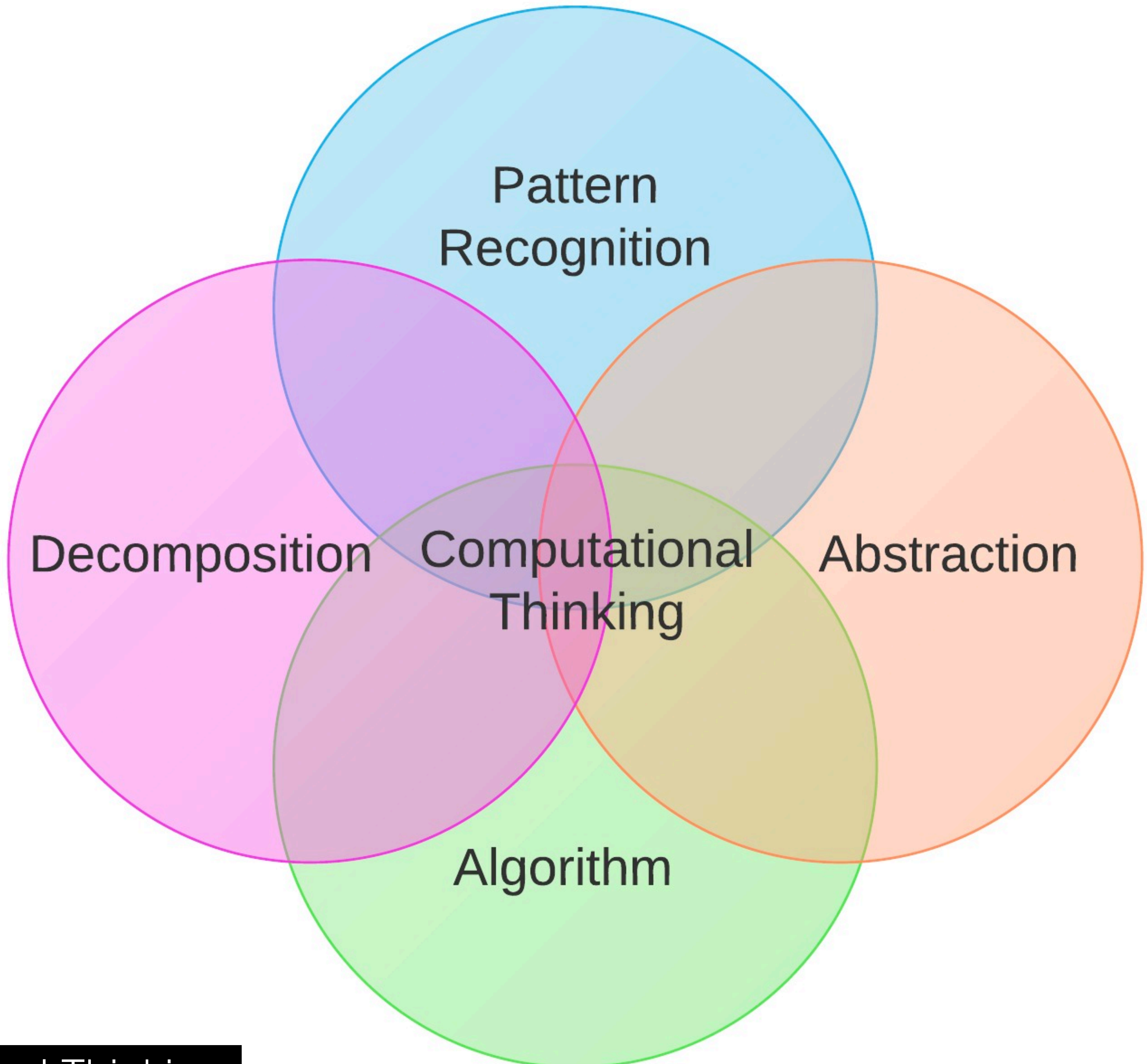
Programming Basics Kick-off

How computers think

```
import zhdk.tensor_flow.*;
import processing.video.*;
//Capture cam;

ObjectDetection TF;
PImage[] testImage;
String[] Images;
int count = 0;
float[][]  box;
String[] labels;
color[] colors;
//
byte[][][][] tensorImage;
void setup() {
  size(570, 855);

  Images = new String[6];
  testImage = new PImage[Images.length];

  for (int i = 0; i  < Images.length; i++) {
    Images[i] = "image"+i+".jpg";
    testImage[i] = loadImage(Images[i]);

  TF = new ObjectDetection(this);
  es[count]);
  // image(testImage[0], 0, 0);
```

Coding Languages

Syntax and instructions



Computational Thinking

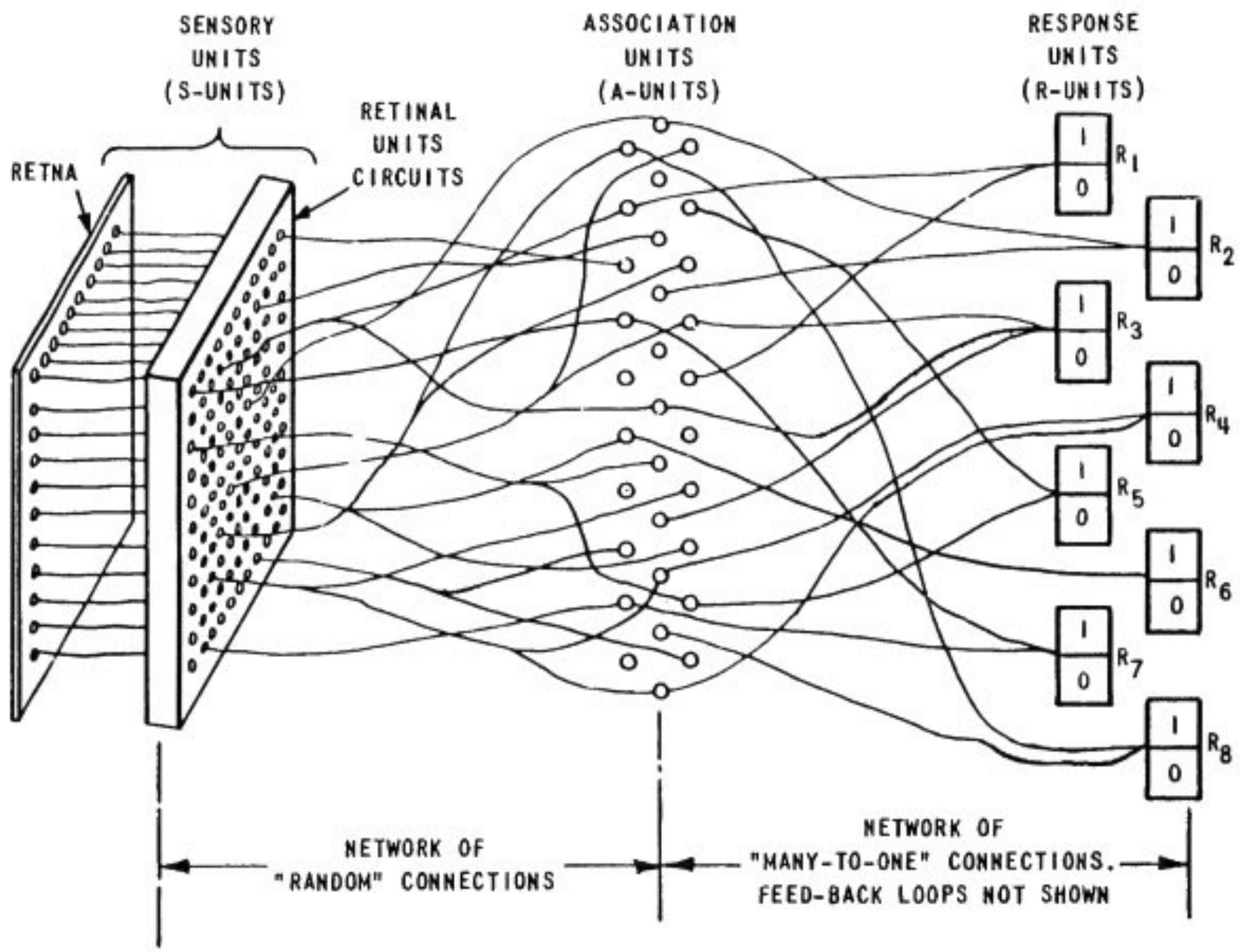
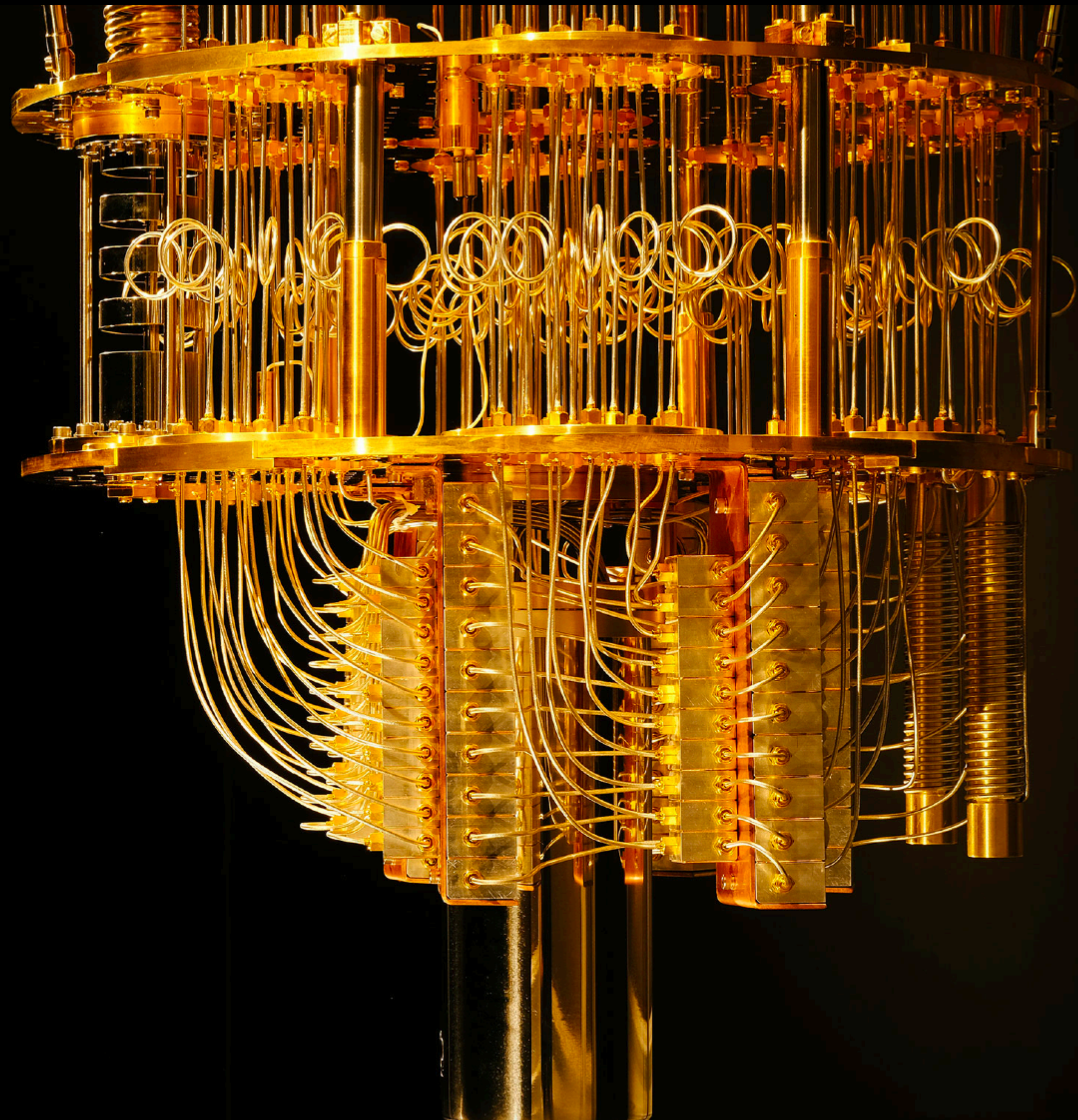


Figure 1 ORGANIZATION OF THE MARK I PERCEPTRON

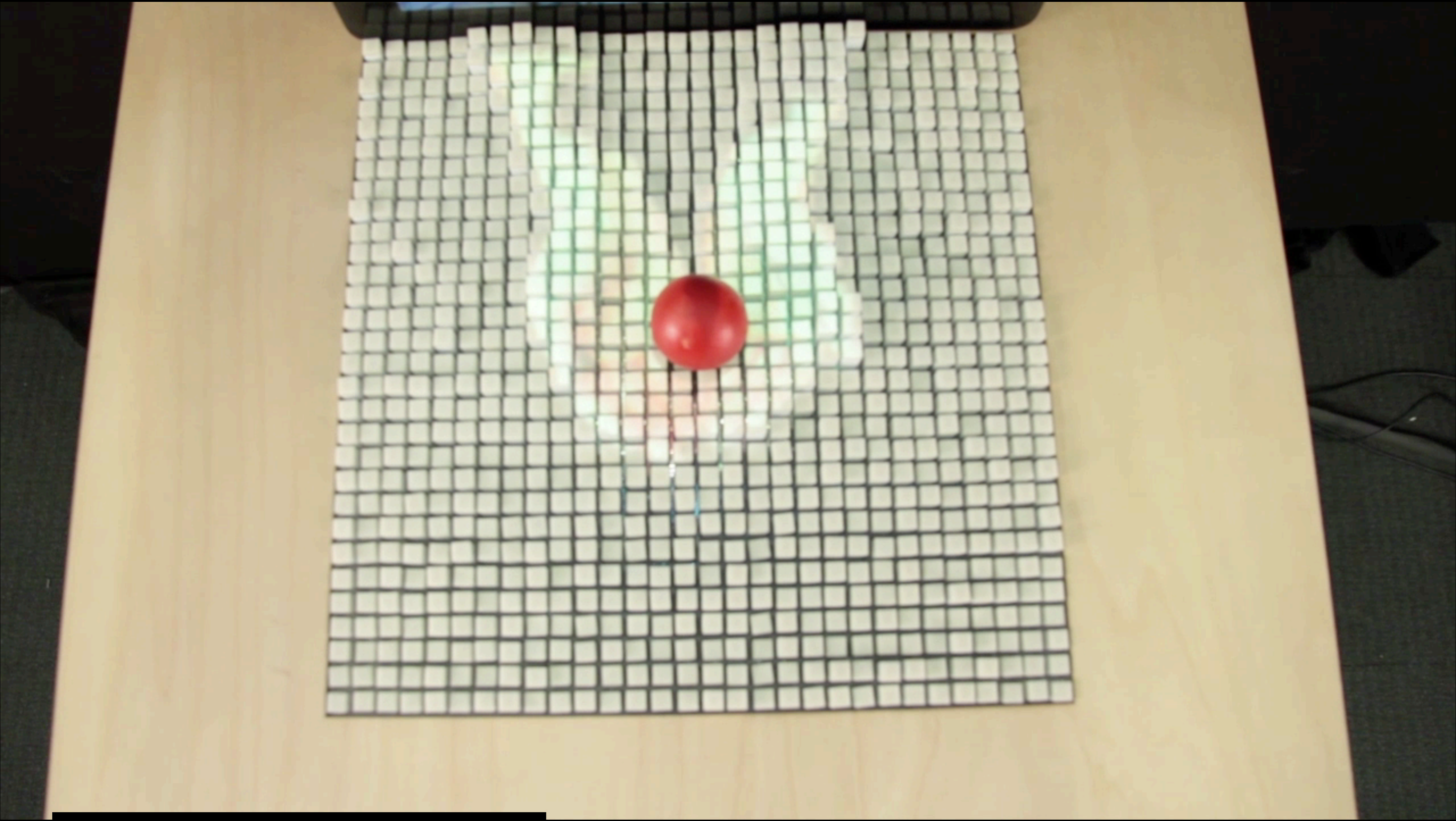
Artificial Neural Networks



Quantum Computing

Creative Code

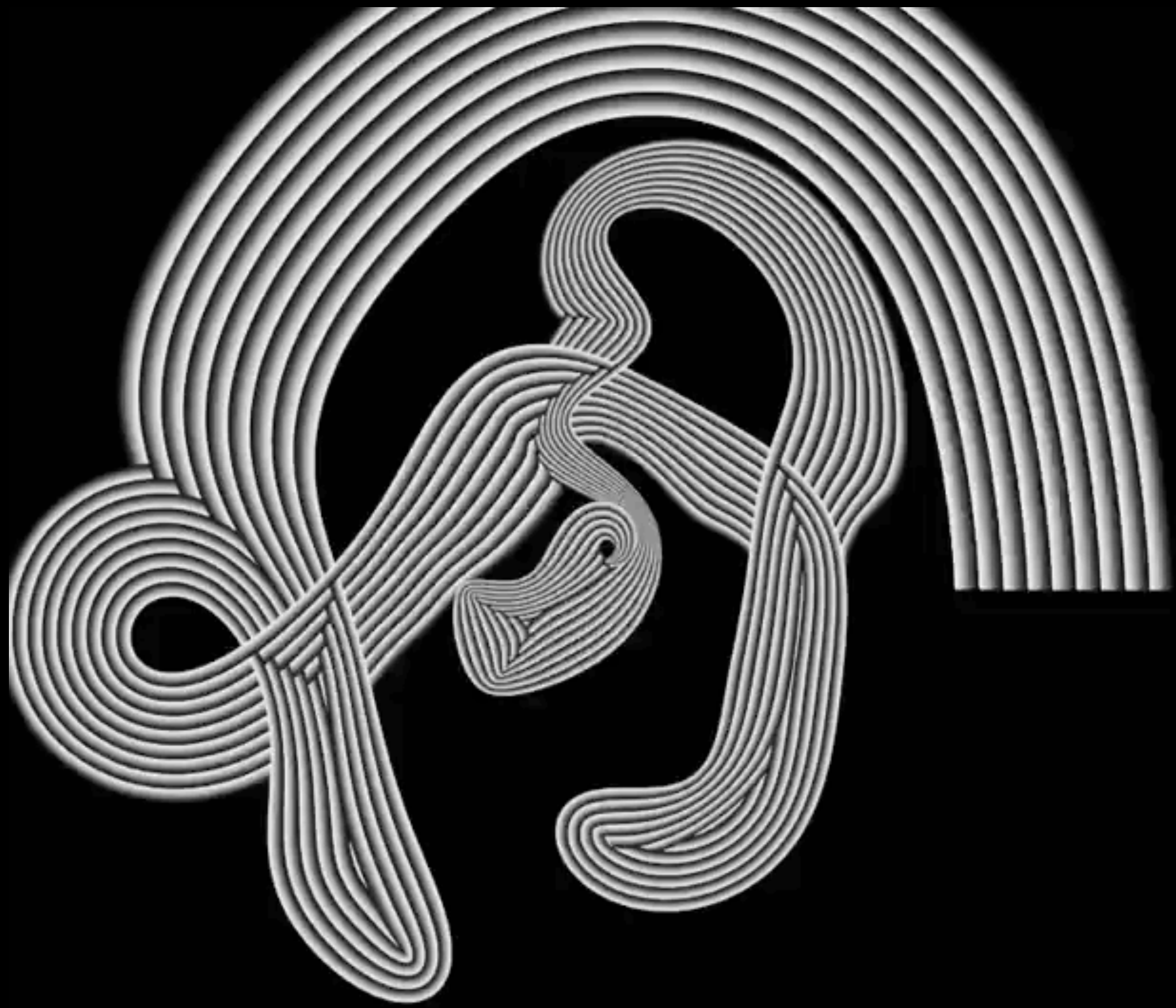
inFORM - Tangible Media Group MIT



Human Computer Interaction

Data Visualisation

Interactive Experience



Art


Gramazio & Kohler
Digital Fabrication


Gramazio & Kohler
FIRE EXIT
Digital Fabrication


Heydar Aliyev Centre, Zaha Hadid
Parametric Design


Michael Hansmeyer
Generative Design

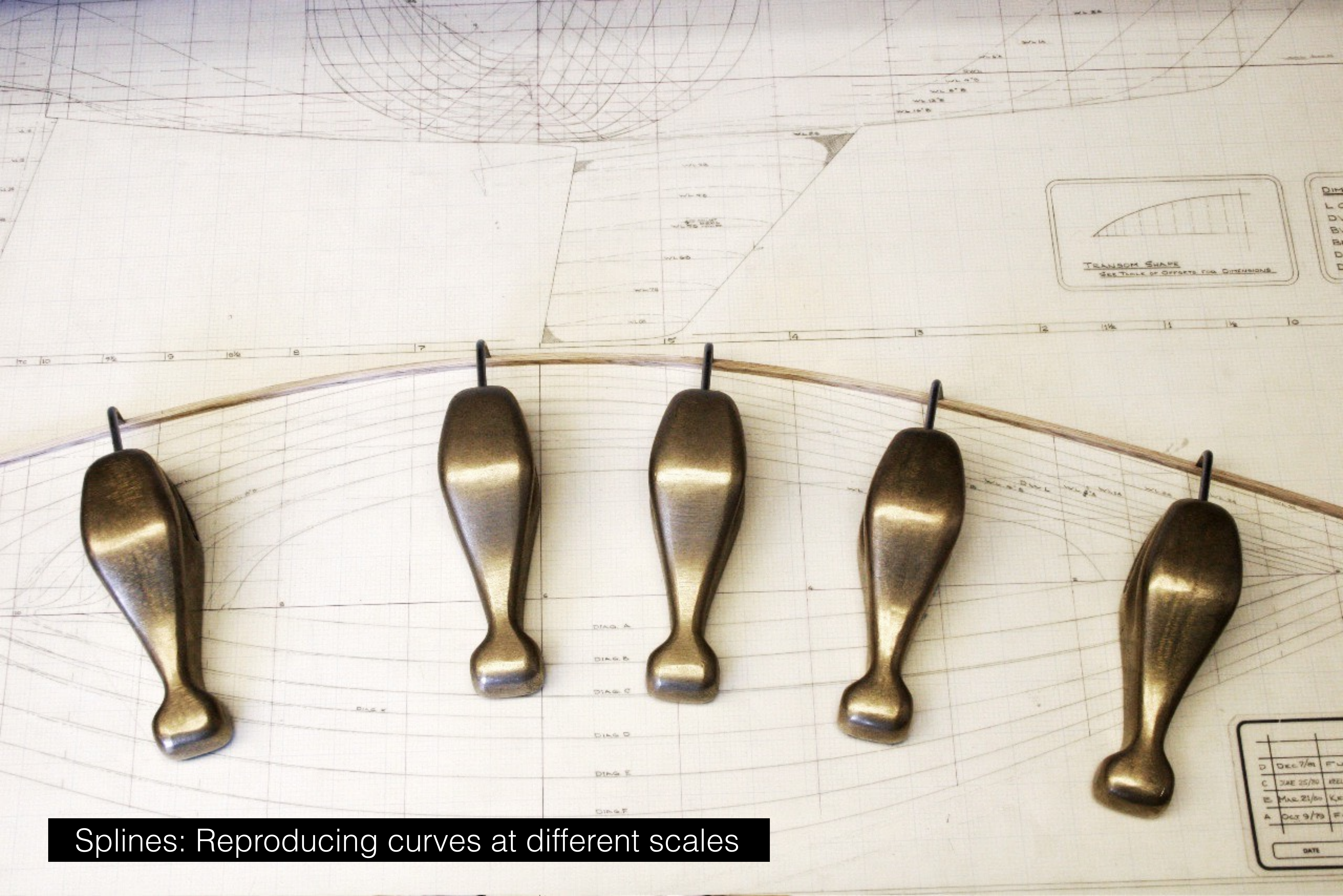
Generative Design

Iris van Herpen and Neri Oxman


Nervous System

the times before designers had computation

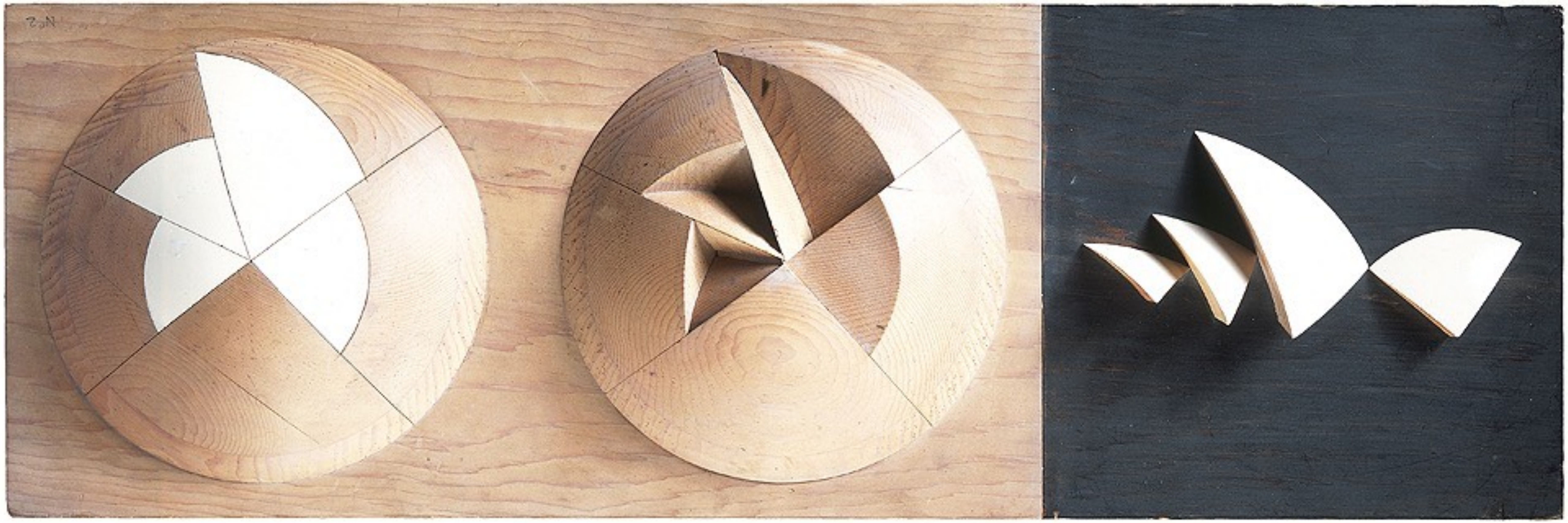
Reproducible curves



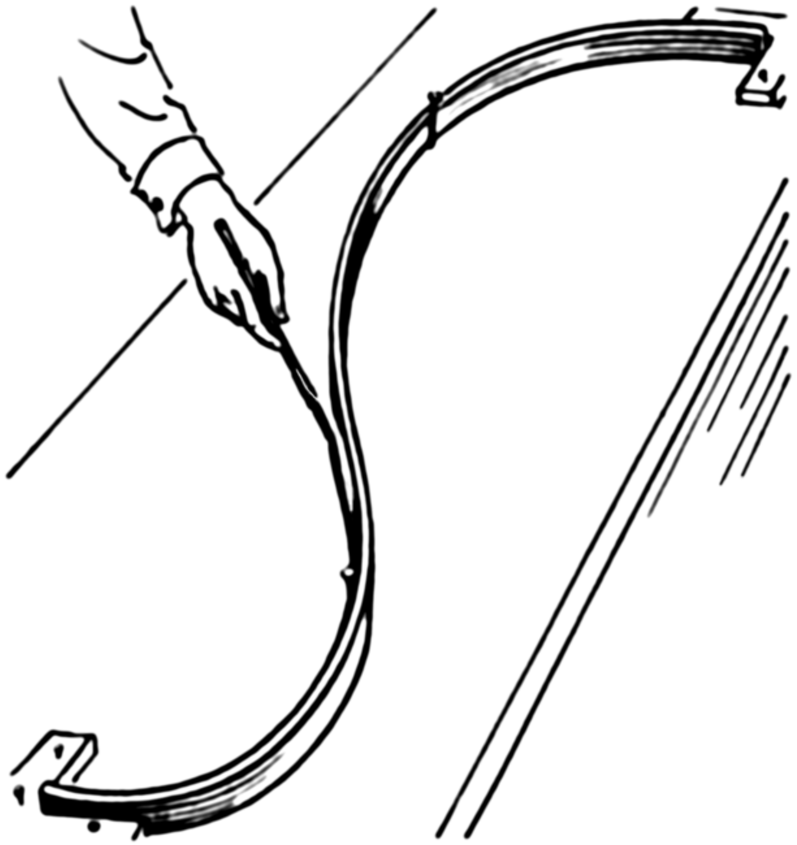
Splines: Reproducing curves at different scales

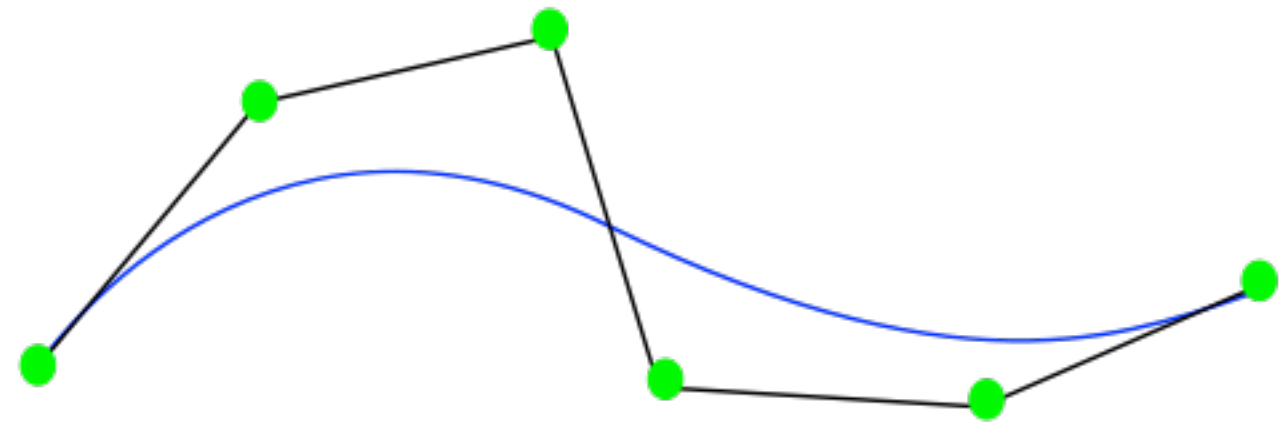
Before Parametric Design

Jørn Utzon sketches



Before Parametric Design





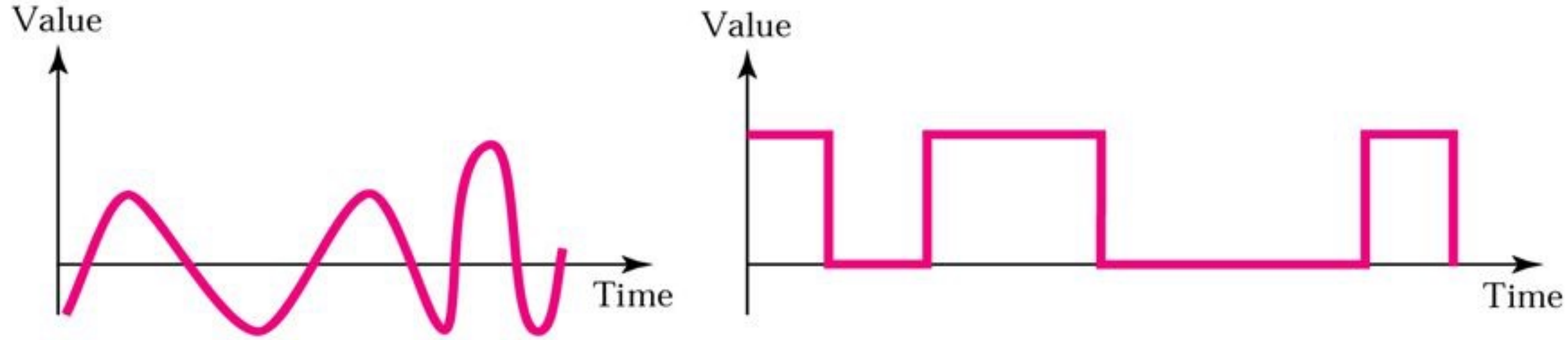
Splines: Analog to Mathematical Model (Bezier Curve)

Getting to the Basics

- What is Digital?
- What is Analog?

Analog and Digital Signals

- An analog signal is a continuous wave form that changes smoothly over time
- A digital signal is discrete. It can have only a limited number of defined values, often as simple as 1 and 0



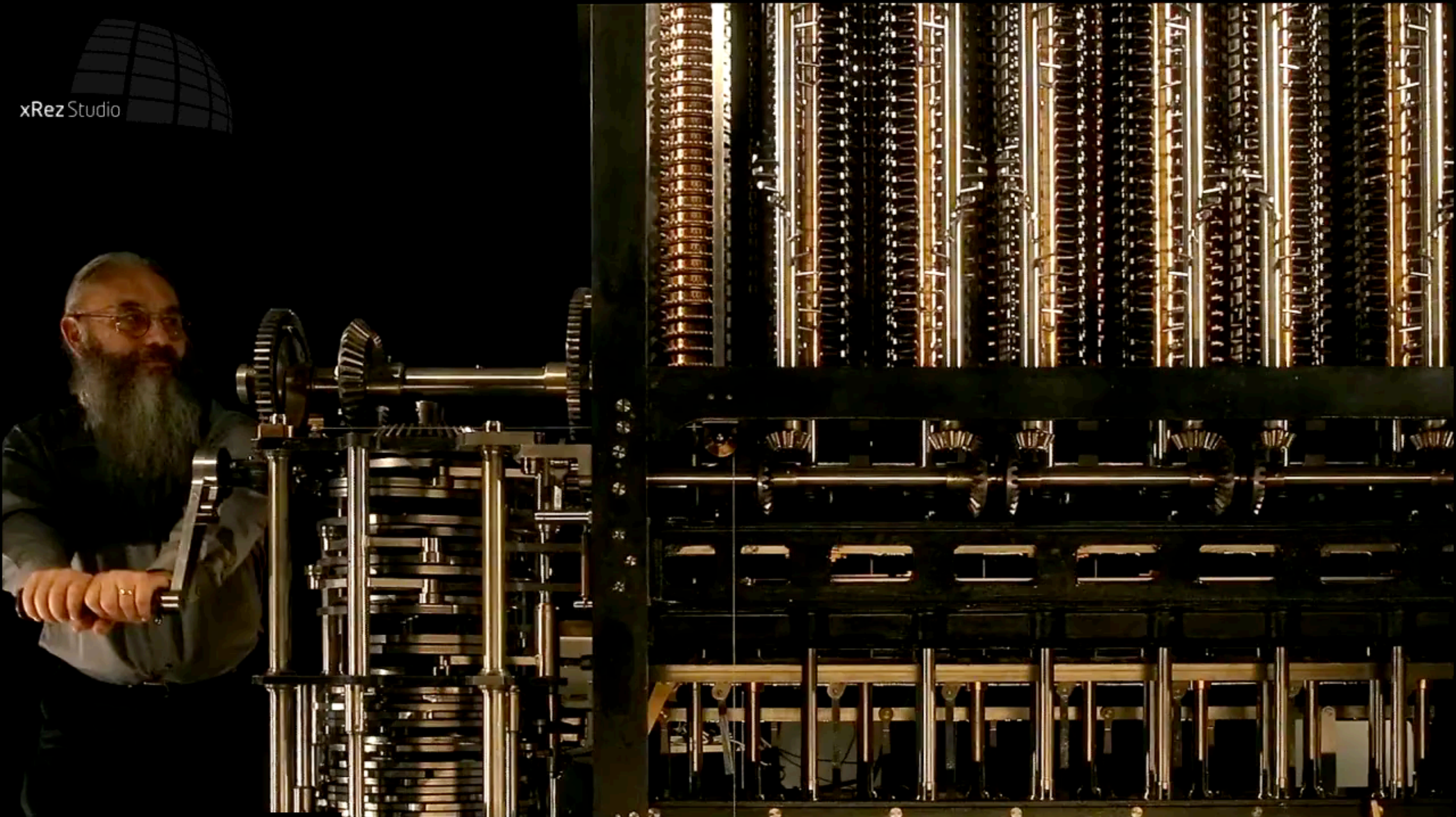
a. Analog signal   b. Digital signal

Analog vs Digital

Analog Mediums

Jacquard Loom

Jacquard Loom



Babbage engine

Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page

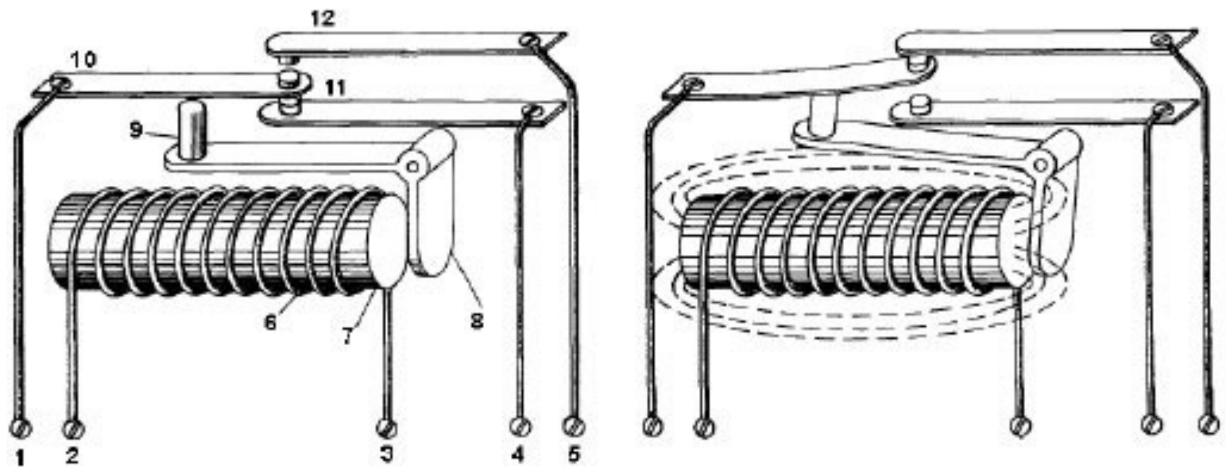
Number of Operation.	Nature of Operation.	Variables acted upon.	Variables receiving results.	Indication of change in the value on any Variable.	Statement of Results.	Data.			Working Variables.							
						${}^1V_1$ ○ 0 0 0 1 [1]	${}^1V_2$ ○ 0 0 0 2 [2]	${}^1V_3$ ○ 0 0 0 4 [n]	${}^0V_4$ ○ 0 0 0 0 [ ]	${}^0V_5$ ○ 0 0 0 0 [ ]	${}^0V_6$ ○ 0 0 0 0 [ ]	${}^0V_7$ ○ 0 0 0 0 [ ]	${}^0V_8$ ○ 0 0 0 0 [ ]	${}^0V_9$ ○ 0 0 0 0 [ ]	${}^0V_{10}$ ○ 0 0 0 0 [ ]	${}^0V_{11}$ ○ 0 0 0 0 [ ]
1	×	${}^1V_2 \times {}^1V_3$	${}^1V_4, {}^1V_5, {}^1V_6$	$\left\{\begin{matrix}{}^1V_2 = {}^1V_2\\{}^1V_3 = {}^1V_3\end{matrix}\right\}$	$= 2n$	...	2	n	$2n$	$2n$	$2n$					
2	−	${}^1V_4 - {}^1V_1$	${}^2V_4$	$\left\{\begin{matrix}{}^1V_4 = {}^2V_4\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n-1$	1	...	...	$2n-1$							
3	+	${}^1V_5 + {}^1V_1$	${}^2V_5$	$\left\{\begin{matrix}{}^1V_5 = {}^2V_5\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n+1$	1	...	...	...	$2n+1$						
4	÷	${}^2V_5 \div {}^2V_4$	${}^1V_{11}$	$\left\{\begin{matrix}{}^2V_5 = {}^0V_5\\{}^2V_4 = {}^0V_4\end{matrix}\right\}$	$= \frac{2n-1}{2n+1}$	...	...	...	0	0	...	...	...	...	...	$\frac{2n-1}{2n+1}$
5	÷	${}^1V_{11} \div {}^1V_2$	${}^2V_{11}$	$\left\{\begin{matrix}{}^1V_{11} = {}^2V_{11}\\{}^1V_2 = {}^1V_2\end{matrix}\right\}$	$= \frac{1}{2} \cdot \frac{2n-1}{2n+1}$	...	2	...	...	...	...	...	...	...	...	$\frac{1}{2} \cdot \frac{2n-1}{2n+1}$
6	−	${}^0V_{13} - {}^2V_{11}$	${}^1V_{13}$	$\left\{\begin{matrix}{}^2V_{11} = {}^0V_{11}\\{}^0V_{13} = {}^1V_{13}\end{matrix}\right\}$	$= -\frac{1}{2} \cdot \frac{2n-1}{2n+1} = A_0$	...	...	...	...	...	...	...	...	...	...	0
7	−	${}^1V_3 - {}^1V_1$	${}^1V_{10}$	$\left\{\begin{matrix}{}^1V_3 = {}^1V_3\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 1 \; (= 3)$	1	...	n	...	...	...	...	...	...	$n-1$	
8	+	${}^1V_2 + {}^0V_7$	${}^1V_7$	$\left\{\begin{matrix}{}^1V_2 = {}^1V_2\\{}^0V_7 = {}^1V_7\end{matrix}\right\}$	$= 2 + 0 = 2$	...	2	...	...	...	...	2				
9	÷	${}^1V_6 \div {}^1V_7$	${}^3V_{11}$	$\left\{\begin{matrix}{}^1V_6 = {}^1V_6\\{}^0V_{11} = {}^3V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} = A_1$	...	...	...	...	...	$2n$	2	...	...	...	$\frac{2n}{2} = A_1$
10	×	${}^1V_{21} \times {}^3V_{11}$	${}^1V_{12}$	$\left\{\begin{matrix}{}^1V_{21} = {}^1V_{21}\\{}^3V_{11} = {}^3V_{11}\end{matrix}\right\}$	$= B_1 \cdot \frac{2n}{2} = B_1 A_1$	...	...	...	...	...	...	...	...	...	...	$\frac{2n}{2} = A_1$
11	+	${}^1V_{12} + {}^1V_{13}$	${}^2V_{13}$	$\left\{\begin{matrix}{}^1V_{12} = {}^0V_{12}\\{}^1V_{13} = {}^2V_{13}\end{matrix}\right\}$	$= -\frac{1}{2} \cdot \frac{2n-1}{2n+1} + B_1 \cdot \frac{2n}{2}$	...	...	...	...	...	...	...	...	...	...	....
12	−	${}^1V_{10} - {}^1V_1$	${}^2V_{10}$	$\left\{\begin{matrix}{}^1V_{10} = {}^2V_{10}\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 2 \; (= 2)$	1	...	...	...	...	...	...	...	...	$n-2$	
13	−	${}^1V_6 - {}^1V_1$	${}^2V_6$	$\left\{\begin{matrix}{}^1V_6 = {}^2V_6\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n-1$	1	...	...	...	...	$2n-1$					
14	+	${}^1V_1 + {}^1V_7$	${}^2V_7$	$\left\{\begin{matrix}{}^1V_1 = {}^1V_1\\{}^1V_7 = {}^2V_7\end{matrix}\right\}$	$= 2 + 1 = 3$	1	...	...	...	...	...	3				
15	÷	${}^2V_6 \div {}^2V_7$	${}^1V_8$	$\left\{\begin{matrix}{}^2V_6 = {}^2V_6\\{}^2V_7 = {}^2V_7\end{matrix}\right\}$	$= \frac{2n-1}{3}$	...	...	...	...	...	$2n-1$	3	$\frac{2n-1}{3}$			
16	×	${}^1V_8 \times {}^3V_{11}$	${}^4V_{11}$	$\left\{\begin{matrix}{}^1V_8 = {}^0V_8\\{}^3V_{11} = {}^4V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} \cdot \frac{2n-1}{3}$	...	...	...	...	...	...	...	0	...	...	$\frac{2n}{2} \cdot \frac{2n-1}{3}$
17	−	${}^2V_6 - {}^1V_1$	${}^3V_6$	$\left\{\begin{matrix}{}^2V_6 = {}^3V_6\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n-2$	1	...	...	...	...	$2n-2$					
18	+	${}^1V_1 + {}^2V_7$	${}^3V_7$	$\left\{\begin{matrix}{}^2V_7 = {}^3V_7\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 3 + 1 = 4$	1	...	...	...	...	...	4				
19	÷	${}^3V_6 \div {}^3V_7$	${}^1V_9$	$\left\{\begin{matrix}{}^3V_6 = {}^3V_6\\{}^3V_7 = {}^3V_7\end{matrix}\right\}$	$= \frac{2n-2}{4}$	...	...	...	...	...	$2n-2$	4	...	$\frac{2n-2}{4}$	...	$\left\{\frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{3} = A_3\right\}$
20	×	${}^1V_9 \times {}^4V_{11}$	${}^5V_{11}$	$\left\{\begin{matrix}{}^1V_9 = {}^0V_9\\{}^4V_{11} = {}^5V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{4} = A_3$	...	...	...	...	...	...	...	...	0		
21	×	${}^1V_{22} \times {}^5V_{11}$	${}^0V_{12}$	$\left\{\begin{matrix}{}^1V_{22} = {}^1V_{22}\\{}^0V_{12} = {}^2V_{12}\end{matrix}\right\}$	$= B_3 \cdot \frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{3} = B_3 A_3$	...	...	...	...	...	...	...	...	...	...	0
22	+	${}^2V_{12} + {}^2V_{13}$	${}^3V_{13}$	$\left\{\begin{matrix}{}^2V_{12} = {}^0V_{12}\\{}^2V_{13} = {}^3V_{13}\end{matrix}\right\}$	$= A_0 + B_1 A_1 + B_3 A_3$	...	...	...	...	...	...	...	...	...	...	....
23	−	${}^2V_{10} - {}^1V_1$	${}^3V_{10}$	$\left\{\begin{matrix}{}^2V_{10} = {}^3V_{10}\\{}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 3 \; (= 1)$	1	...	...	...	...	...	...	...	...	$n-3$	
Here follows a repetition of Operations thirteen to twenty-three.																
24	[illegible]	[illegible]	[illegible]	${}^4V_{13} = {}^0V_{13}$ [illegible]	[illegible]	...	...	...	...	...	...	...	...	...	...	....
25	[illegible]	[illegible]	[illegible]	$\left\{\begin{matrix}{}^?V_6 = {}^0V_6\\{}^5V_7 = {}^0V_7\end{matrix}\right\}$	[illegible] $+ 1 = 4 + 1 = 5$; by a Variable-card. by a Variable card.	1	...	$n+1$	...	...	0	0				

Ada Lovelace

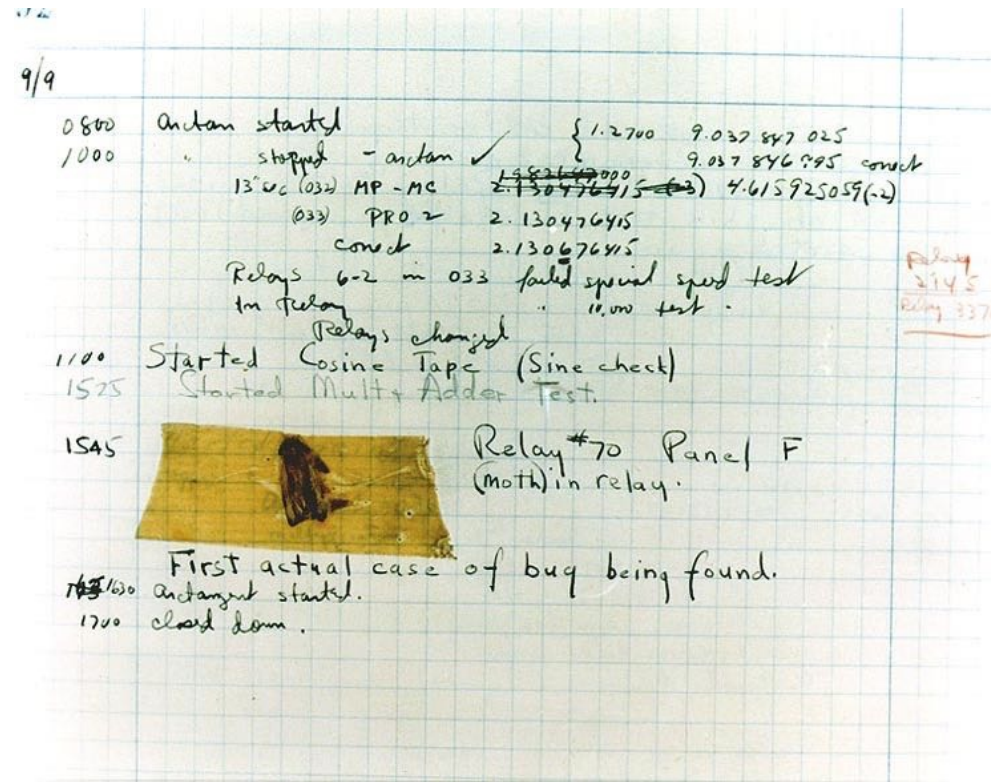
“ [The Analytical Engine] might act upon other things besides *number*, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations, and which should be also susceptible of adaptations to the action of the operating notation and mechanism of the engine...Supposing, for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expression and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent. ”

Ada Lovelace


Electricity!
20th century and the first electronic computers



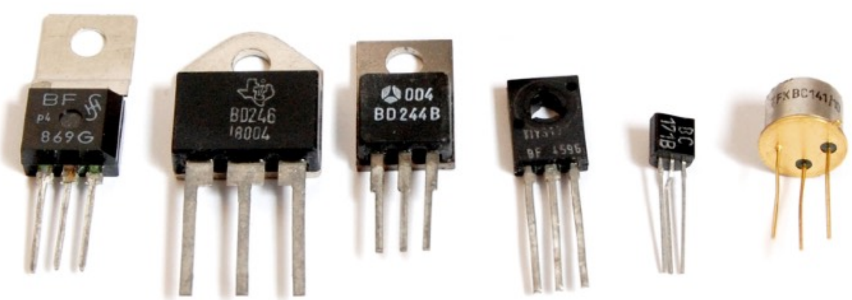
Relays



The first computer bugs

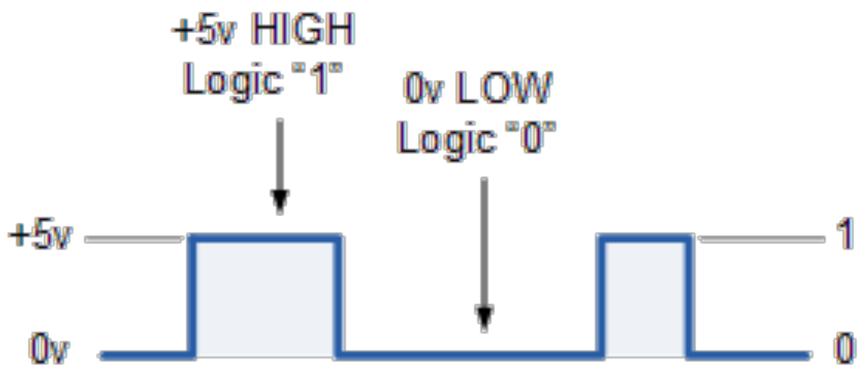
Electromechanical Computers

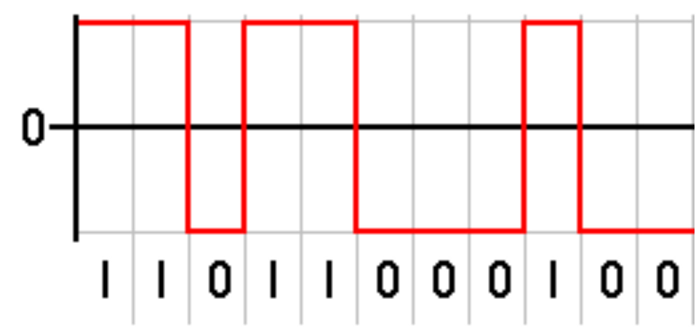
Valves



Transistors

Solid State Computers



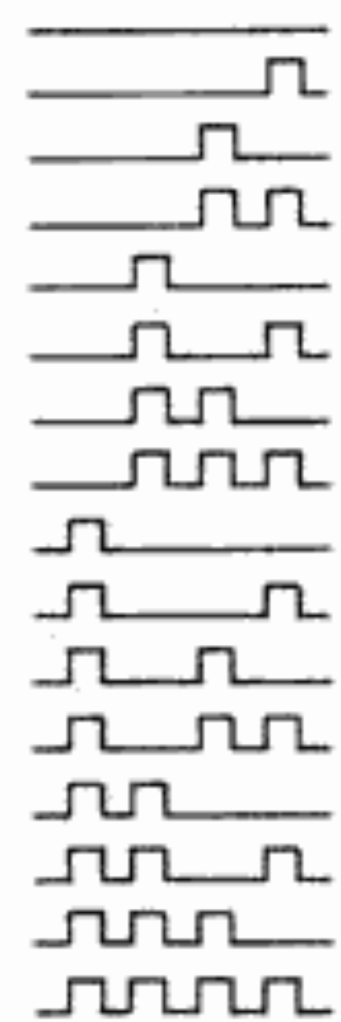


Electricity into Binary

What are Bits all about?

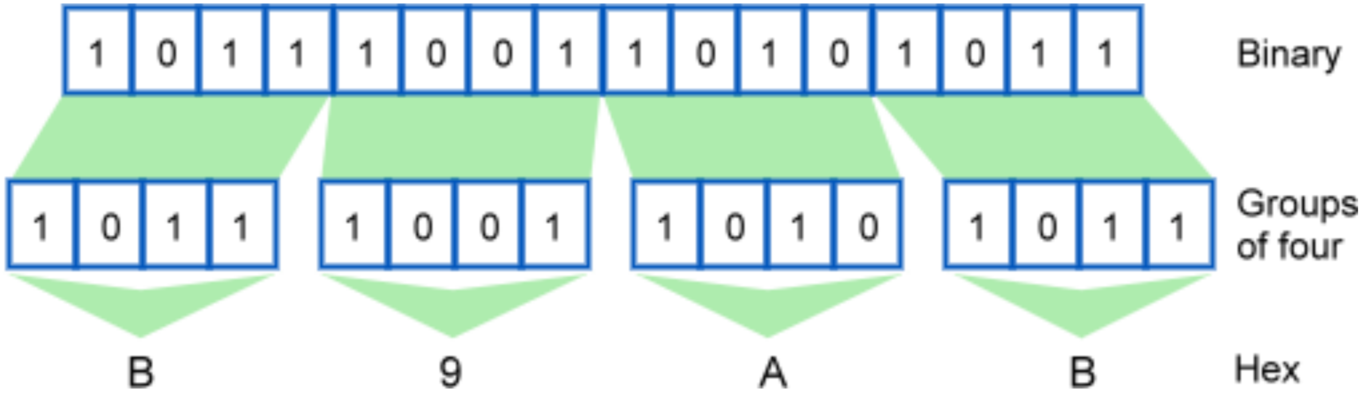
STATE A	STATE B
1	0
TRUE	FALSE
HIGH	LOW
ON	OFF
OPEN	CLOSED
ACTIVE	INACTIVE
UP	DOWN

States

DECIMAL NUMBER	BINARY EQUIVALENT				PULSE - CODE WAVEFORMS
	2^3	2^2	2^1	2^0	2^3 2^2 2^1 2^0
0	0	0	0	0	
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	
7	0	1	1	1	
8	1	0	0	0	
9	1	0	0	1	
10	1	0	1	0	
11	1	0	1	1	
12	1	1	0	0	
13	1	1	0	1	
14	1	1	1	0	
15	1	1	1	1	

Counting in Binary

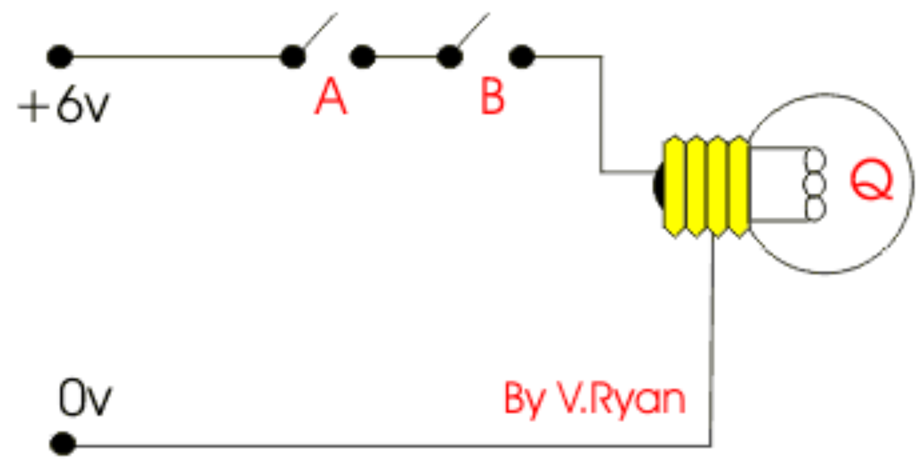
Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F



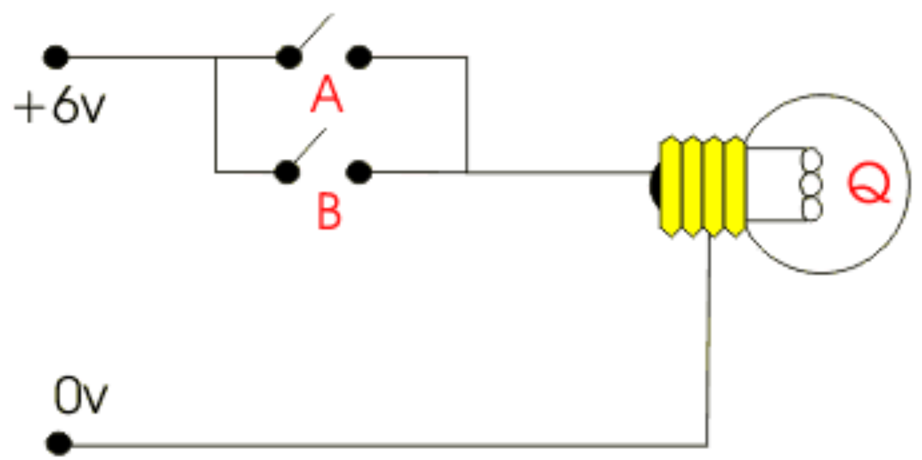
Hexadecimal

Hexadecimal Colour

AND GATE

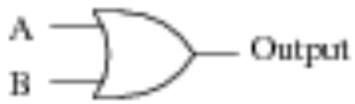


OR GATE



Logic with Switches (boolean logic and logic gates)

OR



A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

AND

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Neg-AND

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

NOR

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

NAND

A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

Neg-OR

A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

XOR

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

XNOR

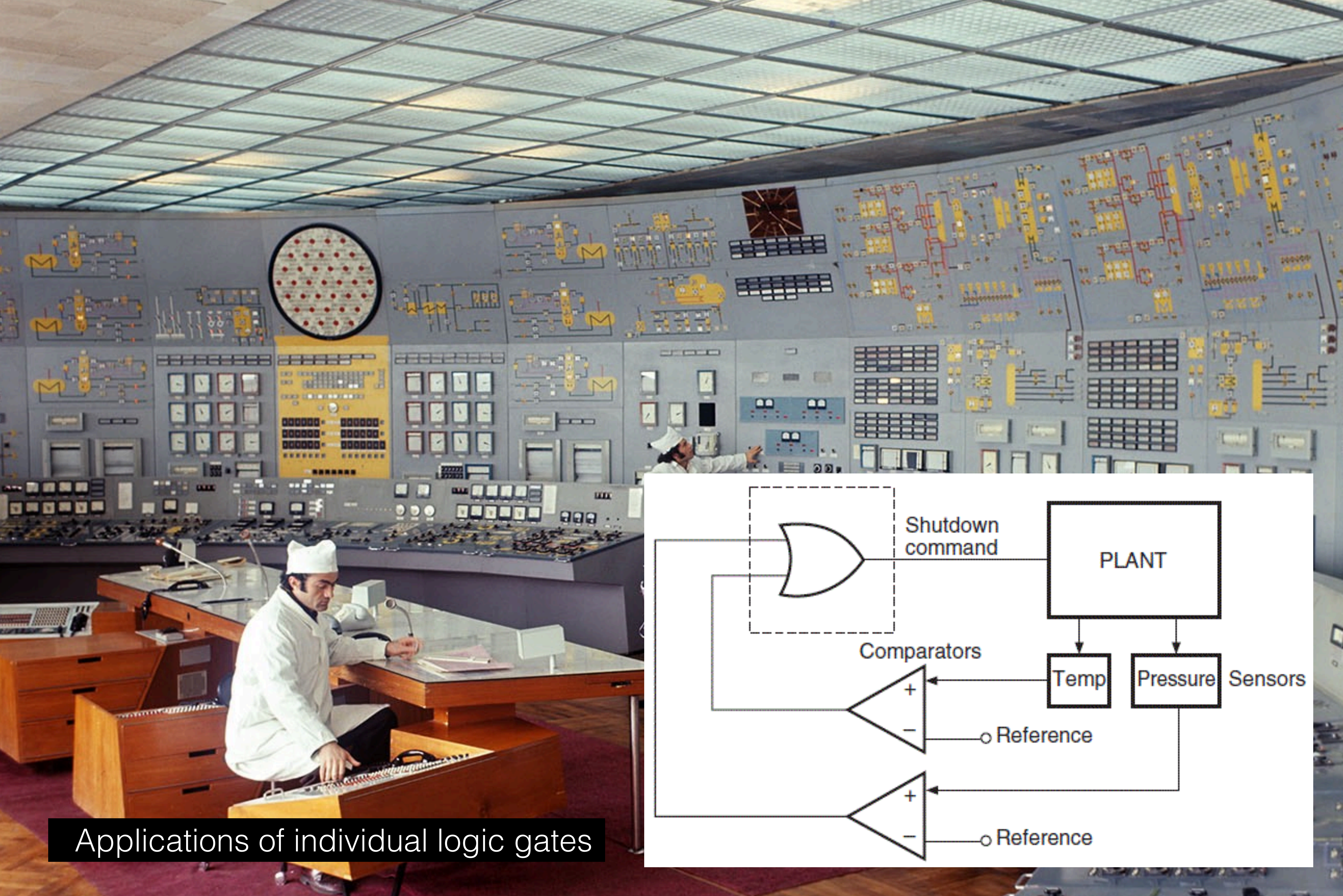
A	B	Output
0	0	1
0	1	0
1	0	0
1	1	1

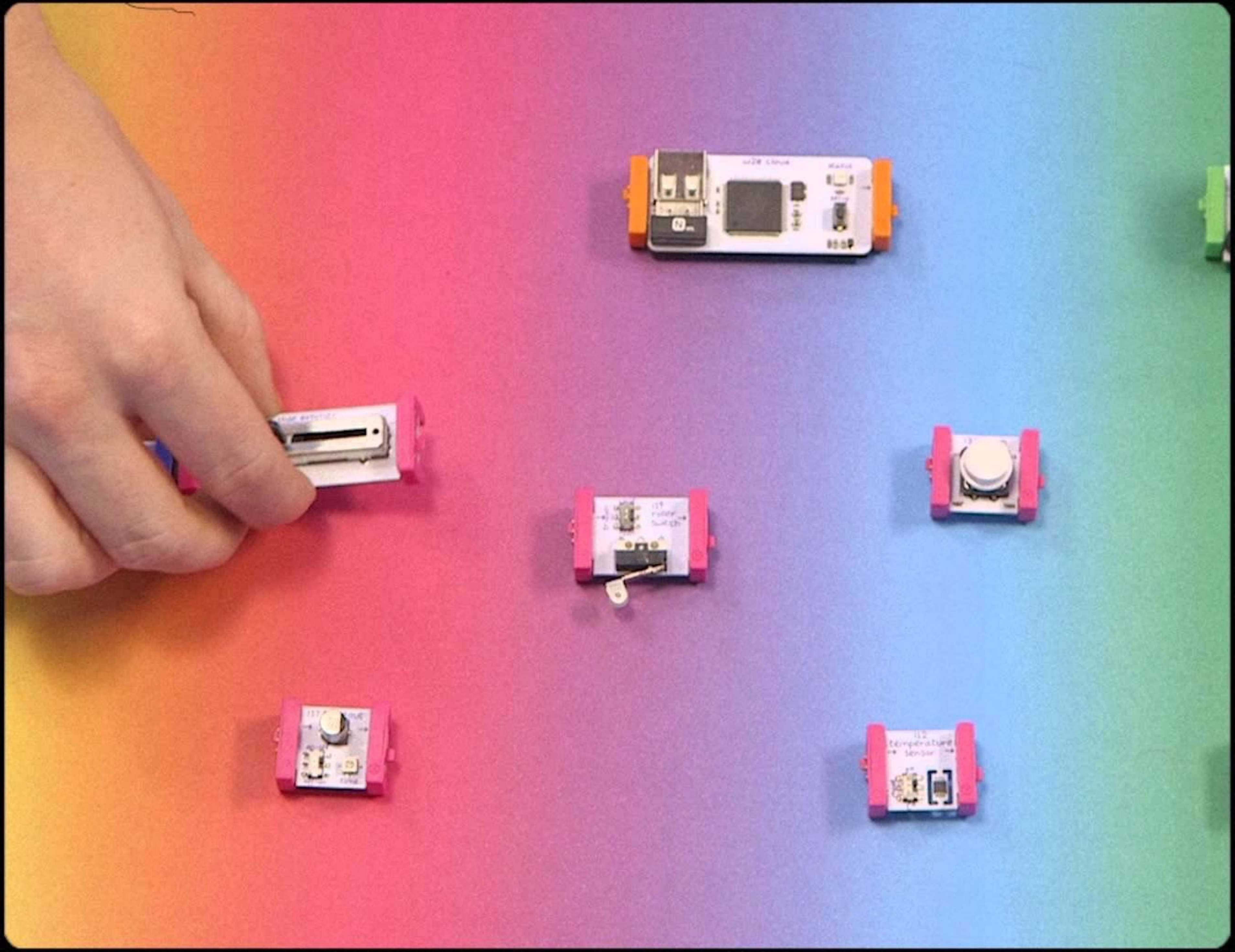
NOT

A	Output
0	1
1	0

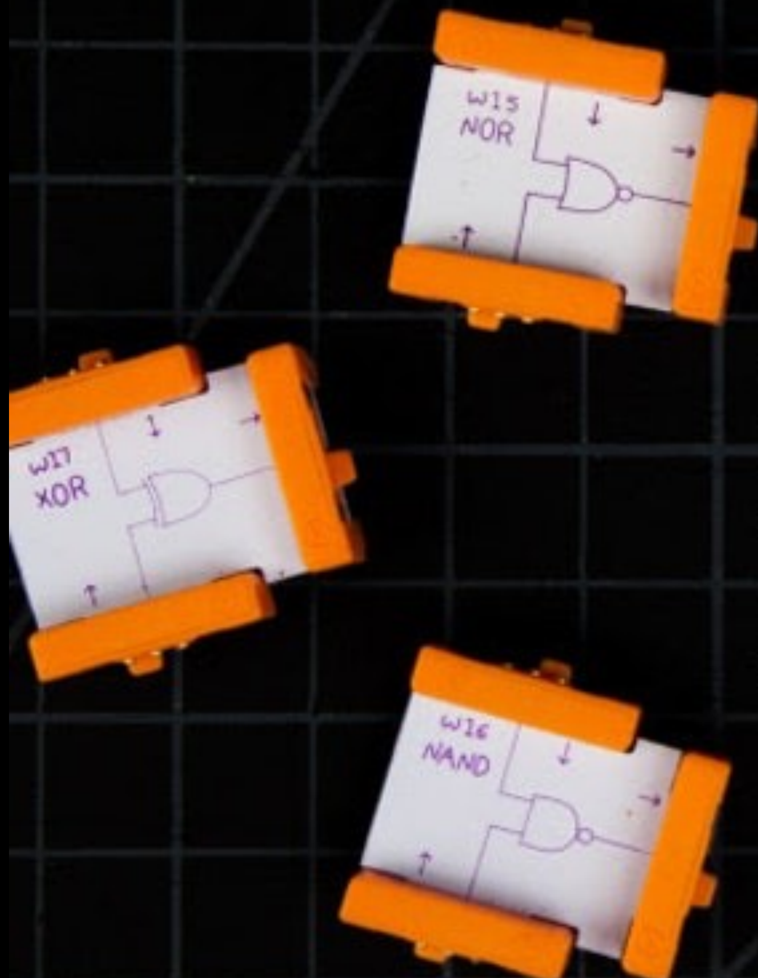
Logic gates

Applications of individual logic gates



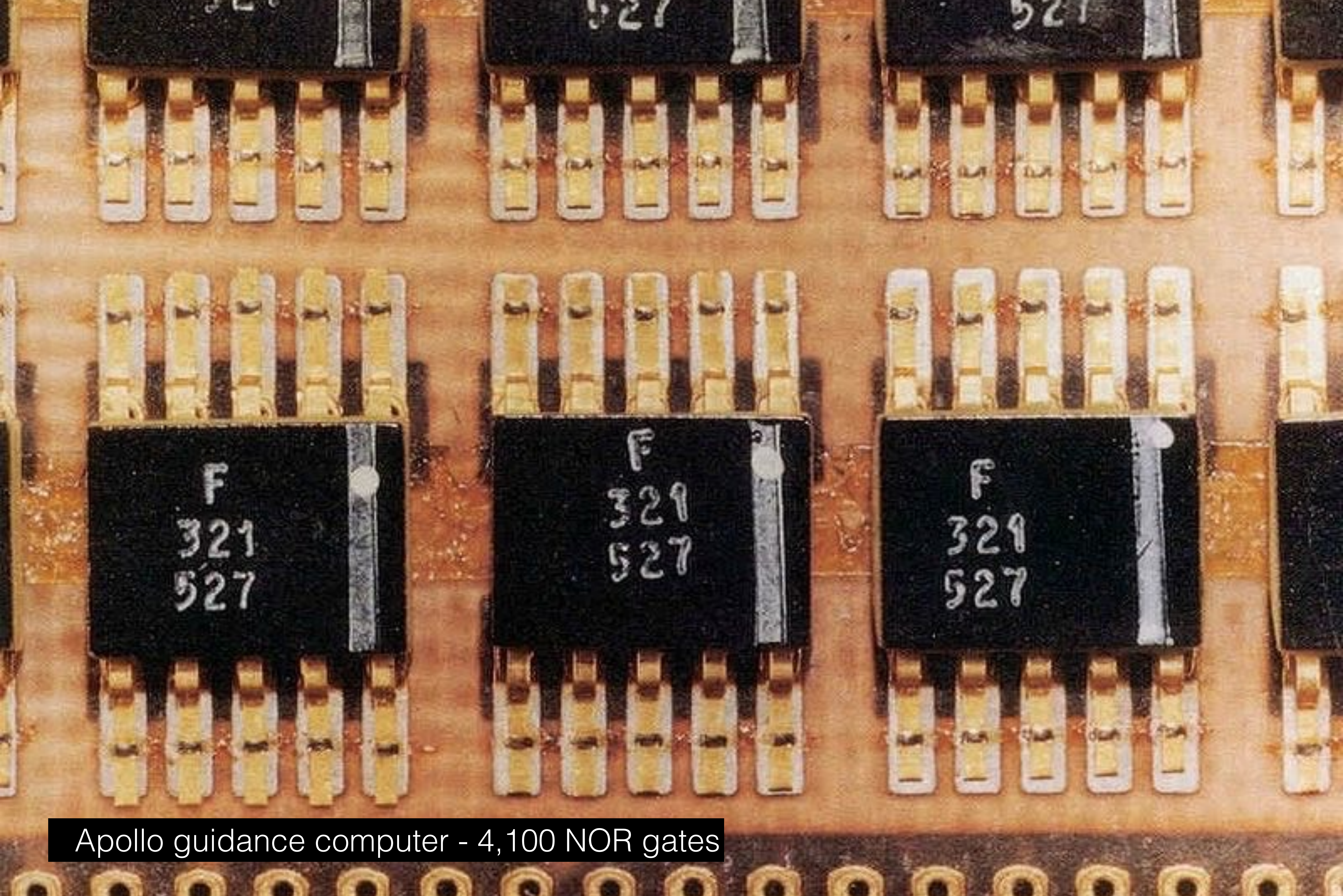


https://vimeo.com/134128442

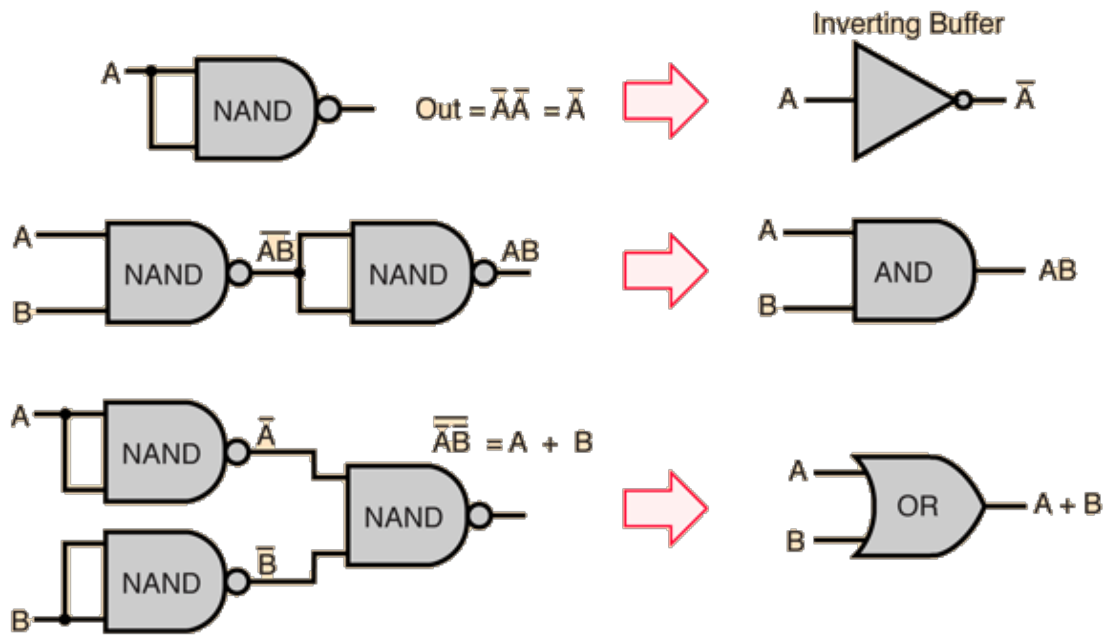


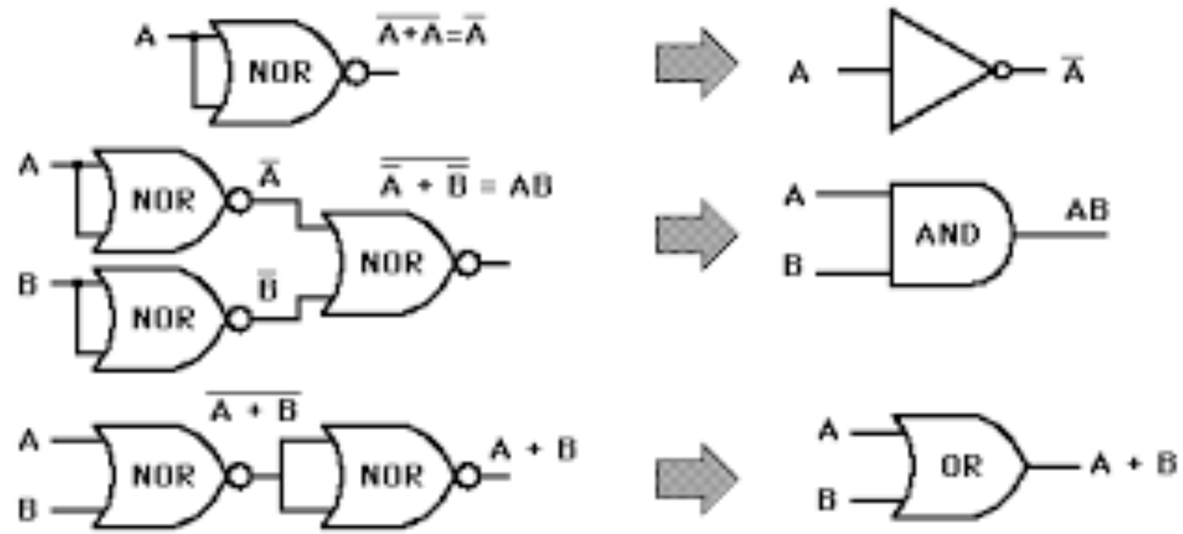
LOGIC MODULES

- Each is a building block of a digital circuit.
- Most have 2 inputs and 1 output.
- Combos of logic = a simple computer!

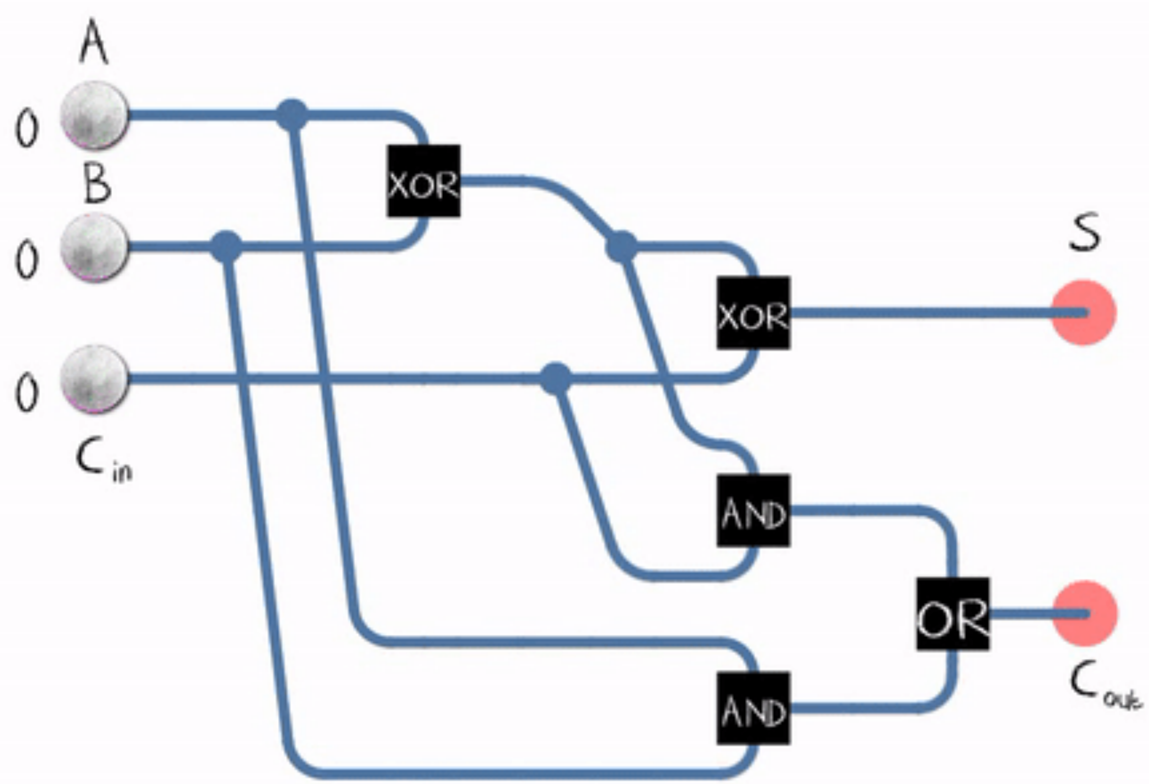


Apollo guidance computer - 4,100 NOR gates

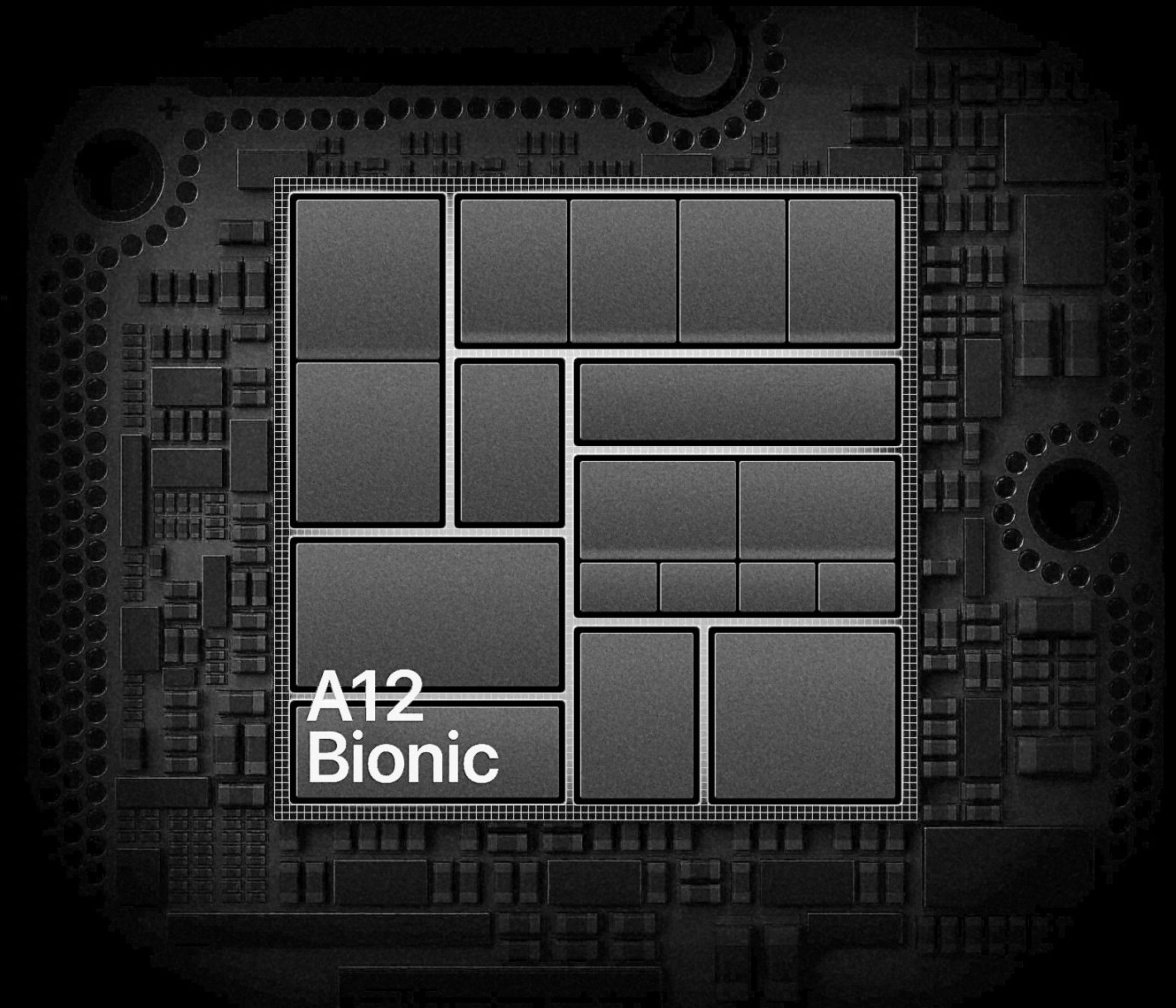




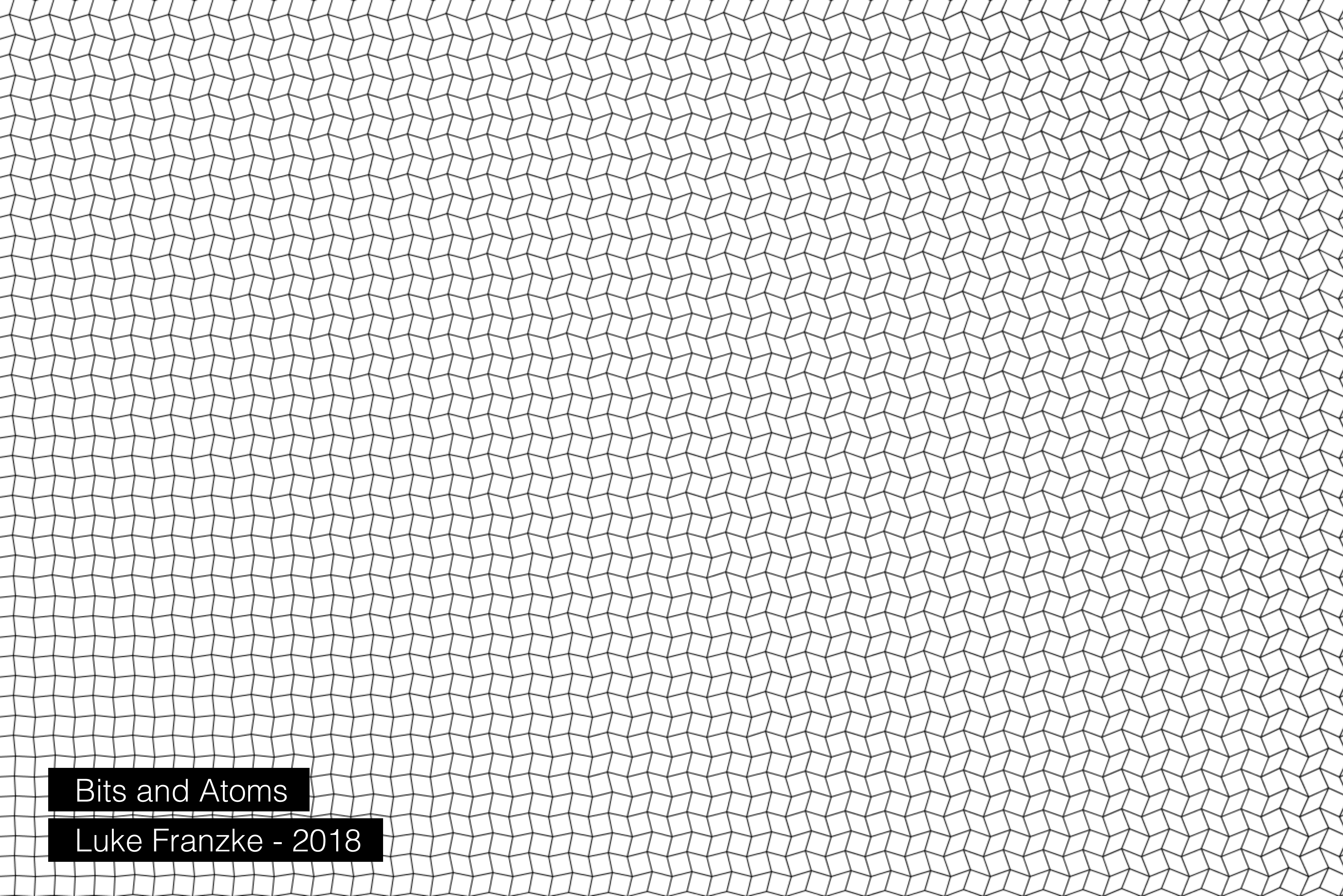
Modularity and Reconfigurability: Universal Gates - NAND & NOR



Logic Gates into Binary adders (and Calculators)



iPhone X A12 CPU: 7 Billion Transistors


Bits and Atoms
Luke Franzke - 2018