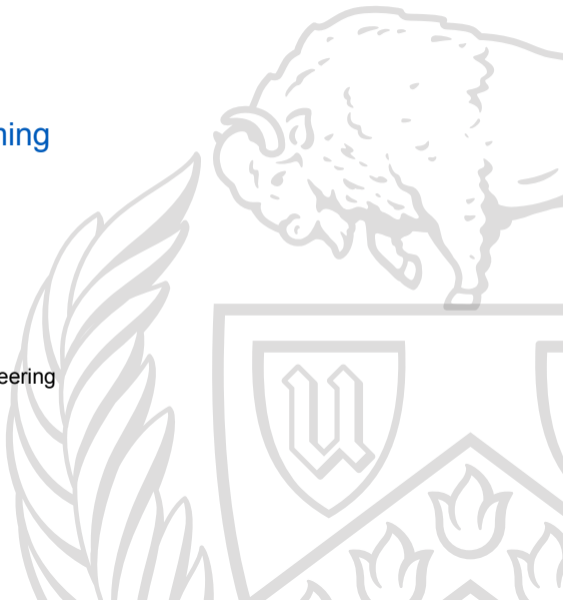


Midterm Review

CSE 220: Systems Programming

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Logistics

Your midterm will be **in class on Wednesday during lecture.**

You will need:

- Yourself
- A writing instrument
- **Nothing else**

If you are late, **you will not be admitted to the room.**

The exam is **closed book, closed notes.**

See Piazza @672

Introduction to CSE 220 and 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.
- Control flow is implemented with comparisons and jumps.
- Use blocks for `if` and `else`!

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**.

Programming Practices

- Cultivate **good work habits**
- **Design** your programs purposefully
- **Use your tools!**
- Practice **good style and form**
- Debug **with a plan**

The **only way** to become a good programmer is to **write programs**.

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.

Integers and Integer Representation

- The CPU and memory deal **only in words**
- Buses and registers have **native word widths**
- Integers have different:
 - Bit widths
 - **Endianness**
 - Sign representation
- **Ones' and two's complement** representation

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.

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