

601.220 Intermediate Programming

C++ classes

C++: non-object-oriented programming

We already saw `structs`, which bring together several variables that collectively describe one "thing":

```
struct rectangle {  
    double width;  
    double height;  
};
```

We might additionally define some functions that do things with rectangles, like print them or calculate their area. For example:

C++: non-object-oriented programming

```
// class1.cpp
1  #include <iostream>
2
3  struct rectangle {
4      double width;
5      double height;
6  };
7
8  void print_rectangle(struct rectangle r) {
9      std::cout << "width=" << r.width << ", height=" << r.height << std::endl;
10 }
11
12 double area(struct rectangle r) {
13     return r.width * r.height;
14 }
15
16 int main() {
17     rectangle r = {30.0, 40.0};
18     print_rectangle(r);
19     std::cout << "area=" << area(r) << std::endl;
20     return 0;
21 }
```

```
$ g++ -o class1 class1.cpp -std=c++11 -pedantic -Wall -Wextra
```

```
$ ./class1
```

```
width=30, height=40
```

```
area=1200
```

C++: object-oriented programming

As good Java or Python programmers, though, we prefer to have the related functionality (`print_rectangle`, `area`) be **part of the object** (the `struct` in this case)

No simple way to do this in C. But in C++...

C++: object-oriented programming

```
// class2.cpp
1  #include <iostream>
2
3  class Rectangle {
4  public:
5      double width;
6      double height;
7
8      void print() const {
9          std::cout << "width=" << width << ", height=" << height << std::endl;
10     }
11
12     double area() const {
13         return width * height;
14     }
15 };
16
17 int main() {
18     Rectangle r = {30.0, 40.0};
19     r.print();
20     std::cout << "area=" << r.area() << std::endl;
21     return 0;
22 }

```

\$ g++ -o class2 class2.cpp -std=c++11 -pedantic -Wall -Wextra

\$./class2

width=30, height=40
area=1200

C++: Object-oriented programming

- A class definition is like a **blueprint** defining a type
- Objects of that type are created from that **blueprint**
- Once we define a class, we have **one blueprint** from which we can **create 0 or more objects**
- Each of the objects is an **instance** of the class and has its own copies of all instance variables

C++: Object-oriented programming

```
void print() const {  
    ...  
}
```

- The use of `const` as modifier in method header indicates that the function will not modify any member fields
- The `rectangle` object on which we call `print` will not be modified by the call

C++ classes

Basic principles for writing C++ classes

- Class **definition** goes **in a .h** file
- Functions can be declared **and defined** inside `class{...};`
- Only define member function **inside the class definition if it's very short**
 - this is called **"in-lining"** the function definition
- Otherwise, put a prototype in the class definition and **define the member function in a .cpp file**
 - you'll need to qualify the function with the class scope such as `Classname::function(){} in the .cpp file`

C++ classes

```
// rectangle.h
#ifndef RECTANGLE_H
#define RECTANGLE_H

class Rectangle {
    ...
    double area() const {
        // short definition inside class (in-lining)
        return width * height;
    }
    ...
};
#endif // RECTANGLE_H
```

C++ classes

```
// rectangle.h
#ifndef RECTANGLE_H
#define RECTANGLE_H

class Rectangle {
    ...
    double area() const;
    ...
};
#endif // RECTANGLE_H

// rectangle.cpp
#include "rectangle.h"

double Rectangle::area() const {
    // define outside class
    return width * height;
}
```

C++ classes

- Fields and member functions can be `public` or `private`
 - (or `protected`, discussed later)
- We use `public:` and `private:` to divide class definition into sections according to whether members are `public` or `private`
- Everything is `private` by default
- A `public` field or member function can be accessed freely by any code with access to the class definition (code that includes the `.h` file)
- A `private` field or member function can be accessed from other member functions in the class, but **not** by a user of the class

C++ classes

```
class Rectangle {  
public:  
    ...  
    double area() const {  
        // definition inside class  
        return width * height; // OK  
    }  
    ...  
private:  
    double width, height;  
};
```

C++ classes

```
class Rectangle {  
    ...  
private:  
    double width, height;  
};  
  
int main() {  
    Rectangle r;  
    std::cout << r.width << std::endl; // not OK!  
    return 0;  
}
```

C++ classes

Do **not** try to initialize class fields immediately when they are declared

```
class Rectangle {  
    ...  
    double width = 10;  // NO!  
    ...  
};
```

This kind of initialization is only allowed for static fields

C++ classes

```
// rectangle.h
#ifndef RECTANGLE_H
#define RECTANGLE_H
class Rectangle {
public:
    double area() const {
        return width * height;
    }

private:
    double width, height;
};
#endif // RECTANGLE_H
```