

Computer Science 210 s1c
Computer Systems 1
2008 Semester 1
Lecture Notes

Lecture 12, 2Apr08:

The LC-3 ISA

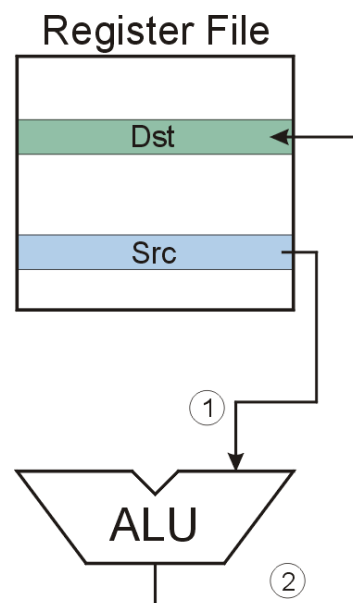
James Goodman



Credits: Slides prepared by Gregory T. Byrd, North Carolina State University

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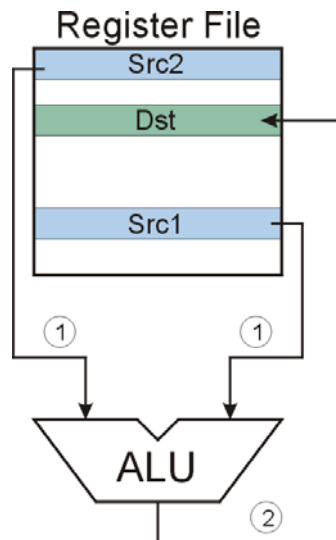
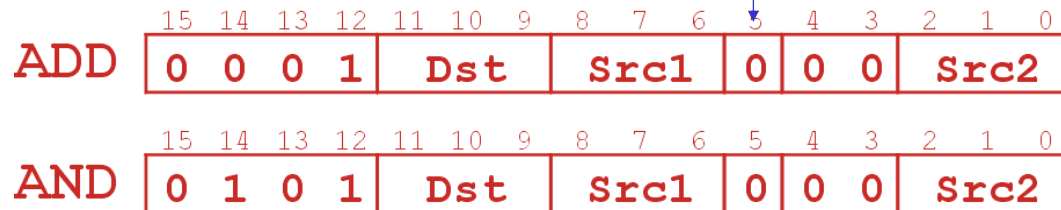
NOT (Register)



*Note: Src and Dst
could be the same register.*

ADD/AND (Register)

this zero means "register mode"



2-Apr-08

CS210

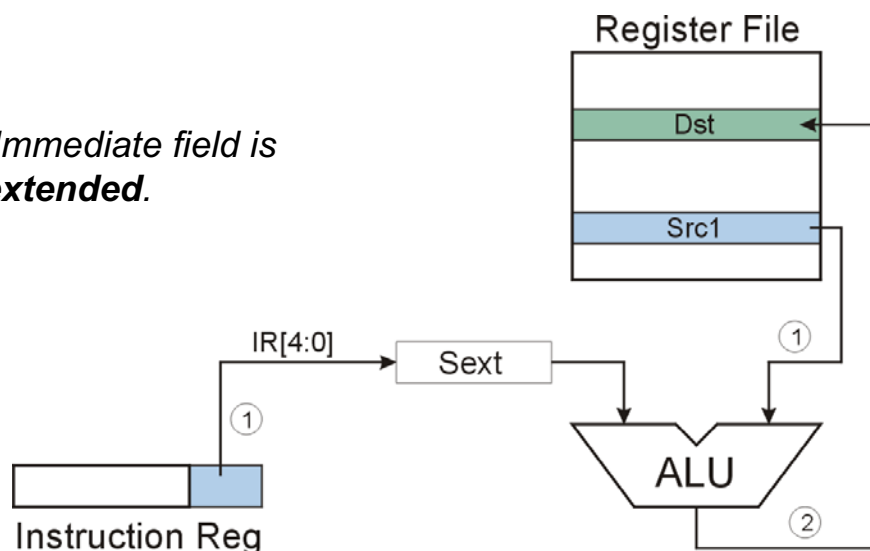
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ADD/AND (Immediate)

this one means "immediate mode"



Note: Immediate field is sign-extended.



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Using Operate Instructions

With only **ADD**, **AND**, **NOT** ...

- How do we subtract?

$$C = A - B$$

- Compute $-B$, the additive inverse of B :
- $-B = (\text{NOT } B) + 1$
- $C = A + (-B) = A + (\text{NOT } B) + 1$

- How do we OR?

Use DeMorgan's theorem

$$\bullet C = A \text{ OR } B = \text{NOT } ((\text{NOT } A) \text{ AND } (\text{NOT } B))$$

- How do we copy from one register to another?

$$B = A + 0$$

- How do we initialize a register to zero?

$$B = X \text{ AND } 0$$

Data Movement Instructions

Load -- read data **from memory to register**

- **LD**: PC-relative mode
- **LDR**: base+offset mode
- **LDI**: indirect mode

Store -- write data **from register to memory**

- **ST**: PC-relative mode
- **STR**: base+offset mode
- **STI**: indirect mode

Load effective address -- compute address, save in register

- **LEA**: immediate mode
- *does not access memory*

PC-Relative Addressing Mode

Want to specify address directly in the instruction

- But an address is 16 bits, and so is an instruction!
- After subtracting 4 bits for opcode and 3 bits for register, we have 9 bits available for address.

Solution:

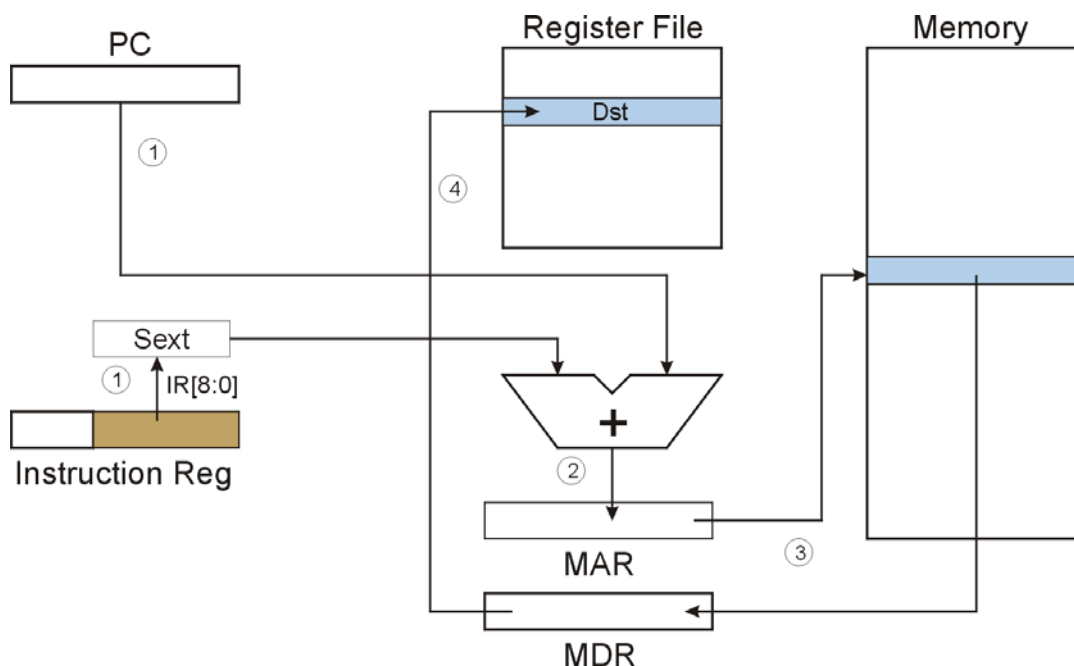
- Use the 9 bits as a **signed offset** from the current PC.

9 bits: $-256 \leq \text{offset} \leq +255$

Can form any address X, such that: $\text{PC} - 256 \leq X \leq \text{PC} + 255$

Remember that PC is incremented as part of the FETCH phase;
This is done *before* the EVALUATE ADDRESS stage.

LD (PC-Relative)





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LDI (Indirect)

