


Introduction

Peeking into Computer Science



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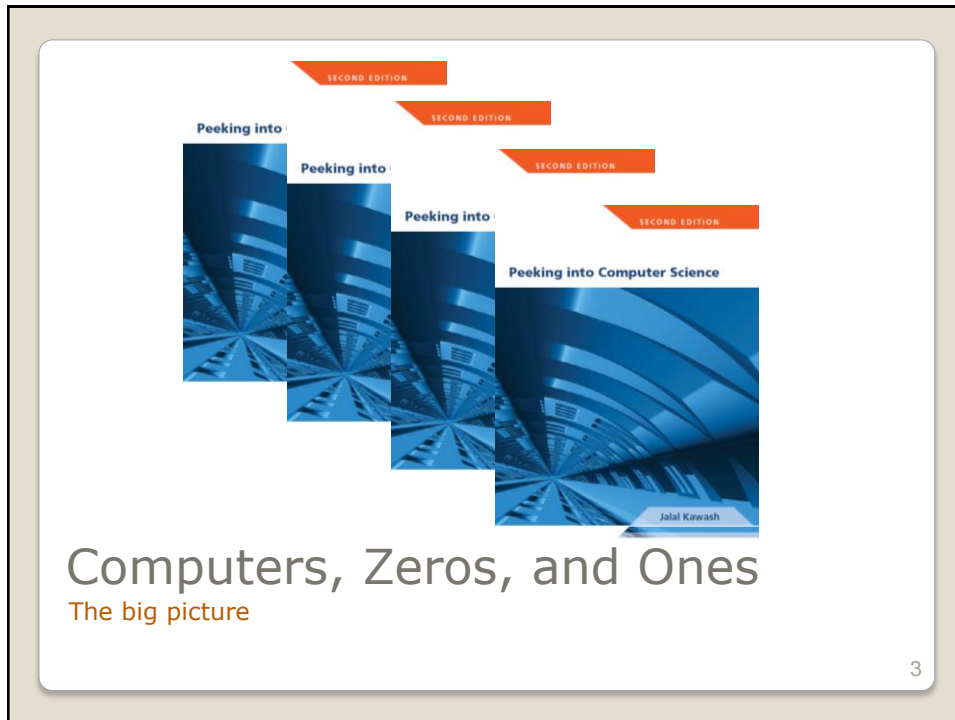
- Mandatory: Chapter 1
- Optional: None

Reading Assignment

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At the end of this section, the student will be able to:

1. Name the 5 basic components of a computer & identify their functions
2. Explain how processor speed is measured
3. Understand Dual-Core architectures
4. Describe the operation of Hard disks and optical CDs
5. Describe the memory hierarchy
6. Understand how information is represented in a computer by 0s and 1s

Objectives

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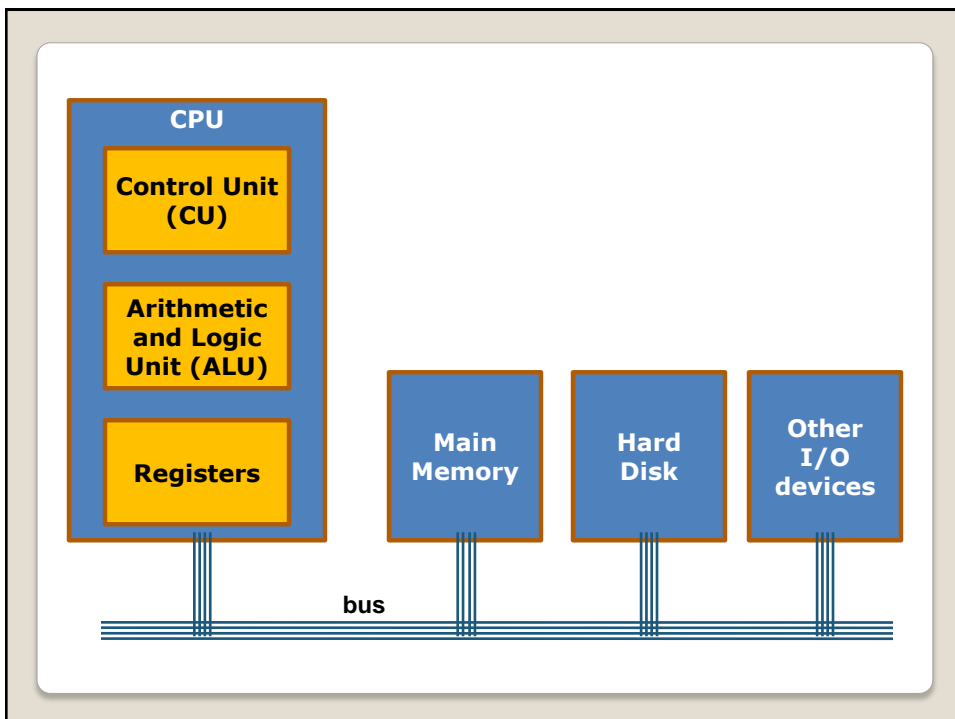
- Computers are general purpose machines
 - Music/Movies
 - Communication
 - More complex operation

Computers

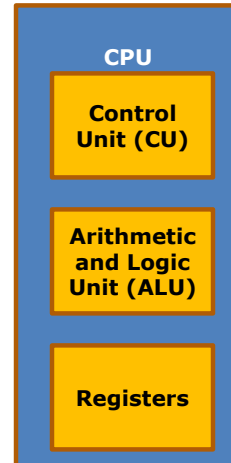
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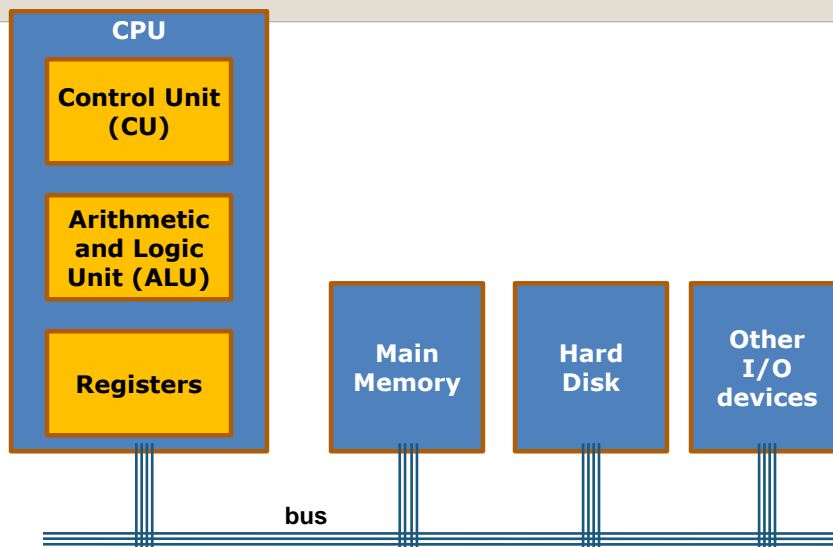
- CPU is the brain of the computer
- Also called processor
- Has two components:
 - Arithmetic and Logic Unit (ALU)
 - Simple arithmetic and logic operations
 - Control Unit
 - Controls the operations of the rest of the machine
- Has a scratch pad
 - Collection of registers
- Connected to the rest of the system components



Central Processing Unit

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The Bus

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No signal (0 bit)

Signal is absent
An unlit lamp
Represents a 0

Signal (1 bit)

Signal is present
A lit lamp
Represents a 1

Signals

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Robot's World

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1	1	1	1	1	1	1	1	1	1
1	0	0	0	1	0	1	0	0	1
1	0	0	0	1	0	1	0	0	1
1	0	0	1	1	0	1	0	0	1
1	0	0	0	1	0	1	0	0	1
1	0	0	0	1	0	0	0	0	1
1	0	0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	1	1	1

Robot's World

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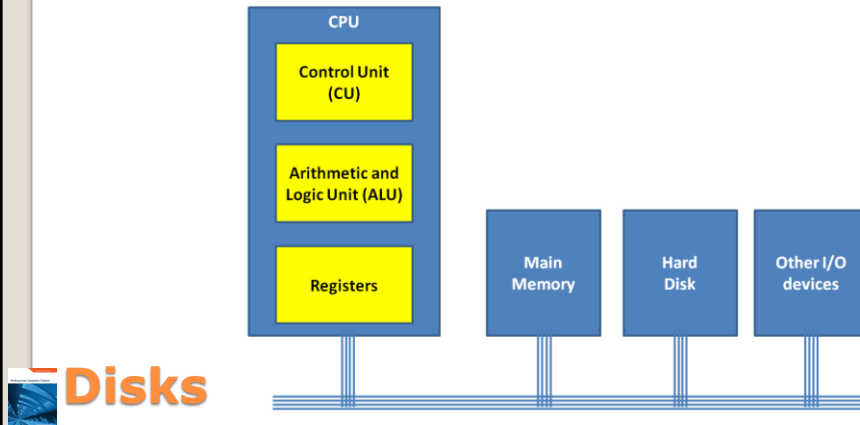
- Random Access Memory
- Holds programs and Data for CPU
- Every thing the CPU operates on (executing a program, playing a song, working on a file) must be in RAM
- Volatile: do not hold data if power is lost
- Need non-volatile storage

Main Memory

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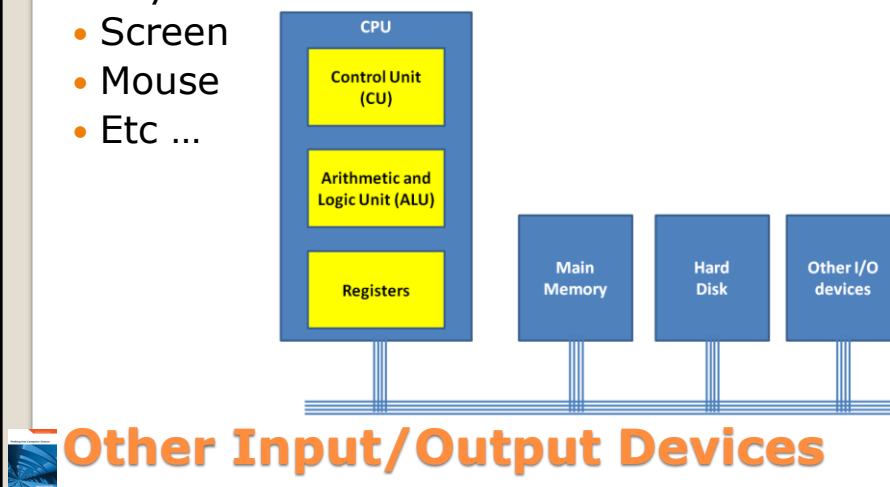
- Non-volatile Storage
- Electro-magnetic signals that stay in the absence of power



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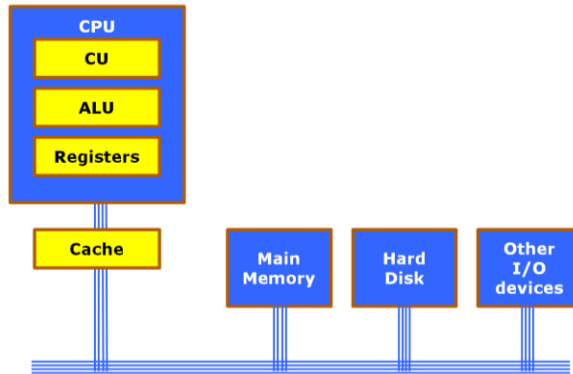
- Printer
- Keyboard
- Screen
- Mouse
- Etc ...



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- Fast Memory that sits between main memory and CPU



Cache Memory

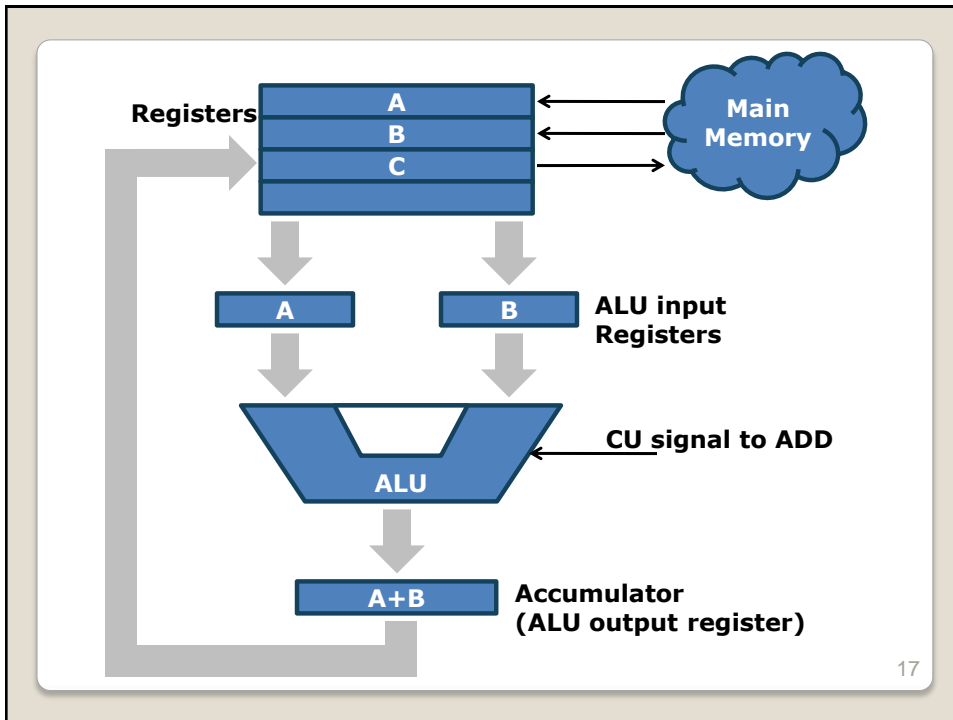
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CPU Operation

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- What does a **3.0 GHz CPU** mean?
- CPU can perform about 3 billion micro-instructions per second

 **Talking Gigahertz**

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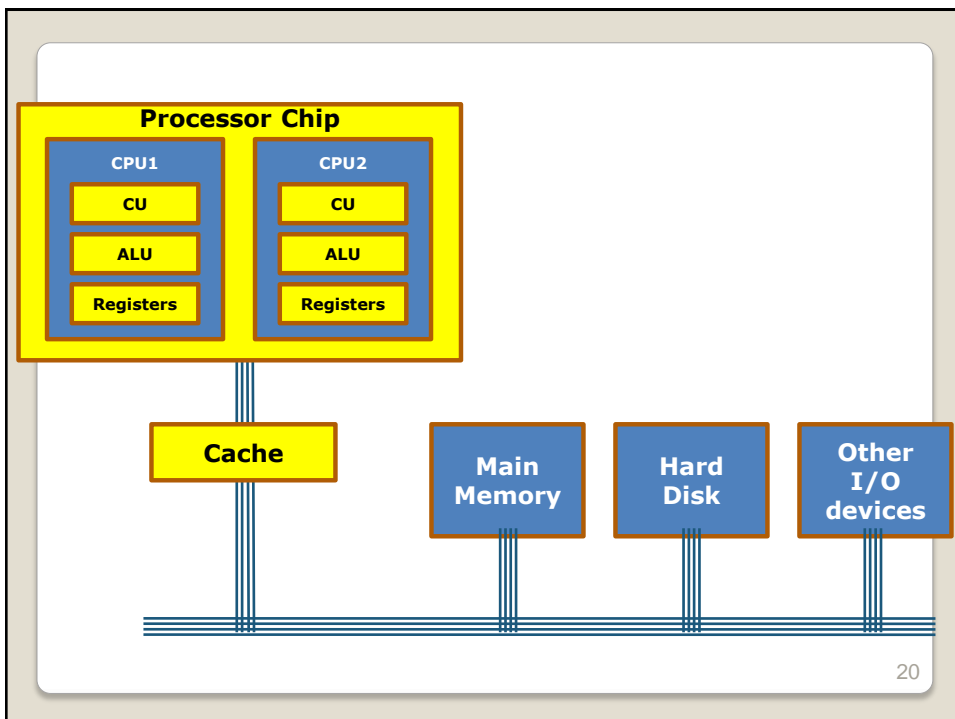
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- A Computer that contains two CPUs on the same chip

Dual Core?

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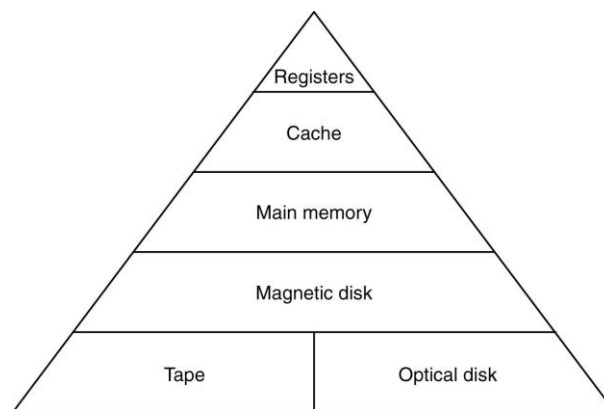
- Byte = 8 bits
- Kilobyte = 1024 bytes
- Megabyte = 1024 Kilobytes
 - 1,048,576 bytes
- Gigabyte = 1024 Megabytes
 - 1,073,741,824 bytes
- Terabyte = 1024 Gigabyte
 - 1,099,511,627,776 bytes



Storage Units

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Memory Hierarchy

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The diagram illustrates the internal structure of a magnetic hard disk. A central yellow spindle is shown with two blue platters mounted on it. A vertical blue arm is attached to the spindle, with four yellow read/write heads extending from it to the surface of the platters. A double-headed arrow above the arm indicates its radial movement. Labels include 'arm movement', 'spindle', 'platter', 'arm', and 'Read/write head'.


Magnetic (Hard) Disk

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The diagram shows a cross-section of a CD-ROM with a total thickness of 1.2 mm. From top to bottom, the layers are: a blue Disk Label, a yellow Protective Lacquer Layer, a blue Reflective Layer, a yellow Dye Layer, and a blue Plastic Layer. A small black square labeled 'pit' is shown in the dye layer. A yellow arrow points to the pit with the text 'A pit prevents a laser beam from being reflected'. Another yellow arrow points to the reflective layer with the text 'reflected laser beam'.

CD-ROMs

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Information Coding
Beyond images

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At the end of this section, the student will be able to:

1. Understand how characters are represented by 0s and 1s
2. Understand the encoding and decoding process
3. Find the minimum number of bits needed to code character information

Objectives

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- Symbols in a computer's memory are stored as 0s and 1s
- Each symbol is given a fixed-length code
- ASCII codes:
 - A is 0100 0001
 - B is 0100 0010
 - C is 0100 0011
 - D is 0100 0100
 - E is 0100 0101
 - Etc..



Fixed-Length Codes

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- The Word ACE is stored in a computer as:

01000001 01000011 01000101

A

C

E



Fixed-Length Codes

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

Source: www.LookupTables.com

More ASCII Codes

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- If the alphabet has two letters only (say 0 and 1), how many **one-letter words** can be formed?
- Only two possibilities exist
- 0
- 1
- So, two words



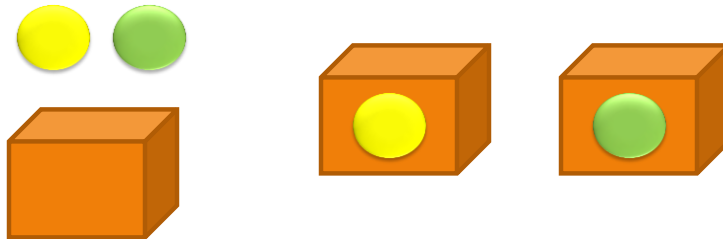
A Counting Problem

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- Think of it this way:
- We have a box that can fit one ball only
- Balls have one of two colors



- How many distinct boxes can we produce?

A Counting Problem

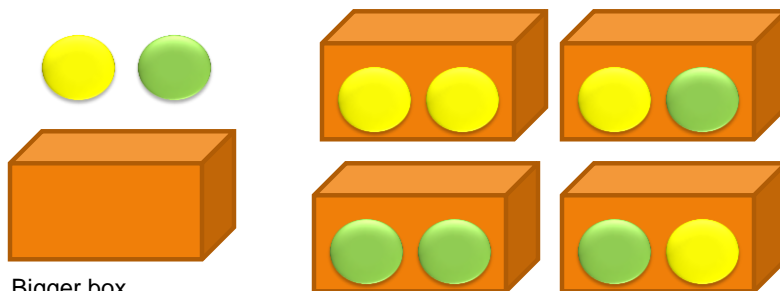


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- If the alphabet has two letters only (say 0 and 1), how many **two-letter words** can be formed?



Bigger box
Can hold 2 balls

A Counting Problem



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- If the alphabet has two letters only (say 0 and 1), how many **two-letter words** can be formed?
- 00
- 01
- 10
- 11
- So, four words



A Counting Problem

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- If the alphabet has two letters only (say 0 and 1), how many **three-letter words** can be formed?
- 000, 001, 010, 011, 100, 101, 110, 111
- So, eight words



A Counting Problem

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- If the alphabet has two letters only (say 0 and 1), how many ***n*-letter words** can be formed?

- 2^n words

A Counting Problem

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- If the alphabet has β letters, how many ***n*-letter words** can be formed?

- β^n words

A Counting Problem

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- Assume we have a file that contains data composed of 6 letters (symbols) only:
- A, I, C, D, E, and S (for space)

```
ACE DICE AIDE CAID  
EAD DAICED ...
```



Back to Coding

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- Assume we have a file that contains data composed of 6 letters (symbols) only:
- A, I, C, D, E, and S (for space)

```
ACESDICESAIDESCAID  
EADSDAICED ...
```



Back to Coding

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- If the file has 1000 characters, how many bits (0s and 1s) are needed to code the file?



Coding

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- The first question is
- How many symbols do we need to represent each character?
- The objective is to keep the size of the file as small as possible
- We have 6 characters (messages) and two alphabet symbols (0 and 1)
- 2 is not enough, since 2^2 is 4



Coding

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- 00 for A
- 01 for S
- 10 for I
- 11 for E

- We cannot represent the rest C and D

- 3 works, since 2^3 is 8, so we can represent up to 8 characters and we only have 6



2 bits are not enough

- Say
- 000 for A
- 001 for S
- 010 for I
- 011 for E
- 100 for C
- 101 for D
- 110 not used
- 111 not used



3 bits are more than enough

- If the file has 1000 characters, how many bits (0s and 1s) are needed to code the file?
- Each character needs 3 bits
- Hence, we need $3 \times 1000 = 3000$ bits



Coding

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