

# C Introduction

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## CS 2130: Computer Systems and Organization 1

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## Announcements

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- Homework 8 released today, due next Monday on Gradescope

# Switch

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## Calling Functions

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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

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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

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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

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```
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

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```
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

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C header files: `.h` files

- Written in C, so look like C
- Only put header information in them
  - Function headers
  - Macros
  - `typedefs`
  - `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

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### 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

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```
#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`

## Macros

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`#define NAME something else`

- Object-like macro
- Replaces NAME in source with something else

`#define NAME(a,b) something b and a`

- Function-like macro
- Replaces NAME(X,Y) with something Y and X

Lexical replacement, *not* semantic

## Interesting Example

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```
#define TIMES2(x)  x * 2           /* bad practice */
#define TIMES2b(x) ((x) * 2)      /* good practice */

int x = ! TIMES2(2 + 3);

int y = ! TIMES2b(2 + 3);
```

## Examples and More

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- header example
- `string.h`
- variadic functions

# Memory

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# The Heap

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**The heap:** unorganized memory for our data

- Most code we write will use the heap
- *Not a heap data structure...*

## The Heap: Requesting Memory

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```
void *malloc(size_t size);
```

- Ask for `size` bytes of memory
- Returns a `(void *)` pointer to the first byte
- It does not know what we will use the space for!
- Does not erase (or zero) the memory it returns

## malloc Example

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```
typedef struct student_s {
    const char *name;
    int credits;
} student;

student *enroll(const char *name, int transfer_credits) {
    student *ans = (student *)malloc(sizeof(student));
    ans->name = name;
    ans->credits = transfer_credits;
    return ans;
}
```

## The Heap: Freeing Memory

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Freeing memory: `free`

```
void free(void *ptr);
```

- Accepts a pointer returned by `malloc`
- Marks that memory as no longer in use, available to use later
- You should `free()` memory to avoid *memory leaks*



## An Interesting Stack Example

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```
int *makeArray() {  
    int answer[5];  
    return answer;  
}  
  
void setTo(int *array, int length, int value) {  
    for(int i=0; i<length; i+=1)  
        array[i] = value;  
}  
  
int main(int argc, const char *argv[]) {  
    int *a1 = makeArray();  
    setTo(a1, 5, -2);  
    return 0;  
}
```

