Computer Architecture II

AGENDA

- Last Session Recap
- Bitwise Operations
- File I/O

LAST SESSION RECAP

- Decimal, Binary, Hexadecimal
- Virtual Machines
- Guided Project Pt. 1

GUIDED PROJECT PT. 1

- **Read the spec!!!**
- This project requires you to read the spec thoroughly and efficiently to accomplish the tasks you're given
- You **don't** need to implement everything in the spec to complete the tasks

GUIDED PROJECT PT. 1

- Implement the CPU constructor
- Implement ram_read and ram_write
- Implement the core of run
- Implement HLT, LDI, PRN

Bitwise Operations

BITWISE OPERATIONS

- Operations that manipulate individual bits
- These are the foundational operations that the CPU uses to manipulate numbers and run logic
- You will be using these operations for your project

Operator	Description
`&`	Bitwise AND
`|`	Bitwise OR
`^`	Bitwise XOR
`~`	Bitwise NOT
`<<`	Bitwise left shift
`>>`	Bitwise right shift

COMMON BITWISE OPERATIONS

- There are two types of bitwise operations - *unary & binary*
- Unary Bitwise Operators *(una = one)*
  - **~ (NOT)** - Return opposite of bit *a*
- Binary Bitwise Operators *(bi = two)*
  - **& (AND)** - return 1 if both bits *a* and *b* are 1
  - **| (OR)** - return 1 if either a or b is 1
  - **^ (XOR)** - return 1 if one of the bits is 1, but NOT both

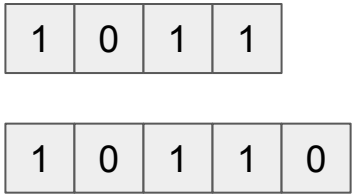
X	Y	X&Y	X|Y	X^Y	~(X)
0	0	0	0	0	1
0	1	0	1	1	1
1	0	0	1	1	0
1	1	1	1	0	0

AND, OR, XOR Demo

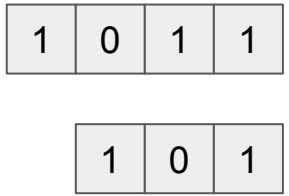
BIT SHIFTING

- Bitwise Left Shift
  - Equivalent to multiplying by pow(2, n)
  - This is used in the DJB2 hash function!
- Bitwise Right Shift
  - Equivalent to dividing by pow(2, n)

Left Shift << 1



Right Shift >> 1



Bit Shifting Demo

BIT MASKING

- Used to turn bits on/off
- Can also be used to get the status of bits
- This is very useful to extract the number of arguments in an instruction for your project

Bit Masking Demo

File I/O

FILE I/O

- Today, you will be implementing *load()*, which loads a program from an input file
- You will need to know how to read an input file and parse it

File I/O Demo