Logistics

The midterm will be here, in Cooke 121.

Plan to arrive by 1:00 PM.

No:

- Mobile devices, laptops, smart watches
- Notes, textbooks, lecture slides
- Cheating
Introduction to C

- C is a high level language used in systems programming.
- Architectural details are important in C.
- The C/POSIX model is:
  - A dedicated machine for each program
  - Sequential execution of program instructions
  - Data is stored in accessible, addressed memory
- We explored some trivial C programs.
Variables, Strings, and Loops

- C is a typed language
- Every variable has a type
- Variable values must match the type
- Variables have scope, and cannot be used outside that scope
- Arrays are contiguous memory locations
- Array syntax uses []
- C strings are arrays of characters
- Every C string is terminated with a zero byte
- For loop syntax
- For loops are very flexible
Conditionals and Control Flow

- All nonzero values are true conditions in C.
- All Boolean expressions use 1 for true.
- The bool keyword holds only 0 or 1.
- C uses short-circuit evaluation of Boolean logic.
- if and switch implement conditionals.
- Use blocks for if and else!
- Control flow is implemented with comparisons and jumps.
Memory and Pointers

- Memory locations are identified by **addresses**.
- Addresses are **integers**.
- Our system’s memory is **like one large array**.
- POSIX processes appear to have their own dedicated **memory**.
- Pointers **hold addresses and have types**.
- Unix processes are **divided into sections**.
- Pointers and arrays are **closely related, but not the same**.
A Tour of Computer Systems

- Architectural details matter
  - Bus widths
  - Numeric properties
  - Performance details
- C and POSIX are just one possible system
- All systems have those details
- Software correctness can be critically important
Memory Allocation

- The heap is where you manually allocate memory.
- The C standard library contains a flexible allocator.
- Heap allocations are sized by the programmer.
Alignment, Padding, and Packing

- Integers, pointers, and floating point numbers are **scalar types**.
- Arrays and structures are **aggregate types**.
- Structures can contain members of **mixed type**.
- Scalar types must be **aligned**.
- Aggregate types must **align for scalars**.
- Allocation normally aligns to the **largest type**.
- Pointer arithmetic uses **stride** in computations.
- `void *` has a **stride of 1**.
- The `void *` type can be used for **raw memory manipulation**
- **Casting `void *`** to another type is convenient
- **Math on `void *`** is by **byte**
Floating Point Numbers

- Numbers can have fractional portions
- Both fixed and floating point representations can be calculated in both binary and decimal
- IEEE 754 standardizes a floating point representation
- Floating point numbers have fixed precision, but variable magnitude
Bitwise Operations

- C can manipulate individual bits in memory.
- Bit operations can be subtle and tricky!
- Signedness matters.
- Bit manipulations can force endianness or other representations.
Open review

Please ask questions.
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