# C Introduction

CS 2130: Computer Systems and Organization 1
November 3, 2025

# Announcements

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

# Structures

`struct` - Structures in C

- Act like Java classes, but no methods and all public fields
- Stores fields adjacently in memory (but may have padding)
- Compiler determines padding, use `sizeof()` to get size
- Name of the resulting type includes word `struct`

```
struct foo {
    long a;
    int b;
    short c;
    char d;
};

struct foo x;
x.b = 123;
x.c = 4;
```

# Structure Literals

```
struct a {
    int b;
    double c;
};

/* Both of the following initialize b to 0 and c to 1.0 */
struct a x = { 0, 1.0 };
struct a y = { .b = 0, .c = 1.0 };
```

# typedef

`typedef` - give new names to any type!

- Fairly common to see several names for same data type to convey intent
- Ex: `unsigned long` may be `size_t` when used in sizes
- Examples:

```
typedef int Integer;
Integer x = 4;
typedef double ** dpp;
```

- Used with *anonymous structs*:

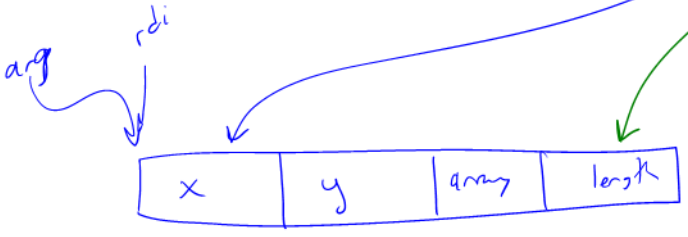
```
typedef struct { int x; double y; } foo;
foo z = { 42, 17.4 };
```

# Struct Example

```
typedef struct {
    long x;
    long y;
    long *array;
    long length;
} foo;
```

# Struct Example

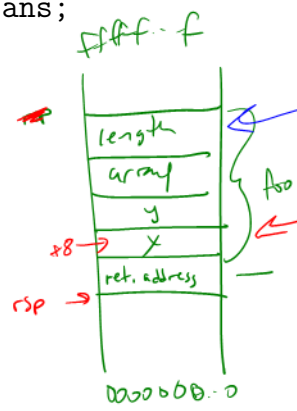
```
long sum2(foo *arg) {
    long ans = arg->x;
    for(long i = 0; i < arg->length; i += 1)
        ans += arg->y * arg->array[i];
    return ans;
}
```




```
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
```