C Introduction

CS 2130: Computer Systems and Organization 1

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Announcements

- Homework 7 due tonight at 11:59pm on Gradescope
- Exam 2 Friday

Struct Example

```
long sum2(foo *arg) {
    long ans = arg->x;
    for(long i = 0; i < arg->length; i += 1)
        ans += arg->y * arg->array[i];
    return ans;
}
```

```
sum2:
    movq    (%rdi), %rax
    movq    24(%rdi), %r8
    testq   %r8, %r8
    jle     .LBB1_3
    movq    8(%rdi), %rdx
    movq    16(%rdi), %rsi
    xorl    %edi, %edi
.LBB1_2:
    movq    (%rsi,%rdi,8), %rcx
    imulq   %rdx, %rcx
    addq    %rcx, %rax
    incq    %rdi
    cmpq    %rdi, %r8
    jne     .LBB1_2
.LBB1_3:
    retq
```

Struct Example

```
long sum1(foo arg) {
    long ans = arg.x;
    for(long i = 0; i < arg.length; i += 1)
        ans += arg.y * arg.array[i];
    return ans;
}
```

```
sum1:
    movq    8(%rsp), %rax
    movq    32(%rsp), %r8
    testq   %r8, %r8
    jle     LBB0_3
    movq    16(%rsp), %rdx
    movq    24(%rsp), %rsi
    xorl    %edi, %edi
.LBB0_2:
    movq    (%rsi,%rdi,8), %rcx
    imulq   %rdx, %rcx
    addq    %rcx, %rax
    incq    %rdi
    cmpq    %rdi, %r8
    jne     .LBB0_2
.LBB0_3:
    retq
```

C Reference Guide

Calling Functions

The C code

```
long a = f(23, "yes", 34uL);
```

compiles to

```
movl $23, %edi
leaq label_of_yes_string, %rsi
movq $34, %rdx
callq f
# %rax is "long a" here
```

without respect to how `f` was defined. It is the calling convention, not the type declaration of `f`, that controls this.

Calling Functions

But, if the C code has access to the type declaration of `f`, then it might perform some implicit casting first; for example, if we declared

```
long f(double a, const char *b, double c);

long a = f(23, "yes", 34uL);
```

then the call would be interpreted by C as having implicit casts in it:

```
long a = f((double)23, "yes", (double)34uL);
```

Calling Functions

and the arguments would be passed in floating-point registers, like so:

```
movl $23, %eax
cvtsi2sd %eax, %xmm0           # first floating-point argument

leaq label_of_yes_string, %rdi # first integer/pointer argument

movl $34, %eax
cvtsi2sd %eax, %xmm1           # second floating-point argument

callq f
# %rax is "long a" here
```

Functions Declaration

```
int f(int x);
```

- Declaration of the function
- Function header
- Function signature
- Function prototype

We want this in every file that invokes `f()`

Functions Definition

```
int f(int x) {
    return 2130 * x;
}
```

- Definition of the function

We only want this in **one** `.c` file

- Do not want 2 definitions
- Which one should the linker choose?

Header Files

C header files: `.h` files

- Written in C, so look like C
- Only put header information in them
  - Function headers
  - Macros
  - `typedef`s
  - `struct` definitions
- Essentially: information for the **type checker** that does not produce any actual binary
- `#include` the header files in our `.c` files

Big Picture

Header files

- Things that tell the type checker how to work
- Do not generate any actual binary

C files

- Function definitions and implementation
- Include the header files

Including Headers

`#include "myfile.h"`

- Quotes: look for a file where I'm writing code
- Our header files

`#include <string.h>`

- Angle brackets: look in the standard place for includes
- Code that came with the compiler
- Likely in `/usr/include`

Example: string.h