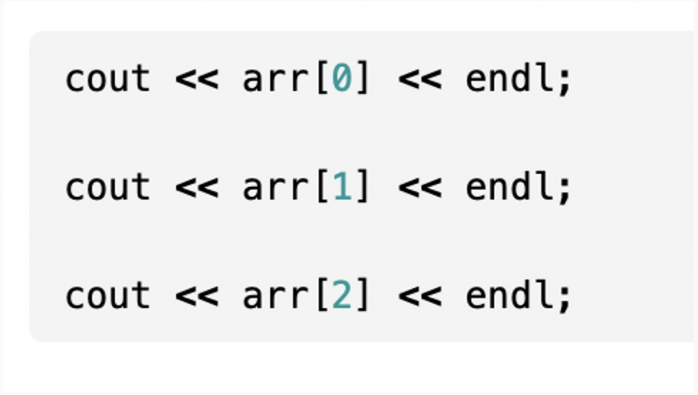
CSCI 104

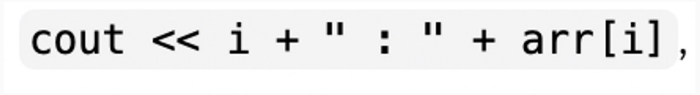
Lab 5: Inheritance and STL

Why use Inheritance?

- It’s another way to reuse our code!
- Reusing code makes it more readable and less repetitive
- Similar concept to for loops



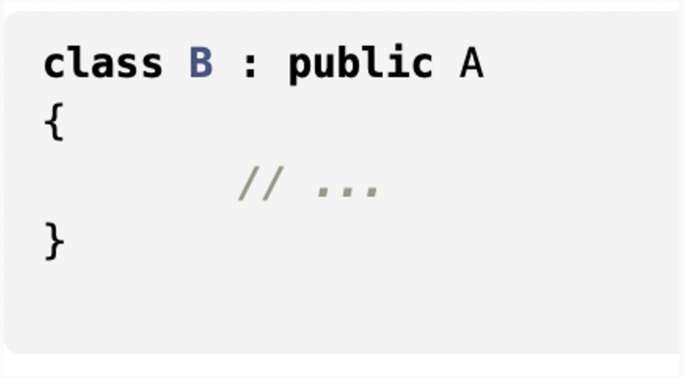
```
cout << arr[0] << endl;

cout << arr[1] << endl;

cout << arr[2] << endl;
```



```
cout << i + " : " + arr[i],
```

What is Inheritance?

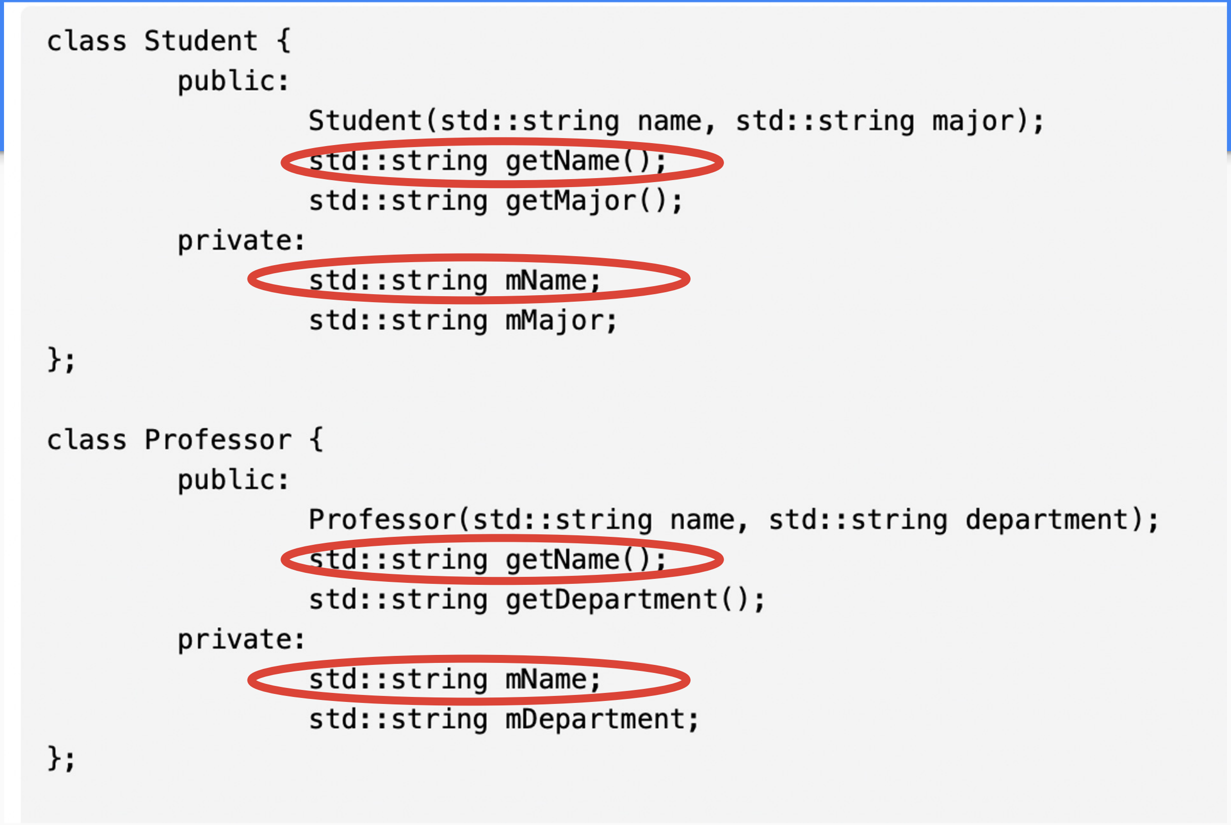
- Core concept in OOP!
- Class B inherits from Class A
  - Class B = child class
  - Class A = parent/base class
  - Class B can access the data members and functions of Class A
  - Class B can also:
    - Create its own data members and functions
    - Overwrite functions from Class A



```
class B : public A
{
        // ...
}
```

Example

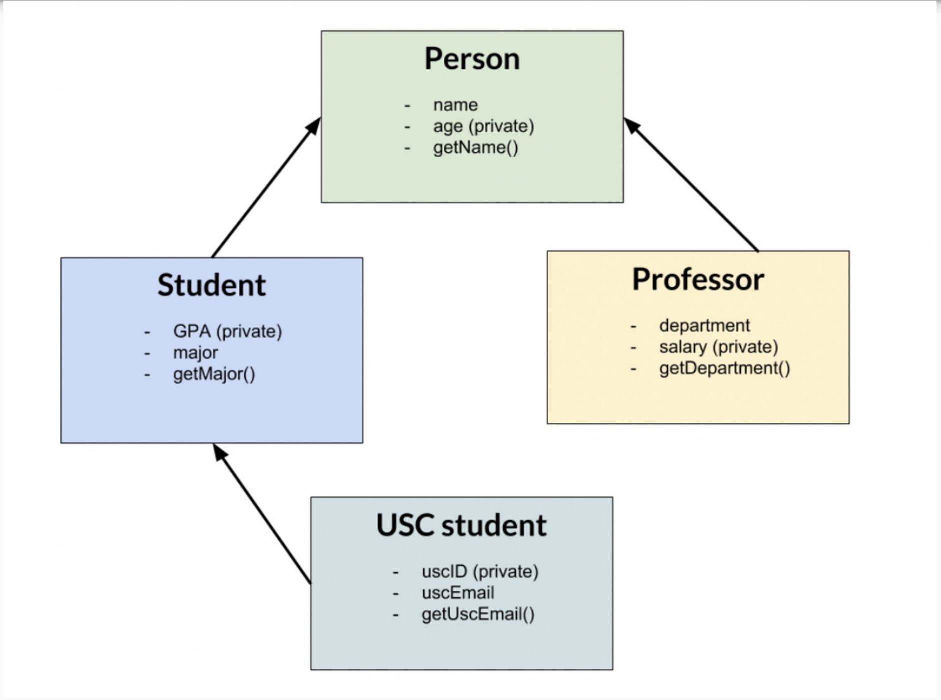
- Print out majors for students and department for professors
- Print out names for everyone

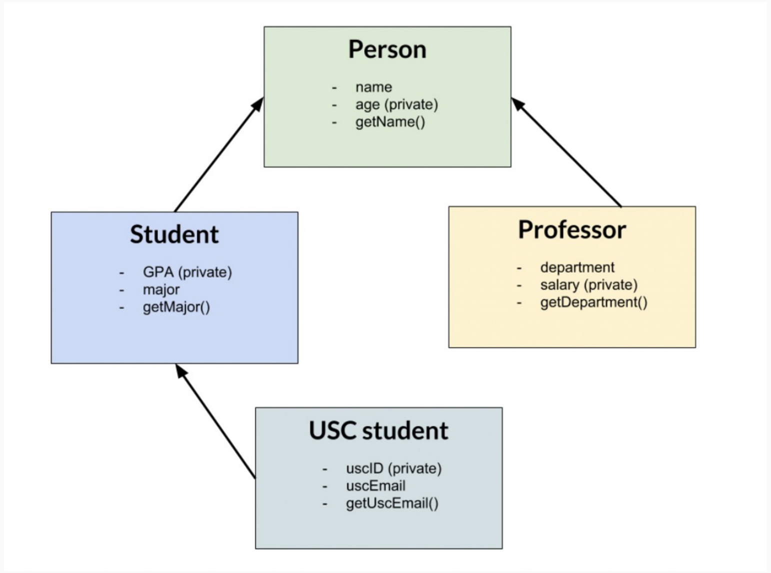


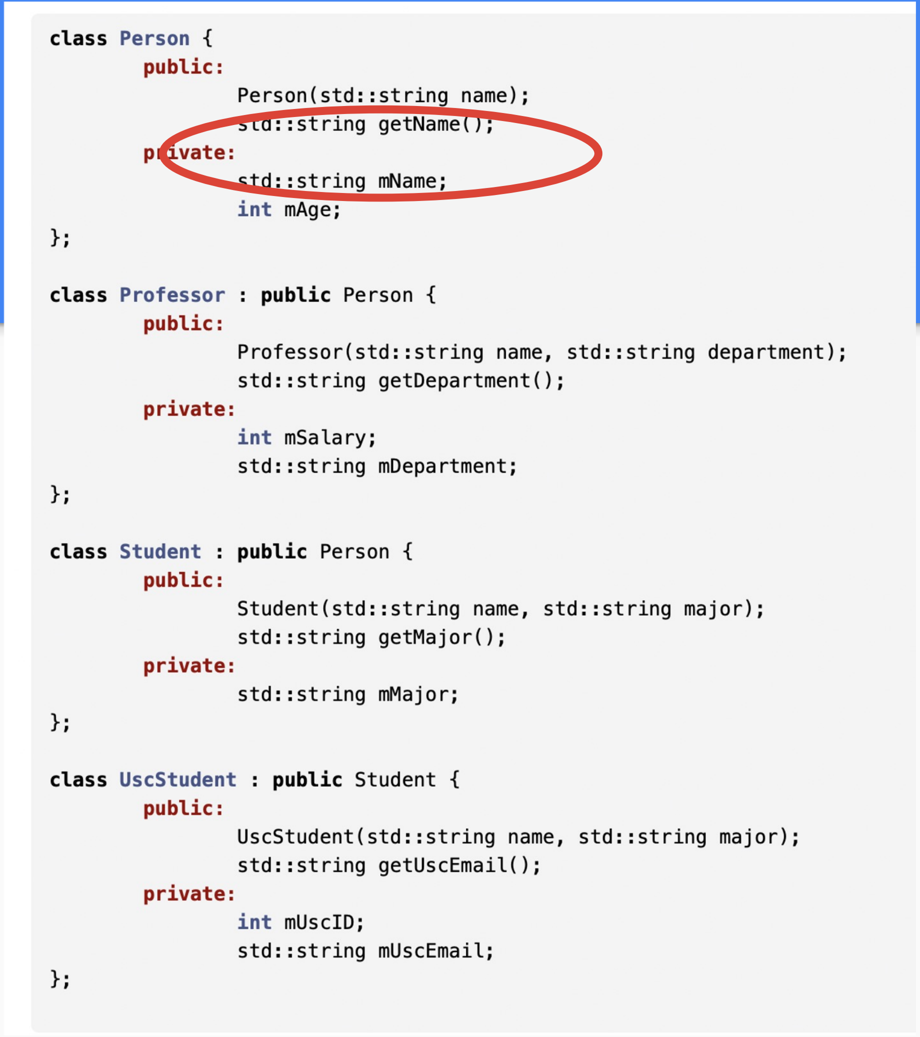
```
class Student {
        public:
                Student(std::string name, std::string major);
                std::string getName();
                std::string getMajor();
        private:
                std::string mName;
                std::string mMajor;
};

class Professor {
        public:
                Professor(std::string name, std::string department);
                std::string getName();
                std::string getDepartment();
        private:
                std::string mName;
                std::string mDepartment;
};
```

Example but with Inheritance

- Common data members and functions can go into the parent class Person
- No need to copy code for each class!



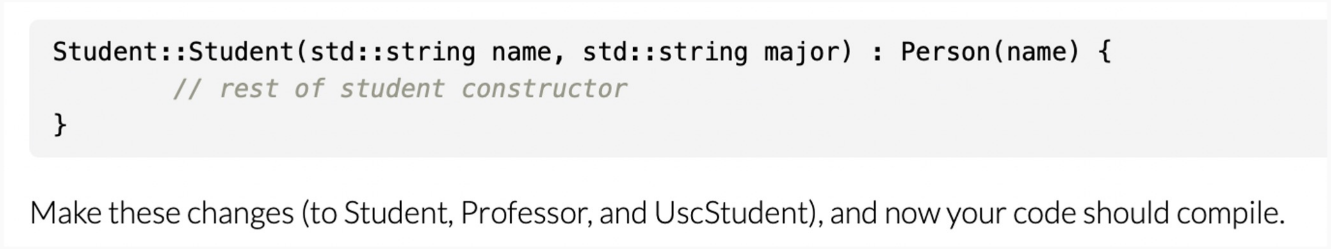




```
class Person {
        public:
                Person(std::string name);
                std::string getName();
        private:
                std::string mName;
                int mAge;
};

class Professor : public Person {
        public:
                Professor(std::string name, std::string department);
                std::string getDepartment();
        private:
                int mSalary;
                std::string mDepartment;
};

class Student : public Person {
        public:
                Student(std::string name, std::string major);
                std::string getMajor();
        private:
                std::string mMajor;
};

class UscStudent : public Student {
        public:
                UscStudent(std::string name, std::string major);
                std::string getUscEmail();
        private:
                int mUscID;
                std::string mUscEmail;
};
```

Constructors

- Run make in part1 of the folder
- ERROR: “no matching function for call to ‘Person::Person()’ ”
- Compiler confused
    - Inheriting from Person class, need to call constructor
    - Since we didn’t call constructor, default constructor implicitly called
    - But there’s no default constructor for Person
    - Need to explicitly call Person constructor



```
Student::Student(std::string name, std::string major) : Person(name) {
        // rest of student constructor
}
```

Make these changes (to Student, Professor, and UscStudent), and now your code should compile.

Inheritance Visibility

- Write public function printTranscript() in UscStudent class which prints out name of school, student’s name, GPA, and their major
- PROBLEMS when compiling!

Inheritance Visibility

- Need to change access level of GPA data member
- Would compile if we made it public but we don’t want it to be public because then even third parties can access
- Still want to access it from UscStudent Class
- What should we do???

Private, Protected, Public

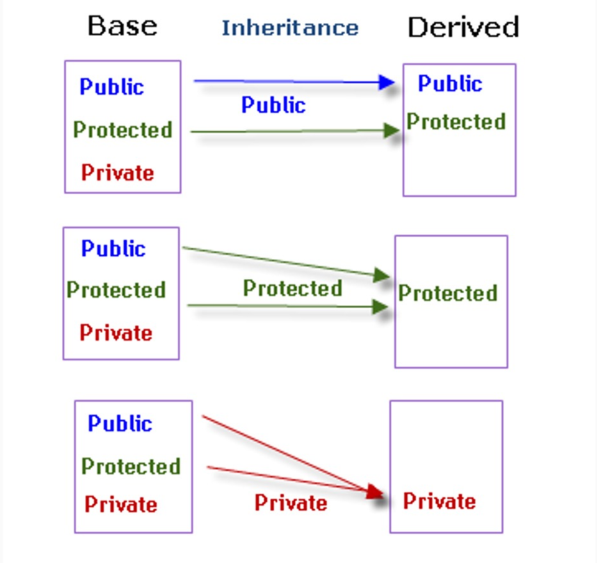


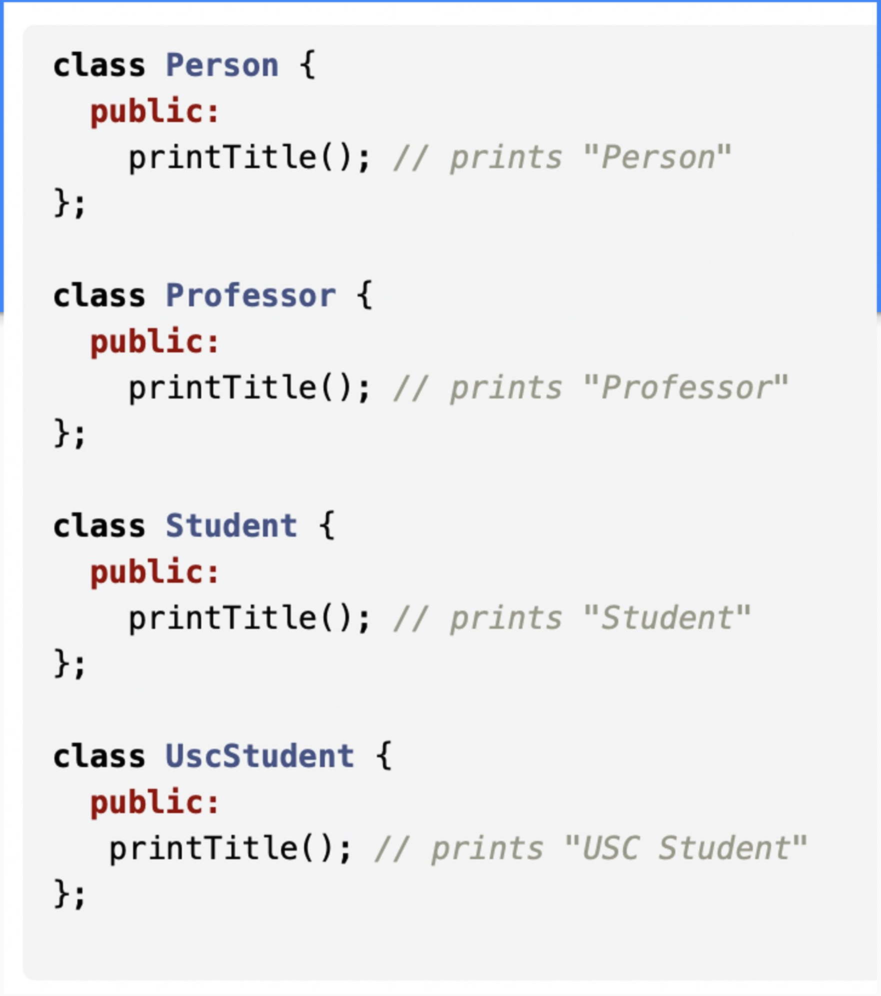
Fig: Visibility after inheritance

- UscStudent is type of student: needs same data members as Student
- But we don’t want outsiders to have access to setGPA() function
- What inheritance should we use???

```
class UscStudent : protected Student {
```

Polymorphism

- Determining whether to use the function in child or base class



```
class Person {
  public:
    printTitle(); // prints "Person"
};

class Professor {
  public:
    printTitle(); // prints "Professor"
};

class Student {
  public:
    printTitle(); // prints "Student"
};

class UscStudent {
  public:
   printTitle(); // prints "USC Student"
};
```

Static Binding

- Looks at the Type of pointer

```
UscStudent* u = new UscStudent();
u->printTitle(); // will print "USC Student"
```

What will this print out?

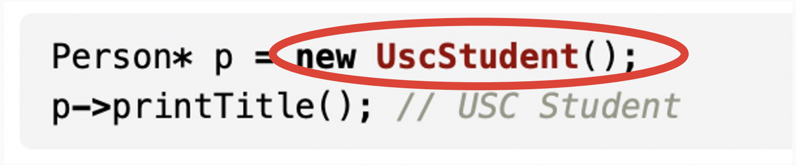
```
Person* p = new UscStudent();
p->printTitle();
```

Person

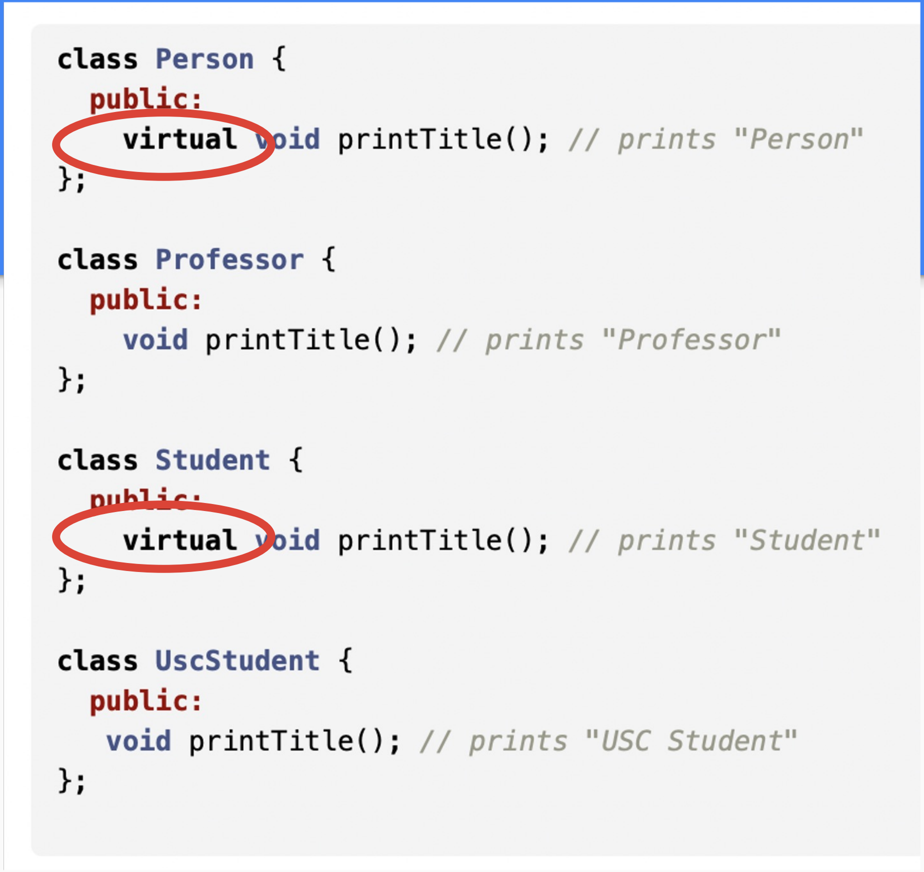
```
class Person {
  public:
    printTitle(); // prints "Person"
};

class Professor {
  public:
    printTitle(); // prints "Professor"
};

class Student {
  public:
    printTitle(); // prints "Student"
};

class UscStudent {
  public:
   printTitle(); // prints "USC Student"
};
```

Dynamic Binding

- Virtual keyword
- Looks at the type of object that is being pointed at
- Note: all base classes should have virtual destructor



```
Person* p = new UscStudent();
p->printTitle(); // USC Student
```

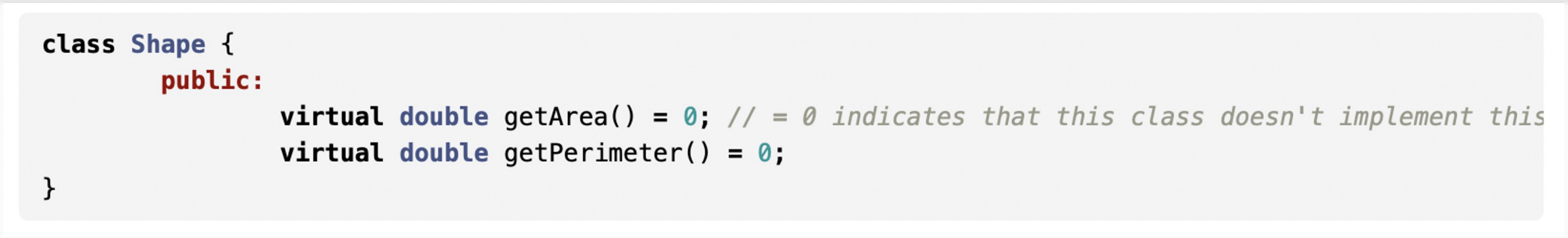


```
class Person {
  public:
    virtual void printTitle(); // prints "Person"
};

class Professor {
  public:
    void printTitle(); // prints "Professor"
};

class Student {
  public:
    virtual void printTitle(); // prints "Student"
};

class UscStudent {
  public:
   void printTitle(); // prints "USC Student"
};
```

Abstract Classes

- Class that has at least one pure virtual function
- Virtual function
  - Member function declared in the base class
  - re-defined/overridden in base class
- Pure virtual function
  - Virtual function
  - Only declare it in the base class
  - Implement in the child classes
  - Indication by “=0”

Abstract Class Example



```
class Shape {
        public:
                virtual double getArea() = 0; // = 0 indicates that this class doesn't implement this
                virtual double getPerimeter() = 0;
}
```

- Child classes could include: Circle, Rectangle, Triangle, etc
- To instantiate this class, we need to implement these functions in the children classes

STL - Maps

- Key-value pairs of items, good for look-ups
- Operations: insert, search, remove
    - More specifics on these operations in the Bytes page lab writeup
- All O(log(n))

Insert

```
myMap.insert(std::make_pair("Key", "Value")); // Inserts the pair
myMap["Key"] = "Overwrites Previous Value"; // Overwrites "Value"
myMap.insert(std::make_pair("Key", "This should do nothing")); //
```

Search (Find)

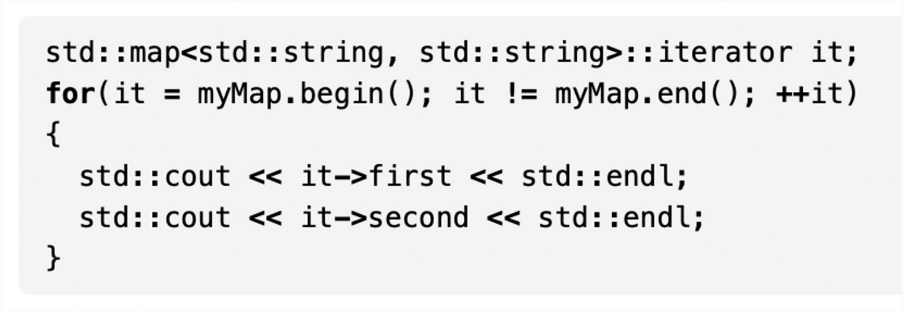
```
std::map<std::string, std::string>::iterator it = myMap.find("Key");
if (it != myMap.end()) // we found the element
{
  std::cout << it->first << " has value " << it->second << std::endl;
}
```

Remove

```
// This first searches for an object containing "Key", then removes it
myMap.erase("Key");
```

STL - Iterators

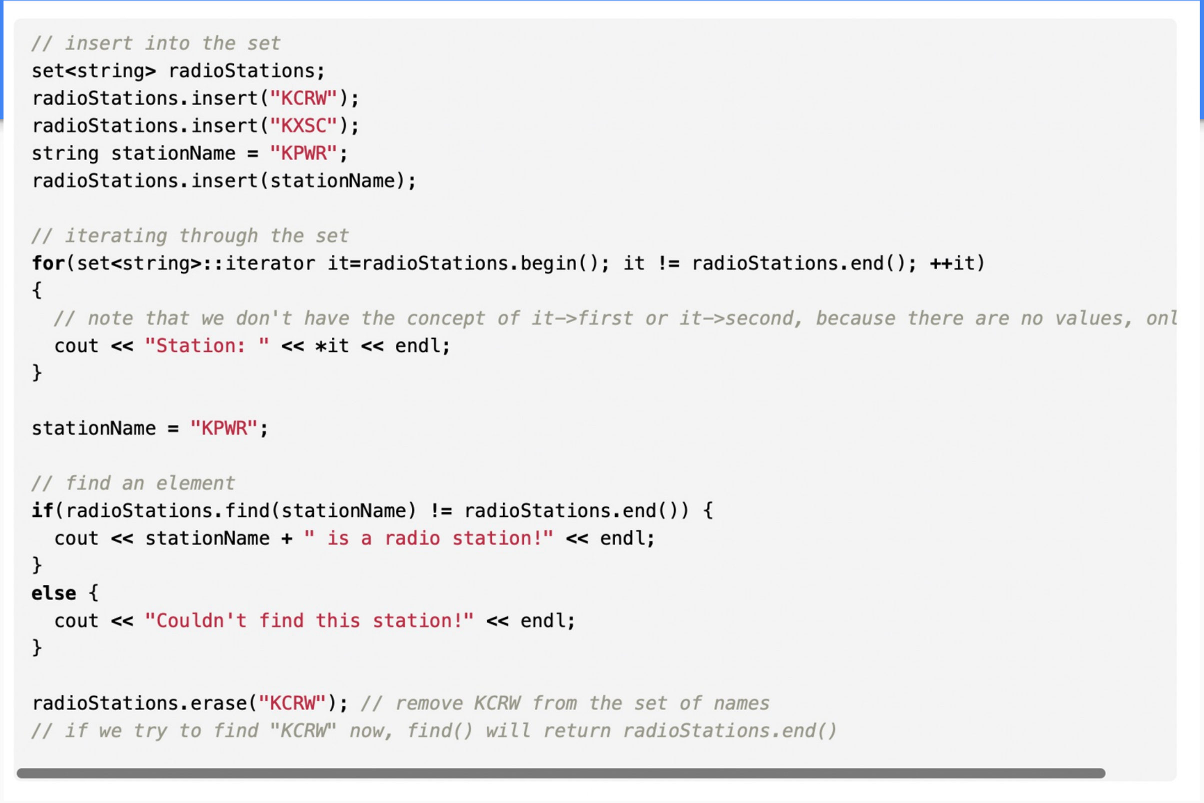
- If we want to loop through all elements
- This for loop will take O(n)
- Very similar to normal for loops
- Use .begin() and .end()



```
std::map<std::string, std::string>::iterator it;
for(it = myMap.begin(); it != myMap.end(); ++it)
{
  std::cout << it->first << std::endl;
  std::cout << it->second << std::endl;
}
```

STL - Sets

- Similar to maps
- Only have keys
    - No values
- Keys are unique
- Use iterator to walk through all elements



```
// insert into the set
set<string> radioStations;
radioStations.insert("KCRW");
radioStations.insert("KXSC");
string stationName = "KPWR";
radioStations.insert(stationName);

// iterating through the set
for(set<string>::iterator it=radioStations.begin(); it != radioStations.end(); ++it)
{
  // note that we don't have the concept of it->first or it->second, because there are no values, onl
  cout << "Station: " << *it << endl;
}

stationName = "KPWR";

// find an element
if(radioStations.find(stationName) != radioStations.end()) {
  cout << stationName + " is a radio station!" << endl;
}
else {
  cout << "Couldn't find this station!" << endl;
}

radioStations.erase("KCRW"); // remove KCRW from the set of names
// if we try to find "KCRW" now, find() will return radioStations.end()
```

The Lab

- Follow the bytes page on the lab
- Part1 helps conceptually and the lab page walks you through everything
- Then look at part 2 files
    - Three major classes: Schedule, Assignment, Course
    - Functions in Assignment and Course are complete, but you need to make small change to Assignment to pass all tests
    - Need to implement functions in Schedule
- "Make" will run tests for you
- Need to pass all tests to get checked off OR be working throughout the whole lab section