Memory, Data, & Addressing I

CSE 351 Winter 2024

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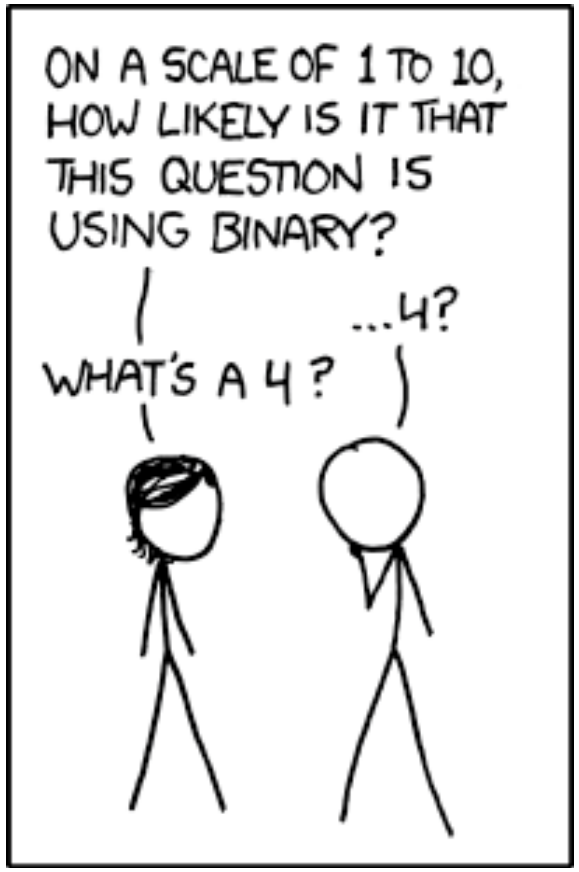


http://xkcd.com/953/

Relevant Course Information

- Upcoming deadlines
  - Pre-Course Survey and HW0 due tonight
  - HW1 due Monday (1/8)
  - Lab 0 due Monday (1/8)
    - This lab is *exploratory* and looks like a HW; the other labs will look a lot different
- Ed Discussion etiquette
  - For anything that doesn't involve sensitive information or a solution, post publicly (you can post anonymously!)
  - If you feel like you question has been sufficiently answered, make sure that a response has a checkmark

EPA

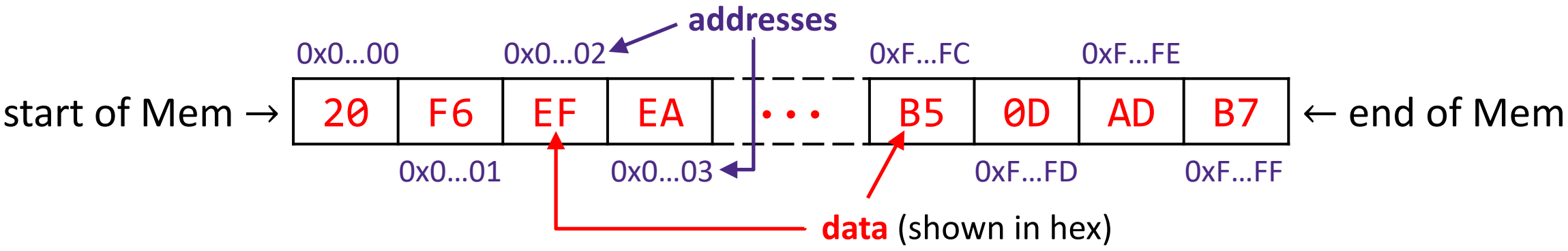
- Encourage class-wide learning!
- Effort
  - Attending support hours, completing all assignments
  - Keeping up with Ed Discussion activity
- Participation
  - Making the class more interactive by asking questions in lecture, section, support hours, and on Ed Discussion
- Altruism
  - Helping others in section, support hours, and on Ed Discussion

Memory & Data I

Lesson Summary (1/2)

- Memory is a long, *byte-addressed* array
  - Word size bounds the size of the *address space* and memory
  - Address of a chunk of memory given by the address of the lowest byte in chunk

- Endianness determines memory storage order for multi-byte data
  - Least significant byte in lowest (little-endian) or highest (big-endian) address of memory chunk



Lesson Summary (2/2)

- Programming Data
  - Variable declaration allocates space for data type size
  - Assignment results in value being put in memory location

C Data Type	x86-64 Size
char	1B
short	2B
int	4B
long	8B
long long	8B
float	4B
double	8B
long double	16B

	0x00	0x01	0x02	0x03	
0x00	A7	00	32	00	
0x04	00	01	29	F3	x
0x08	DE	AD	BE	EF	
0x0C	FA	CE	CA	FE	
0x10	26	00	00	00	
0x14	00	00	10	00	
0x18	01	00	00	00	y
0x1C	FF	00	F4	96	
0x20	EE	EE	EE	EE	
0x24	00	00	00	00	

Lesson Q&A

- Learning Objectives:
  - (Define the concept of pointers and) their significance in computer memory organization.
  - (Design code that can correctly) interpret and manipulate multi-byte data in both little-endian and big-endian byte orderings.

- What lingering questions do you have from the lesson?
  - Chat with your neighbors about the lesson for a few minutes to come up with questions

Memory & Data I – Practice

Polling Questions (1/2)

- By looking at the bits stored in memory, I can tell what a particular 4 bytes is being used to represent.

  A. True **B. False**

- We can fetch a piece of data from memory as long as we have its address.

  A. True **B. False**

- Which of the following bytes have a most-significant bit (MSB) of 1?

  A. 0x63 **B. 0x90** **C. 0xCA** **D. 0xF**

Polling Questions (2/2)

- We store the value `0x 01 02 03 04` as a ***word*** at address 0x100 in a big-endian, 64-bit machine
- What is the ***byte of data*** stored at address 0x104?

A. 0x04
B. 0x40
C. 0x01
D. 0x10
E. We're lost…

Homework Setup

- Assume that a snippet of memory is shown below (in hex), starting with the byte at address 0x08 on a *little-endian* machine:

```
addr:  0x08 0x09 0x0A 0x0B 0x0C 0x0D 0x0E 0x0F
data: | A2 | D0 | 4F | C4 | A0 | 0C | F7 | 27 |
```

- What is the value of the `int` stored at address `0x0C`?

Memory & Data I – Context

Modern System Details

- Current x86-64 systems use **64-bit (8-byte) words** ("64-bit machines")
  - Potential address space: $\mathbf{2^{64}}$ addresses
    2^{64} bytes ≈ **1.8 x 10^{19} bytes**
    = 18 billion billion bytes = 18 EB (exabytes)
  - Actual physical address space: **48 bits**
    - This is sufficient space for now and allows for some operating system tricks
    - Example address: `0x 7f fc 3d d5 06 94`

- There's a lot more to this story… stay tuned for virtual memory!

Discussion Question

- Discuss the following question(s) in groups of 3-4 students
  - I will call on a few groups afterwards so please be prepared to share out
  - Be respectful of others' opinions and experiences

- Over time, computers have grown in word size:

Word size	Instruction Set Architecture	First? Intel CPU	Year Introduced
8-bit	??? (Poor & Pyle)	Intel 8008	1972
16-bit	x86	Intel 8086	1978
32-bit	IA-32	Intel 386	1985
64-bit	IA-64	Itanium (Merced)	2001
64-bit	x86-64	Xeon (Nocona)	2004

  - What do you think were some of the *causes*, *advantages*, and *disadvantages* of this trend?

Group Work Time

- During this time, you are encouraged to work on the following:
  1) If desired, continue your discussion
  2) Work on the homework problems
  3) Work on the lab (if applicable)

- Resources:
  - You can revisit the lesson material
  - Work together in groups and help each other out
  - Course staff will circle around to provide support