L38PA

ECE 198 KL

bigger picture: connecting to engineering big software systems

~~C++ classes~~ goals
background
modules

C++ classes
fields & static data
functions (member & class)
inheritance

next time: constructors & destructors
access control

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another common use of function pointer tables (jump tables) in C

abstract interface to 'device'
- interrupt controller - (hw behaves differently)
- file operations
- device drivers

what kind of 'file'?

Saturday 4-6

extra office hours for me / review

P12 ... shift to Tuesday now

The organization of data and function specialization that we examined in the last two lectures [see library-example code for more detail] forms the core of data & function inheritance in C++.

What are those?
- parent-child relationship between structures (base-derived)
- if parent has a field, so does the child (data inheritance)
- if function can operate on a parent, it can operate on a child (function inheritance)

Ways to make programming big systems easier.

Avoid replicating code — when one type of structure is just a special kind of another type, most of the data and behavior (functions) are identical.

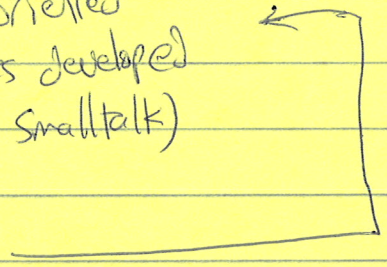
Simplify usage — in example, we can write functions that work for all references in the library; we don't always want to do things the same way for more specialized references (books, conference papers, etc.), so we allow specialization (replacement) of functions (using function pointer tables in C/C++)

Simplify extensibility — only write/change behavior that is new/different — reuse other code & data whenever possible.

background

~60's software systems large enough that they are divided into modules to make reasoning about them easier

late 60s & 70s — object-oriented languages developed (Simula, Smalltalk)



1972
David Parnas: information hiding
- module defines an interface (functions)
- how functions are implemented and what information (fields, data structures) are used should be hidden from other modules

79 C with classes

80s C++ takes off — blends benefits of object-oriented design with clarity & performance of C

Typically, a module is organized around one of more data structures

Recall that a data structure is

- a struct with fields [sometimes >1]
- related static data
- interface functions that operate on one or more instances
- internal / implementation functions
- initialization / teardown routines for an instance

Module also includes initialization / teardown routines for the module.

C++: smallest module: a class

discuss later — mostly an artifact

```
class name : public parentclass {
    // fields declared — same as a struct
    // associated functions declared (interface and implementation)
    // static data related to class also appear here
    // initialization / teardown routines for an instance
};
```

basically everything above

→ Let's examine each in more detail --

Fields — identical to structs

- add a line that looks like a variable declaration

```
int x;
double y;
player_t* p;
```

- now each instance has a field named x, y, or p
- layout in memory matches order in class definition
- fields in a class come after fields in parent class (identical to how we drew for C)

Static data: looks like a field, but add 'static' in front ⇒ one copy for class, in global data area

Functions — syntax introduced to make easier

Often a function takes a pointer to an instance

Function declared in class definition using style you know is a member function or method

```
int memberfunc (char x, double* y);
```

Member functions take an implicit argument with type pointer to class instance

In other words, if we have the Class. ALPHA,
with member function declared

```
int memberfunc ( char x, double* y);
```

The real [implemented in same way as C function,
with clear translation to assembly
& calling convention] is

```
int memberfunc (ALPHA* this, char x, double*y);
```

Note: first argument
has a name (not chosen by you): "this"

Using a member function: like a field...

```
ALPHA a;
ALPHA* ptr;

a.memberfunc('x', NULL);  // this is &a

ptr -> memberfunc('z', NULL); // this is ptr
```

What if I don't want an implicit pointer to class?
Add 'static' to front of function declaration
in class definition
called a class function

Invoking a class function...

Everything in a class definition is implicitly prefixed with the class name
(avoid conflicts in naming)

But often compiler can figure out which thing you want:

```
ALPHA a;
a.memberfunc(...)
```

↑ a is an ALPHA

↑ the function defined in ALPHA

Often not true for class functions.

In ALPHA

```
static void classfunc(int g);
```

To use: ← new namespace operator — join pieces of namespace together

```
ALPHA::classfunc(42);
```

Inheritance

Mentioned already for data

```
class ALPHA : public BETA {
---
};
```

An ALPHA has all fields of a BETA
(data inheritance)

We can also invoke any member function of BETA on an ALPHA
(function inheritance)

If BETA and ALPHA both define a function, compiler will call the one corresponding to the current type

~~ALPHA* a~~
~~BETA~~

```
ALPHA a;
BETA b1;
BETA* b2 = &a; // compiler approves & casts implicitly
```

Why?

```
a.myfunc(); // ALPHA version
b1.myfunc(); // BETA version
b2->myfunc(); // [ask] BETA version
```

Compiler will set up & use virtual tables automatically

If you want the behavior that we implemented in C using function pointer tables, add "virtual" before myfunc declaration in BETA (ALPHA recommended, but optional)