

LIS-3353

Computers:
From numbers
to thinking

Simplest computer I can think of...





If the British went out by Water, we would shew
two Lanthorns in the North Church Steeple; and if
by Land, one, as a Signal.

(Paul Revere)

izquotes.com

BINARY system. TWO possible choices

Binary System

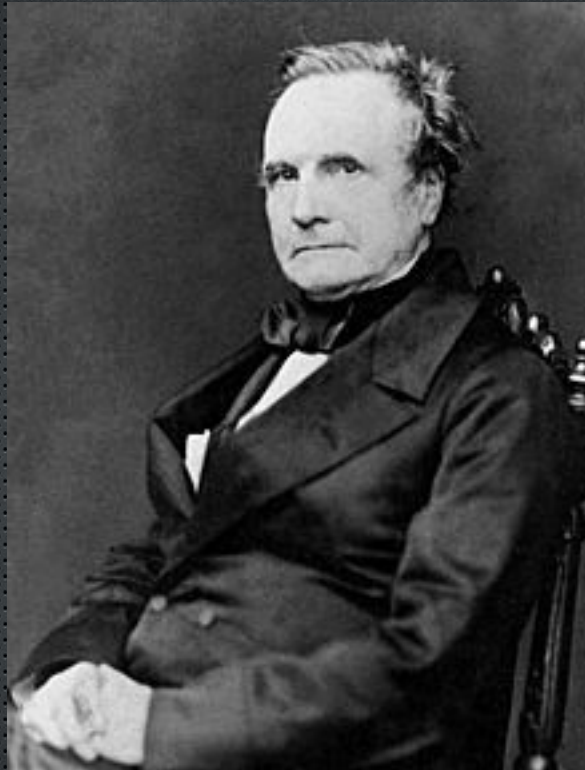
0 and 1

HUGE CONCEPT #1

All computers do is “numbers”

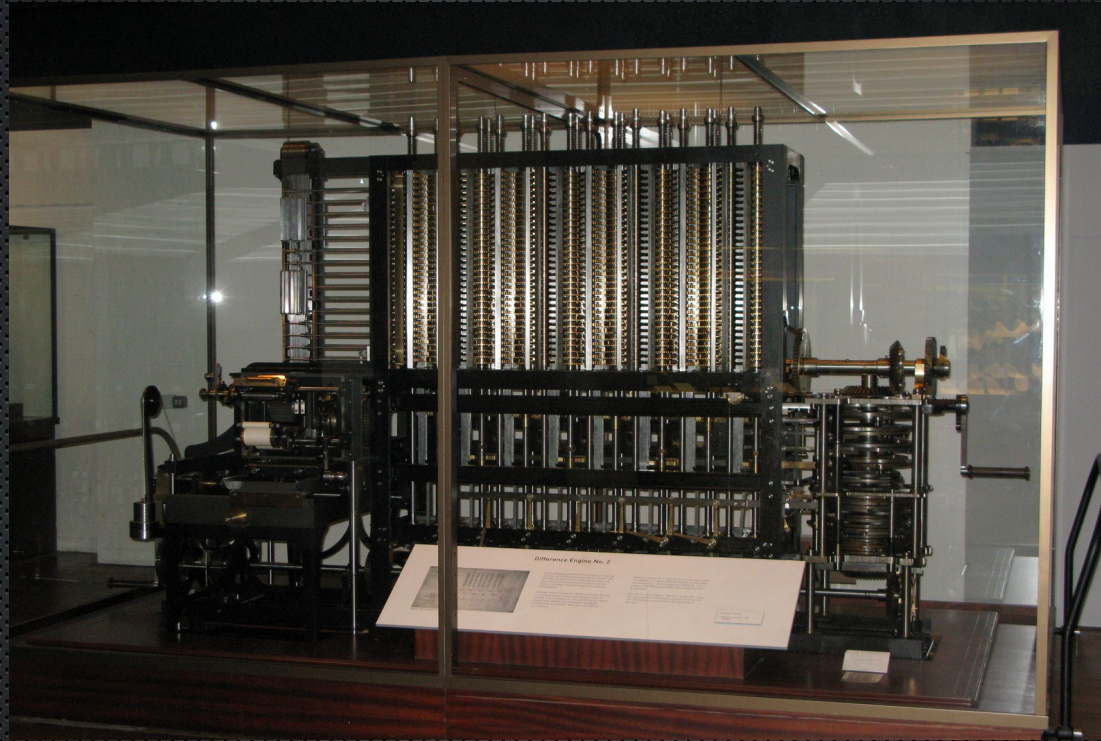
- you put numbers into them
- it messes with the numbers
- it gives you some numbers back

Charles Babbage



“The whole of arithmetic now appeared within the grasp of mechanism.”

The Difference Engine



..which is this



How many light switches..

..would it take to store “what season is it?”

A minimum of 2:

Winter	OFF-OFF	00
Fall	OFF-ON	01
Spring	ON-OFF	10
Summer	ON-ON	11

HUGE CONCEPT #1

All computers do is “numbers”

- you put numbers into them
- it messes with the numbers
- it gives you some numbers back

(but, you can store **anything** in numbers)

The first “program?”

Diagram for the comparison by the Engineer of the Numbers of Thresholds. See Note G1, (page 64 of eng)

Number of Operations	Number of Variables	Variable used	Variable receiving result	Reduction of storage in the variable after each Variable	Estimation of Result	Working Variables										Result Variables			
						$\frac{a}{b}$	$\frac{a}{c}$	$\frac{a}{d}$	$\frac{a}{e}$	$\frac{a}{f}$	$\frac{a}{g}$	$\frac{a}{h}$	$\frac{a}{i}$	$\frac{a}{j}$	$\frac{a}{k}$	$\frac{a}{l}$	$\frac{a}{m}$	$\frac{a}{n}$	$\frac{a}{o}$
1	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	1	a	$a \leftarrow \frac{a}{b} \cdot \frac{a}{c} \cdot \frac{a}{d} \cdot \frac{a}{e}$	$\frac{a}{b}$	$a \leftarrow \frac{a}{b}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Blank before a sign of operation means to omit them.

Ada Lovelace



From “Difference Engine” to “Analytical Engine”...which...

'might act upon other things besides number... the Engine might compose elaborate and scientific pieces of music of any degree of complexity or extent.'

A minimum of 2:

Winter	OFF-OFF	00
Fall	OFF-ON	01
Spring	ON-OFF	10
Summer	ON-ON	11

What about “words?”

Let's say, we want to say, “Hi.”

ASCII (technically not what we use today, but hey...)

ASCII Code: Character to Binary

0	0011 0000	O	0100 1111	m	0110 1101
1	0011 0001	P	0101 0000	n	0110 1110
2	0011 0010	Q	0101 0001	o	0110 1111
3	0011 0011	R	0101 0010	p	0111 0000
4	0011 0100	S	0101 0011	q	0111 0001
5	0011 0101	T	0101 0100	r	0111 0010
6	0011 0110	U	0101 0101	s	0111 0011
7	0011 0111	V	0101 0110	t	0111 0100
8	0011 1000	W	0101 0111	u	0111 0101
9	0011 1001	X	0101 1000	v	0111 0110
A	0100 0001	Y	0101 1001	w	0111 0111
B	0100 0010	Z	0101 1010	x	0111 1000
C	0100 0011	a	0110 0001	y	0111 1001
D	0100 0100	b	0110 0010	z	0111 1010
E	0100 0101	c	0110 0011	.	0010 1110
F	0100 0110	d	0110 0100	,	0010 0111
G	0100 0111	e	0110 0101	:	0011 1010
H	0100 1000	f	0110 0110	;	0011 1011
I	0100 1001	g	0110 0111	?	0011 1111
J	0100 1010	h	0110 1000	!	0010 0001
K	0100 1011	I	0110 1001	'	0010 1100
L	0100 1100	j	0110 1010	"	0010 0010
M	0100 1101	k	0110 1011	(0010 1000
N	0100 1110	l	0110 1100)	0010 1001
				space	0010 0000

What about “words?”

Let's say, we want to say, “Hi.”

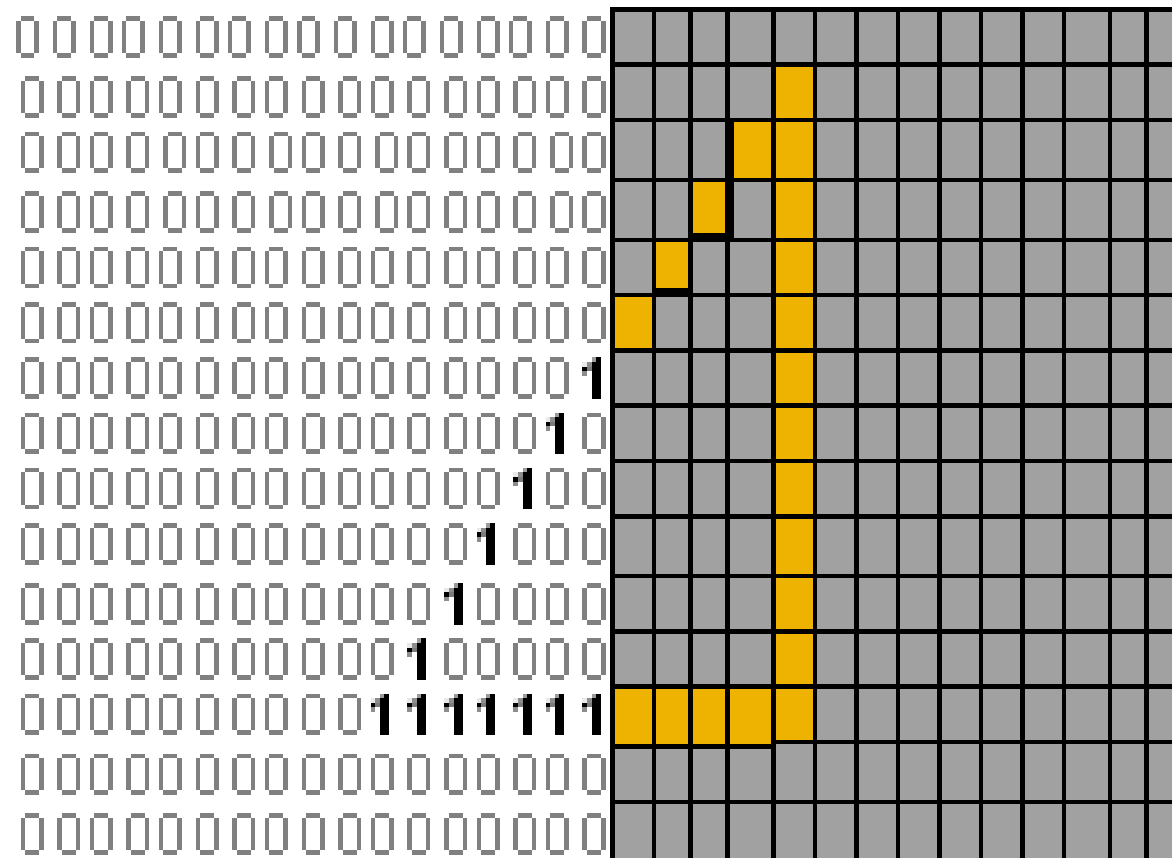
H - 01001000

i - 01101001

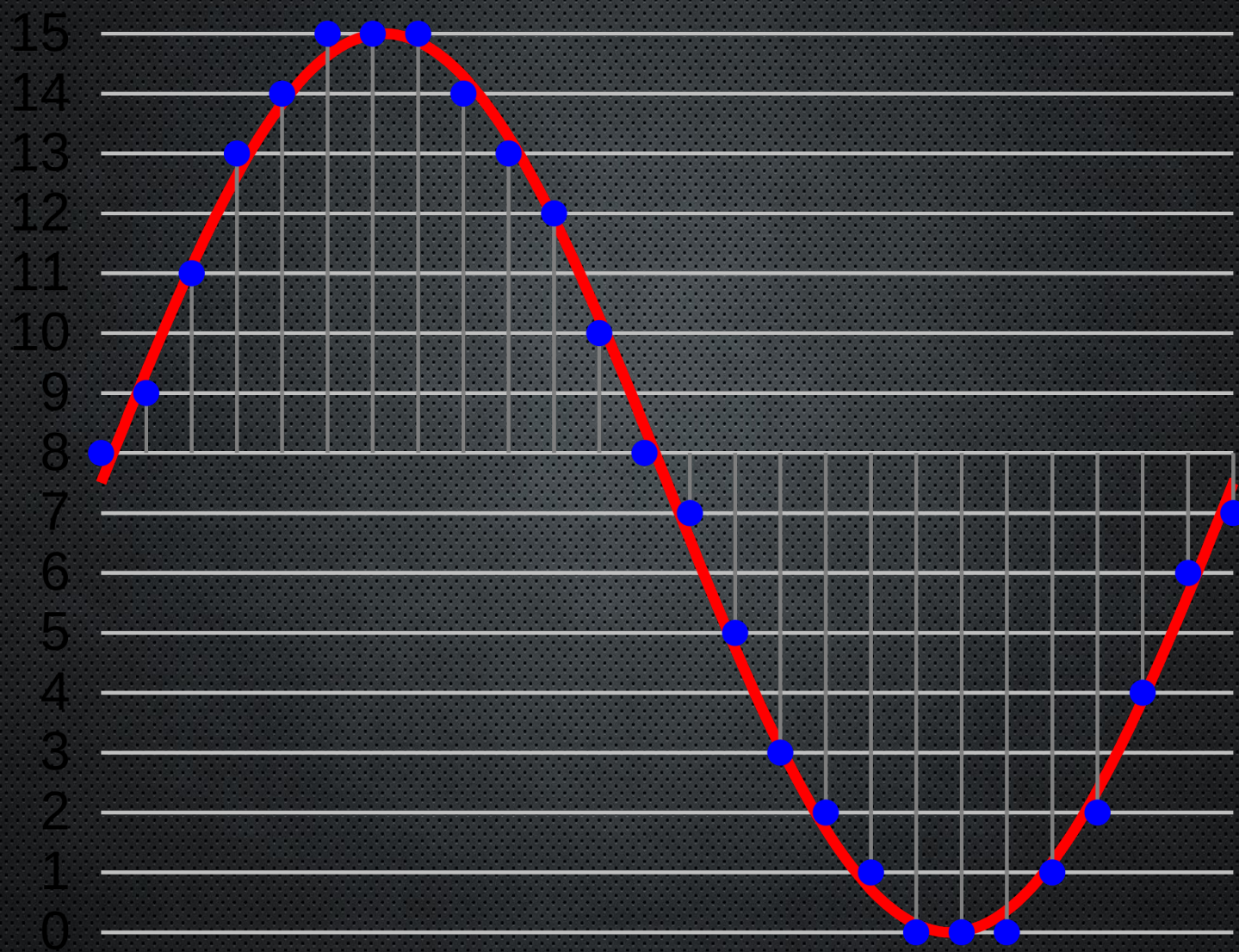
01001000,01101001

(or really, just "72,105". More on that later...)

Images?



Sound/Music?



- email?
- mp3 file?
- snapchat photo?
- tweet?

ALL NUMBERS.
ALWAYS “CONVERTIBLE”

HUGE CONCEPT #2

*All computers do is follow a very precise **list of instructions** that one or more people wrote.*

Understanding Power

```
10 PRINT "John is AWESOME";  
20 GOTO 10
```


Go to the store; if they have 2% lactose free chocolate milk, then get me a carton.

Misusing Power

go to the store;

if [[they have 2% lactose free
chocolate milk]]

then

get me a carton.

An almost random bit on recursion

- In computers, it's actually okay to define something with itself.

PSUEDOCODE!

Define function="EscapeFromRoom"{

1) If there's a door in arms-reach, exit - you're done, else

2) If you can, take one step forward then EscapeFromRoom, else

3) Rotate to the left until there's not a wall in front of you then EscapeFromRoom

}

(this will get you out of any "regular" empty room)

The Magic Genie
Recursion, trees, and “crowdsourcing”

{0) Start with “Is it Batman”?}

1) Ask my (yes/no) questions down the tree

2) If win, “yay”

3) If lose, add/replace new last question to one for which my guess was wrong and her guess was right (*optionally, try to be “half-y”?*)

- repeat until genius

Alan Turing



Not Alan Turing but I'll probably check out
the movie too...



“Lots of very simple instructions can add up to complex computations.”

“Turing Machine (Turing Completeness)”

(an infinite tape w/ simple instructions)



“Lots of very simple instructions can add up to complex computations.”

“Lambda Calculus”

(mathy way to express the above; this is literally all you have to know)

A.I. ARTIFICIAL INTELLIGENCE!

- up for debate but, history tells a lot; I'd suggest people “move the goalposts” a lot.

“Tests”

- games like Chess

or...

The Turing Test

Simplest expression:

Could a computer (typing/chatting online)
fool a human into thinking it was a human?

(Short answer: YEP. Happens all the time.

Consider “moving the goalposts, again”)