Constructors

Clock Class

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

Naked members are assumed to be associated with `this`
`minutes + min` is equivalent to `this->minutes + min`

```
#ifndef CLOCK_H
#define CLOCK_H
#include<string>
using std::string

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

    void add_minutes(int);
};
string print_clk(const Clock &c);
#endif
```

What is a constructor

- We’ve seen these special methods before (in Python or Java)
- These are the methods responsible for creating / initializing a user defined struct / class

Really more like initializers

- Constructors are really more initializers than “creators” as they are part of a pipeline
- Your constructor fits into the creation process pipeline allowing you to initialize elements of your data struct

Pipeline


Create a variable
Apply class template
Initialize with Constructor
Object initialized

Default /synthetic constructor

- If you do not provide a constructor, C++ will provide one
- The *synthesized constructor* will initialize each data member to its default value
  - long: 0
  - double: 0.0
  - string: “”

Problems

- Default constructor takes no arguments
  - A user cannot change the initial data members of a variable
- Default value for each data member is OK for most types, but there are exceptions
  - Pointers are not initialized to a useable value
  - User-defined types must have a default

Constructor

- Constructor is a function member with the same name as the class itself:
  - There is **no return** from a constructor
    - Not a `void` return, no return (no type)
  - Unlike Python, the constructor can be overloaded based on parameters
    - Many different constructors depending on parameters

Clock Constructors

```
Clock::Clock() {
   minutes = 0;
   hours = 0;
   period = “AM”;
}
Clock::Clock(int min,
                int hr,
                string prd) {
    minutes = min;
    hours = hr;
    period = prd;
}
```

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

    Clock();
    Clock(int m, int h,
             string s);

    void add_minutes(int);
};
```

Calling the constructor

```
Clock my_clk;  // Call to default constructor, no args
                                    // Not even empty parens!!!
Clock a_clk(1, 1, "PM");  // Call to 3-arg constructor
```

- First declaration is a call to the user-defined default constructor
- Second is a call to the 3-arg constructor

What type do you return in a constructor?

- The type of the class the constructor belongs to
- A pointer to the class (named `this`)
- You can't return in a constructor
- I don't know

Synthetic Default Constructor and Initializer Lists

All or nothing

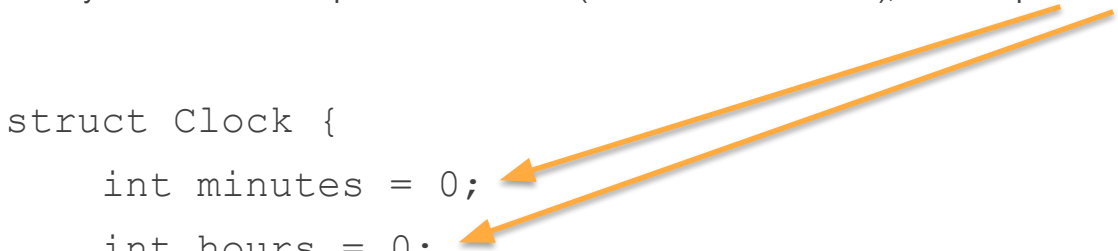
- If you define **any** constructor then C++ no longer provides any synthesized default constructor
  - When you define a constructor it is up to you to provide all the constructors necessary for your class
  - If you still want a default (no-argument) constructor, you have to provide it

Get the C++ default back

- We said that if you define any constructor, the C++ default (the no-arg constructor) can no longer be used.
- If you are interested in using the C++ default, you can by using the `= default` designator on your no-arg constructor

Default uses default data member values

- If you declare the no-param constructor (the default constructor), it will respect **default data member** values



```
struct Clock {
    int minutes = 0;
    int hours = 0;
    string period;

    Clock() = default;
    …
```

Initializer List

- If all you are doing (as we are doing in the clock example) is setting a data member directly to some parameter, there is a shortcut
  - The initializer list

Format

```
Clock(int m, int h, string s) : minutes(m),
                                hours(h), period(s) {};
```

- Colon indicates what follows is an init list
- Each comma separated phrase afterwards is the name of a data member and, in parens, the name of the parameters used to set that data member.
- The empty `{}` is **required** at the end
  - Could provide code here if you chose, but it should be short

Order depends on declaration

- The order of initialization of data members from an initialization list goes in the **order of declaration** in the class, **not** the order of parameters in the initializer constructor
  - You'll get a warning if the param order and the declaration order differ
  - It could matter to the code as well

.h vs .cpp

- You can put the constructor in the .h or the .cpp
- Traditionally
  - Initializer list constructors go in the header
  - Constructors that “do work”, i.e. require a function body to do something, go in .cpp

All in header!

```
struct Clock {
    int minutes = 0;
    int hours = 0;
    string period;

    Clock() = default;
    Clock(int m, int h, string s) : minutes(m), hours(h), period(s) {};

    void add_minutes(int);
};
```

Advertising vs implementation

- You try to keep implementation out of the header when possible.
- Remember
  - The header is the ad for the class. This is **what** the class does
  - The implementation file is **how** the class does what is advertised

Converting Constructor

There are two senses of cast

- **to**-casting: cast a known type to a new variable of your class type
- **from**-casting: cast a variable of your class type to a known type

Converting Constructor

- If you write a constructor with a single parameter, then that constitutes a converting constructor
  - When C++ sees a type that, when passed to a constructor, creates the required type, it will call that constructor and do the conversion

Converting Constructor

```
struct Clock {
     int minutes = 0;
     int hours = 0;
     string period;

     Clock() = default;
     Clock(int m, int h, string s) : minutes(m), hours(h), period(s) {};

     // implicit to-cast
     Clock(string);
     // explicit to-cast
     explicit Clock(string);

     void add_minutes(int);
};
```

A converting constructor, from string to Clock

If explicit, then compiler **cannot call** it implicitly, but programmer can call explicitly (like with static_cast).

Constructor with string param, expects “hr:min:period”

```
Clock::Clock(string s) {
  // format is hr:min:period
  vector<string> fields;
  split(s, fields, ‘:’)
  hours = stol(fields[0]);
  minutes = stol(fields[1]);
  period = fields[2];
}
```

Explicit

- The call to the one-string parameter could be used by C++ **implicitly**, that is without being explicitly called by the user (like a long -> double conversion in mixed math, done by the compiler)
- The keyword `explicit` in front of a constructor means that it will not be called implicitly by C++ but can be called explicitly by the user.

Conversion

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

Only one conversion at a time

```
string s = “12:12:PM”;
cout << clk_to_string(s) << endl;
cout << clk_to_string(string(“11:11:PM”));
// cout << clk_to_string(“11:11:PM”));
```

- Last one won’t work. A literal character string is not an STL string object.
- This requires two conversions: char* -> string -> Clock

Default params in constructor can be a problem

- Slightly modified .h file

```
Clock(int m=0, int h=0, string s="AM") :
          minutes(m), hours(h), period(s) {};

Clock("11:11:PM");
```

- Which one?

Default constructor

- In fact, a constructor that defaults all of its parameters is defining the default constructor
  - Could call it with no args, so default