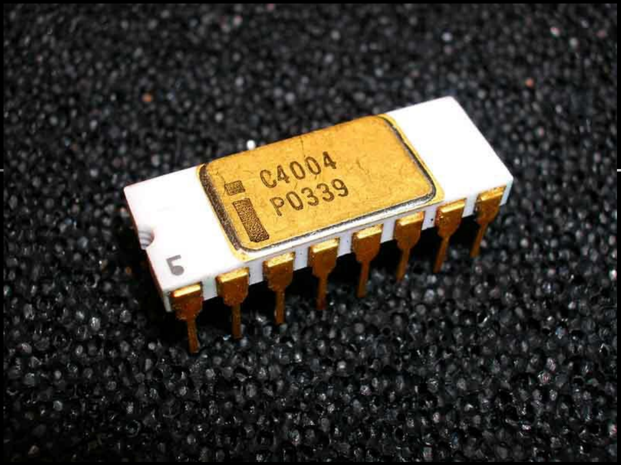
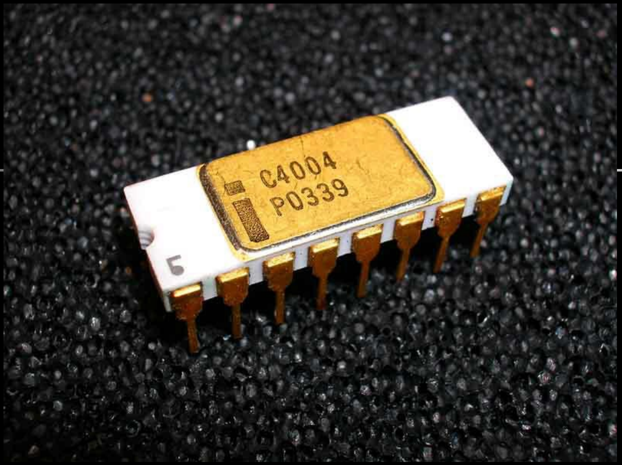
Microprocessors

Wis0027@vsb.cz

What are those?

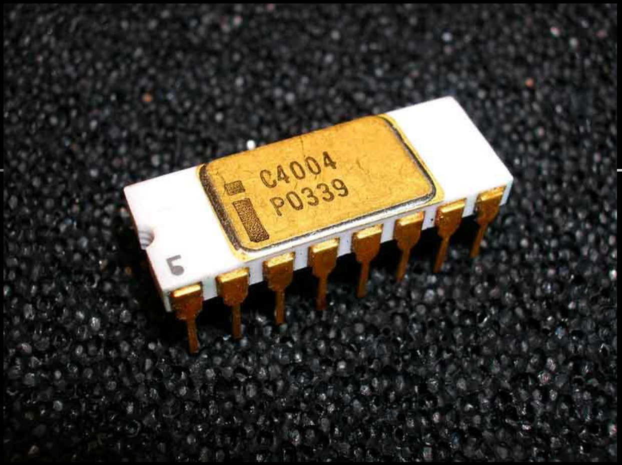


What are those?



- Microprocessor =
  - Processor

What are those?

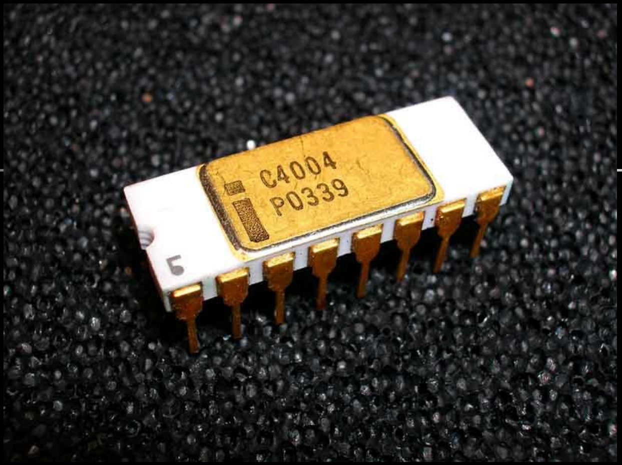


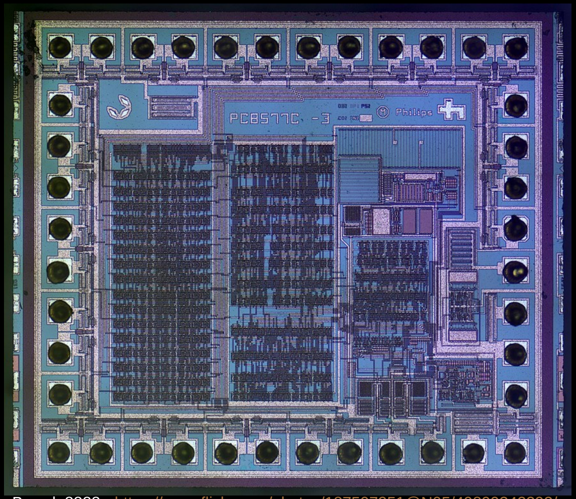
- Microprocessor =
  - Processor
  - On a microchip

What are those?

- Microprocessor =
  - Processor
  - On a microchip

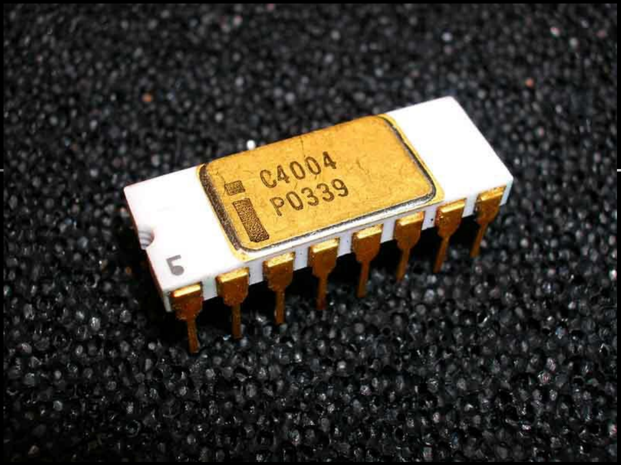
    (A single integrated circuit)





By cole8888 - https://www.flickr.com/photos/187597251@N05/49899342293/, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=95653492

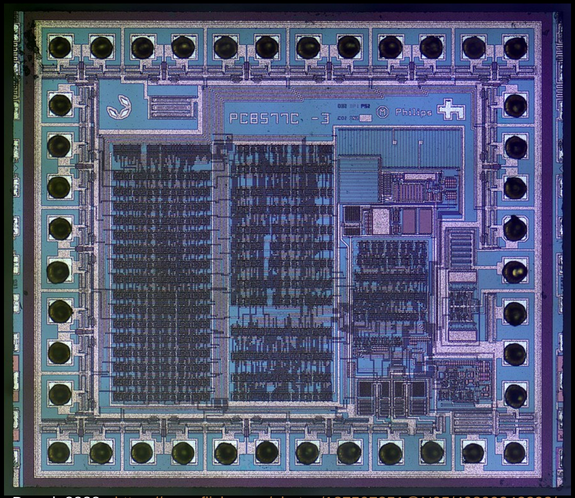
What are those?



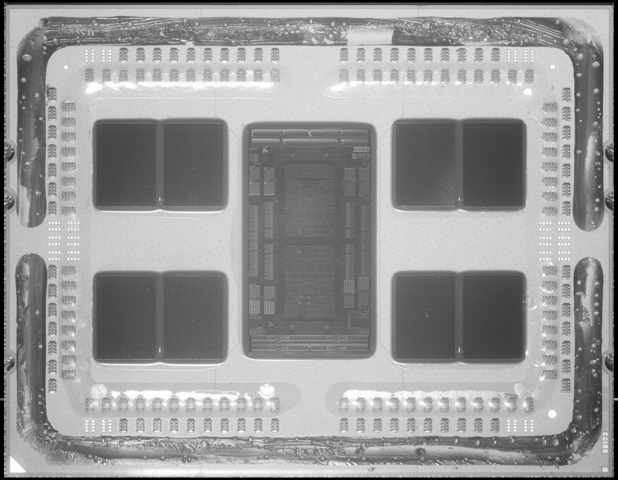
- Microprocessor =
  - Processor
  - On a microchip

    (A single integrated circuit)

    (or multiple)



By cole8888 - https://www.flickr.com/photos/187597251@N05/49899342293/, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=95653492



What does it do?

What does it do?

- Stuff in binary
  - 10111011100011101010111001000010

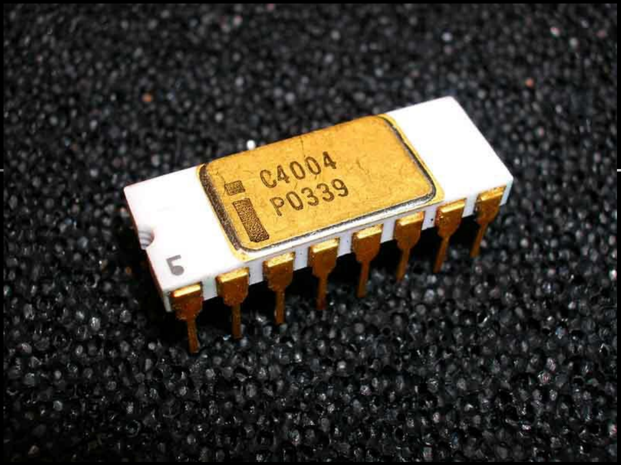
What does it do?

- Stuff in binary
  - 10111011100011101010111001000010
  - Digital

What does it do?

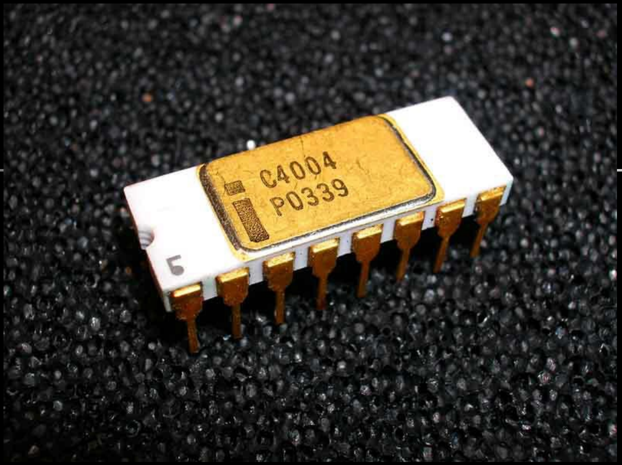
- Stuff in binary
  - 10111011100011101010111001000010
  - Digital
  - Why?
    - Easy to distinguish

What does it do?



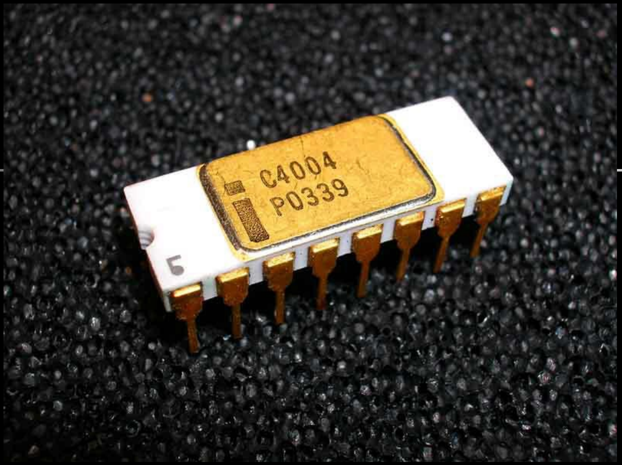
- Stuff in binary
  - 10111011100011101010111001000010
  - Digital
  - Why?
    - Easy to distinguish
    - Off/On ~0V/XV

What does it do?



- Input/Output

What does it do?



- Input/Output
  - Into memory

What does it do?

- Input/Output
  - Into memory
- Logic

What does it do?

- Input/Output
  - Into memory
- Logic
  - Combinational

What does it do?

- Input/Output
  - Into memory
- Logic
  - Combinational
  - Sequential → clock

What does it do?

- Operations

What does it do?

- Operations
  - Arithmetic

What does it do?

- Operations
  - Arithmetic (+, -, *, /,...)

What does it do?

- Operations
  - Arithmetic (+, -, *, /,…)
  - Logic

What does it do?

- Operations
  - Arithmetic (+, -, *, /,…)
  - Logic (>, <, =,...)

What does it do?

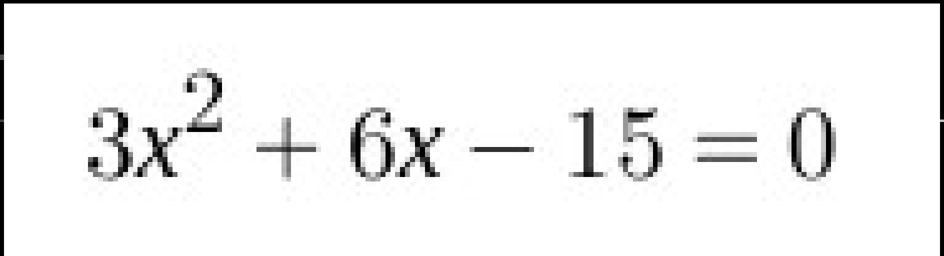
- Operations
    - Arithmetic (+, -, *, /,…)
    - Logic (>, <, =,…)
    - Control (input, output,...)

What does it do?

- Operations
  - Arithmetic (+, -, *, /,…)
  - Logic (>, <, =,…)
  - Control (input, output,…)
- Process instructions

Instructions?

Instructions?



$$3x^2 + 6x - 15 = 0$$

Instructions?

$$3x^2 + 6x - 15 = 0$$

- Find a common divisor (3)

Instructions?

$$3x^2 + 6x - 15 = 0$$

- Find a common divisor (3)
- Divide members by it

$$x^2 + 2x - 5 = 0$$

Instructions?

$$3x^2 + 6x - 15 = 0$$

- Find a common divisor (3)
- Divide members by it $x^2 + 2x - 5 = 0$
- Calculate the discriminant D so that $D = \sqrt{b^2 - 4ac}$ where $ax^2 + bx + c = 0$

Instructions?

$$3x^2 + 6x - 15 = 0$$

- Find a common divisor (3)
- Divide members by it $x^2 + 2x - 5 = 0$
- Calculate the discriminant D so that $D = \sqrt{b^2 - 4ac}$ where $ax^2 + bx + c = 0$ $D = 24$
- If D >= 0, solve for x1, x2

$$x_1 = \frac{-b + \sqrt{D}}{2a} \qquad x_2 = \frac{-b - \sqrt{D}}{2a}$$

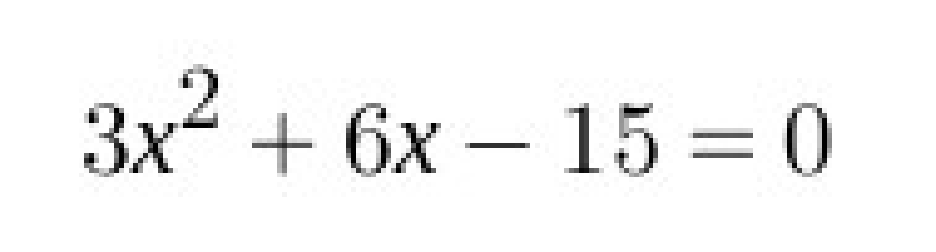
Instructions?

$$3x^2 + 6x - 15 = 0$$

- Find a common divisor (3)
- Divide members by it $x^2 + 2x - 5 = 0$
- Calculate the discriminant D so that $D = \sqrt{b^2 - 4ac}$ where $ax^2 + bx + c = 0$ $D = 24$
- If D >= 0, solve for x1, x2

$x_1 = \frac{-b + \sqrt{D}}{2a}$ $x_2 = \frac{-b - \sqrt{D}}{2a}$ $x_1 = \sqrt{6} - 1$ $x_2 = -\sqrt{6} - 1$

Instructions?



$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15							

0

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15							

3

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15							

12

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15							

-180

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15	-180						

-180

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15	-180						

6

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15	-180						

36

Instructions?

$$3x^2 + 6x - 15 = 0$$

- For our microprocessor?
  - Stupid, good at math
- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

3	6	-15	-180						

216

Instructions?

- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..

Instructions?

- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..
- Load @= 0, Mult # = 1, Mult @ = 2, Store @ = 3, Sub @ = 4,...

Instructions?

- Load @0, Mult #4, Mult @2, Store @3, Load @1, Mult @1, Sub @3, ..
- Load @= 0, Mult # = 1, Mult @ = 2, Store @ = 3, Sub @ = 4,…
- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,...

Instructions?

- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,…
  - Numbers

Instructions?

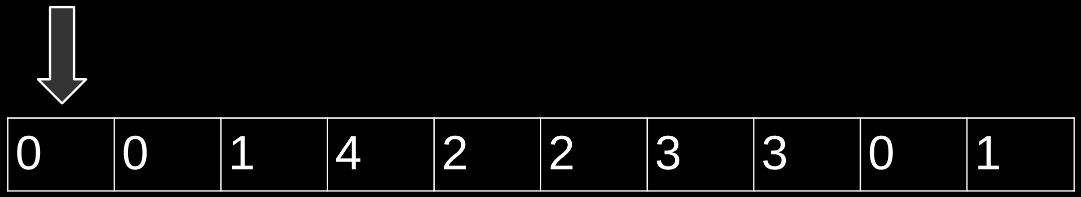
- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,…
  - Numbers
  - Can be stored in memory

Instructions?

- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,…
  - Numbers
  - Can be stored in memory
- Program counter

Instructions?

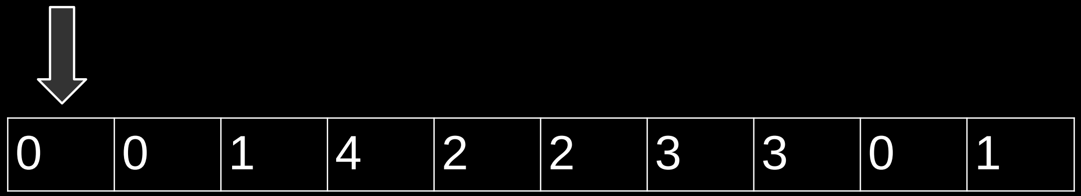
- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,…
  - Numbers
  - Can be stored in memory
- Program counter



0	0	1	4	2	2	3	3	0	1

Instructions?

- 0 0 1 4 2 2 3 3 0 1 2 1 4 3,…
  - Numbers
  - Can be stored in memory
- Program counter
  - Incremented, Jump, Branch



0	0	1	4	2	2	3	3	0	1

What does it do a lot?

What does it do a lot?

- Fetch instruction

What does it do a lot?

- Fetch instruction
- Decode it

What does it do a lot?

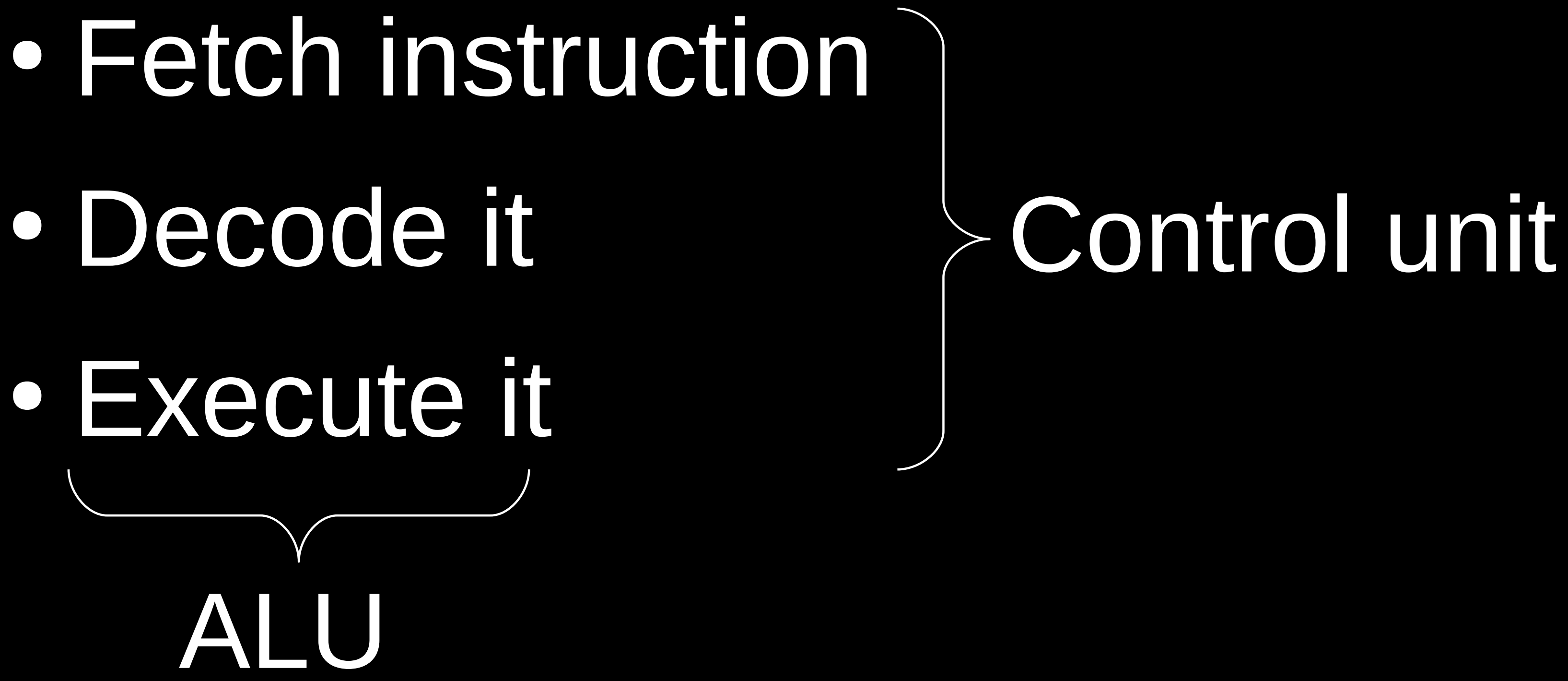
- Fetch instruction
- Decode it
- Execute it

What does it do a lot?

- Fetch instruction
- Decode it
- Execute it

Control unit

What does it do a lot?



- Fetch instruction
- Decode it
- Execute it

Control unit

ALU

Extra

Extra

- Pipelining

Extra

- Pipelining
- Branch Prediction

Extra

- Pipelining
- Branch Prediction
- Architecture

Extra

- Pipelining
- Branch Prediction
- Architecture
- Multi-threading, Multi-core

Extra

- Pipelining
- Branch Prediction
- Architecture
- Multi-threading, Multi-core
- Caching

The end

Questions?

The end