6.S096 Lecture 10 – Course Recap, Interviews, Advanced Topics
Grab Bag & Perspective

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When do you want to use C/C++?

Need a tiny short script?
No, use Python or something else instead.

Need extreme portability with little effort?
No, use an cross-platform interpreted language or Java.

Need the absolute best performance?
Yes.

Need a powerful language for a large software project, integrated with many different libraries?
Yes, C++.
C Interviews

Would most likely be focused on the low-level things.

- Security concerns: buffer overflows
- Floating-point subtleties
- Performance (cache efficiency, etc)
- Detecting a memory leak
- Pointers and data structures involving them
- Declaration vs definition, compilation
C++ Interviews

Would most likely be focused on the concerns of large software projects.

- Questions about design patterns
- How is inheritance implemented? (vtable)
- Properly writing copy constructors
- Knowing important language “quirks” or features
- Knowledge of the STL
- Differences between C++ and Java
- Read Effective C++ as prep!
What are the differences between C++ and Java?

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- C++ can be by value, pointer, or reference.
- C++ allows operator overloading.
- C++ allows multiple inheritance.
- Java runs on the JVM, C++ is compiled to the architecture.
How does this structure look?

Our code is

```cpp
class Base {
    int _a;
    public:
        void func();
};

int main() {
    return 0;
}
```

and we compile it with `g++ -onovtable novtable.cpp -fdump-class-hierarchy`. 
The Result

Class Base

size=4 align=4
base size=4 base align=4
Base (0x7f05145d34e0) 0

This tells us the size of class Base is 4, and it should be aligned on word boundaries (locations in memory that are a multiple of 4 bytes).
How does this structure look?

Our code is

```cpp
class Base {
    int _a;

    public:
    virtual void func();
};

int main() {
    return 0;
}
```

and we compile it with g++ -ovtable vtable.cpp -fdump-class-hierarchy.
The Result

<table>
<thead>
<tr>
<th>Vtable for Base</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Base::_ZTV4Base: 3u entries</td>
<td></td>
</tr>
<tr>
<td>0 (int (*)(...))0</td>
<td></td>
</tr>
<tr>
<td>8 (int (*)(...))(&amp;_ZTI4Base)</td>
<td></td>
</tr>
<tr>
<td>16 (int (*)(...))Base::func</td>
<td></td>
</tr>
</tbody>
</table>

Class Base

- size=16 align=8
- base size=12 base align=8

Base (0x7ff9385d44e0) 0

- vptr=((& Base::_ZTV4Base) + 16u)

- Notice that class Base now has size 16! (+ 8 byte pointer)
- Should be aligned on multiples of 16 bytes in memory.
- What’s a Vtable?
What’s a Virtual Table (vtable)?

How C++ really implements inheritance
And more involved...

Our code is

```cpp
class Base {
    int _a;

public:
    virtual void func();
};

class Derived : public Base {
public:
};
```
The Result

Vtable for Base
Base::_ZTV4Base: 3u entries
0   (int (*)(...))0
8   (int (*)(...)(& _ZTI4Base)
16  (int (*)(...)Base::func

//...
Vtable for Derived
Derived::_ZTV7Derived: 3u entries
0   (int (*)(...))0
8   (int (*)(...)(& _ZTI7Derived)
16  (int (*)(...)Base::func // points to Base::func!
Name Mangling

You’ll notice `_ZTV7Derived` and `_ZTI4Base` 

This will be important for overloading functions: generate a unique symbol identifier for the function.

- For example: `_ZN4Base4funcERi`
- Parse as: `_ZN` reserved identifier
- `4 Base`: 4 character name
- `4 func`: 4 character name
- `ERi`: taking reference to int

There are many different schemes!

In the case of ZTV and ZTI above, ZTV means we’re talking about a vtable and ZTI indicates some type info.
Threading and Parallelism

<thread>

OpenMP

MPI

CUDA
Components

Requirements

25% **Physics Engine** - quality and extensibility of simulation code

25% **Visualization** - OpenGL; getting a good visualization working

15% **Unit testing** - gtest, quality and coverage of tests

15% **Software Process** - code reviews, overall integration of project

10% **Interactive** - user interactivity with simulation (keyboard, mouse, etc)

10% **Do something cool** - make it look cool, add a useful feature, do something interesting!

Remember: Extra 5% available in all areas for exceptional effort.
What have you always wanted to know about C or C++?
C++ is a BIG language!

Write more code!

Sharpen your saw with books:

- Effective C++, More Effective C++, and Effective STL by Scott Meyers
- The C++ Programming Language by Bjarne Stroustrup
- C++ Templates: The Complete Guide by D. Vandervoorde and N. Josuttis
- Design Patterns by the Gang of Four
- Exceptional C++ by Herb Sutter
- Thinking in C++ by B. Eckel (can find free online)
- API Design for C++ by Martin Reddy
Wrap-up & Friday

Final project due Sunday 2/2 at 6pm.

Send me your 2nd code review Saturday 2/1 please!

Questions?

Let me know what you end up doing with C/C++!
(can reach me at akessler@mit.edu)