



Compilation Pipeline C Introduction

CS 2130: Computer Systems and Organization 1
October 24, 2025

Announcements

- Homework 6 **due Monday at 11:59pm**
- Quiz 6 opens today, due ~~Friday~~ by 11:59pm
Sunday

C

C is a thin wrapper around assembly

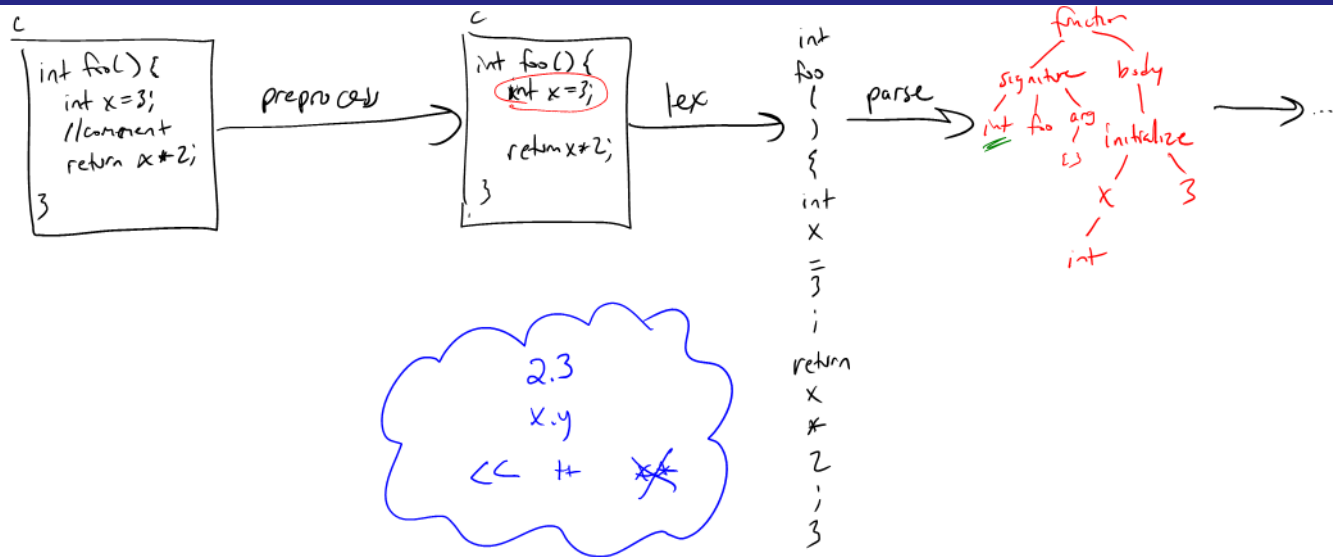
- This is by design!
- Invented to write an operating system
 - Can write inline assembly in C
- Many other languages decided to look like C

Compiling C to Assembly

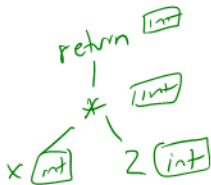
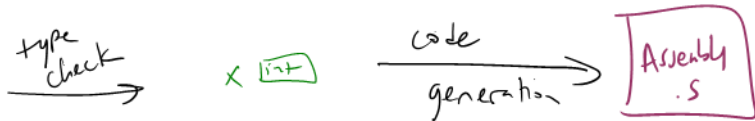
Multiple stages to compile C to assembly

- Preprocess - produces C
 - C is actually implemented as 2 languages:
C preprocessor language, C language
 - Removes comments, handles preprocessor directives (#)
 - `#include`, `#define`, `#if`, `#else`, ...
- Lex - breaks input into individual tokens
- Parse - assembles tokens into intended meaning (parse tree)
- Type check - ensures types match, adds casting as needed
- Code generation - creates assembly from parse tree

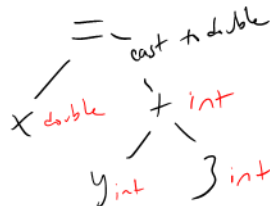
Compiling C to Assembly



Compiling C to Assembly



double x;
int y = 2;
x = y + 3;



Errors

Compile-time errors

- Errors we can catch during compilation (this process)
- **Before** running our program

Runtime errors

- Errors that occur when running our programs

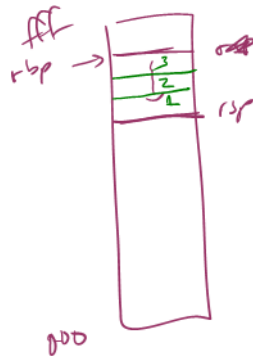
Simple C Example

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

The `main` function

- Start running the `main()` function
- `main` must return an integer - **exit code**
 - 0 = everything went okay
 - Anything else = something went wrong
- There *should* be arguments to `main`

Example



Data Types in C

Integer data types

Data type	Size
char	
short	
int	
long	
long long	

Each has 2 versions: *signed* and *unsigned*

Data Types in C

Floating point

- float
- double

Data Types in C

Data Types in C

Pointers - how C uses addresses!

Data Types in C

Pointers - how C uses addresses!

- Hold the address of a position in memory
- Need to know the kind of information stored at that location

Example

```
int main() {  
    int x = 3;  
    long y = 4;  
    int *a = &x;  
    long *b = &y;  
    long z = *a;  
    int w = *b;  
    return 0;  
}
```

Example

```
int main() {  
    int x = 3;  
    long y = 4;  
    int *a = &x;  
    long *b = &y;  
    long z = *a;  
    int w = *b;  
    return 0;  
}
```

0000000000000000 <main>:

```
0: 55  
1: 48 89 e5  
4: 31 c0  
6: c7 45 fc 00 00 00 00  
d: c7 45 f8 03 00 00 00  
14: 48 c7 45 f0 04 00 00  
1b: 00  
1c: 48 8d 4d f8  
20: 48 89 4d e8  
24: 48 8d 4d f0  
28: 48 89 4d e0  
2c: 48 8b 4d e8  
30: 48 63 09  
33: 48 89 4d d8  
37: 48 8b 4d e0  
3b: 48 8b 09  
3e: 89 4d d4  
41: 5d  
42: c3
```

```
push    %rbp  
mov     %rsp,%rbp  
xor     %eax,%eax  
movl    $0x0,-0x4(%rbp)  
movl    $0x3,-0x8(%rbp)  
movq    $0x4,-0x10(%rbp)  
  
lea     -0x8(%rbp),%rcx  
mov     %rcx,-0x18(%rbp)  
lea     -0x10(%rbp),%rcx  
mov     %rcx,-0x20(%rbp)  
mov     -0x18(%rbp),%rcx  
movslq  (%rcx),%rcx  
mov     %rcx,-0x28(%rbp)  
mov     -0x20(%rbp),%rcx  
mov     (%rcx),%rcx  
mov     %ecx,-0x2c(%rbp)  
pop     %rbp  
retq
```