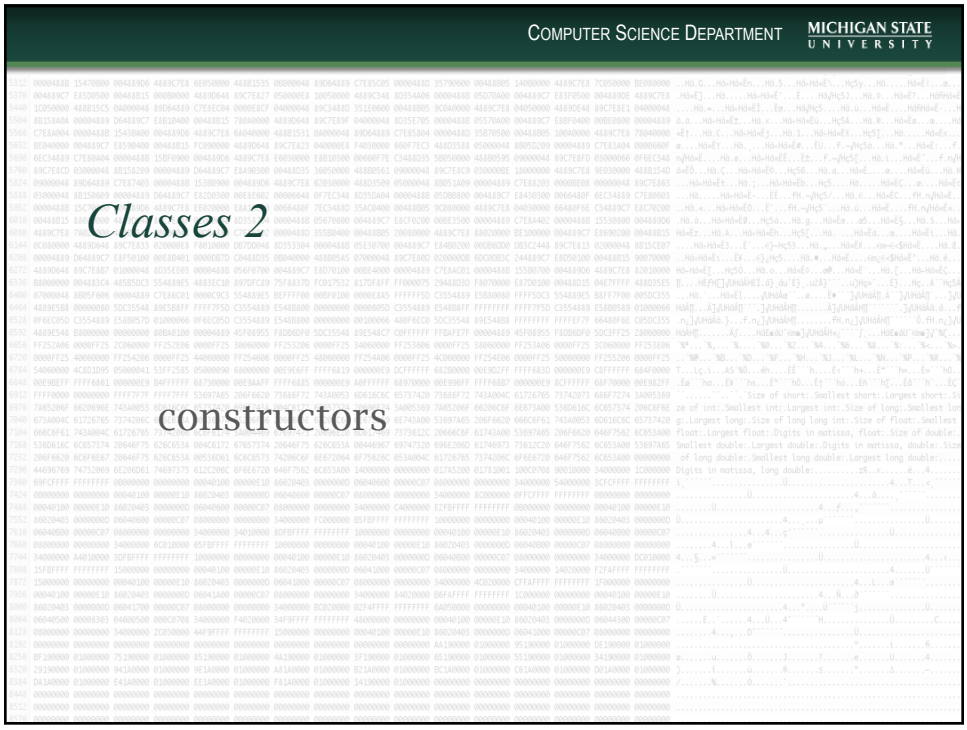
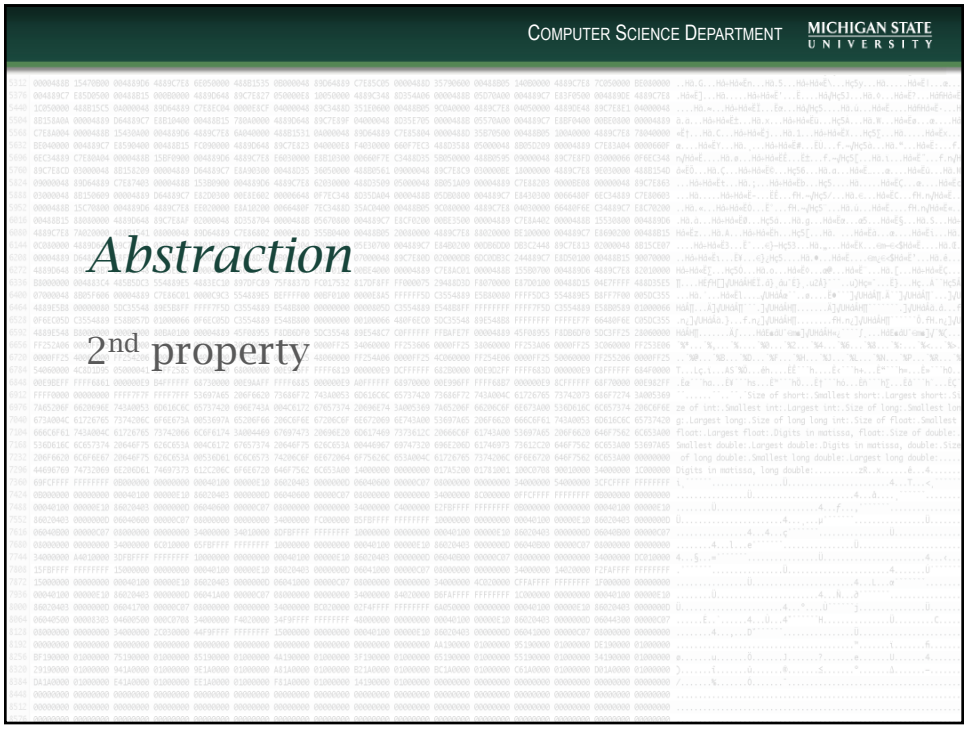

COMPUTER SCIENCE DEPARTMENT
MICHIGAN STATE UNIVERSITY
Classes 2
constructors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Abstraction
2nd property

Abstraction

the idea

We want to provide an **interface** to our class.

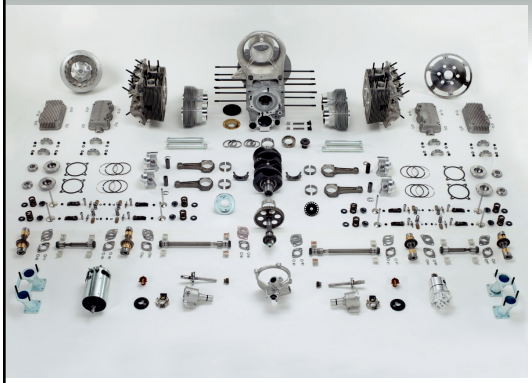
- an interface is a simple, user-oriented way to access the functionality represented by our class
- the methods we define are that interface

information hiding

By abstraction, we are "hiding" the details of how a struct/class is implemented.

We design the interface, the methods, so that the user can access the functionality without worrying about details

abstraction helps change



What if I take out that volkswagen engine and replace it with a porsche engine

Much change, same interface

If

- the interface is well designed
- is respected by the people doing the changes

Then the user access to the underlying object should be the same

Data structures

Imagine that you make a class that implements a company inventory.

- you make the class and you use vectors for the underlying implementation
- you decide later to change the implementation to a map
- users should not care!!! Works the same for them (if you did it right)

Remember `this`

You must remember `this`, a kiss is just a kiss, a sigh is just a sigh.

special variable

C++ marks/remembers the calling object in a member function call

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

in the member function `add_minutes`, the variable `this` points to `my_c`

```
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

It is a pointer!


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

naked data members in a member function are assumed to be associated with `this`

`minutes + min` is equivalent to `this->minutes + min` or `(*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
```

Constructors

Ex 16.1

what is a constructor

We've seen these special member functions before (in Python, in Java).

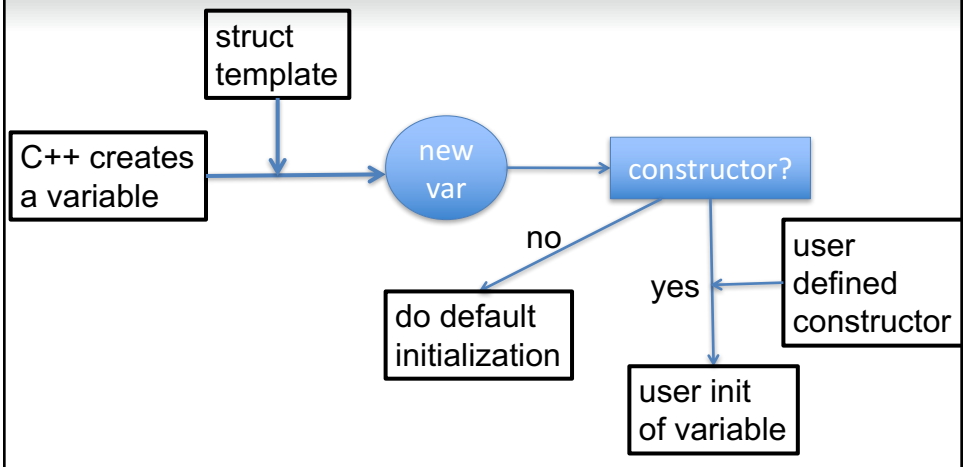
These are the member functions responsible for creating/initializing a user defined struct/class

Really more like initialize

Constructors are really more initializers than "creators", as they are part of a pipeline.

Your constructor fits into the pipeline, the creation process, allowing you to initialize elements of your data struct.

Pipeline



Default/synthesize constructor

So if you do not provide a constructor, C++ will synthesize a constructor.

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 as it is already part of a pipeline
  - 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;
}
```

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

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

  Clock();
  Clock(int m, int h,
        string s);
  void add_minutes(int);
};

string print_clk(const Clock &c);
#endif
```

main

```
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

all or nothing

If you define ***any*** constructor, then C++ no longer provides a 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 constructor (a no-argument constructor), you have to provide it.

construction shortcuts

Ex 16.2

All in header!

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

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);
};

string print_clk(const Clock &c);
#endif
```

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.

However, if you're 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) =default, it will respect default data member values

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

   Clock()=default;
   …
```

the default ctor will assign
minutes ← 0
hours ← 0
period (call the std::string default ctor)

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.

This is called 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 parameter used to set that data member.
- the empty `{}` is ***required*** at the end.
  - could provide code here if you choose, 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*** on the order of parameters in the initializer constructor.

- you'll get a warning if the param order and 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

.h means inline

if you put the constructor in the .h, then that means these constructors will be ***inlined***.

Instead of creating a function, everywhere that the constructor occurs is physically ***replaced*** with the appropriate code to do construction

- should be simple, as this could be an expensive process.

well, kind of anyway

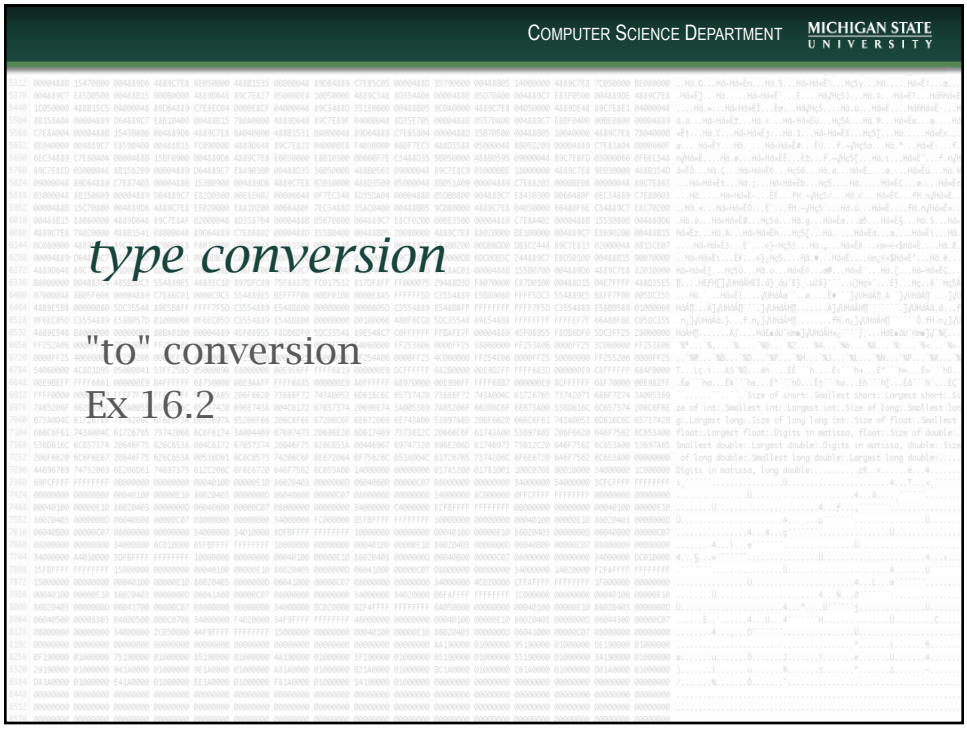
Inlining is an interesting process, whose consequences are difficult to easily ascertain. However, the compiler is free to do as it wishes with inlining

- so even though it is inlined, it may in fact be turned into a regular function by the compiler
- compilers are free to optimize things as they choose ☺

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.



there are two senses of cast

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

to-casting is easy!

to casting is construction

If you write a constructor with a single parameter, then that constitutes a to-cast.

- when C++ sees a type that, when passed to a constructor, creates the required type, it will call that constructor and do the conversion.

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

struct Clock{
  int minutes;
  int hours;
  string period;
   Clock()=default;
   Clock(int m, int h, string s) : minutes(m), hours(h),
                                   period(s) {}
   // to-cast
   Clock(string)
   // explicit Clock(string);
  void add_minutes(int);
};
string print_clk(const Clock &c);
#endif
```

A to-cast, from string to Clock

if explicit, then compiler ***cannot call*** it implicitly, but programmer can call explicitly

ctor 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

remember it's a function, takes a Clock

```
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"));
```

implicit conversions!!!

Last one won't work. A literal character string is not an STL string object. So this requires two conversions:
char* → string → Clock

default params in ctor can be a problem

Slightly modified .h file

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