Lecture 0 - Binary World of Computers

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Decimal

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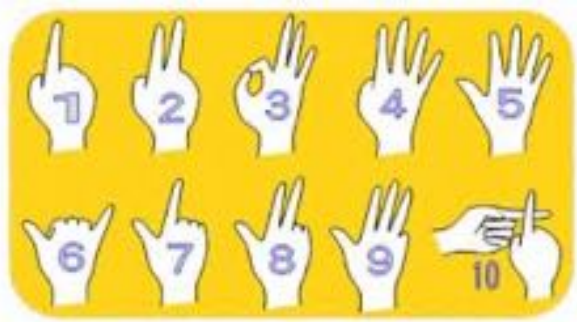
Binary
11111100110

Octal
3746

Hexadecimal
7E6

How high can you count on one hand?

1. 10 (0 ~ 9 or 1 ~ 10)
2. 12
3. 24
4. 32
5. More than 32



How to count to 12 on one hand?

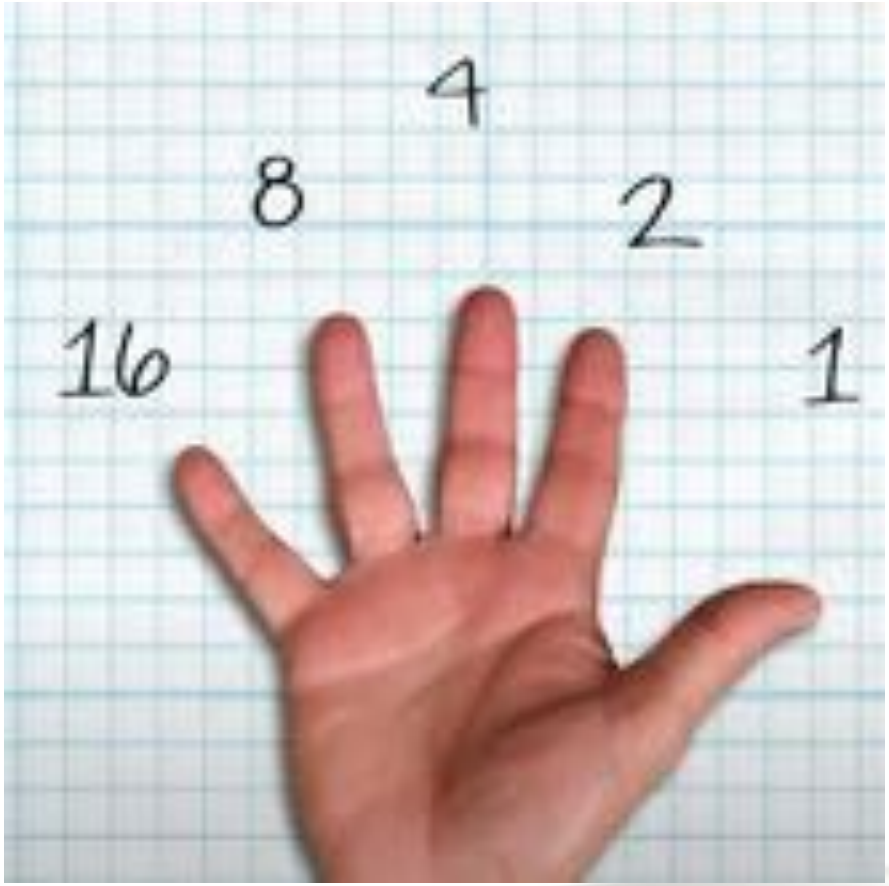
- Each finger is divided into three sections.
- Use the thumb as a pointer to point to the 12 numbers.
- You can use two hands to count to 144 numbers.

How to count to 24 on one hand?

- Each finger is divided into three sections and three creases.
- Use the thumb as a pointer to point to the 24 numbers.
- You can use two hands to count to 576 numbers.

How to count to 32 on one hand?

- We can use the binary representation (up or down) as well as the positional notation.
- Each finger indicates a power of two based on its position.
- You can use two hands to count to 1024 numbers.

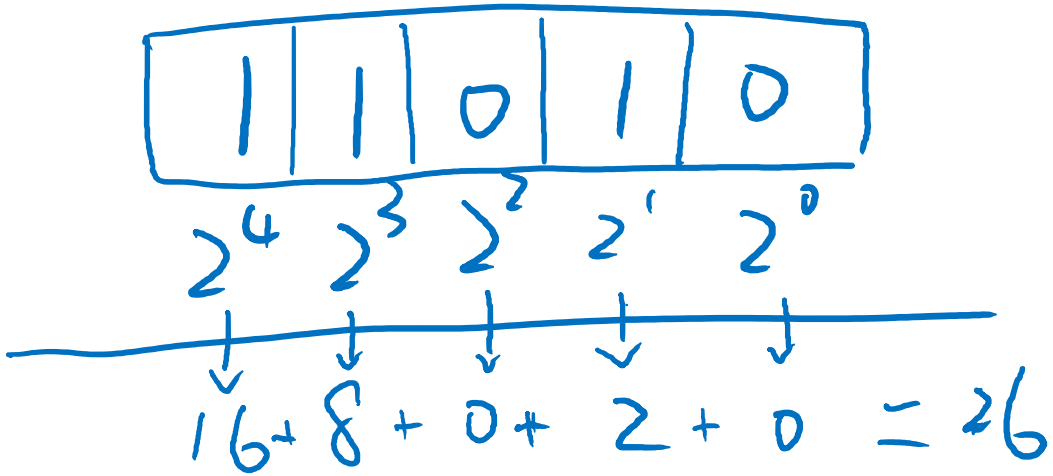


What numbers are they indicating?

How to convert from binary to decimal?

$11010_2 = 26_{10}$

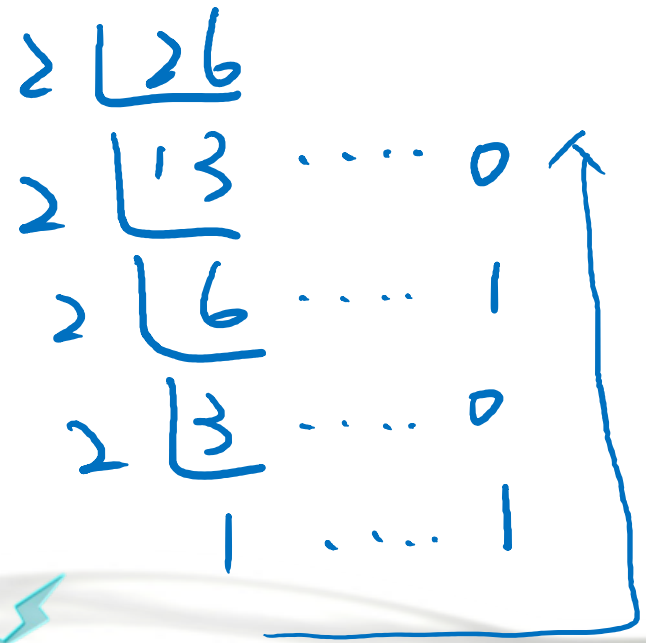
Use the positional notation



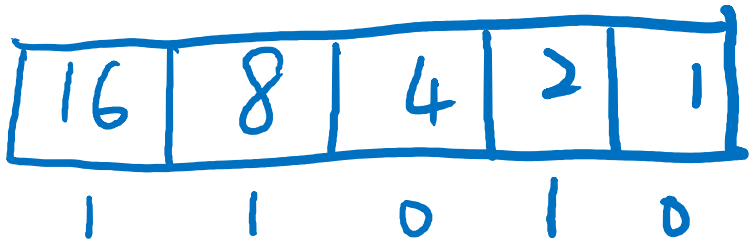
How to convert from decimal to binary?

$26_{10} = 11010_2$

1. Performing Short Division by Two with Remainder



2. Descending Powers of Two and Subtraction



26 - 16 = 10

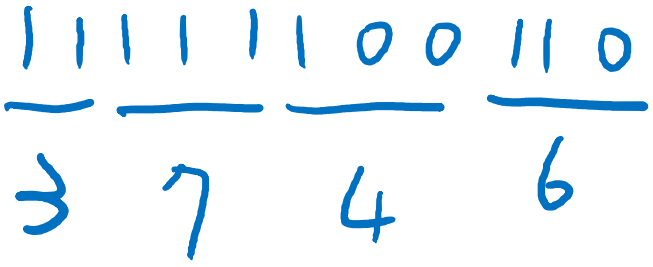
10 - 8 = 2

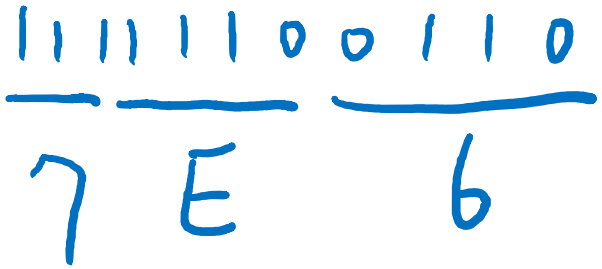
2 - 2 = 0

How to convert from binary to octal and hexadecimal?

$11111100110_2 = 3746_8 = 7E6_{16}$

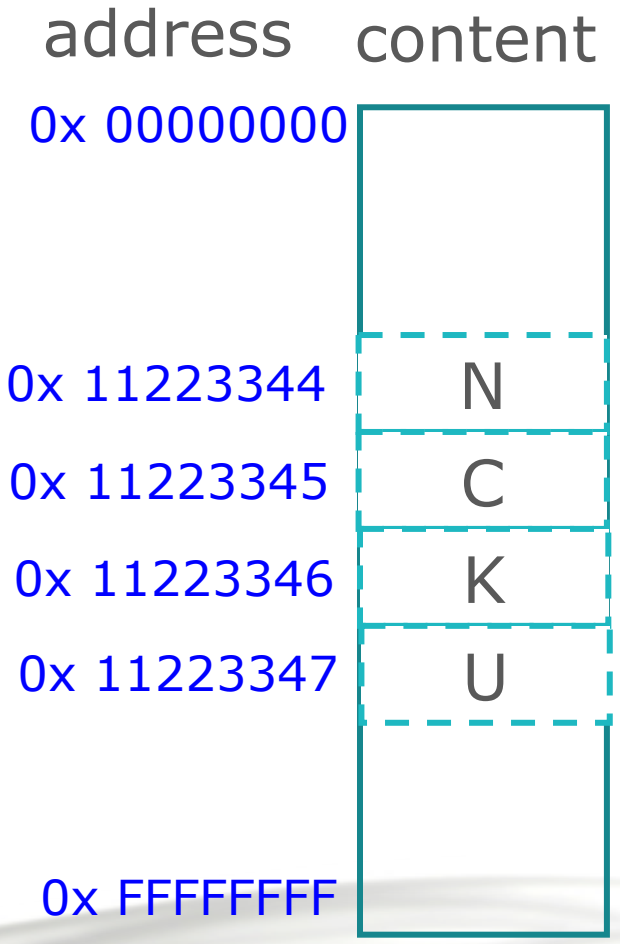
- Group each three (for octal) or four (for hexadecimal) bits from right to left.
- Each group consists of one digit.





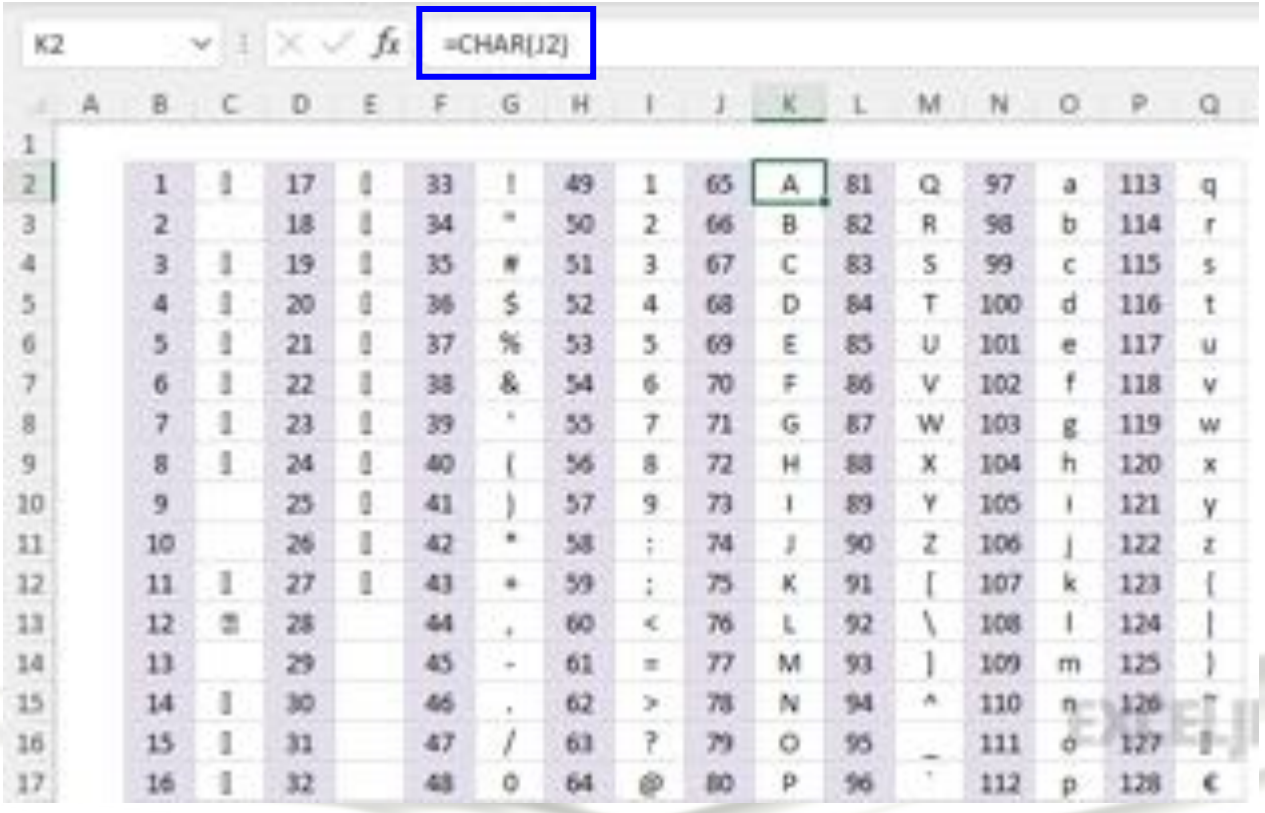
How is the data stored in the computer?

- A BIT (Binary Digit) is the most basic unit of information.
- A BYTE (Binary Term; deliberate respelling of “bite”) most commonly consists of eight bits to encode a single character.
  e.g. A is encoded as 01000001 (or decimal 65), and B is encoded as 01000010 (or decimal 66).
- In many computer architectures, byte is the smallest addressable unit of memory.



How is the data stored in the computer?

- ASCII (American Standard Code for Information Interchange) is the most common character encoding format for text data in computers.

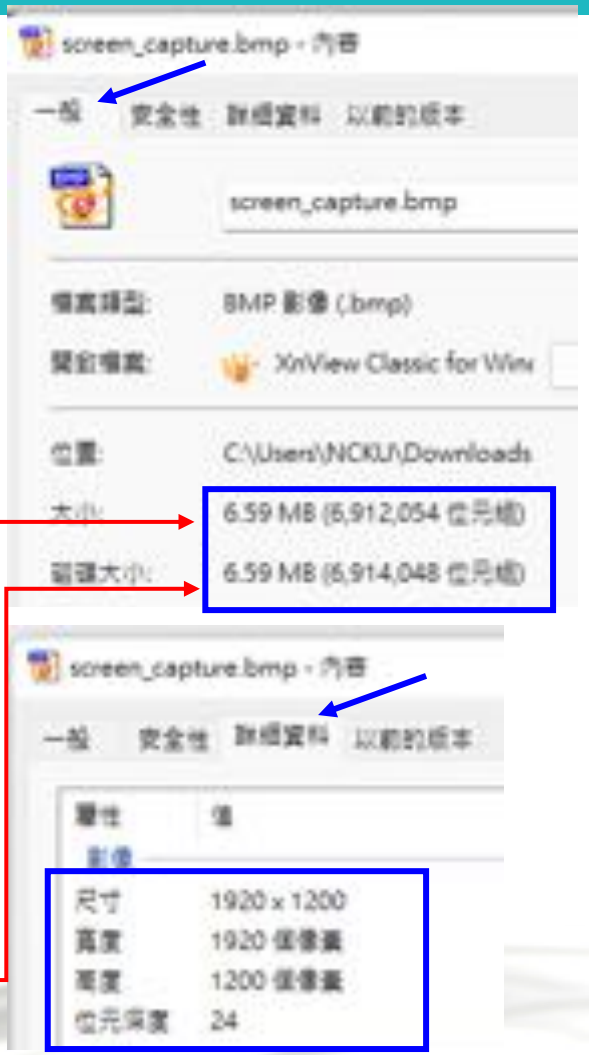


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2		1		17		33	!	49	1	65	A	81	Q	97	a	113	q
3		2		18		34	"	50	2	66	B	82	R	98	b	114	r
4		3		19		35	#	51	3	67	C	83	S	99	c	115	s
5		4		20		36	$	52	4	68	D	84	T	100	d	116	t
6		5		21		37	%	53	5	69	E	85	U	101	e	117	u
7		6		22		38	&	54	6	70	F	86	V	102	f	118	v
8		7		23		39	'	55	7	71	G	87	W	103	g	119	w
9		8		24		40	(	56	8	72	H	88	X	104	h	120	x
10		9		25		41	)	57	9	73	I	89	Y	105	i	121	y
11		10		26		42	*	58	:	74	J	90	Z	106	j	122	z
12		11		27		43	+	59	;	75	K	91	[	107	k	123	{
13		12		28		44	,	60	<	76	L	92	\	108	l	124	|
14		13		29		45	-	61	=	77	M	93	]	109	m	125	}
15		14		30		46	.	62	>	78	N	94	^	110	n	126	~
16		15		31		47	/	63	?	79	O	95	_	111	o	127	
17		16		32		48	0	64	@	80	P	96	`	112	p	128	€

How is a bitmap image stored in computers?

- Color depth is the number of bits per pixel (usually 24).
- If we capture a 1920x1200 screen and save as a bitmap file (.bmp), the required storage should be 1920 x 1200 x 3 = 6,912,000 bytes.

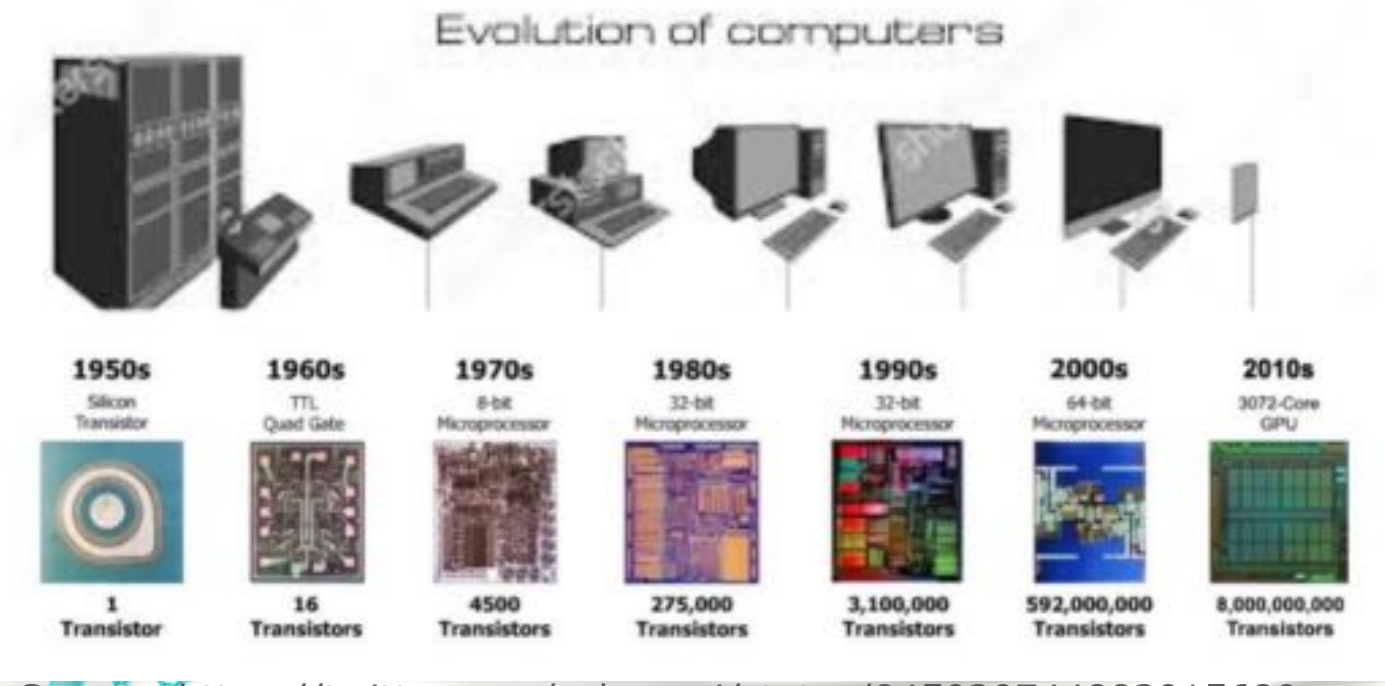
1920 x 1200 screen capture

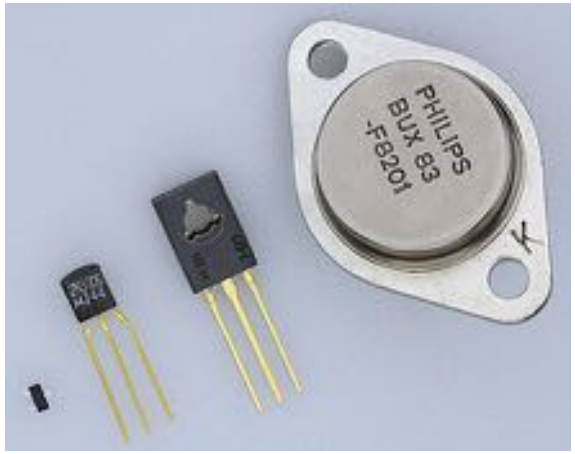


- Since a .bmp file requires a 54-byte header, the file size should be 6,912,054 bytes.
- Disk space is allocated in blocks (usually 4096 bytes), so the actual required disk storage space is 6,914,048 bytes.

Why computer world is binary?

- Modern computers are powered by "transistors," a type of electronic switch in digital circuits, that can be either "on" or "off".
- However, it may not be binary in a quantum computer.





Source: https://twitter.com/sehnaoui/status/845020744883015680

References

- How high can you count on your fingers? (YouTube video) https://www.youtube.com/watch?v=UixU1oRW64Q
- BMP file format https://en.wikipedia.org/wiki/BMP_file_format
- 電晶體是如何運作的 - Gokul J. Krishnan https://www.youtube.com/watch?v=WhNyURBiJcU