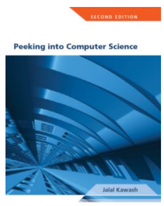
Introduction



Peeking into Computer Science

- Mandatory: Chapter 1
- Optional: None

Reading Assignment

Computers, Zeros, and Ones

The big picture

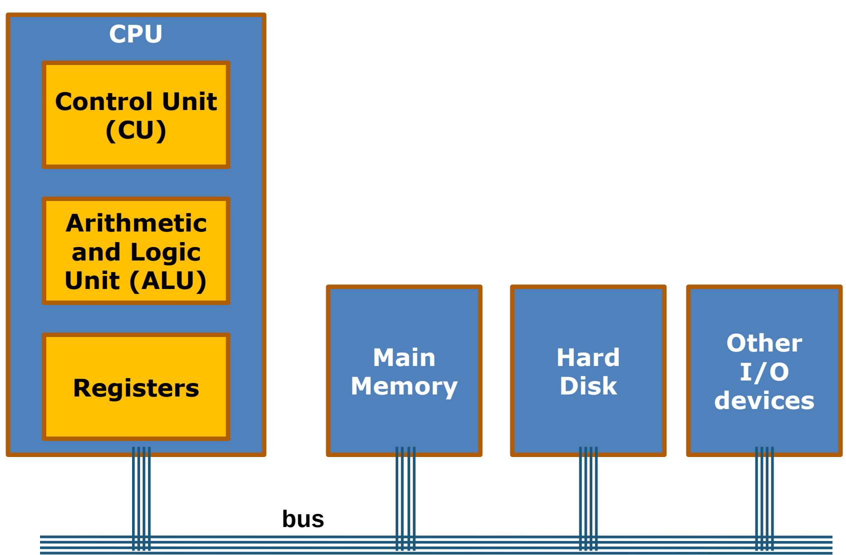
At the end of this section, the student will be able to:

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

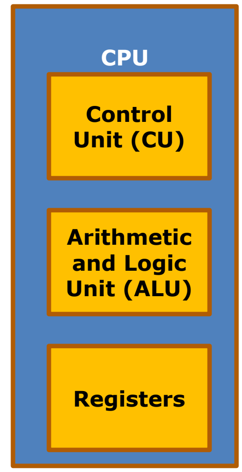
- Computers are general purpose machines
  - Music/Movies
  - Communication
  - More complex operation

Computers

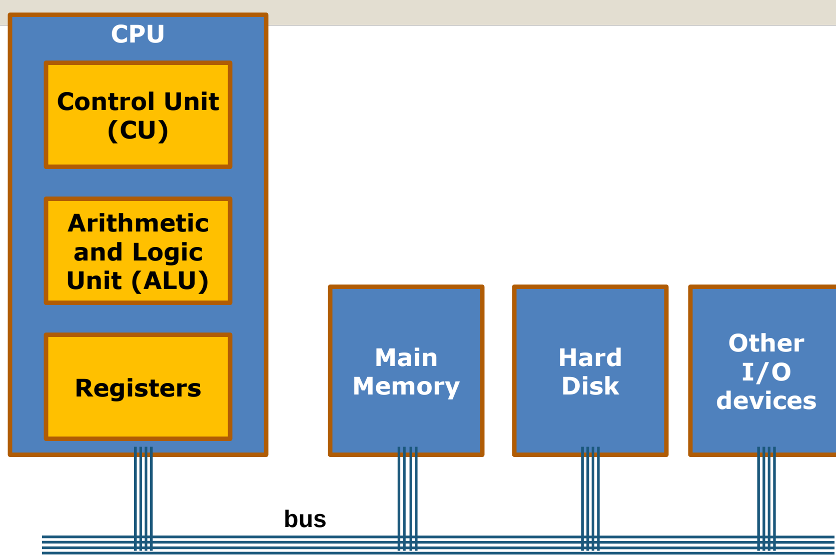


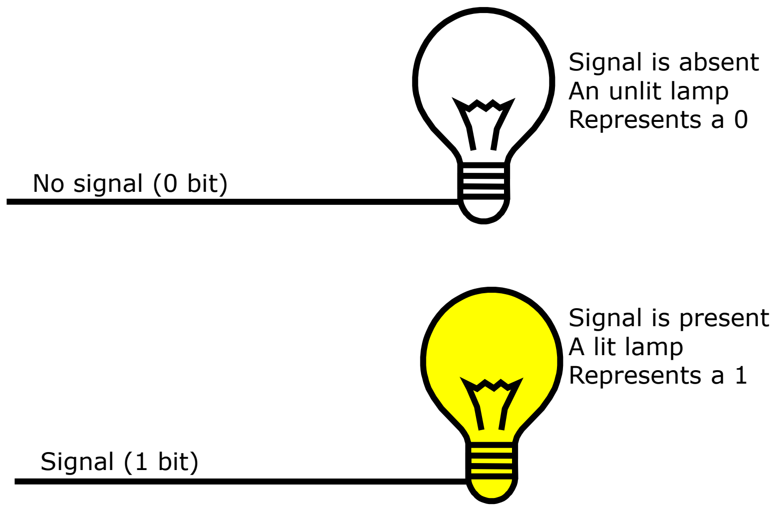
Central Processing Unit

- 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

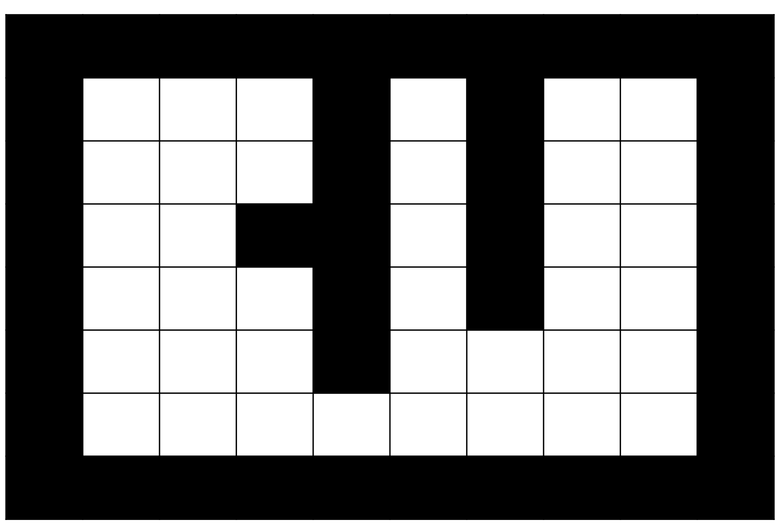


The Bus





Signals



Robot's World

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

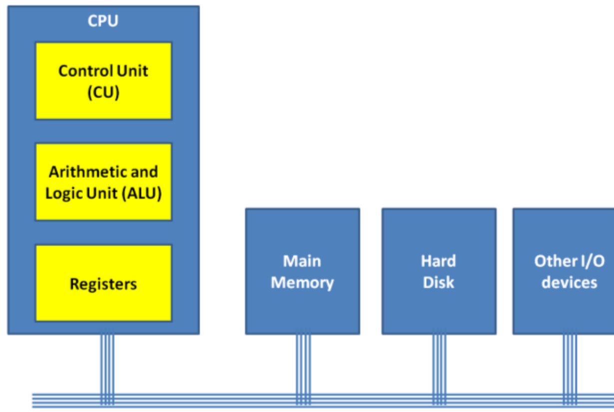
Robot's World

- 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

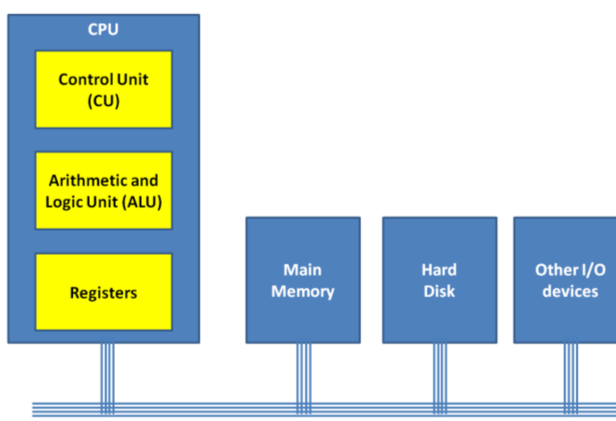
Disks

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

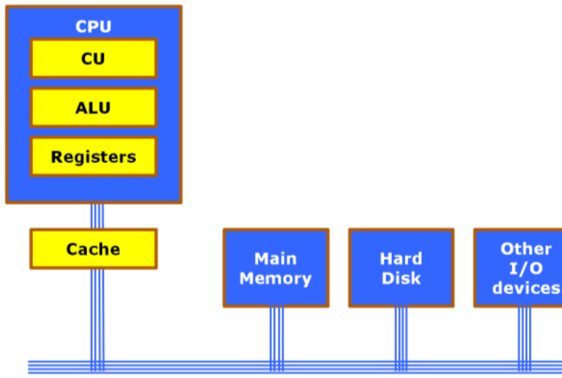


Other Input/Output Devices

- Printer
- Keyboard
- Screen
- Mouse
- Etc …



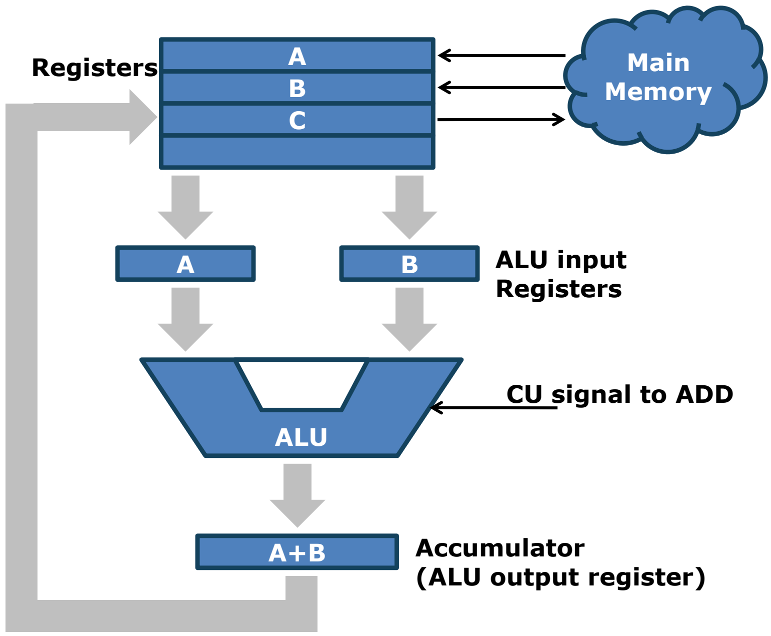
- Fast Memory that sits between main memory and CPU



Cache Memory

CPU Operation

Peeking into Computer Science
© Jalal Kawash 2010



17

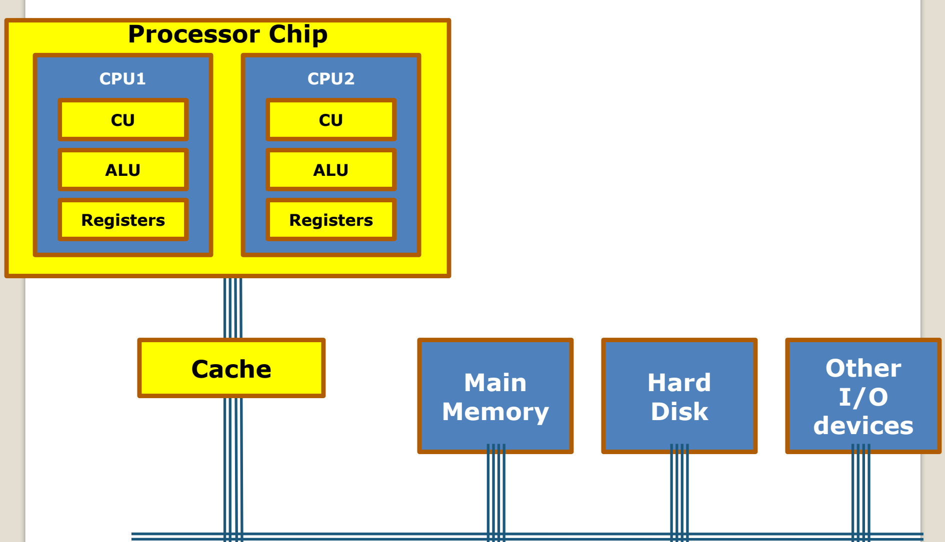
- What does a **3.0 GHz CPU** mean?
- CPU can perform about 3 billion micro-instructions per second

Talking Gigahertz

Peeking into Computer Science © Jalal Kawash 2010

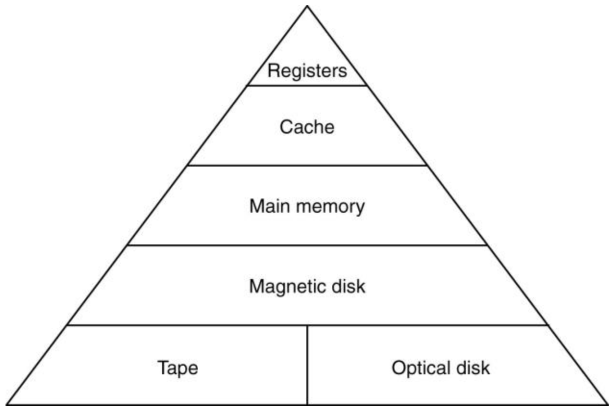
- A Computer that contains two CPUs on the same chip

Dual Core?

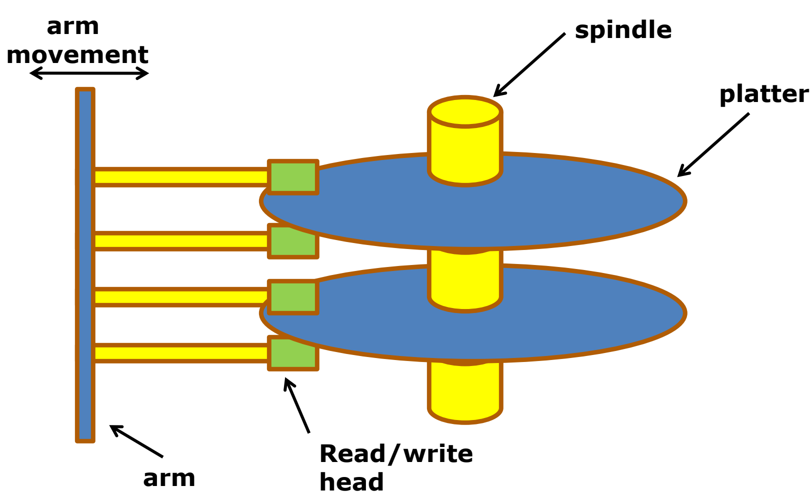


- Byte = 8 bits
- Kilobyte = 1024 bytes
- Megabyte = 1024 Kilobytes
  - 1,048,576 bytes
- Gigabyte = 1024 Megabytes
  - 1,073,741,824 bytes
- Terabyte = 1024 Gigabyte
  - 1,099,511,627,776 bytes

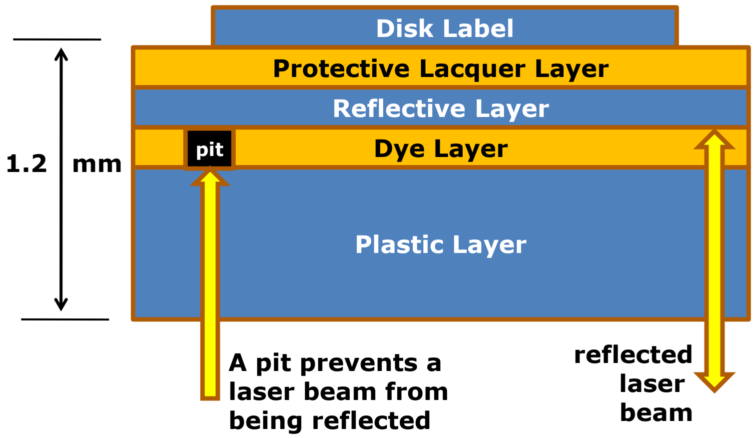
Storage Units



Memory Hierarchy



Magnetic (Hard) Disk



CD-ROMs

Peeking into Computer Science © Jalal Kawash 2010

Information Coding

Beyond images

26

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

- 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

Fixed-Length Codes

- The Word ACE is stored in a computer as:

01000001	01000011	01000101
A	C	E

More ASCII Codes

Dec	Hx	Oct	Char	Description	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

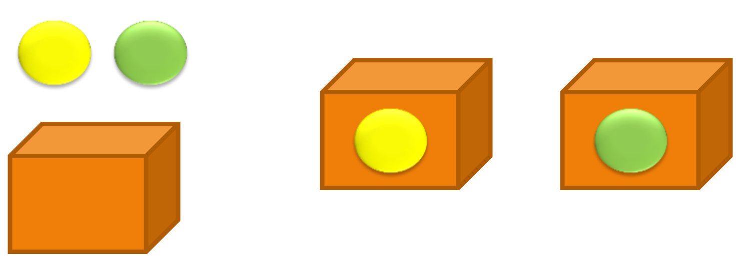
Source: www.LookupTables.com

A Counting Problem

- 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

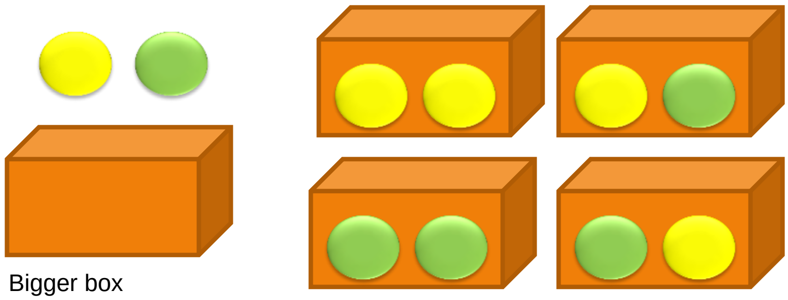
A Counting Problem

- 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?

- 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

- 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

- 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

- 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

A Counting Problem

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

Back to Coding

- 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

- 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 …

Coding

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

- 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

- 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 3x1000 = 3000 bits

Coding