Review: Exam 1

Computer Science E-1

3/4/11

Reminders

- Exam 1 on Monday, March 7th
- Local students: in lieu of lecture
  - 5:30 – 7:30pm @ Harvard Hall 104
- Distance students: remote proctoring
  - https://www.computerscience1.net/2011/spring/FAQs
- 2 hours
- Closed-book
- Paper & Writing Utensil

Study Tips

- Know the lectures!
  - Look over slides/topics
  - Would you be able to explain them to someone?
  - Re-watch/Skim videos
- Try the practice exam.
  - Familiarize with format
  - Get an idea of iffier areas
- Skim readings/sections if want more details
  - internet = good resource too!

(Ambitious?) Agenda

- Binary
  - & Decimal
  - ASCII
- Hardware
  - Memory
  - HDD
  - Add-ons
- Internet
  - IP Addresses
  - NAT
  - DNS
  - DHCP
  - Data Travel

Binary: The Basics

- Base-2 number system
  - Each digit is a power of two
- Binary Digit: bit
  - One (1) or Zero (0) only
  - Corresponds with “on” or “off,” “true” or “false”
- Analogy:
  - Using flashlight or switches to represent data
- Language of Computers
  - Why? -> Hardware

Binary From Decimal

- In Decimal: 42

…	1000s	100s	10s	1s	column
…	0	0	4	2	

0*1000 + 0*100 + 4*10 + 2*1= 42

"Algorithm":

1. Biggest bite of remaining
2. What's left?
3. Repeat

- In Binary: 42

…	64s	32s	16s	8s	4s	2s	1s	column
…	0	1	0	1	0	1	0	

1*32 = 32 (42 – 32 = 10 remaining)
+ 1*8 = 40 (42 – 40 = 2 remaining)
+ 1*2 = 42!

Binary To Decimal

- What's 10001 in Decimal?
  - Hint: remember the table and the columns!

…	64s	32s	16s	8s	4s	2s	1s	column
…			1	0	0	0	1	

1*16 + 1*1 = 17!

- Algorithm:
  - Figure out which power of 2 is "on"/present
  - Mathematically add all "on"/present

Question Time!

- Explain the following quote:

"There are only 10 types of people in this world: those who know binary and those who don't."

- What's 61 in Binary?
- Hint:

…	64s	32s	16s	8s	4s	2s	1s	column
…	0	1	1	1	1	0	1	

Binary & Computers

- Everything comes down to bits
  - Hardware:
  - transistors on or off (computations)
  - magnetic particles N or S (hard disk storage)
- 8 bits = 1 byte
- 1024 bytes = 1 kilobyte
- 1024 kilobytes = 1 megabyte
- 1024 megabytes = 1 gigabyte
- 1024 gigabytes = 1 terabyte

Question Time!

- A joke:
- A computer scientist buys a kilo of meat from the butcher's. Five minutes later, he returns claiming he's been cheated. The butcher weighs it: 1000g; the techie states his point has been proven.
- Why or how?
- How much did he "lose"?

Binary Representation

- How do bits and bytes translate into data and programs?
  - Standard mappings
- ASCII
  - (American **Standard Code** for Information Interchange)
  - 8-bits
- Another example:
  - Unicode: 16+ bits

ASCII Representation

- ASCII Table
  - Not just letters and numbers
  - Punctuation, control characters too

- (To memorize:)
- A: 65
- a: 97

Dec	Hx	Oct	Char	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL (null)	32	20	040		Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH (start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX (start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX (end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT (end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ (enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK (acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL (bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS (backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB (horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF (NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT (vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF (NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR (carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO (shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI (shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE (data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1 (device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2 (device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3 (device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4 (device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK (negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN (synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB (end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN (cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM (end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB (substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC (escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS (file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174			|
29	1D	035	GS (group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS (record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US (unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

Source: www.LookupTables.com

Question Time!

Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
64	40	100	@	@	96	60	140	`	`
65	41	101	A	A	97	61	141	a	a
66	42	102	B	B	98	62	142	b	b
67	43	103	C	C	99	63	143	c	c
68	44	104	D	D	100	64	144	d	d
69	45	105	E	E	101	65	145	e	e
70	46	106	F	F	102	66	146	f	f
71	47	107	G	G	103	67	147	g	g
72	48	110	H	H	104	68	150	h	h
73	49	111	I	I	105	69	151	i	i
74	4A	112	J	J	106	6A	152	j	j
75	4B	113	K	K	107	6B	153	k	k
76	4C	114	L	L	108	6C	154	l	l
77	4D	115	M	M	109	6D	155	m	m
78	4E	116	N	N	110	6E	156	n	n
79	4F	117	O	O	111	6F	157	o	o
80	50	120	P	P	112	70	160	p	p
81	51	121	Q	Q	113	71	161	q	q
82	52	122	R	R	114	72	162	r	r
83	53	123	S	S	115	73	163	s	s
84	54	124	T	T	116	74	164	t	t
85	55	125	U	U	117	75	165	u	u
86	56	126	V	V	118	76	166	v	v
87	57	127	W	W	119	77	167	w	w
88	58	130	X	X	120	78	170	x	x
89	59	131	Y	Y	121	79	171	y	y
90	5A	132	Z	Z	122	7A	172	z	z

You receive a top-secret message. What's it say?

- 1000111 = 71 = G
- 1001100 = 76 = L
- 0100001 = 33 = !

;)

On to Hardware…

- The “brains”: CPU
  - (Central Processing Unit)
  - Executes instructions/tasks

- Where do these instructions come from?
  - Memory!

Memory: Two Types

HDD

- Persistent ("Permanent")
  - Stays around after the power's off
- IRL Analogy:
  - Long-term memory
- Larger Space
  - ~ 300GB
- Slower Access
  - Mechanical

RAM

- Volatile
  - Needs "constant" power
- IRL Analogy:
  - Short-term memory
- Smaller Space
  - ~3GB
- Faster Access
  - Electrical

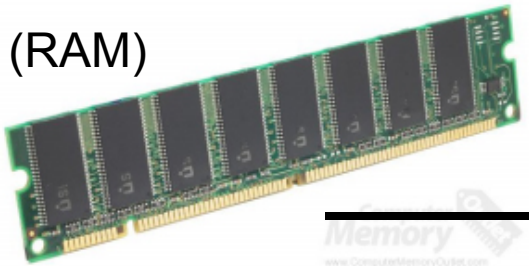
Memory Access

- (Also: L1, L2 caches)
  - Faster than RAM, usually on CPU itself
  - Optimization

(HDD)

(CPU)

(RAM)



L2 L1

(Caches)

Question Time!

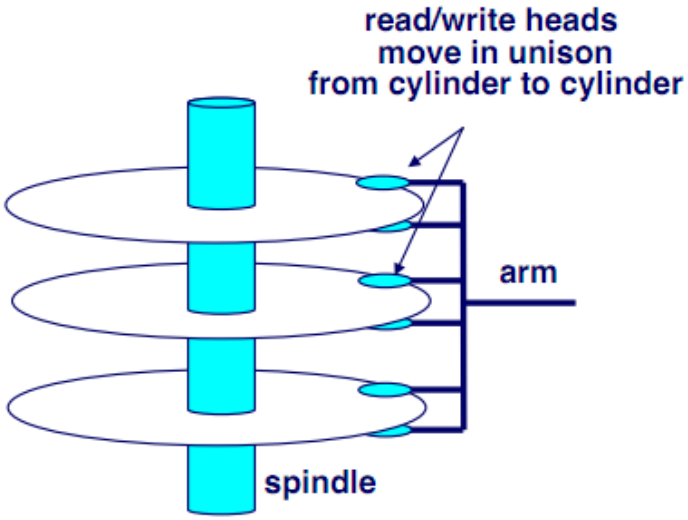
You are studying for the E-1 Exam when a vague analogy hits you:

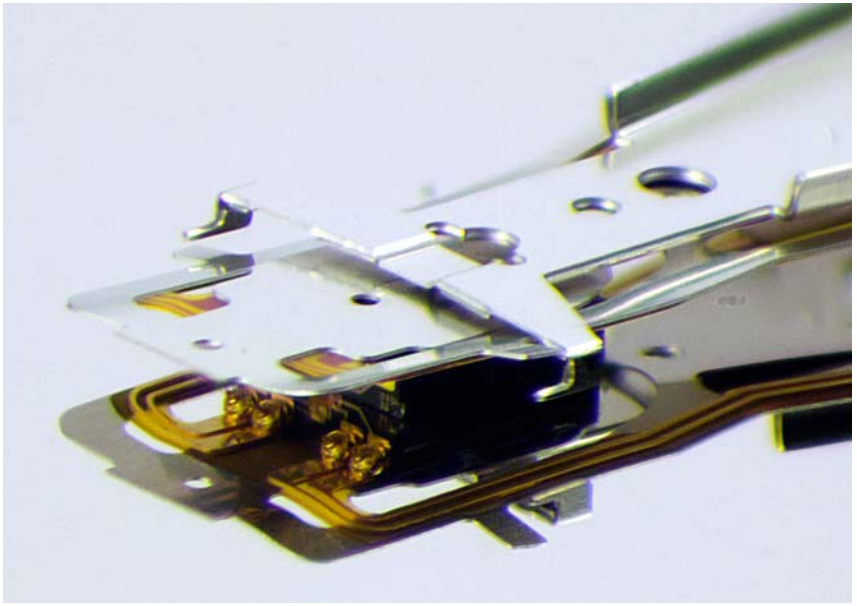
- Bookshelf (HDD) -> Large data collection
- Desk (RAM) -> Retrieved data to use
- Your Brain (CPU) -> Processes retrieved data

How could this relate to Hardware? (Does it?)

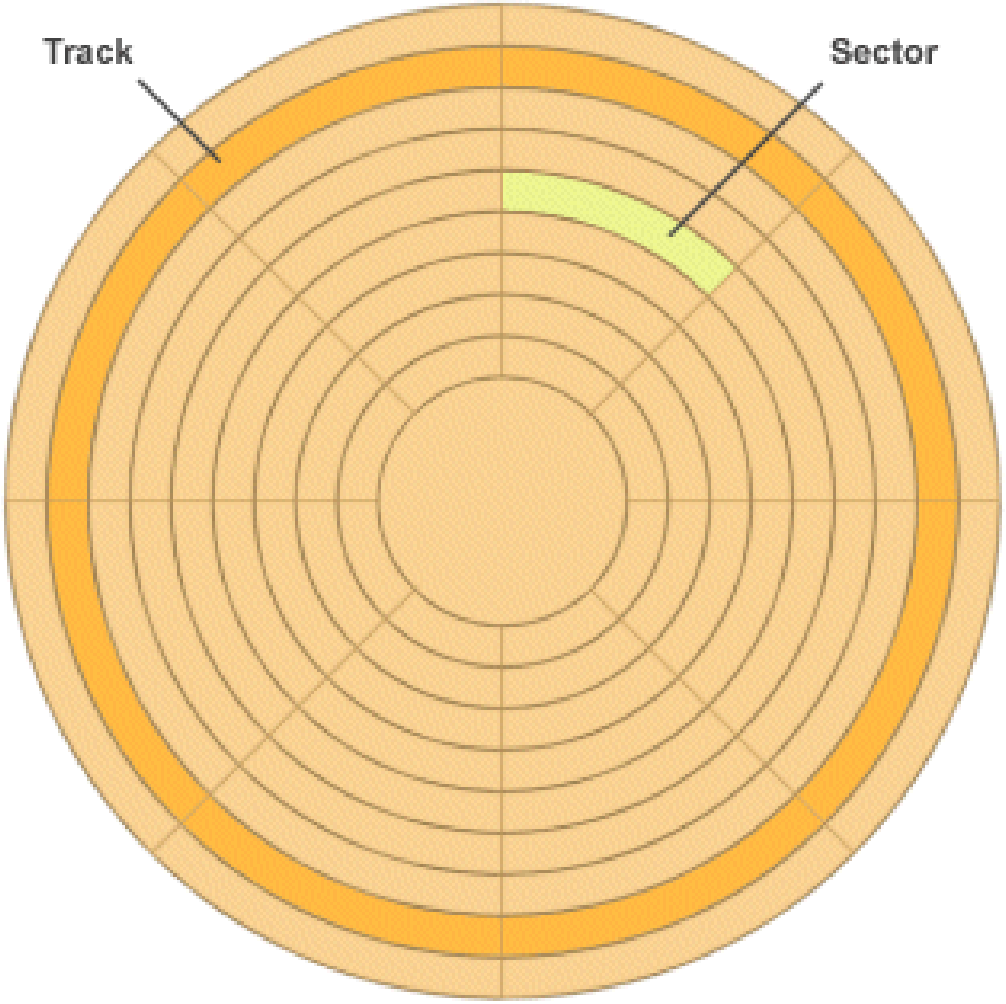
Hard Disk Access

- How do we get data from the Hard Disk, again?





- The platter:
  - Magnetic Particles
  - Spins
    - E.g. 5400RPM
  - N/S binary representation
  - Data can scattered all over
    - A file keeps track of data locations



Tie-In with Floppy Disk Drives

- Similar to HDD
  - Disk with magnetic particles
  - Read/Write head
  - No sweeping arm
  - “platter” is floppy circle of magnetic material

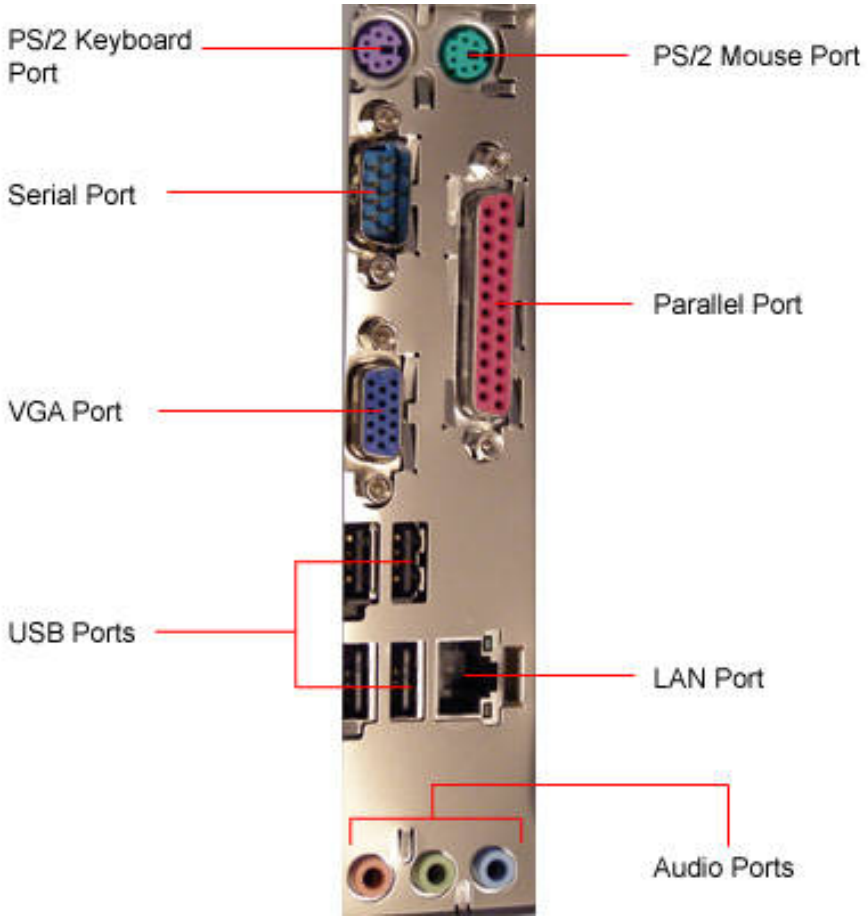
Question Time!

- A friend laments how his laptop (and most computers) doesn't have a floppy disk drive so he can't access all his floppy disk backups.

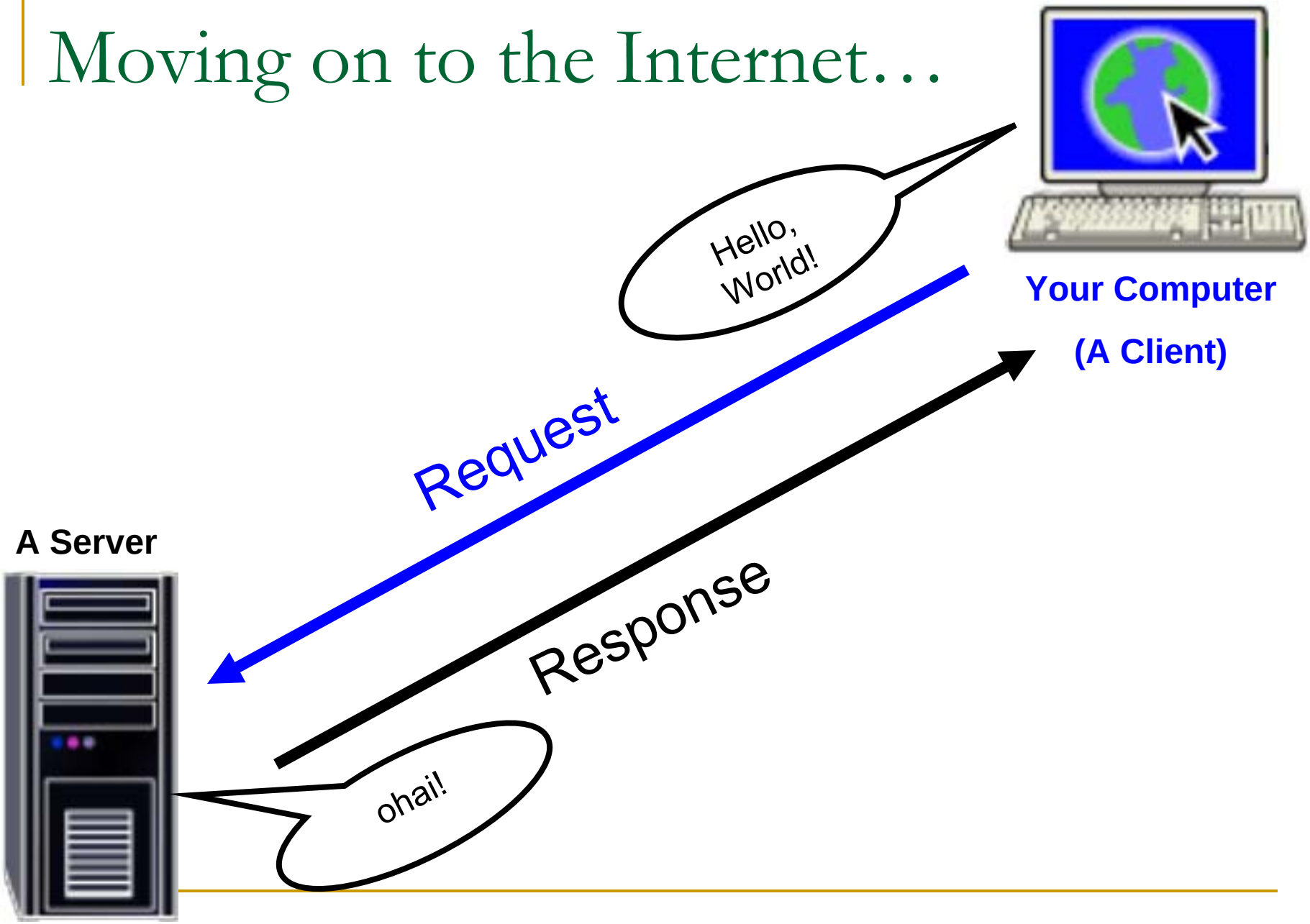
- Is all hope lost?
- What could you suggest to him?

Peripherals

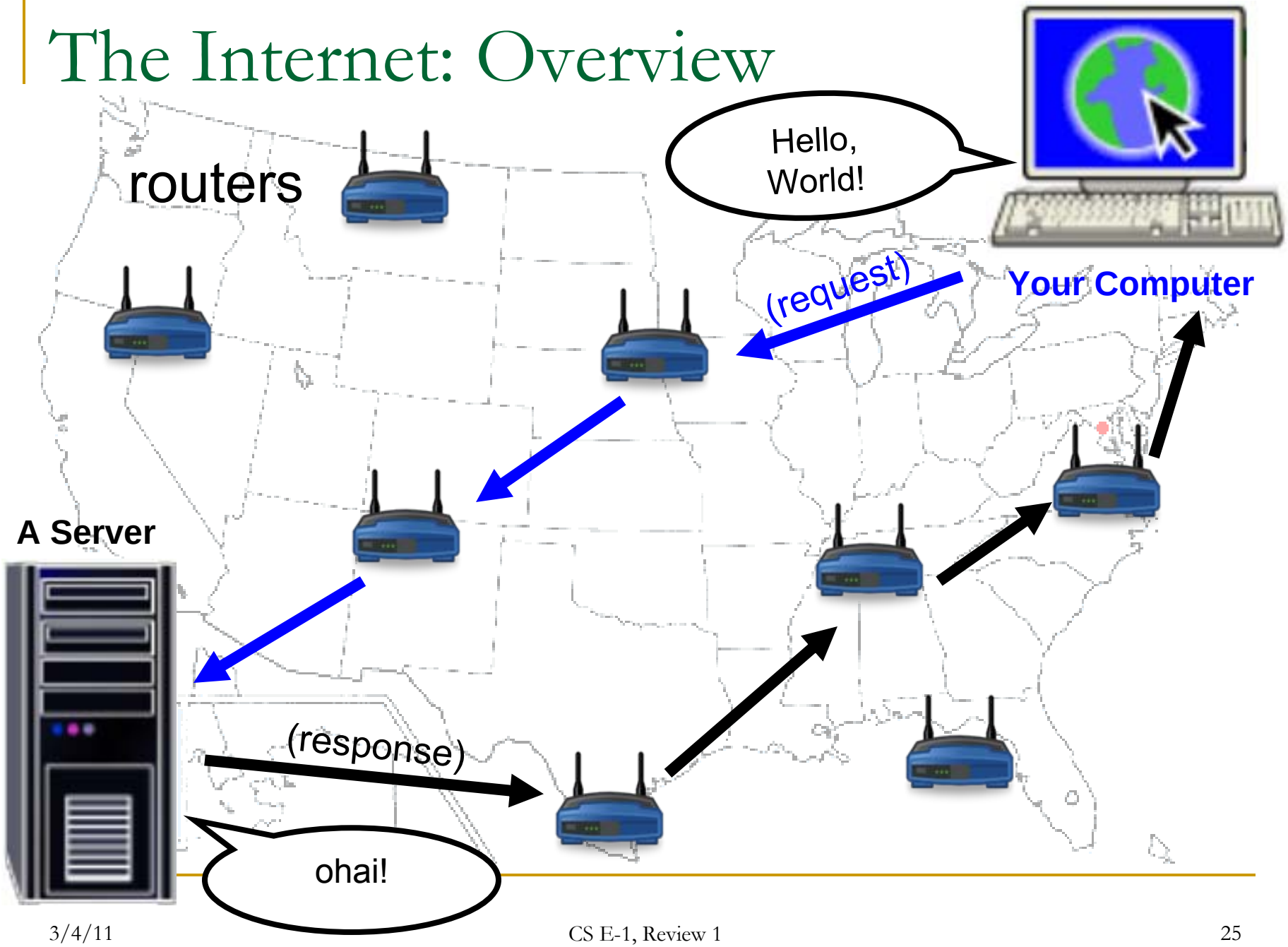
- Computers have slots and ports for add-ons
  - Internal
    - (Additional) RAM
    - (Better) Graphics Card
    - Etc.
  - External
    - Printer
    - Mouse, Keyboard
    - USB (Universal Serial Bus)
    - Etc.



Moving on to the Internet…



The Internet: Overview



Question Time!

- Your friend in Japan refers you to a download page (for an awesome program). The page lists several download "mirrors" (locations):
  - Scratch v.1.2 (Japan)
  - Scratch v.1.2 (Germany)
  - Scratch v.1.2 (U.S.)
- She says the Japan link connects really fast and recommends it.
- Which would you click and why? (Does it matter?)

Latency v. Download Speed

- Latency
  - Delay between when data is requested and received
  - Usually measured in milliseconds [ms]
- Download Speed
  - How fast data transfers
  - Usually measured in megabits per second [Mb/s]
- Analogy: turning on a garden hose
  - Latency: time for water to come out of nozzle
  - Download Speed: how fast water flows out

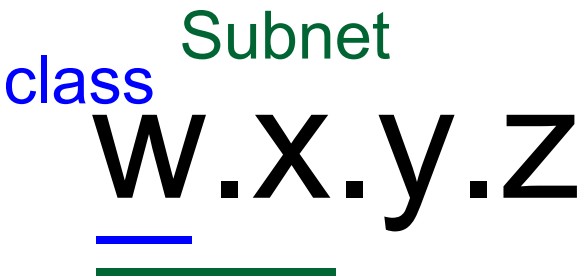
IP Addresses

- How does data know where to go?
  - Internet Protocol (IP) Addresses!

IPv4:

- Form: w.x.y.z
- Each letter/octet a number from 0-255
  - How many possible IP addresses, again?
- Ex: $4*8 = 32$; $2^{32} \approx 4.2$ billion
  - 140.247.149.203

IP Addresses



- Class
  - “chunks” for different entities
- Subnet (general left side):
  - sub-networks, adjacent machines
- Rest (general right side):
  - Individual Machine Identifier

IP Addresses: Public & Private

- Each machine on the internet needs an IP Address.
  - Kind of.
- For a network, each machine can have a private IP address
  - Router mediator has one public IP address
  - So network machines all represented by “one” public IP address
- Called Network Address Translation (NAT)

NAT Visual

From:

(192.168.61.50)

(192.168.61.51)

(192.168.61.55)

(192.168.61.75)

From:

(140.247.149.203)
(140.247.149.203)
(140.247.149.203)
(140.247.149.203)

Domain Name System

- IP Addresses <=> Domain Names
  - Like a phonebook
  - Not a one-to-one relation
  - Top-level Domains (e.g. harvard.edu)
  - SubDomains (e.g. fas.harvard.edu)
- Luckily, automatic.
- DHCP (Dynamic Host Configuration Protocol)
  - Allows your machine to communicate w/Internet

Question Time!

- You get an email from a domain of:
- bank.ofamerica.com
- requesting your account number and PIN.

- Is it legitimate?

Connecting it All

DHCP

Okay, all set. =)

provides…

- IP Address to ID that machine
- DNS server list for Domain Names
- Gateway router
- Subnet mask
  - (used to determine ip addresses on same network)

Traveling Data

- Packets
  - Numbered
  - From:
  - To:
  - Etc.
- If lost, server is informed & sends another
  - Part of the TCP/IP protocol (standard rules for internet communication)

Questions?

- Email us!
- Good luck!