ECE 220 Computer Systems & Programming

Lecture 1 – Course Overview & LC-3 Review

January 15, 2019

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Course Wiki: https://wiki.illinois.edu/wiki/display/ece220/Home

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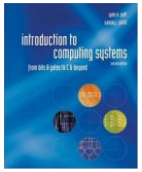
Course Logistics

- 4 Lectures to choose from (Hu, Chen, Bhowmik, Moon)
- Programming Studio on Fridays (10 makeup pts/week towards MPs)
- MPs: due every Thursday @ 10pm (100 pts each, late penalty 2pts/hour)
- Quizzes: 6 programming quizzes, lowest score dropped
- Exams: 2 midterms and a final Exam (paper format)
- Textbook: Patt & Patel, **Introduction to Computing Systems: from bits to gates to C and beyond**, 2nd Edition.
- Academic Integrity



Grading Mechanics:
MPs: 10%
Quizzes: 20%
Midterms: 22% x 2
Final Exam: 26%

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Tools & Resources

- Course wiki – course info, MP write-up, exam info, etc.
- Github – MP/LAB release and submission
- Piazza – discussion board monitored by TAs
- Compass – online grade book
- CBTF – facility for taking programming quizzes, reserve your seat 10 days in advance at https://cbtf.engr.illinois.edu
- Emergency response
- Resources: CARE, counseling center, DRES

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Levels of Transformation in Computing Systems

Problems
Algorithms
Language
Instruction Set Architecture
Microarchitecture
Circuits
Devices
Electrons

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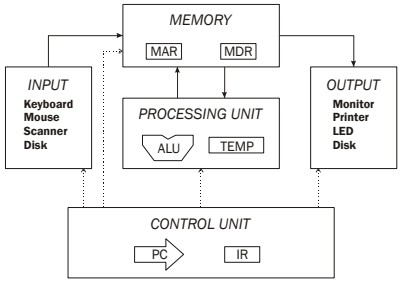
LC-3 Review – The von Neumann Model

1. Memory
2. Processing Unit
3. Input
4. Output
5. Control Unit



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LC-3 Review - Memory

Load and Store Using

- **MAR**: Memory Address Register (_____ -bit)
- **MDR**: Memory Data Register (_____ -bit)

Load Data from Memory Address X

Step 1: place address x in _____

Step 2: send _____ signal to memory

Step 3: data in _____ is placed in _____

Store Data to Memory Address Y

Step 1: place address Y in _____, place data in _____

Step 2: send _____ signal to memory

Step 3: data is _____

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LC-3 Review – Processing Unit, Input/Output, Control Unit

Processing Unit

- The Arithmetic and Logic Unit (ALU) only has _____, _____, _____ operations
- Temporary Storage using general-purpose registers: _____

Input – Keyboard (use 2 registers)

1.
2.

Output – Monitor (use 2 registers)

1.
2.

Control Unit

IR: instruction register – _____

PC: program counter – _____

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LC-3 Review – ISA (Instruction Set Architecture)

Memory Organization

- Address space (# of distinct memory locations): _____
- Addressability (# of bits stored in each memory location): _____

Register Set

- Eight 16-bit general-purpose registers: R0, R1, …R7
- special-purpose register: _____, _____

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LC-3 Review – ISA (Instruction Set Architecture)

Instruction Set

Data Types: 16-bit 2's complement integers

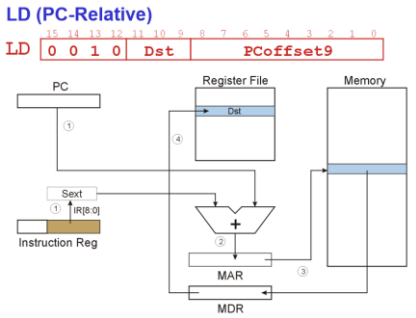
Addressing Modes (how the location of operand is specified):
Non-memory addresses – immediate (part of instruction), register
Memory address – PC-relative, base+offset, indirect

Opcodes (16-bit, bits 12-15 used to specify the opcode):
Operate instructions: ADD, AND, NOT
Data movement instructions: LD, LDI, LDR, LEA, ST, STR, STI
Control instructions: BR, JSR/JSRR, JMP, RET, TRAP, RTI
Condition codes: N (negative), Z (zero), P (positive)

Using LD, LDI, LDR, LEA

```
.ORIG x3000
LD   R6, LABEL
LDI  R6, LABEL
LDR R2, R6, #0
LEA  R2, LABEL
LABEL    .FILL x4000
.END

; Assume the following
; Address      Content
; x4000        x5000
;   …            …
; x5000        x6000
```



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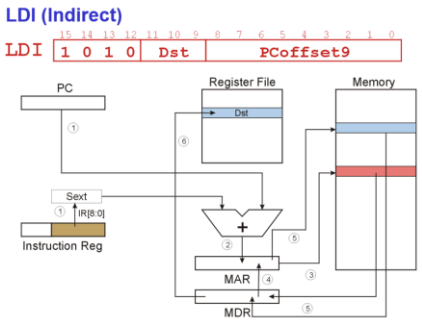
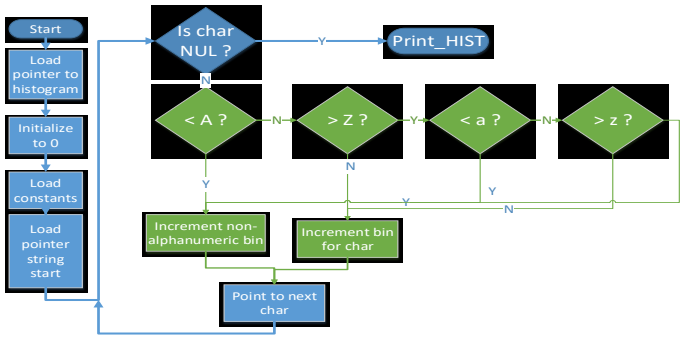


LC-3 Exercise

1. Initialize a register
2. Copy value from one register to another
3. Compute 5 - 3
4. Compute 4 x 3

MP1 – Printing a Histogram



- ASCII Table

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