

Discussion 02

C/Memory

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Announcements

Agenda

- C Basics
- Structs and Unions
- Memory Review
- Endianness
- Q&A

C Basics



Types in C

- Everything in the computer is just bits!
 - What does that even mean?
- Definitions
 - `char` := 1 byte
 - `short` := 2 bytes
 - `int` := 4 bytes
 - `long` := 8 bytes
- Pointers? “32/64-bit systems”

Pointers (Pt. 1)

- Variables
 - nicknames for a value
 - Must be declared, and then initialized
 - `char *x; // declaration`
 - `x = "hello" // initialization`
 - Sit somewhere in memory
 - Are a series of `n` bits interpreted in a specific way
- Memory Addresses
 - Are just another variable type, that looks a bit different (like arrays)
 - Technically, just integers!
 - Declared with `type*`, then initialized with a valid memory address value

Pointers (Pt. 2)

- Dereference
 - Memory addresses hold a value, that can be retrieved by `*addr`
- Address
 - Every variable has its own memory address, found at `&var` ! (where the variable lives)
- Pointers are sized depending on the architecture!
- Why do pointer sizes change?

Useful Tips

```
char **double_ptr = malloc(sizeof(char*) * num_elem);  
char *single_ptr = malloc(sizeof(char) * num_elem);  
double_ptr[1] = single_ptr;  
*double_ptr = single_ptr;  
double_ptr = &single_ptr;
```


The `sizeof()` function

- Returns the size of the type of the given variable, in bytes
- What's `sizeof(char*)`?
 - 1 byte

Pointer Arithmetic

```
int *int_arr = malloc(20 * sizeof(int))
```

- `int_arr[i]` vs. `*(int_arr + i)`
- What happens when you add `i` to a pointer?

Structs and Unions

Structs

- Blocks of memory storing consecutive values
- Accessing fields
 - `struct.field`
 - `(*struct_ptr).field`
 - `struct_ptr->field`
- Compiler aligns memory to field's natural size
 - Every field sits on memory addresses that is a multiple of its size

TypeDef

- Create a nickname that can be referred to for values
- Typedef vs. `#define`
 - Both give aliases/nicknames to values
 - Typedef can only give symbolic names
 - `#define` can define aliases for values
 - `#define ONE 1;`
 - `typedef unsigned char BYTE;`
 - Typedef: interpreted by compiler
 - `#define`: substituted by the C pre-processor

TypeDef (Example)

```
struct ll_node {  
    int val = 0;  
    ll_node* next;  
};  
struct ll_node {  
    int val = 0;  
    Node* next;  
} Node;
```

Unions

- Effectively the same as structs EXCEPT not all fields will exist simultaneously
- Can still use dot notation to get fields
- Memory will be allocated for the largest field in the union!

Memory Structure

- Memory is contiguous!
- From top-down, it's separated into 4 chunks
 - Stack
 - Heap
 - Static/data
 - Text/Code

Memory Structure (Pt.1)

- Code/text
 - The code that you intend to execute
- Static/data
 - Primarily constants that don't need to be changed
CAN be changed, e.g.
global variables

Memory Structure (Pt.2)

- Heap
 - Memory that is ~~dynamically~~ allocated
 - Can only put things on the heap using malloc()
 - MUST be freed!!!
 - Grows bottom-up
- Stack
 - Memory that is “automatically” allocated by the system
 - Will be “freed” by the system
 - Grows top-down

Endianness

- Big endian: most significant byte @ smallest address
- Little endian: most significant byte @ largest address
- Base line: if you store something into memory, you should be able to read out the same value! (double flipping)

Thank you!

Feedback