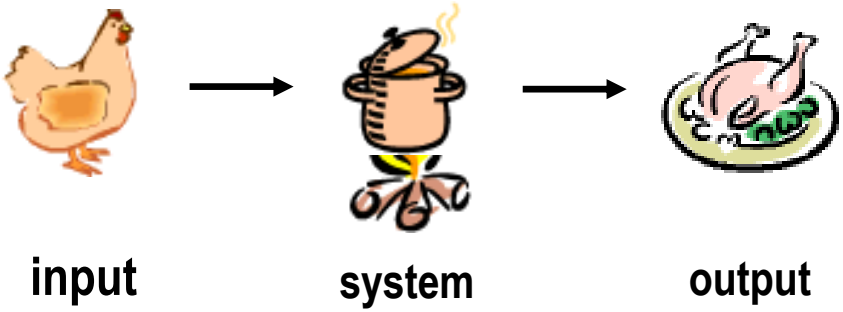
Unit 1: Basic of Electronic Systems and Micro:bit

What is a System?

- System: A combination and interconnection of several components to perform a task



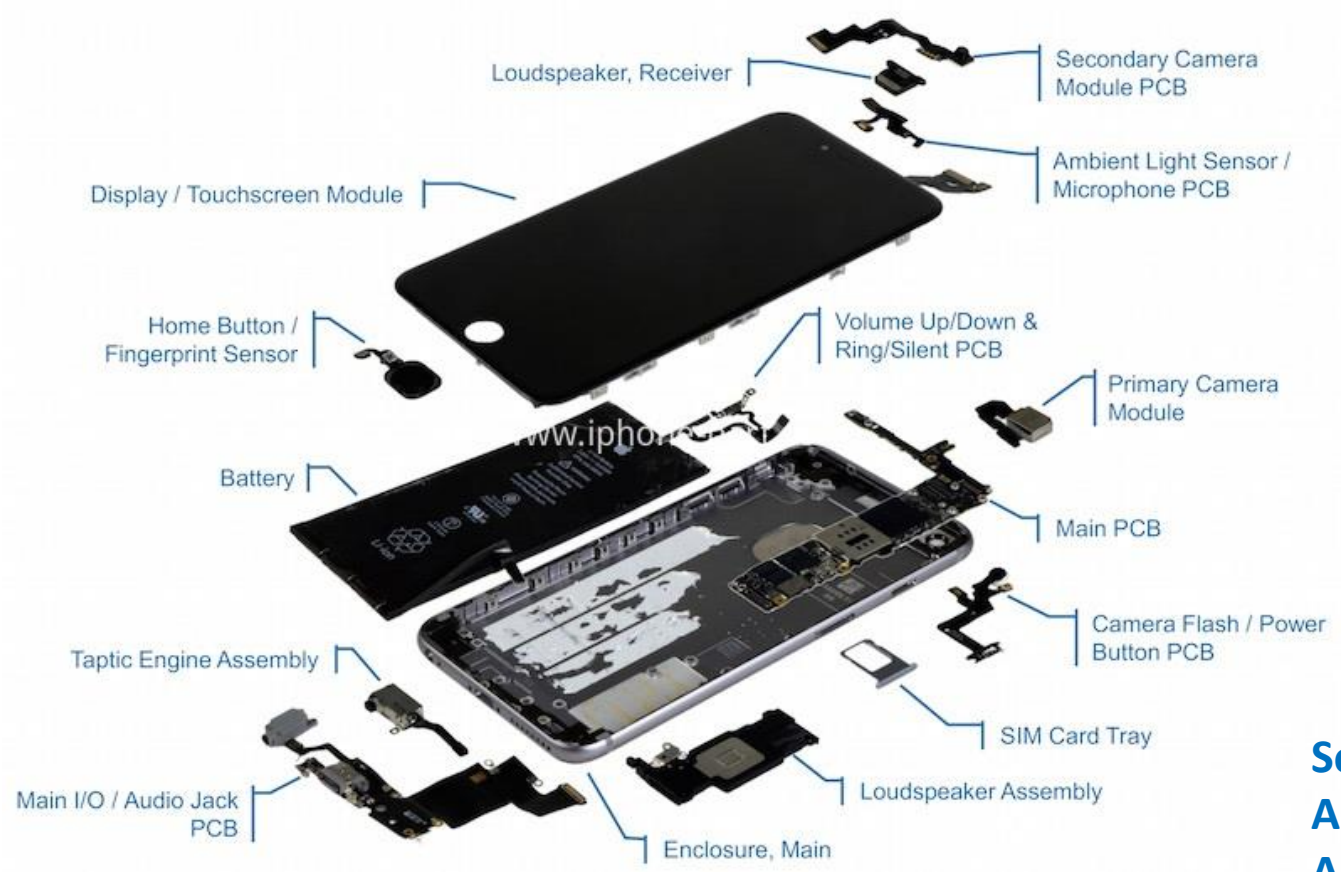
Electronic System Design

- Input: "cause" of the change
- Output: resulting action ("effect") that occurs on the system output due to the cause

For an autonomous car, the controller drives the car (OUTPUT) based on the road environment (INPUT)

Electronic System = Hardware + Software

- Eg. Mobile Phone



Hardware:
Camera module,
Loudspeaker,
Battery,
Fingerprint sensor,
Home button,
…

Software:
Android / iOS (system)
App

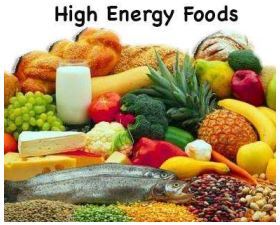
Main Classification for Hardware Modules

- Controller / Processor :

- Sensors: Temperature, light, …

- Wireless communications: Bluetooth, Zigbee

- Power: battery, DC/DC converter



- Actuators: motor, Display unit

Connections between Modules

Power Supply Unit

Power input

Memory (e.g. store program)

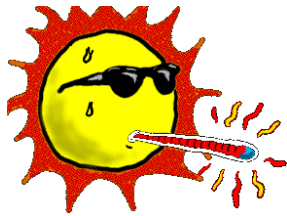
Processing Unit (e.g. do calculation)

Input / Output ports

Controller / CPU

Sensors

input



output

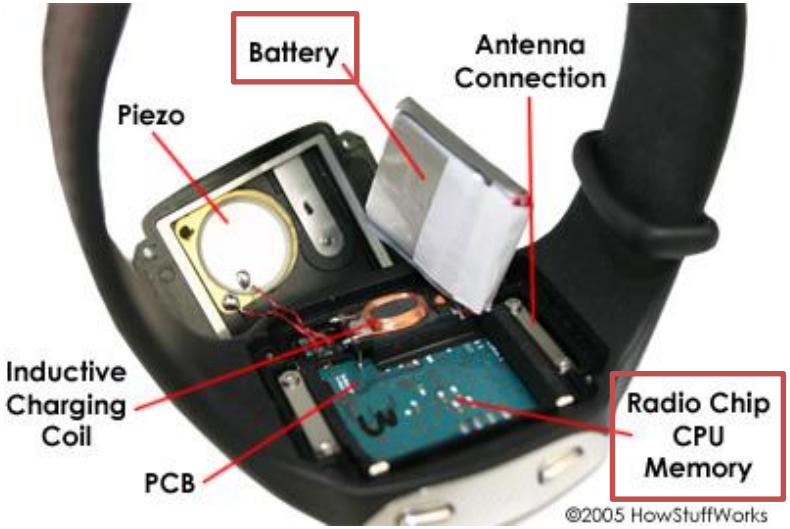
Actuators

Wireless Comm. Module

Example: Smart watch

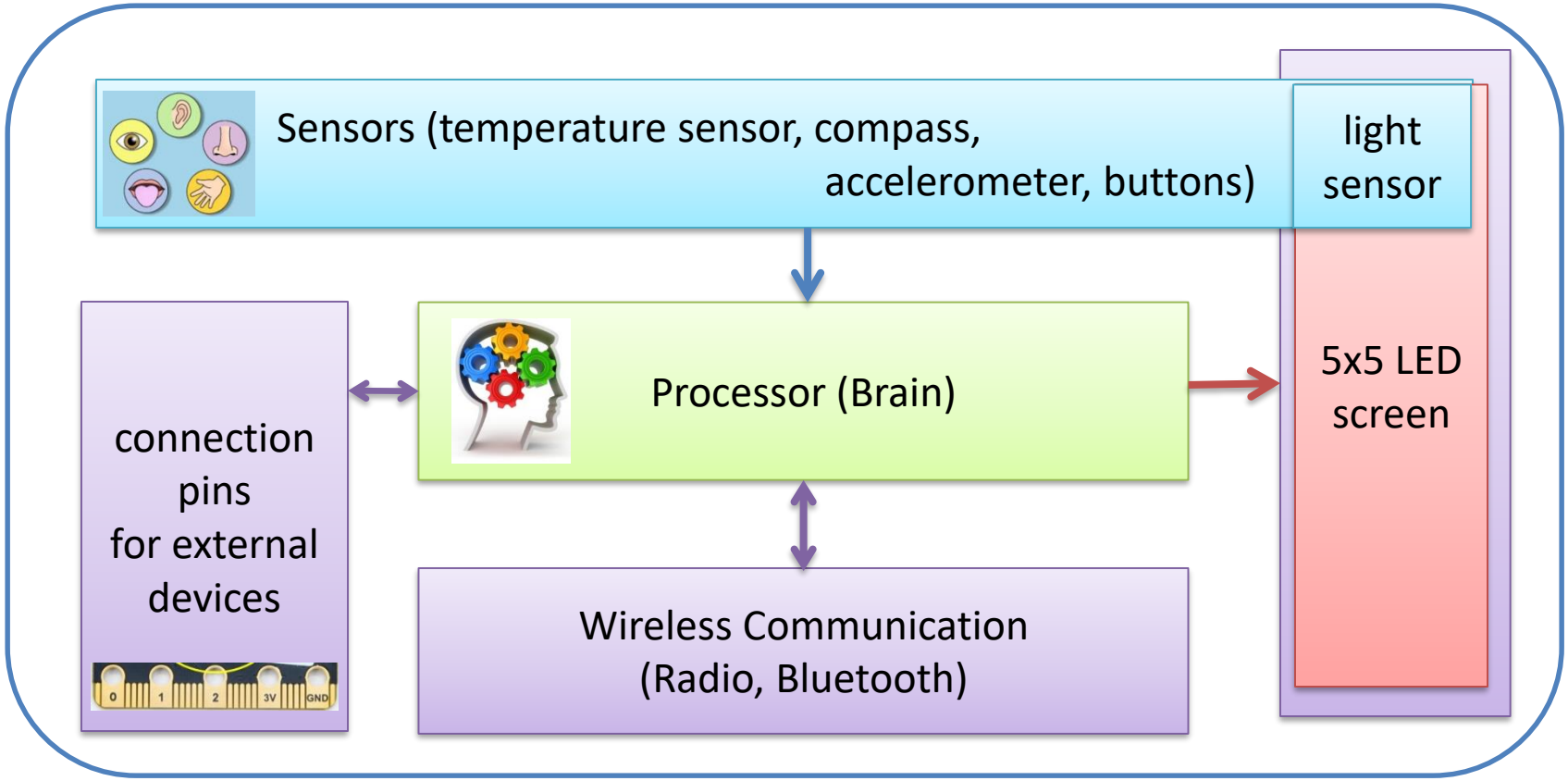
Sensor:
heart beat sensor

Actuator:
Display



Inside: Battery, controller,
Radio chip + antenna (for wireless comm.)

Micro:bit as a System



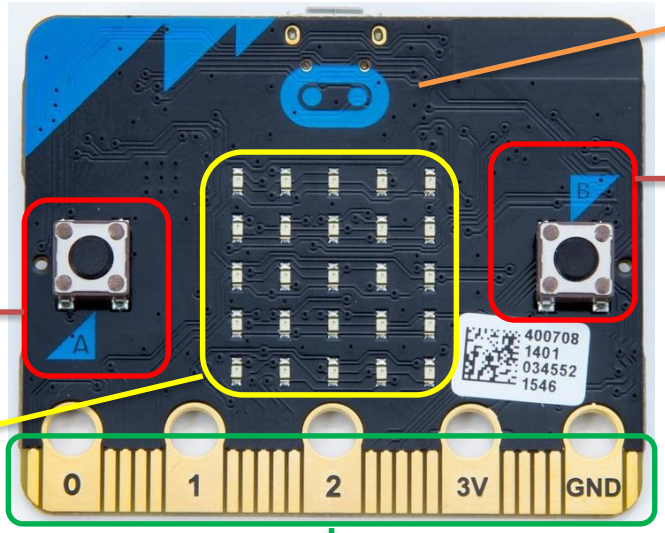
inputs

both
Input / output

outputs

Recognize Your Micro:Bit

Front



logo

Push button switch B

Push button switch A

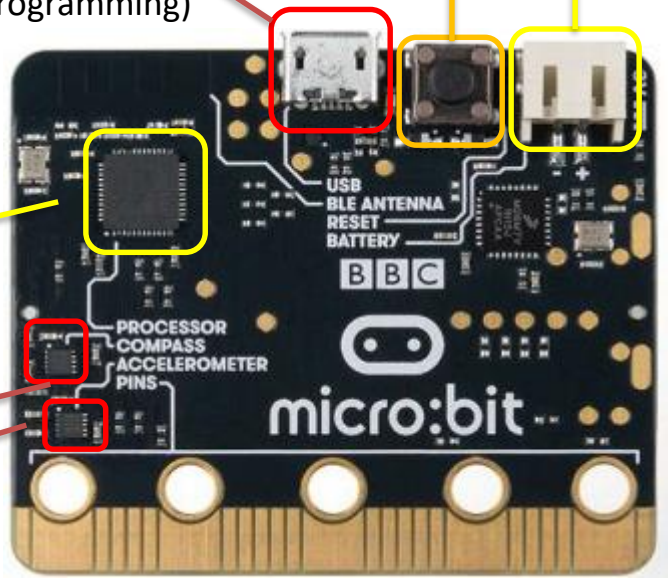
5x5 LEDs (and light sensor)

Connection fingers

Reset button

micro-USB Connector (programming)

Power Connector (to battery pack 3V)



Processor M0
(do calculation, logic, … also has temperature sensor)

compass

accelerometer

https://microbit.org/guide/features/

https://www.youtube.com/watch?v=7kTxukIcLd4

Back

Overview

- 5x5 programmable LEDs (forming a LED screen)
- 2 programmable buttons (Button A and B)
- Physical connection pins (25 edge connectors)
- Light and temperature sensors; digital compass
- Motion sensors (accelerometer)
- Wireless Communication (Radio and Bluetooth)
- USB interface

Basic Descriptions

- LED (Light Emitting Diode)
  - Allow you to display text, numbers and images
- Buttons (button A and button B)
  - Allow you to trigger codes on the device by detecting when these buttons are pressed or not.
- Pins
  - Allow you to read a sensor (as input) or control an actuator (as output) by connecting them to the pins

Basic Descriptions

- Light sensor
  - By reversing the LEDs, they can be used to detect ambient light
- Temperature sensor
  - To detect the current ambient temperature, in degrees Celsius
- Accelerometer
  - To measure the acceleration of your micro:bit;
  - It can sense when the micro:bit is accelerating or detect other actions, e.g. shake, tilt, and free-fall.

Basic Descriptions

- Compass / Magnetometer
  - It detects the earth's magnetic field, and hence can detect which direction the micro:bit is facing.
  - The compass needs to be calibrated before use.
- Radio
  - Allow wireless communications between micro:bits
- Bluetooth
  - Allow the micro:bit communicating with a phone
- USB Interface
  - To power up the micro:bit and download programs onto micro:bit
  - Allow wired communication with PCs

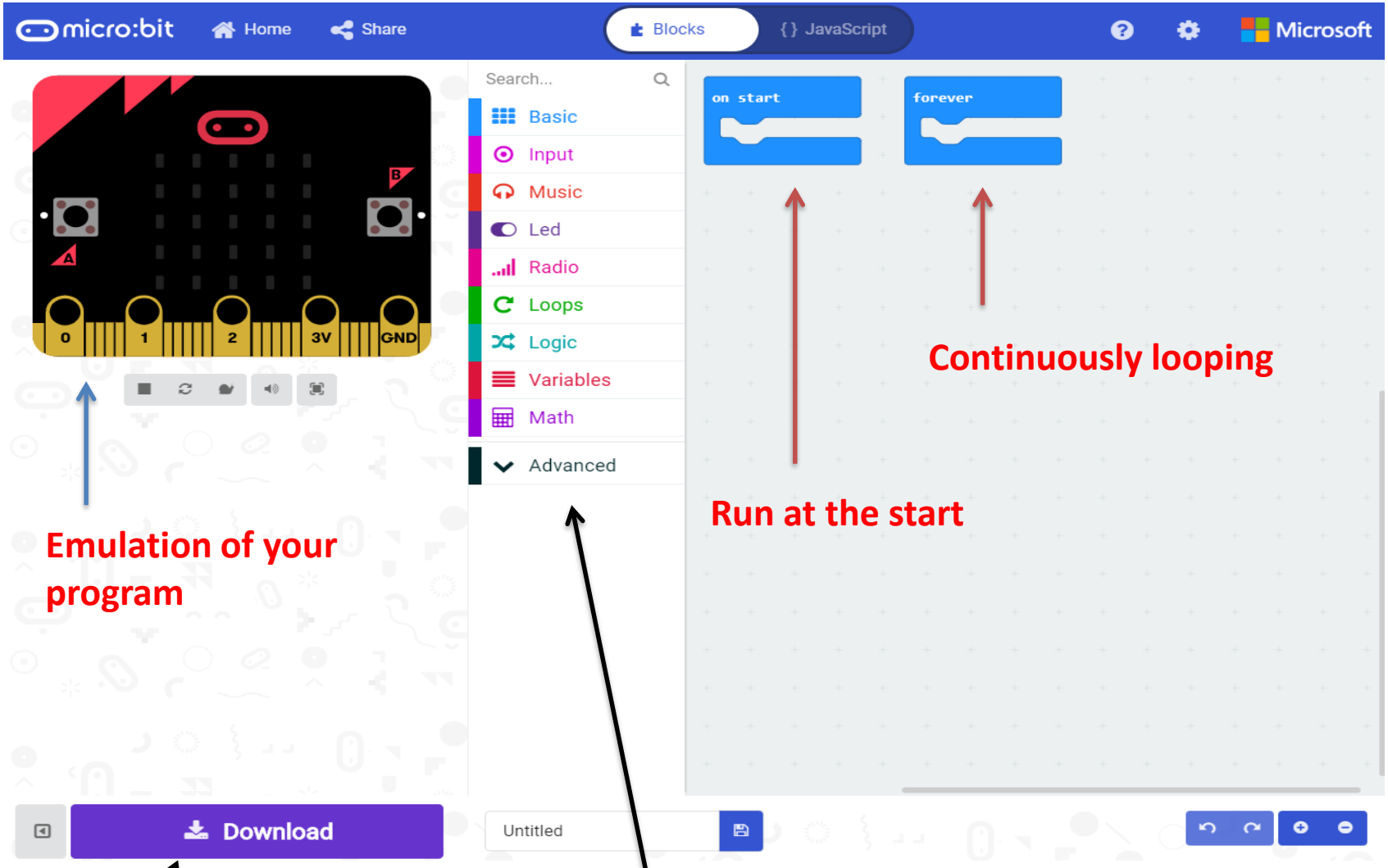
Programming Platform

There is a number of programming platforms supporting MicroBit. All these platforms have their own pros and cons. Due to various reasons, we will use some of these platforms in the beginning to illustrate the functionality of MircoBit. Moreover, MU python editor will be selected as the main software tool in this course.

- Microsoft MakeCode (Blocks or JavaScript) (for beginning)
  - https://www.microsoft.com/en-hk/makecode
- Micropython (python based, Mu editor)
  - https://microbit-micropython.readthedocs.io/en/latest/ (Microsoft editor)
  - *https://codewith.mu/en/about (MU editor as main tool in this coures)
- Arduino IDE (C language based) (will not be used)
  - https://learn.adafruit.com/use-micro-bit-with-arduino/overview

User Interface of Microsoft MakeCode

https://makecode.microbit.org/



Emulation of your program

Run at the start

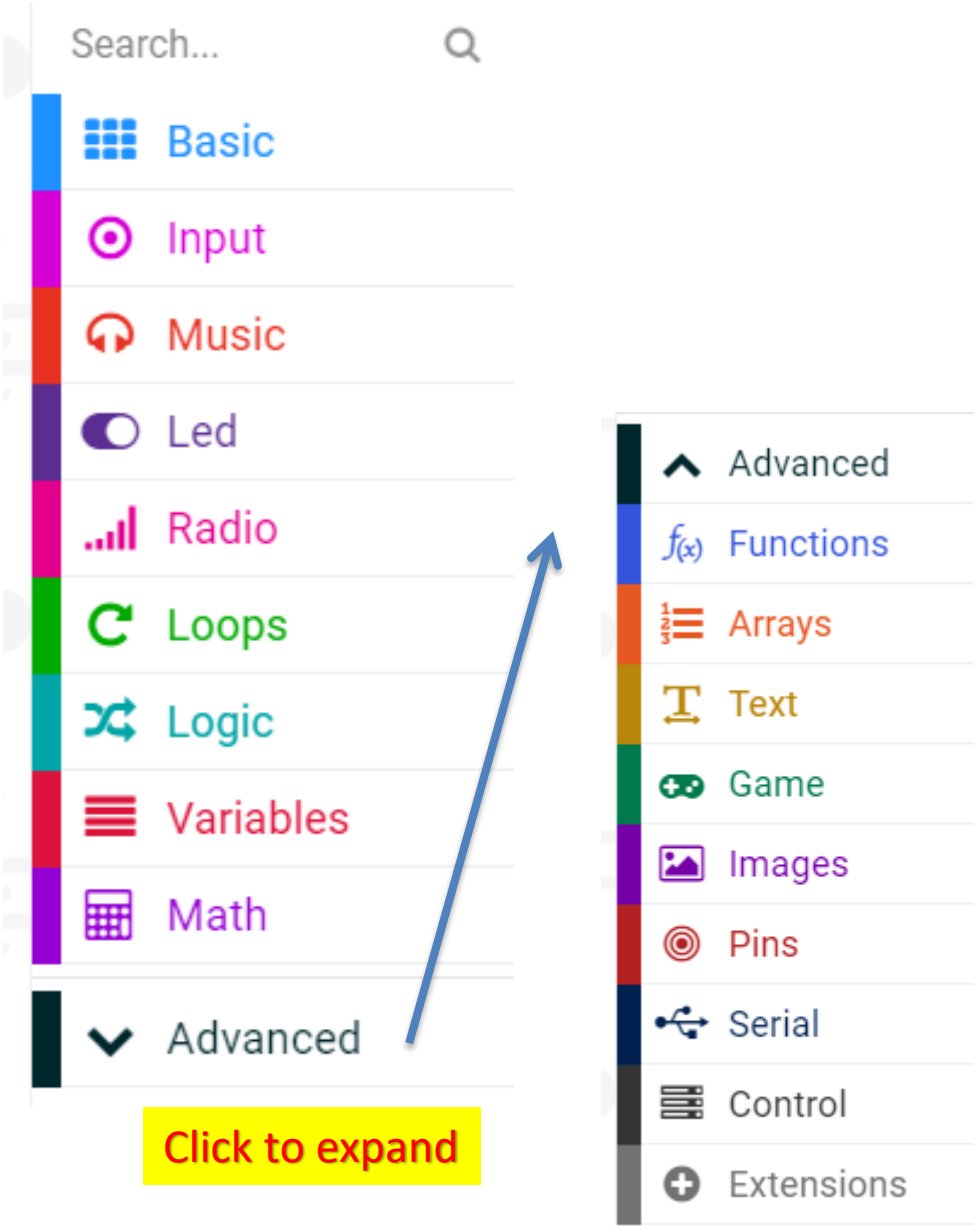
Continuously looping

Libraries that you can use by dragging the blocks

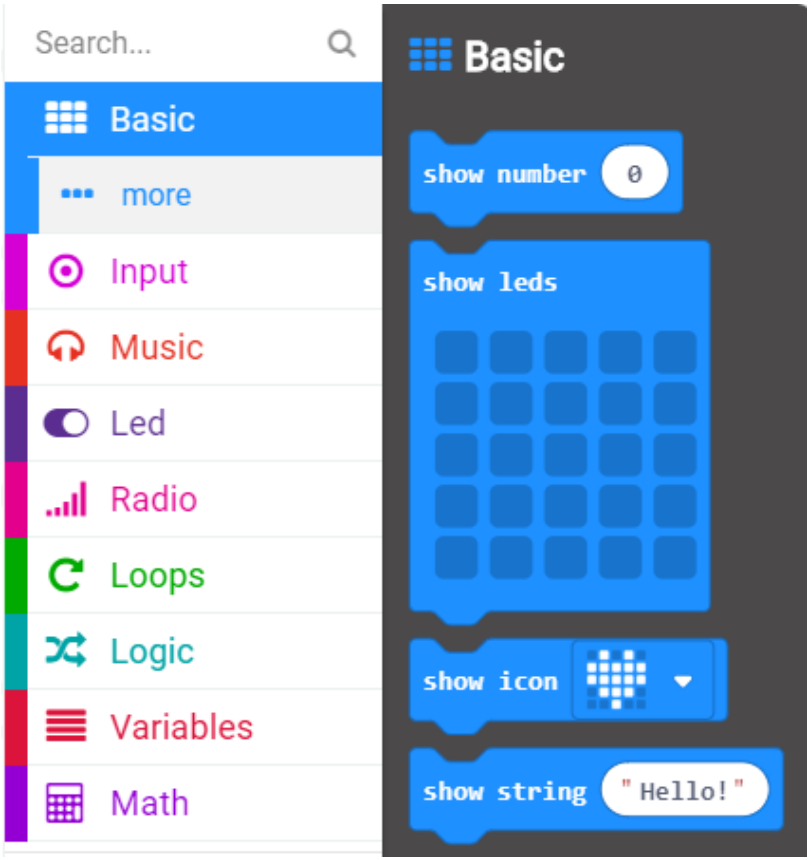
Download (hex file) to micro:bit after finished coding

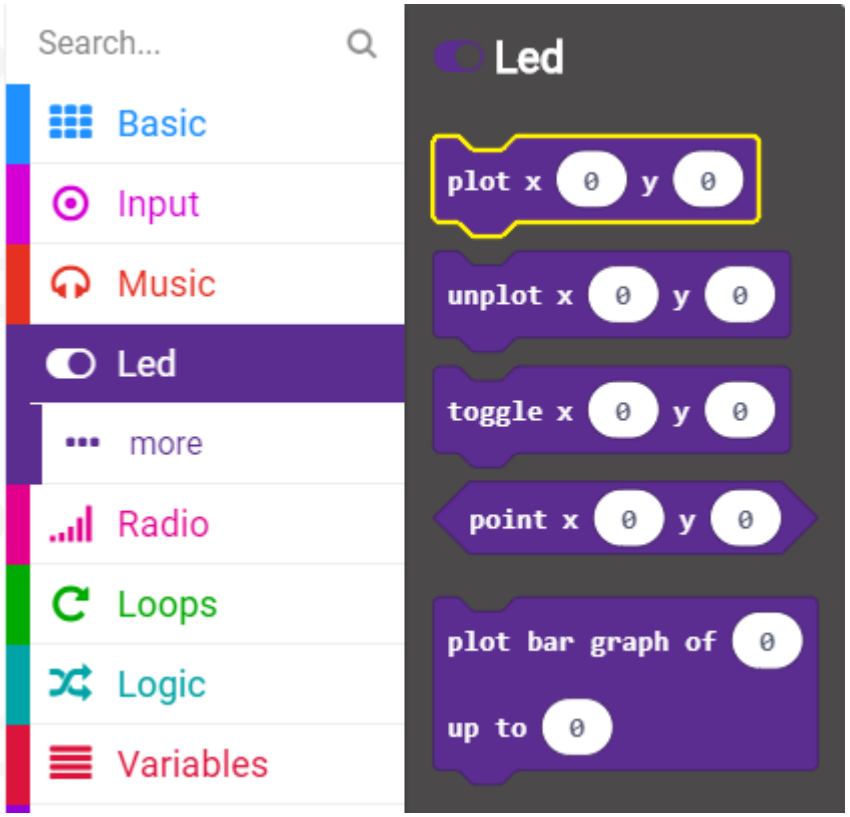
Libraries

- In MakeCode, there are pre-installed libraries that contain built-in functions



Examples of Libraries

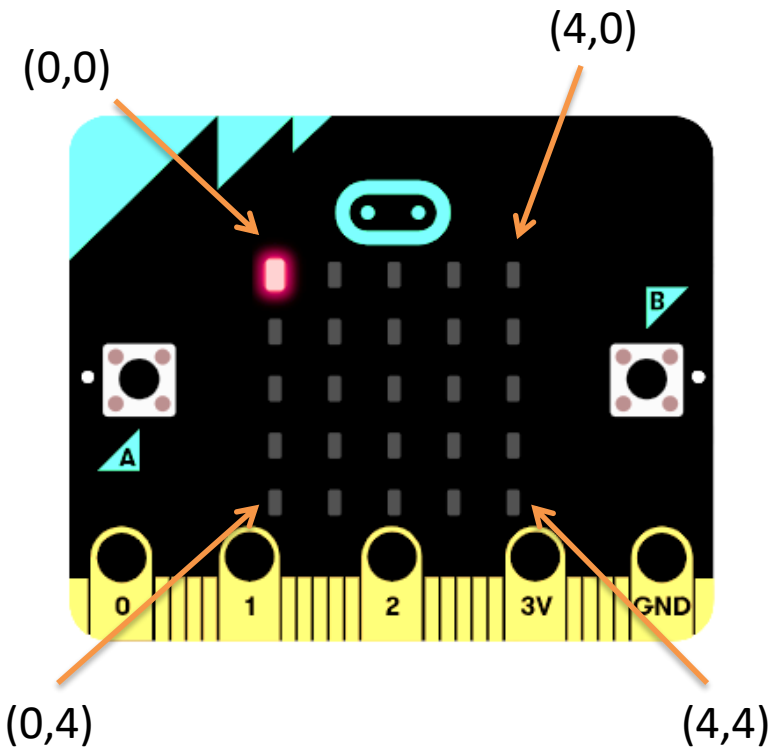


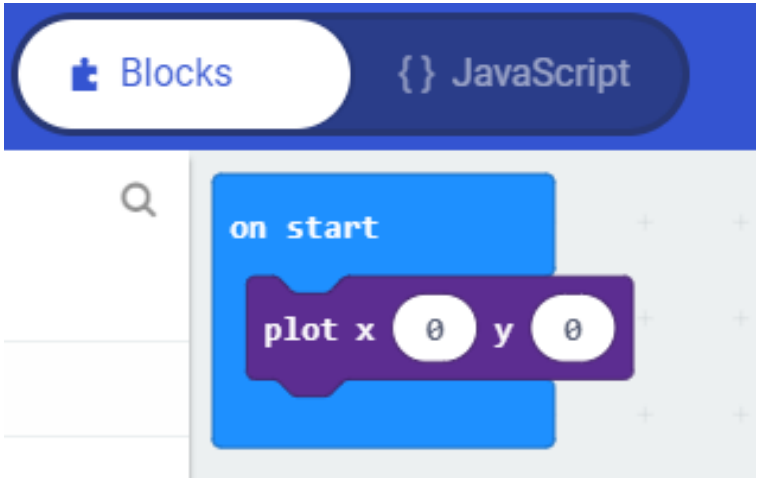


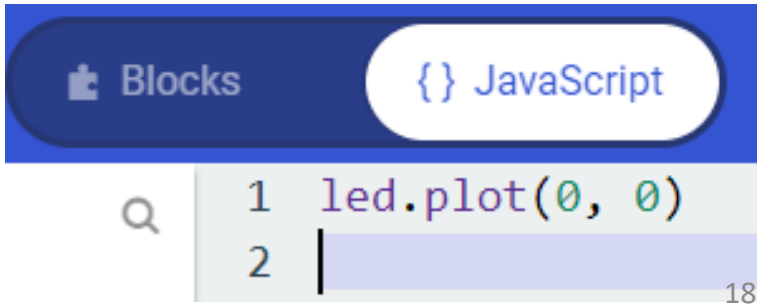
- many others …

Simple Program Examples

- Example 1: Lighting an on-board LED

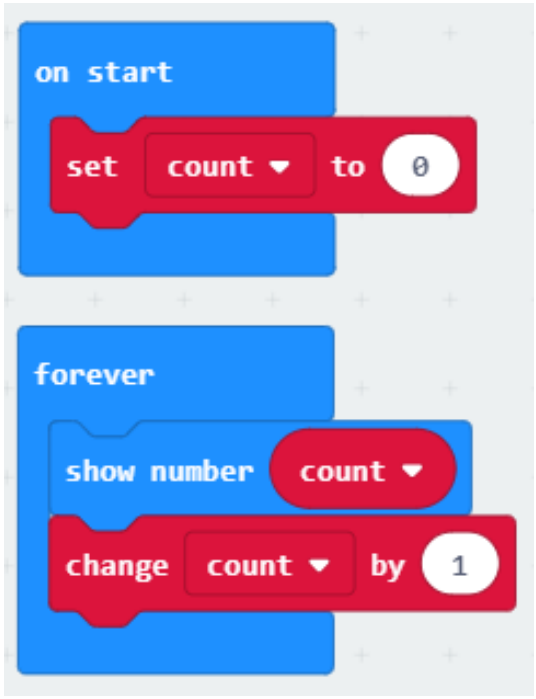




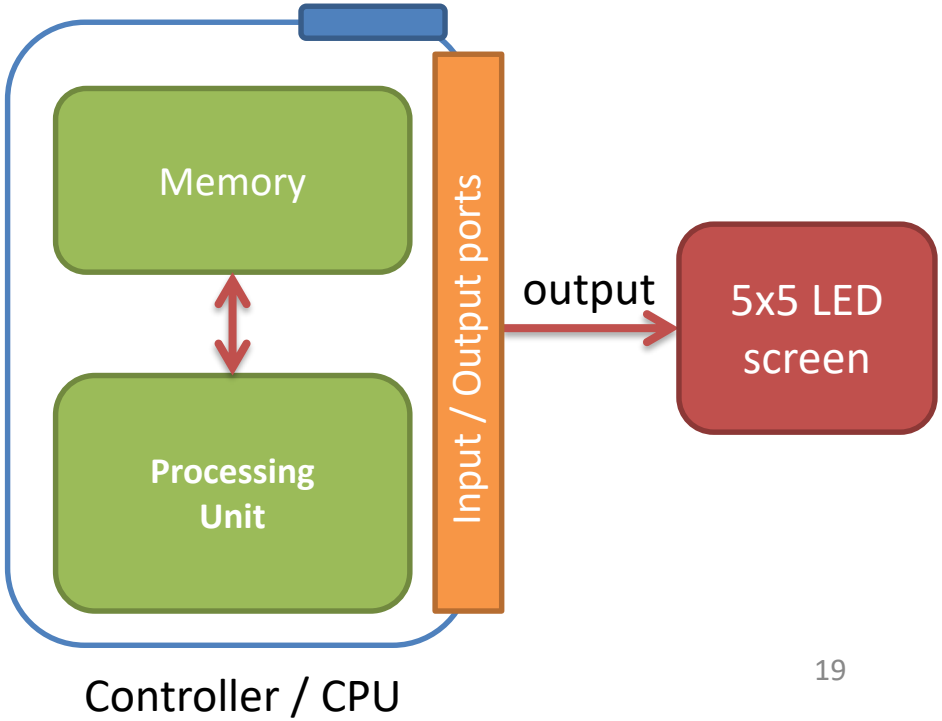


Program Structure

- A controller program consists of 2 parts:
  - **on start**: For initialization, and the codes only run once.
  - **forever**: The codes will loop continuously (Note: Controller program will not stop)
- The program is downloaded to the memory

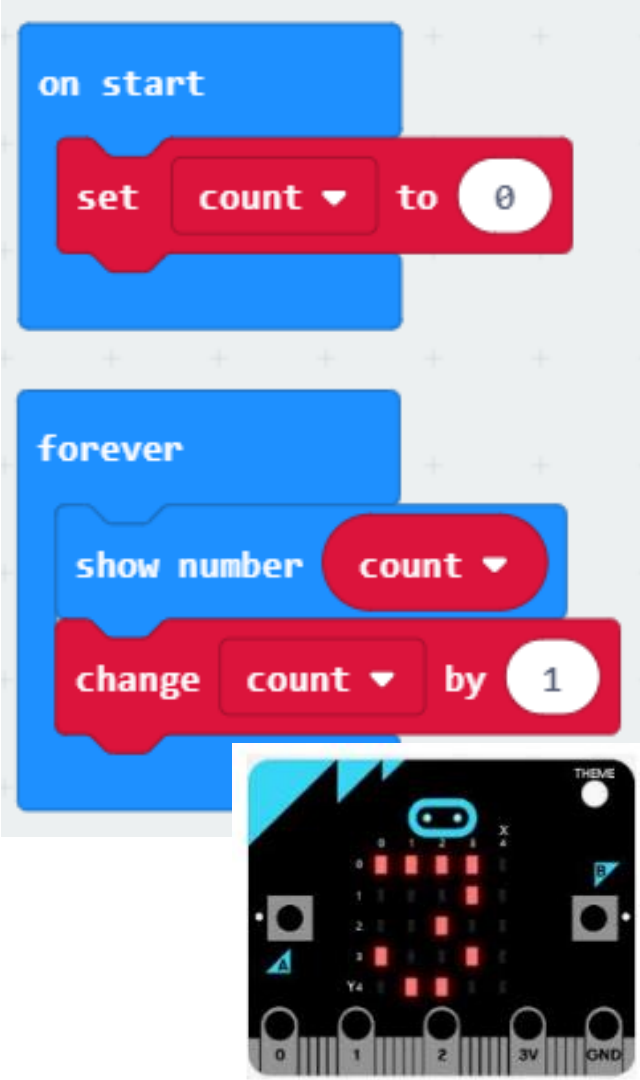


Download to memory



Example 2

- Display 0,1,2,… consecutively



Javascript (syntax must be correct)

```
1  let count = 0
2  count = 0
3  basic.forever(function () {
4      basic.showNumber(count)
5      count += 1
6  })
```

TEXT format (simply copying the texts based on blocks)

```
on start
{
  set count to 0
}
forever
{
  show number count
  change count by 1
}
```

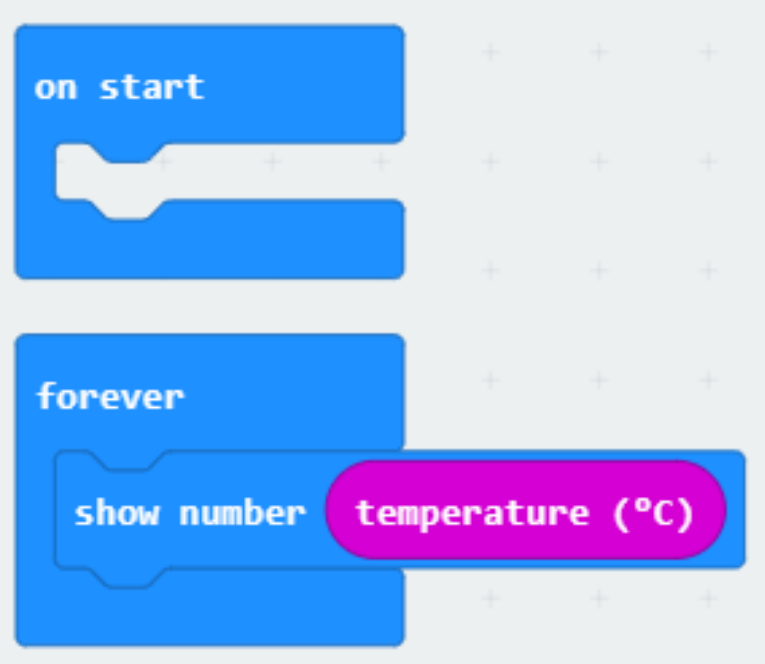
Note: This is not a programming language. It is only used in pen-and-paper exercises (eg. test, exam).

Question

- What are the outputs of the following two programs?

Example 3

- Display the current temperature




```
1  basic.forever(function () {
2      basic.showNumber(input.temperature())
3  })
```

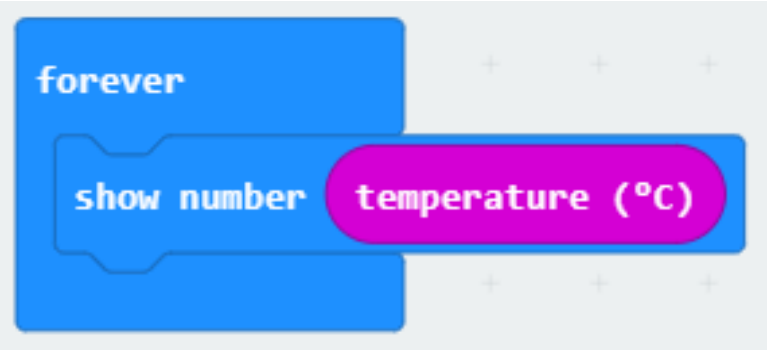
sense the ambient temperature

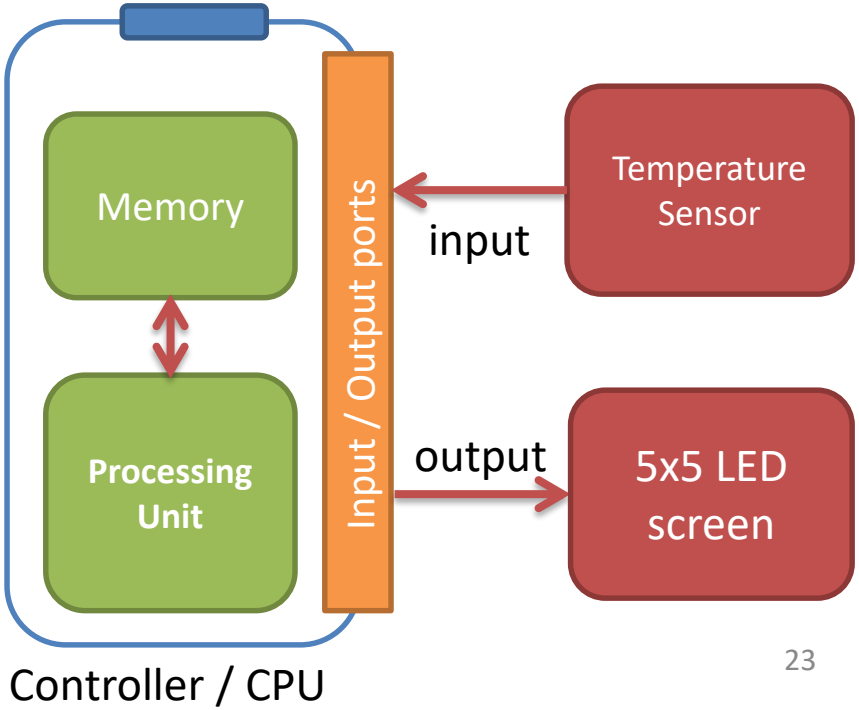
TEXT format (simply copying the texts in the blocks)

```
forever
{
  show number temperature (C)
}
```

Explanation

- The controller performs the followings repetitively
  - Get the output from the sensor
  - Convert it into degree Celsius
  - Output the value to 5x5 LED screen





References

- Make-code for MicroBit
  - https://makecode.microbit.org/reference
  - https://makecode.microbit.org/courses/csintro

- MU python editor for MicroBit
  - https://www.youtube.com/watch?v=my_MkYRoXQ8 (video – new version)
  - https://www.youtube.com/watch?v=zmOxOusMvjo (video – old version)
  - https://codewith.mu/en/tutorials/1.0/microbit (latest version 1.0.3)

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