Lecture 1b: Compiling C++; Style

CS 70: Data Structures and Program Development

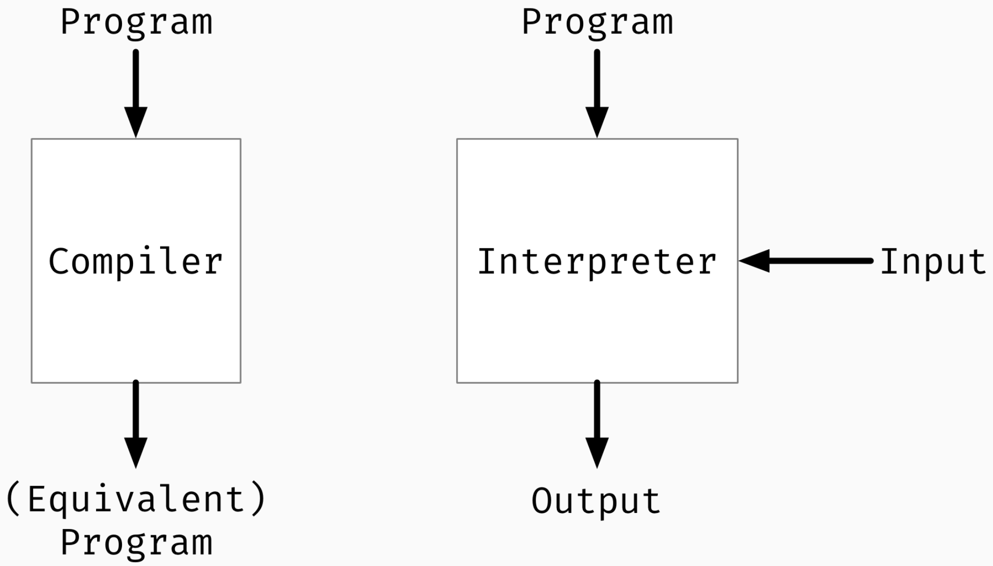
Thursday, January 24

Today's Learning Targets

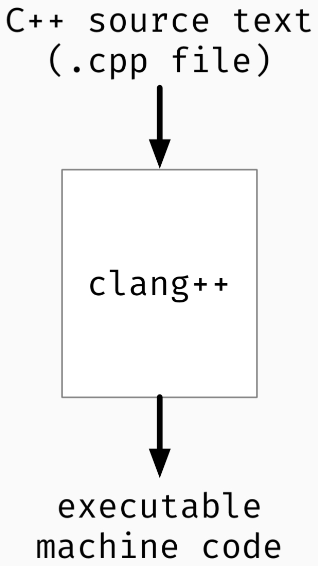
- I can explain the steps to compile multi-file C++ code.
- I can contrast the design goals of Java and C++.
- I can identify code with bad style.
- I can write readable and elegant C++ code.

Compiling C++

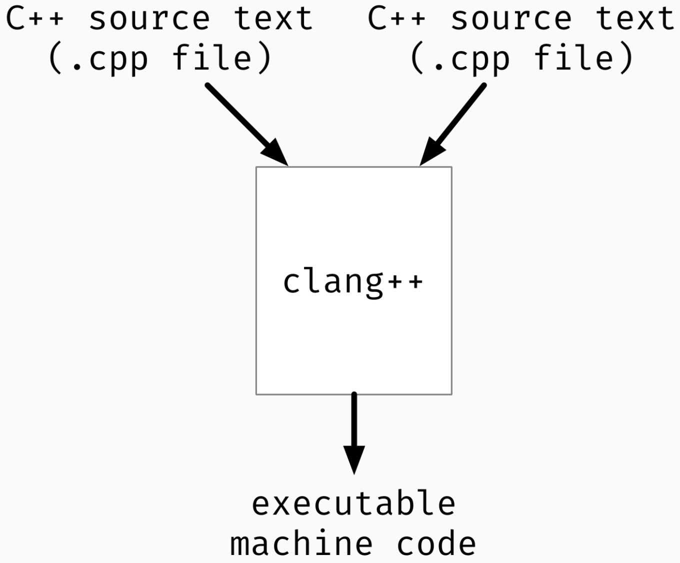
Recall: Compiling vs. Interpreting



Compiling C++ (1 file)



Compiling C++ (multiple files)

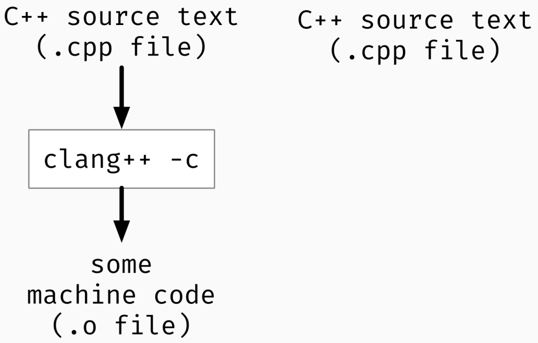


Compiling C++ (multiple files, better!)

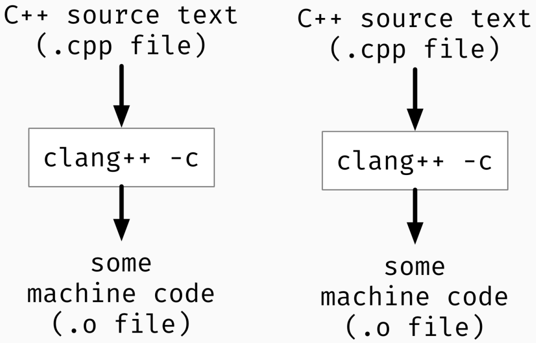
C++ source text
(.cpp file)

C++ source text
(.cpp file)

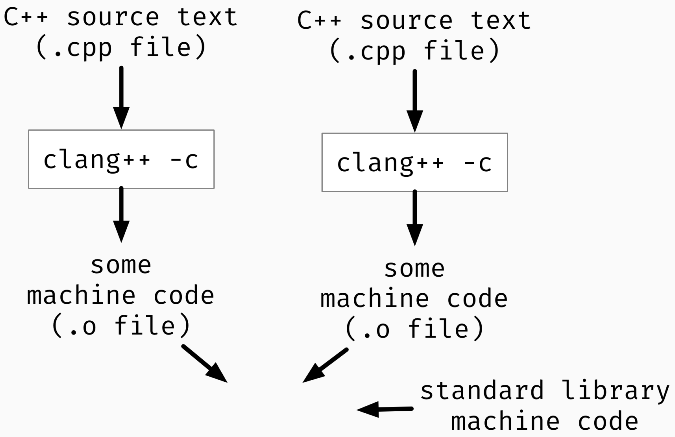
Compiling C++ (multiple files, better!)


C++ source text (.cpp file)
C++ source text (.cpp file)
clang++ -c
some machine code (.o file)

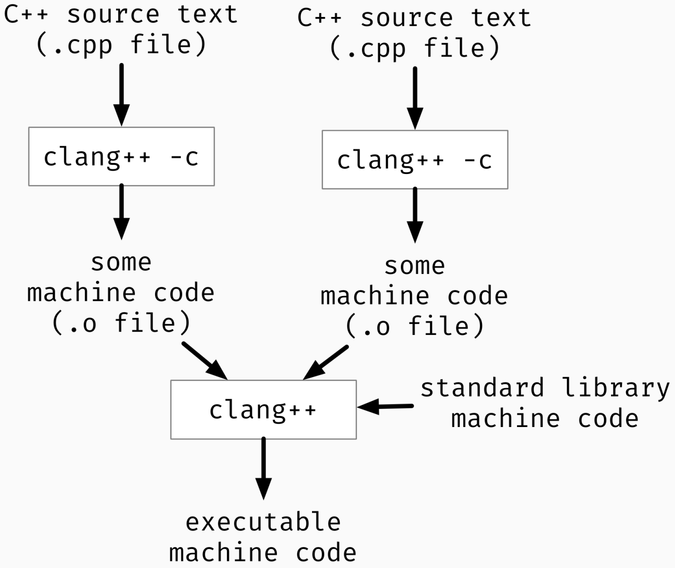
Compiling C++ (multiple files, better!)


C++ source text (.cpp file)
clang++ -c
some machine code (.o file)
C++ source text (.cpp file)
clang++ -c
some machine code (.o file)

Compiling C++ (multiple files, better!)


C++ source text (.cpp file)
C++ source text (.cpp file)
clang++ -c
clang++ -c
some machine code (.o file)
some machine code (.o file)
standard library machine code

Compiling C++ (multiple files, better!)


C++ source text (.cpp file)
C++ source text (.cpp file)
clang++ -c
clang++ -c
some machine code (.o file)
some machine code (.o file)
clang++
standard library machine code
executable machine code

Question

a. Suppose our program has three `.cpp` source files. To get a runnable program, how many times should `clang++` run?

b. Suppose now we change one definition in one `.cpp` file. To get an updated runnable program, how many times should `clang++` run?

System Header Files

```
#include <iostream>
#include <string>

int main() {
  std::string message = "Hello, World!";
  std::cout << message << "\n";
  return 0;
}
```

User Header Files

```cpp
------------------ exclaim.hpp ----------------
#include <string>

// Adds an !
std::string exclaim(std::string sentence);
---------------------main.cpp------------------
#include <iostream>

#include "exclaim.hpp"

int main() {
  std::cout << exclaim("wow") << std::endl;
}
```

User Header Files (continued)

```
------------------ exclaim.hpp ----------------
#include <string>

// Adds an !
std::string exclaim(std::string sentence);

------------------ exclaim.cpp ----------------
#include "exclaim.hpp"
#include <string>

std::string exclaim(std::string sentence) {
  return sentence + "!";
}
```

I changed `exclaim.cpp`. Steps to recompile?

```
------------------ exclaim.cpp ----------------
#include "exclaim.hpp"
#include <string>

// Don't add ! if the string ends in !
std::string exclaim(std::string sentence) {
  size_t length = sentence.size();
  if (length > 0 && sentence[length-1] == '!') {
      return sentence;
  } else {
      return sentence + "!";
  }
}
```

Programming Language Design Principles

Design Principles for C++

C++ is a statically typed, object-oriented, imperative language.

Design Principles for C++

C++ is a statically typed, object-oriented, imperative language.

Design goals for the language include:

- "C++ is a better C"
- Efficiency (in time and space) **No Overhead**
- Trust (i.e., obey) the programmer

Design Principles for Java

Java is a statically typed, object-oriented, imperative language.

Design Principles for Java

Java is a statically typed, object-oriented, imperative language.

Design goals for the language include:

- Safety (ensure bad things can't happen)
- Portability (Write Once, Run Everywhere)
- Familiarity

C++ or Java?

(a) A `long` integer is a 64-bit number.

(b) A `long` integer has some number of bits (perhaps the same number as in a CPU register).

C++ or Java?

(a) If you try to access index 100 of a 10-element array of integers, an error (exception) will be reported.

(b) If you try to access index 100 of a 10-element array of integers, anything could happen (but you'll most likely get back some bits taken from memory past the end of the array, interpreted as an integer.)

Style

Readings

What were the big ideas?

Style and Elegance

- Readability should be your top priority
- And all other things being equal,
    - Maximize maintainability / extensibility
    - Don't be *gratuitously* inefficient.
- **Nobody** writes beautiful code all the time
    - Go back and fix things!

Consistency

http://minorcreations.files.wordpress.com/2012/07/one.png
One of these things is not like the other....

Use Consistency and Inconsistency to Your Advantage

- Similar things should *look* similar
- Different things should *look* different

(In)consistent with what?

Use Consistency and Inconsistency to Your Advantage

- Similar things should *look* similar
- Different things should *look* different

(In)consistent with what?

- With ourselves (within a file)
- With culture (project conventions)

We will ask you to generally follow Google's C++ Style Guide (as implemented in the `cpplint` tool)

Consistency: Variable Names

Variable names and functions: camelCase

- `count`, `i`, `activeTask`, `launchMissiles()`

Data members (fields): camelCase + trailing underscore

- `front_`, `currentCapacity_`

Class names: Capitalized CamelCase

- `Gene`, `StudentTranscript`

Constants: All caps, underscore between words

- `VERSION`, `MAX_STUDENTS`

Consistency: Applying Idioms

```
const size_t NUM_LETTERS = 26;
std::string alphabet;
for (size_t i = 0; i < NUM_LETTERS; ++i) {
    alphabet += ('a' + i);
}

for (size_t i = 0; i < alphabet.size(); ++i) {
    std::cout << alphabet[i] << " " << i << "\n";
}
```

Consider this code example

- What, specifically, is wrong with it?
- Why, specifically, is this a problem?
- How would you suggest fixing the problem(s)?

```
// MUST be set to 1!
Params.ParentalLevel = 3; // QA now insists this be 2
```

Consider this code example

- What, specifically, is wrong with it?
- Why, specifically, is this a problem?
- How would you suggest fixing the problem(s)?

```
// if ((typec!="20") && (typec!="13") && (typec!="5") && (typec!="4"))
if (typec !="20") {
    if (typec != "13") {
        if (typec != "5") {
            if (typec != "4") {
                selectType("ALLOC");
                return;
            }
        }
    }
}
```

Exercise

Find the code fragment for your group

- What, specifically, is wrong with it?
- Why, specifically, is this a problem?
- How would you suggest fixing the problem(s)?
- Is there *anything* good to say about the style?

The last student to join will be the group's spokesperson.

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```
std::string capitalizedName(std::string name)
{
    if (name == "aafke") {
       return "Aafke";
    } else if (name == "aaron") {
       return "Aaron";
    }
        // lots and lots of similar lines, not shown
    } else if (name == "zuzana") {
       return "Zuzana";
    } else if (name == "zuzanna") {
       return "Zuzanna";
    } else if (name == "zuzanny") {
       return "Zuzanny";
    } else {
       // Name not in the database yet,
       // but lowercase is better than nothing
       return name;
    }
}
```

5

```
bool validateSSN(std::string ssn)
{
    if ( ssn[0] != '0' && ssn[0] != '1' && ssn[0] != '2' && ssn[0] != '3' &&
         ssn[0] != '4' && ssn[0] != '5' && ssn[0] != '6' && ssn[0] != '7' &&
         ssn[0] != '8' && ssn[0] != '9' ) {
        return false;
    }
    if ( ssn[1] != '0' && ssn[1] != '1' && ssn[1] != '2' && ssn[1] != '3' &&
         ssn[1] != '4' && ssn[1] != '5' && ssn[1] != '6' && ssn[1] != '7' &&
         ssn[1] != '8' && ssn[1] != '9' ) {
        return false;
    }
    // plus 7 more similar cases

    return true;
}
```

4a

```cpp
// This is the first example of C++ code that you should critique
const std::string twentySpaces = "                         ";
```

4b

```
void SPdfsR(Graph G, int s)
  { link u; int i, t; double wt;
    int **p = G->path; double **d = G->dist;
    for (u = G->adj[s]; u != NULL; u = u->next)
      {
        t = u->v; wt = u->wt;
        if (d[s][t] > wt)
          { d[s][t] = wt; p[s][t] = t; }
        if (d[t][t] == maxWT) SPdfsR(G, t);
        for (i = 0; i < G->V; i++)
          if (d[t][i] < maxWT)
            if (d[s][i] > wt+d[t][i])
              { d[s][i] = wt+d[t][i]; p[s][i] = t; }
      }
  }
```

3

```
// This is Java code to critique, not C++ syntax!

synchronized (surelyReachableObjectsWhichHaveToBeMarkedAsSuch) {
    waitRecommended =
      surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContentedSize
        == surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContented.size();

    surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContentedSize =
        surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContented.size();

    while (!surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContented.isEmpty())
        {
          surelyReachableObjectsWhichHaveToBeMarkedAsSuch.push(
            surelyReachableObjectsWhichShouldHaveBeenProcessedButWereLockContented.getFirst() );
        }
}
```

2

```
/**
 * function is03or09or10.
 * takes: prodCode
 * returns: bool
 */
bool is03or09or10(std::string prodCode)
{
    if ("03" == prodCode) return true;
    else if ("09" == prodCode) return true;
    else if ("10" == prodCode) return true;
    else return false;
}

// other functions not shown: is01, is02, and is004or005
```

1

```
void validate(Person p)
{
    const int TWO = 2;
    bool validated = true;
    std::string myMessage, val;

    // Name
    val = p.name;
    if (!(val.find(" ")!=std::string::npos)) || !(val.size()>TWO)) {
       myMessage += "Please fill in your full Name\n";
       validated = false;
    }

    // Address
    val = p.address;
    if (!(val.size()>TWO)) {
       myMessage += "Please fill in your full Address\n";
```

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```
bool b(std::string a) {
    int b = -1, c = a.length();
    goto p;
    while(b<c){
        if  (a   [b] != a   [c])  return false;
    p:  ++b; c--; }
                                  return true;
}
```

7

```
public boolean foo(... omitted ...) {
    try {
        synchronized (... omitted ...) {
            if (... omitted ...) {
            } else {
            }
            for (... omitted ...) {
                if (... omitted ...) {
                    if (... omitted ...) {
                        if (... omitted ...) {
                            if (... omitted ...)
                            {
                                if (... omitted ...) {
                                    for (... omitted ...) {
                                    }
                                }
                            }
                        } else {
                            if (... omitted ...) {
                                for (... omitted ...) {
                                    if (... omitted ...) {
                                    } else {
                                    }
                                    if (... omitted ...) {
                                    } else {
                                        if (... omitted ...) {
                                        }
                                    }
                                    if (... omitted ...) {
```

etc.

See you in lab tomorrow!

- Tomorrow in Lab:
  - Version Control, Git, and Github
  - Starting HW1
- To-do:
  - Do HW0
  - Find a partner