Classes

Object-Oriented Programming

- Object-oriented programming (OOP) is a view of how both data and function that work with that data can be grouped together as a single programming entity.
- This organization is typically called a **class**
- Complexity is the biggest problem faced by a programmer. OOP is one way to control complexity

Class Implementation

- A `class` (or `struct`) contains two things
  - data
  - functions that operate on that data
- Organized together so it is easier to keep track of

OOP Principles

- General Principles
  - Composition
  - Abstraction
  - Encapsulation
  - Inheritance
  - Polymorphism
- Different languages take different approaches to these principles

What is a type again?

- A type has a number of aspects
  - The elements that are part of a type
    - Ex: a fraction has a numerator and a denominator
    - The size and number of elements in a type determine its size
  - Methods (member functions) that can be applied to the type

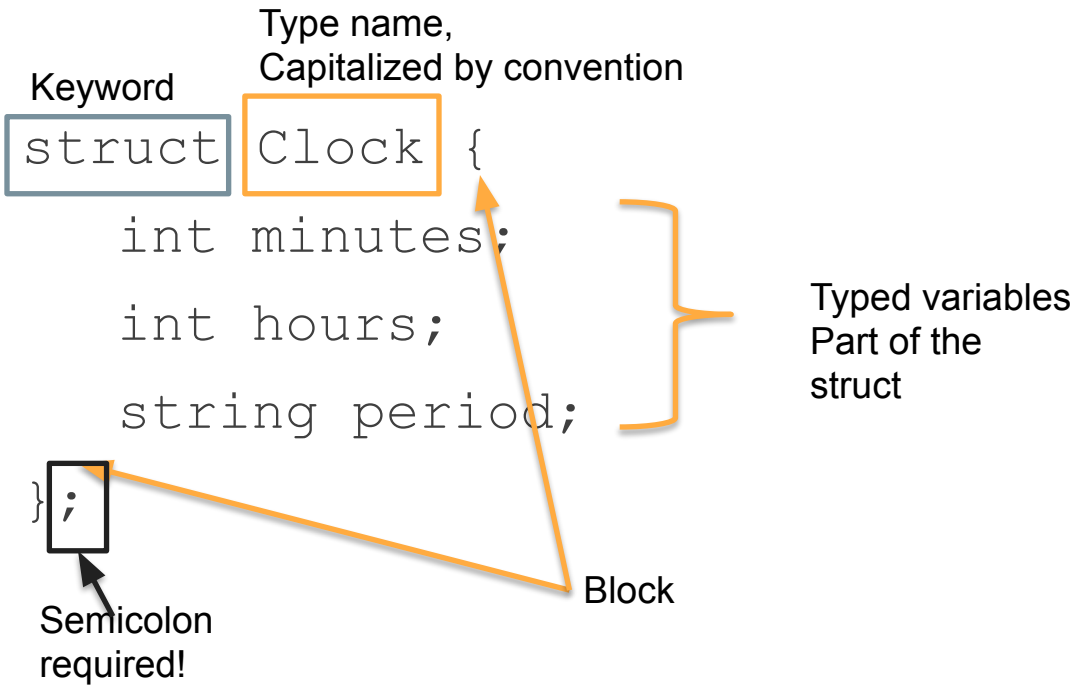
Structs

- A `struct` (short for structure) is a way to compose a new type (that we can declare, that we can pass to a function, etc) where we can decide what the underlying parts of the type consist of

Clock

```
struct Clock {
    int minutes;
    int hours;
    string period;
};
```

Clock


Type name,
Capitalized by convention
Keyword
struct Clock {
int minutes;
int hours;
string period;
};
Typed variables
Part of the
struct
Block
Semicolon
required!

Clock is now a type

- The `struct Clock` is now a type
- We can use it to declare a variable of type `Clock`

Is this allowed?

```
struct Thing {
   int x;
   Thing y;
};
```

- The code does not compile
- Yes, you can have recursive structs
- Depends on the type of Thing
- I don't know

Separate declaration and definition

- Typically, we place the structure definition in the header file and then any functions associated with the structure in an implementation file
- No functions yet, just the declaration

Definition in a header file

```
// main
#include “clock.h”
int main() {
   Clock my_c;
}
```

```
// Clock.h
struct Clock {
   int minutes;
   int hours;
   string period;
};
```

Instance vs Class

- An instance (such as `my_c`) is a variable created from the `Clock` pattern
  - An instance / variable is what we typically manipulate
- The type / class is the pattern we want all instances to follow

Class Attributes

How to access the struct elements

- Once we create the variable `my_c` of type `Clock`, we can manipulate the elements that are present in **every** `Clock` instance
- **Every** instance of type `Clock` has
  - an integer `minutes` variable
  - an integer `hours` variable
  - a string `period` variable

Proper term, data member

- The proper term for the elements present in a variable of a `struct` is **data member**
- A variable of type `Clock` has 3 data members: `minutes`, `hours`, `period`
- We defined those three in the `struct`

Two types of members

- Broadly speaking, a `struct` has two general types of members
  - data members
  - function members (methods)

Member access

- This is the same as it was in Python
- `my_c.hours`
  - Refers to the `hours` member of the variable of type `Clock` called `my_c`

Data member access

```
// main
#include “clock.h”
int main() {
   Clock my_c;
   my_c.hours = 10;
   cout << my_c.hours
        << endl;
}
```

```
// Clock.h
struct Clock {
   int minutes;
   int hours;
   string period;
};
```

More access

- As a programmer you can:
  - Access the value of a data member
  - Set the value of a data member
  - Just like you can any other variable

Refs and Ptrs

- `Clock` is a type just like `int` or `string`.
- We can make references and pointers to it just like we could for any other type

Example

```
#include “clock.h”
int main() {
   Clock my_c;
   Clock &ref_c = my_c;
   Clock *ptr_c = &my_c;
   my_c.hours = 10;
   ref_c.minutes = 20;
   ptr_c->period = “A.M.”;
   cout << my_c.hours << endl;
}
```

What happens here?

```
int x = 34;

int * y = &x;

*y++;
```

- The code does not compile
- x gets incremented
- y gets incremented
- I don't know

-> syntax

- `Clock *ptr_c = &my_c;`

```
(*ptr_c).hours = 10;
ptr_c->hours = 10;
```

- Last two statements mean exactly the same thing
  - deref pointer
  - access the member of deref'ed object

Pass a Clock var to a function

```
string print_clk(const Clock & c) {
   ostringstream oss;
   oss << “Hours:” << c.hours << “, Minutes:”
         << c.minutes << “, Period:” << c.period;
   return oss.str();
}
```

First Clock

- Example 15.1

Member Functions

Functions working with Clock

- We put functions that work with `Clock` or are a part of `Clock` in a separate implementation file

Function Members

- Example 15.2

Function members -> Methods

- Besides **data** members, we can also have **function** members
  - Better name: **methods**
- Methods have some special properties
  - Called in context of an object
  - Special privileges

How called

- We use a `.` to call a method in the context of an object
  - Ex: `my_c.add_minutes(5);`
  - Call the method `add_minutes` in the context of the `my_c` variable of type `Clock` passing 5 as an argument

Methods are specific to a type

- Methods are specific to the struct / class / type they are associated with
  - We can call `add_minutes` on a `Clock` as `add_minutes` is part of `Clock`
  - Can't call `add_minutes` on a `string`. No such method is defined for use by a `string`

Declare method inside of struct block

- To make a method, we declare the method **inside** of the block of `struct`
  - Indicates it is part of the `struct`
  - This is only the declaration
    - Still need a definition

Definition add_minutes

```
void Clock::add_minutes(int min) {
    auto temp = minutes + min;
    if (temp >= 60) {
        minutes = temp % 60;
        hours = hours + (temp / 60);
    } else
        minutes = temp;
}
```

Scope

- `Clock::add_minutes(int min) { …`
- Scope resolution operator
- The method `add_minutes` is in the scope of the `Clock` struct when it is defined.

Can call as a member

- By declaring `add_minutes` to be part of `Clock`, we can call it as we indicated, as a member function of a `Clock` variable
- `Clock clk;`
- `clk.add_minutes(5);`
- Not so for clk_to_string, just a function
- `clk_to_string(clk);`

The "this" Pointer

How is calling object passed?

```
Clock clk;
clk.add_minutes(5);
```

vs

```
clk_to_string(clk);
```

- Clear in function (2nd) how a Clock instance is passed.
- How is it passed to the method (1st)?

Self

- In Python, we said that the first parameter to every method was the calling object. We always called it `self`

```
my_clk.add_minutes(5);
```

```
void add_minutes(???, int min)
```

- Is there a `self` here?

The special variable this

- There is no “first parameter” in every method.
- Instead, C++ creates a special variable name `this` which is used in a method call

This

```
my_clk.add_minutes(5)
```

```
       this
void add_minutes(int min)
```

- On a method call, C++ automatically binds a variable named `this` to the calling object
- `this` is a **pointer**!

implicit pointer for members

```
Clock::add_minutes(int min) {
    auto temp = minutes + min;
```

…

- In the above, `minutes` is a member of the `struct`.
- In the context of a method, it is assumed that using a “naked” data member means: “the data member associated with the variable `this`”

Rephrase

```
Clock::add_minutes(int min) {
    auto temp = minutes + min;
```

…

- It is as if you had type the below

```
auto temp = (*this).minutes + min;
```

- or

```
auto temp = this->minutes + min;
```

- All three are equivalent (you can do whichever you like)