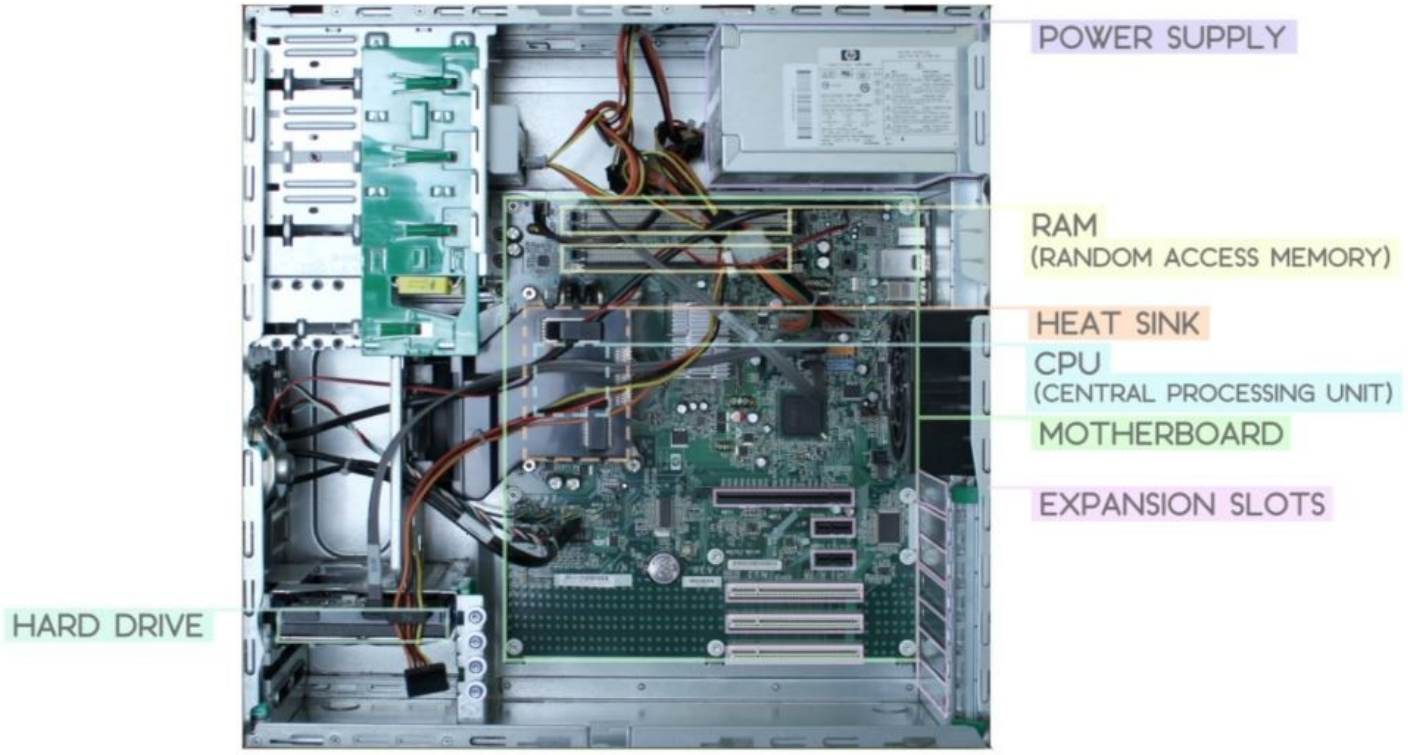
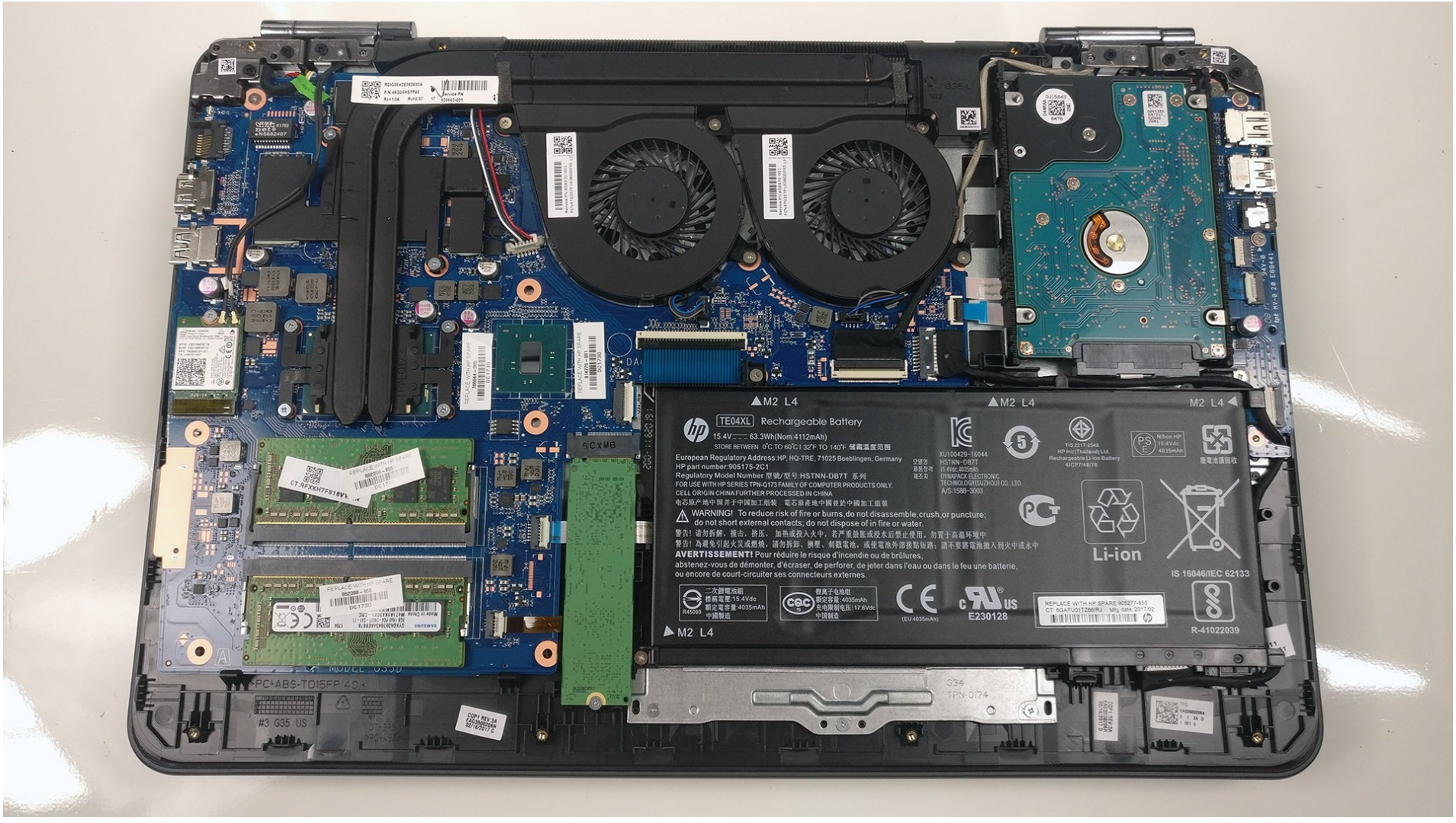
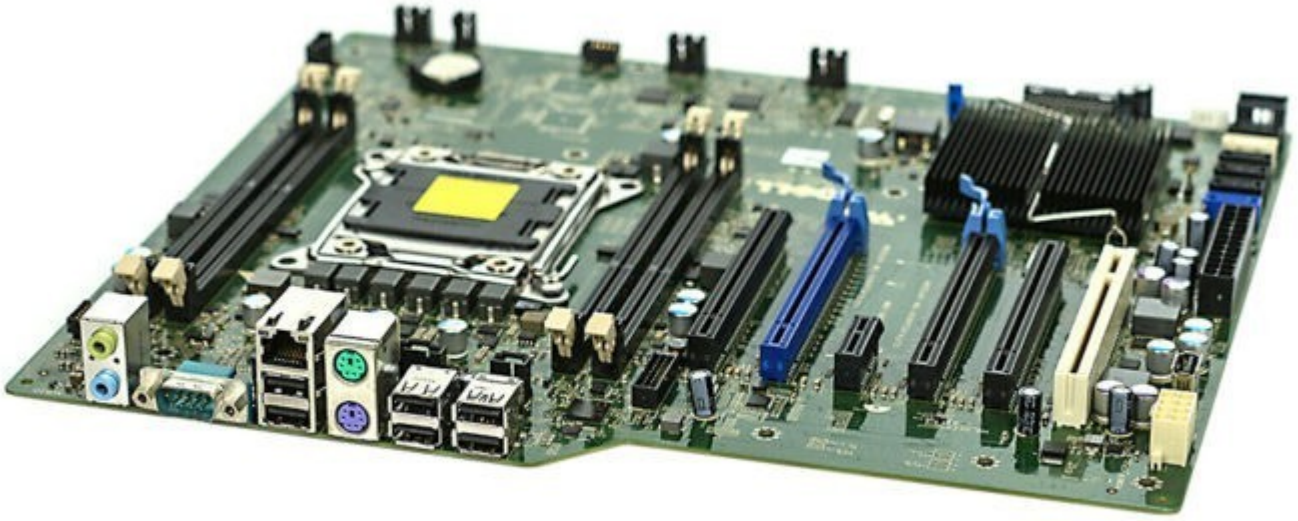
Computers and programming

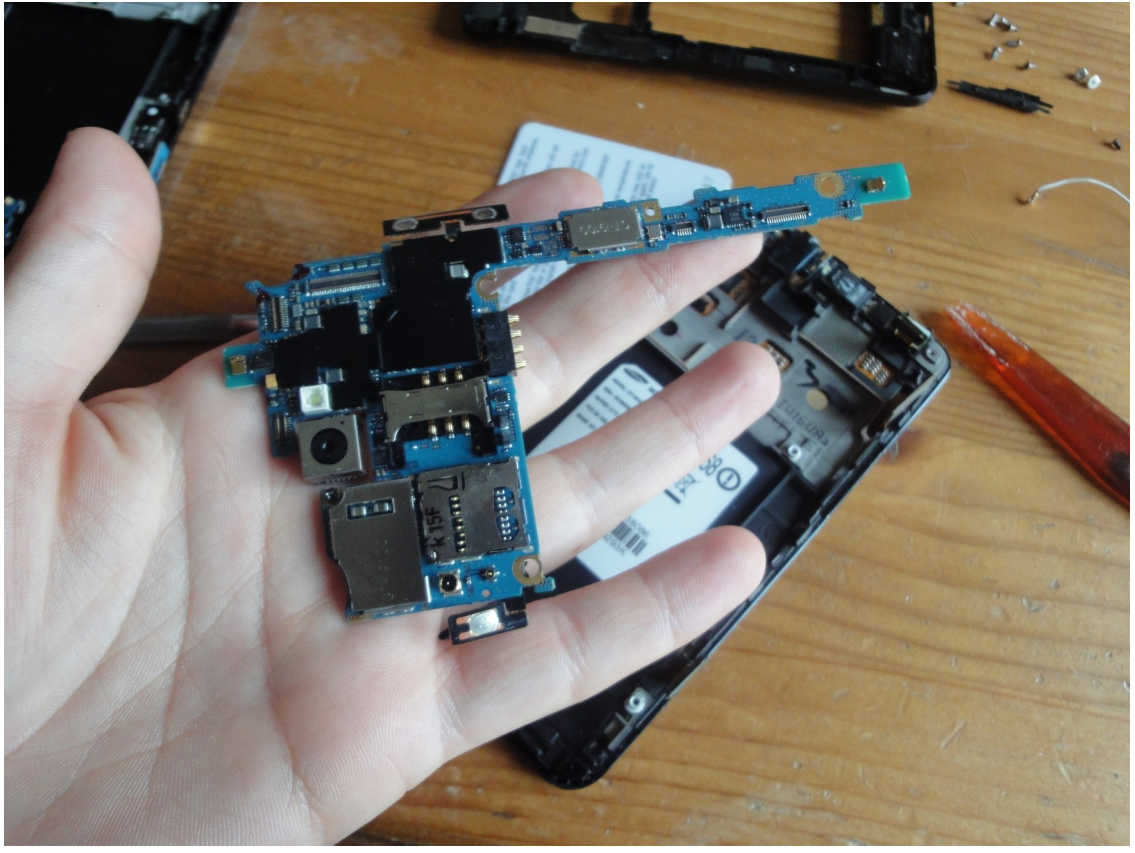
IC152 Lecture 3
Feb 2021

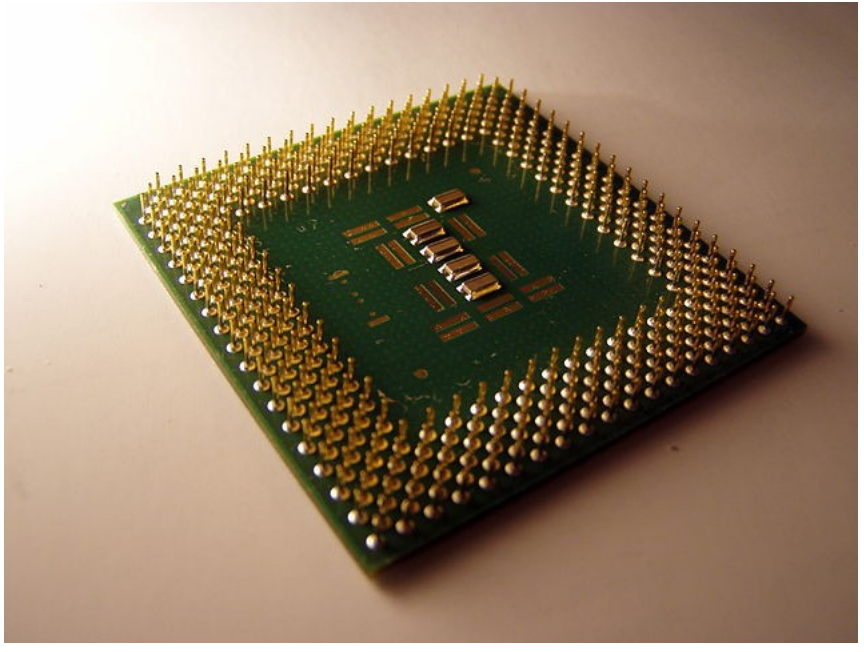
Whats inside?

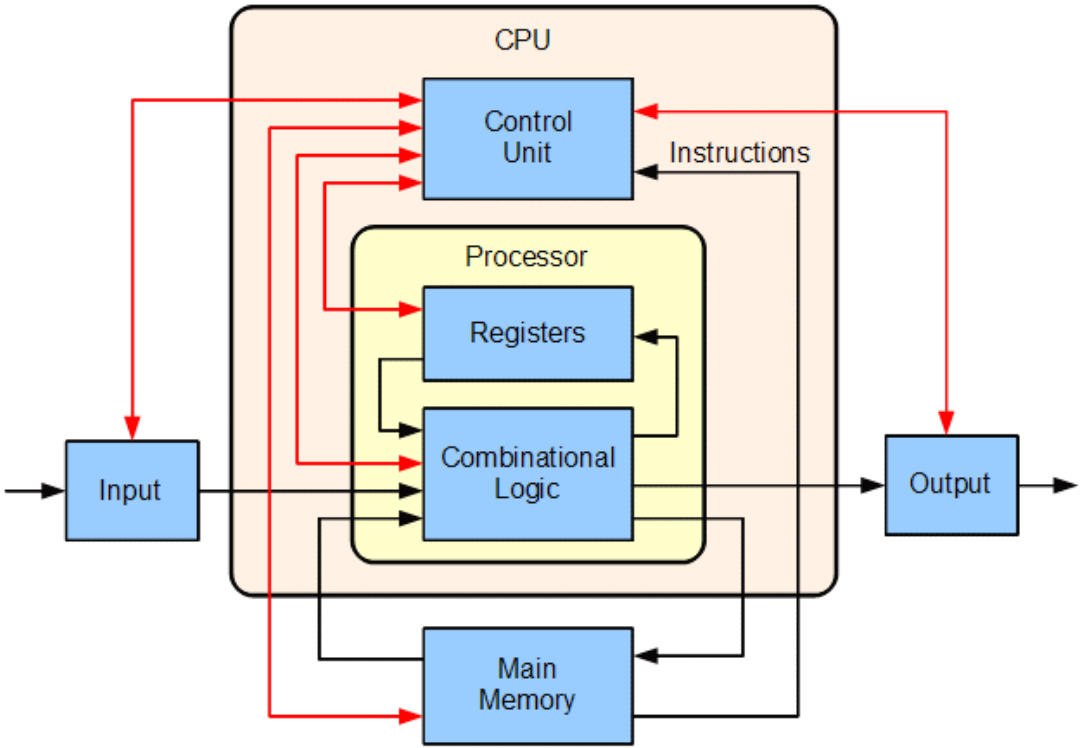



TE04XL Rechargeable Battery
15.4V 63.3Wh(Nom:4112mAh)
Li-ion
IS 16046/IEC 62133
E230128
R-41022039
#3 G35 US



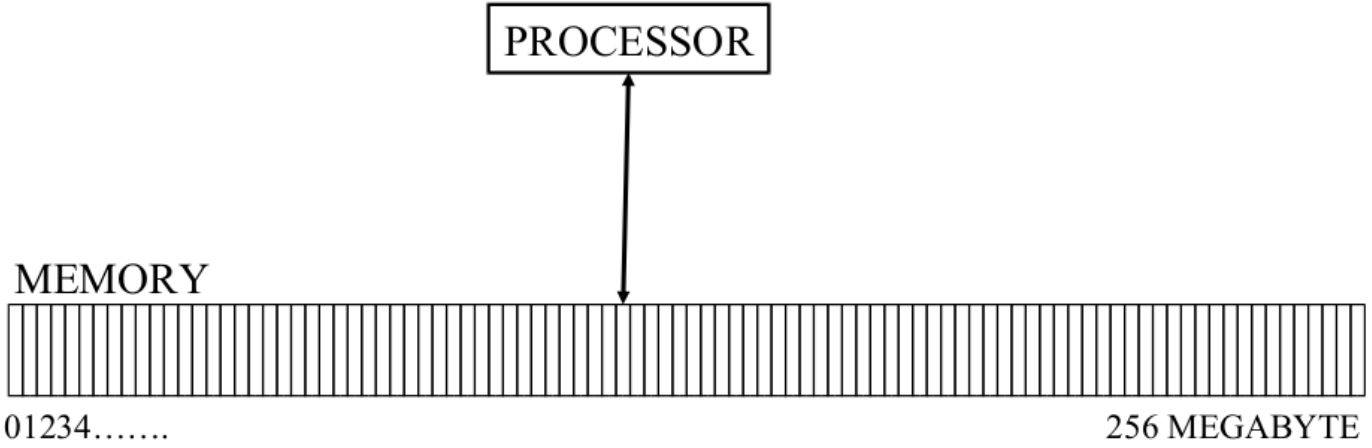






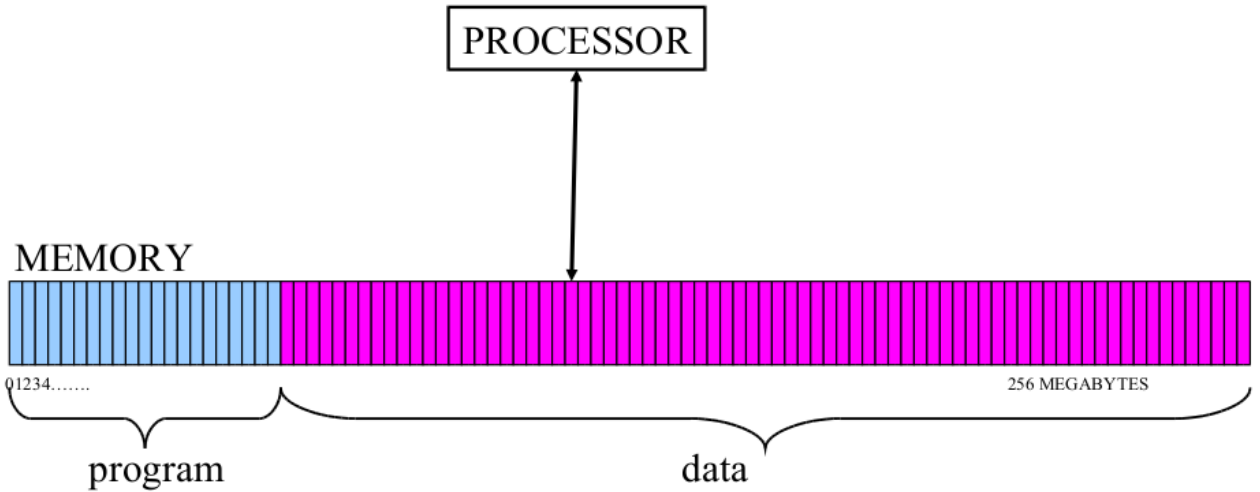
By Lambtron - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=37716438

The computing machine



The computer has a *processor* and a *memory*. The memory is a series of *locations* to store information.

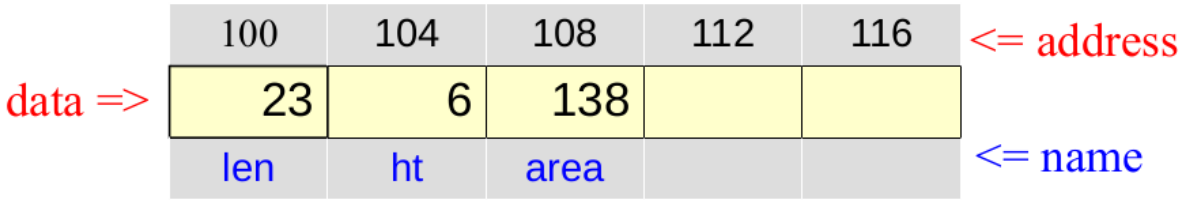
The stored program *von Neumann* computer



- A *program* is a sequence of *instructions* for some task
- Most instructions operate on *data*
- Some instructions *control* the sequence of the instructions
- It is even possible to treat programs as data. By doing so a program could create another program, *or even modify itself*

Variables

- A memory location has an address and contains data
- The memory location is given the name of a variable for ease of use by the programmer



- Type of a variable defines the kind of data
  - e.g. integers (1, 175, 25649), or characters (‘a’, ‘M’, ‘n’, ‘i’, ‘d’)
- All data is stored as a sequence of bits, 0’s and 1’s, in a word of a fixed size. 1 byte = 8 bits

E.g. 01001101 = 77 Type: int 01001101 = 'M' char

Program = Instructions + Data

- Program = sequence of machine instructions that operate on a set of variables
- Most instructions do some operation on a variable and store the result in another variable
- The instruction "X←X+Y" on integer variable:
  Take the integers stored in locations X and Y, add them, and store the sum back in X
- Other kinds of instructions E.g.
  - "jump" to an instruction out of sequence
  - terminate the program
  - read from the keyboard

Programs

- A program is a sequence of instructions
- The processor works as follows:

  Step A: pick next instruction in the sequence

  Step B: get data for the instruction to operate upon

  Step C: execute instruction on data (or “jump”)

  Step D: store results in designated location (variable)

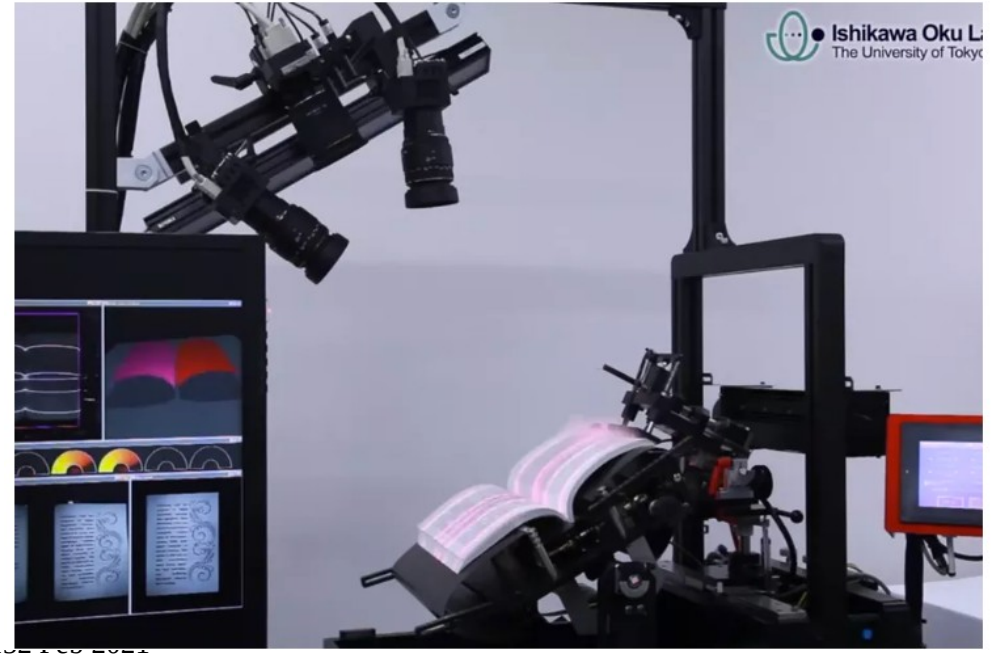
  Step E: go to Step A

Ho do humans solve problems?

- Can handle diverse tasks
- What things did you do yesterday?
  - Eat, sleep, study, respond to FB messages, watch TV etc.
- Over a week?
- Some simple tasks for humans (and most animals)
  - Walk, understand and react to surroundings (eg. crossing the road)
- We can even multitask (drive while talking, eat while watching TV)
- Repeating the same task is boring (eg. arrange 100 newspapers by date) => make mistakes

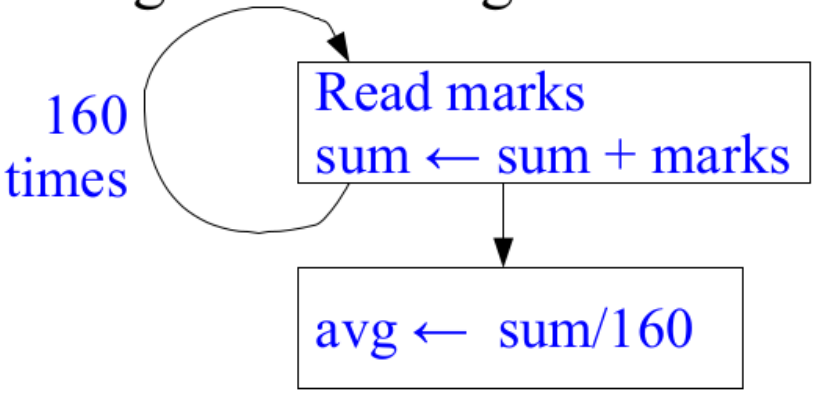
Computers solve problems differently

- Repeat similar tasks, with different data
- Very fast, not bored, no mistakes
- Eg. scanning pages of books
  - 250 pages/min



theverge.com

E.g. Find average of 160 answer scripts



What should be the initial value of the variable sum?
Does it change over time?
Does it always increase over time?
What are the variables in the above procedure?

Problem: Swap 2 Numbers

- Given variables x and y, exchange their vales

Start:

x	y
371	58

Desired:

x	y
58	371

Method 1:

```
x ← y;
y ← x;
```

E.g.

x	y	
371	58	
58	58	x ← y
58	58	y ← x

Wrong!

Padman

Slides from IC152, 2018

… Swap 2 Numbers

Method 2: Need to save original value of x

```
t ← x
x ← y
y ← t
```

x	y	t	
371	58	?	
371	58	371	t ← x
58	58	371	x ← y
58	371	371	y ← t Right !

… Swap 2 Numbers: Code

Pseudo-code

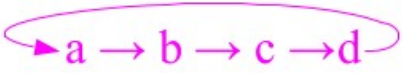
1. Create Temporary variable t
2. Save value of x in t
3. Set x to value of y
4. Set y to value of t

1. Let t be an integer
2. $t \leftarrow x$
3. $x \leftarrow y$
4. $y \leftarrow t$

Python code

```
t = x
x = y
y = t
```

Design a program to swap 4 variables



start with

a = 2
b = ‘IIT’
c = 3.7
d = 17

end with

a = 17
b = 2
c = ‘IIT’
d = 3.7