

Introduction à Arduino

<https://www.arduino.cc>

Février 2023

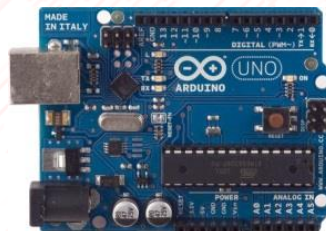
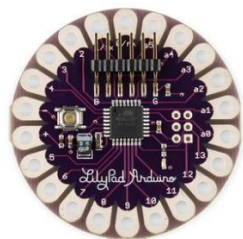
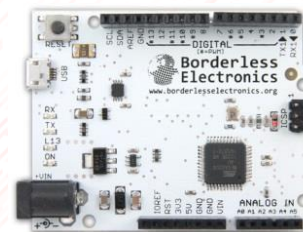
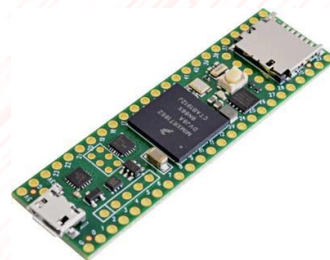
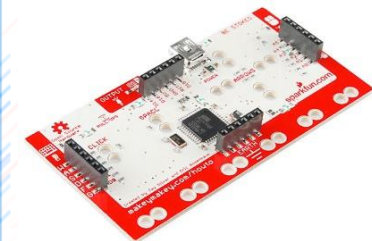
Qu'est ce qu'Arduino ?

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

D'abord du matériel !



avec plein de versions différentes !

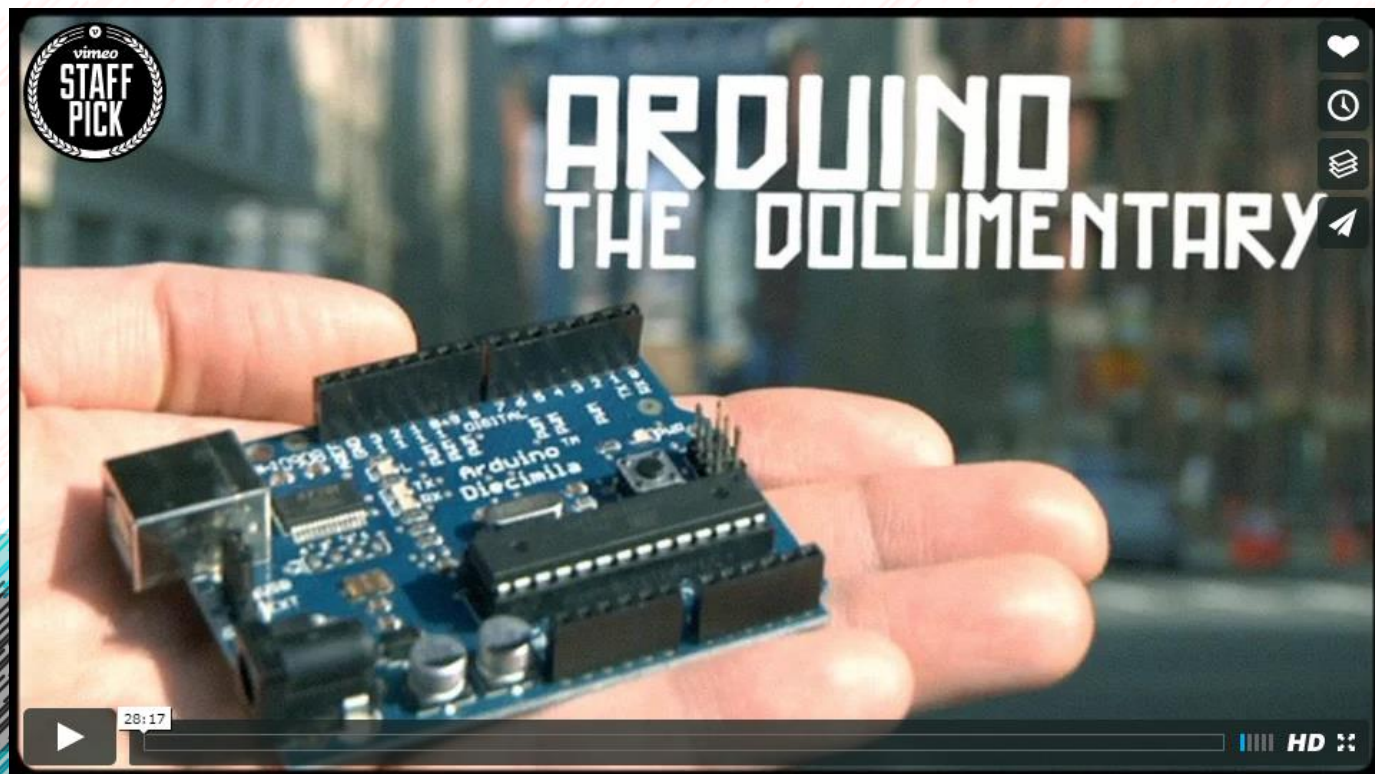
Une histoire d'Arduino ...

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

https://youtu.be/D4D1WhA_mi8

<https://arduinohistory.github.io>



Historique

sketch_feb08a

```
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```

Design by Numbers

<http://dbn.media.mit.edu>

Date : 1999-2001

Lieu : MIT Media Lab

John Maeda



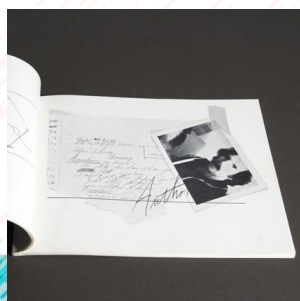
Visible Language Workshop

<http://museum.mit.edu/150/115>

Date : 1975

Lieu : MIT

Muriel Cooper



Processing

<https://www.processing.org>

Date : Printemps 2001

Lieu : MIT Media Lab

Ben Fry / Casey Reas



Processing 4



p5.js

Wiring

<http://wiring.org.co>

Date : 2003

Lieu : IDII

Hernando Barragán



Arduino

<https://www.arduino.cc>

Date : 2005

Lieu : IDII

Massimo Banzi



IDE – Environnement de dév.

sketch_feb08a

```
void setup() {  
  // put your setup code here  
}
```

```
void loop() {  
  // put your main code here  
}
```

The screenshot shows the Arduino.cc website. The top navigation bar includes links for PROFESSIONAL, EDUCATION, STORE, and a search bar. Below this, a secondary navigation bar highlights the SOFTWARE section. The main content area features a section for the Arduino Web Editor, followed by a 'Downloads' section. The download section includes a description of the new major release of the Arduino IDE 2.0.3, a list of download options for Windows, Linux, and macOS, and a link to the source code.

Software | Arduino

arduino.cc/en/software

PROFESSIONAL EDUCATION STORE

SEARCH on Arduino.cc SIGN IN

HARDWARE SOFTWARE CLOUD DOCUMENTATION COMMUNITY BLOG ABOUT

Arduino Web Editor

Start coding online and save your sketches in the cloud. The most up-to-date version of the IDE includes all libraries and also supports new Arduino boards.

CODE ONLINE GETTING STARTED

Downloads

Arduino IDE 2.0.3

The new major release of the Arduino IDE is faster and even more powerful! In addition to a more modern editor and a more responsive interface it features autocompletion, code navigation, and even a live debugger.

For more details, please refer to the [Arduino IDE 2.0 documentation](#).

Nightly builds with the latest bugfixes are available through the section below.

[SOURCE CODE](#)

DOWNLOAD OPTIONS

Windows Win 10 and newer, 64 bits
Windows MSI installer
Windows ZIP file

Linux AppImage 64 bits (X86-64)
Linux ZIP file 64 bits (X86-64)

macOS Intel, 10.14: "Mojave" or newer, 64 bits
macOS Apple Silicon, 11: "Big Sur" or newer, 64 bits

[Release Notes](#)

[Help](#)

Avantages

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```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

Les « + »

- Prototypage rapide et simple d'objets physiques interactifs !
- Peu cher (suivant les cartes), logiciel et matériel open-source (et donc possibilité de clones !)
- Environnement de programmation simple

Avantages

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Multiplateforme (Windows, MacOS, linux, RPi)
- Nombreuses librairies
- Des « *shields* » connectables pour augmenter les possibilités (ethernet, GPS, afficheur graphique, ...)

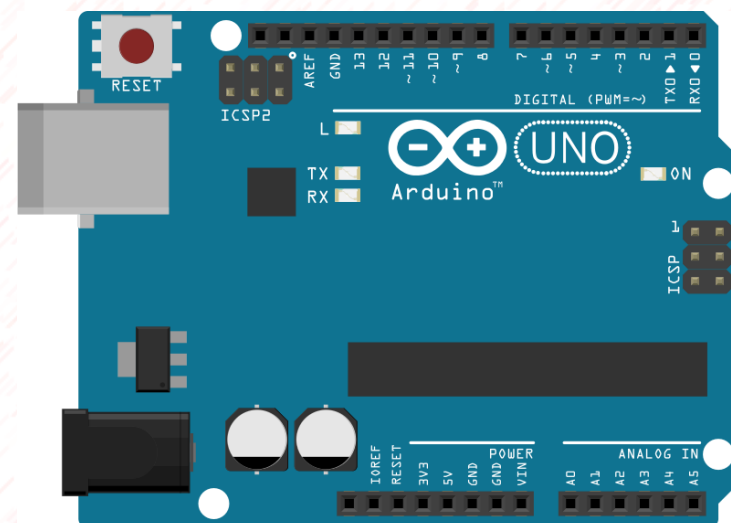
La carte arduino UNO ...

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Des entrées/sorties numériques
- Des entrées analogiques (A)
- ...



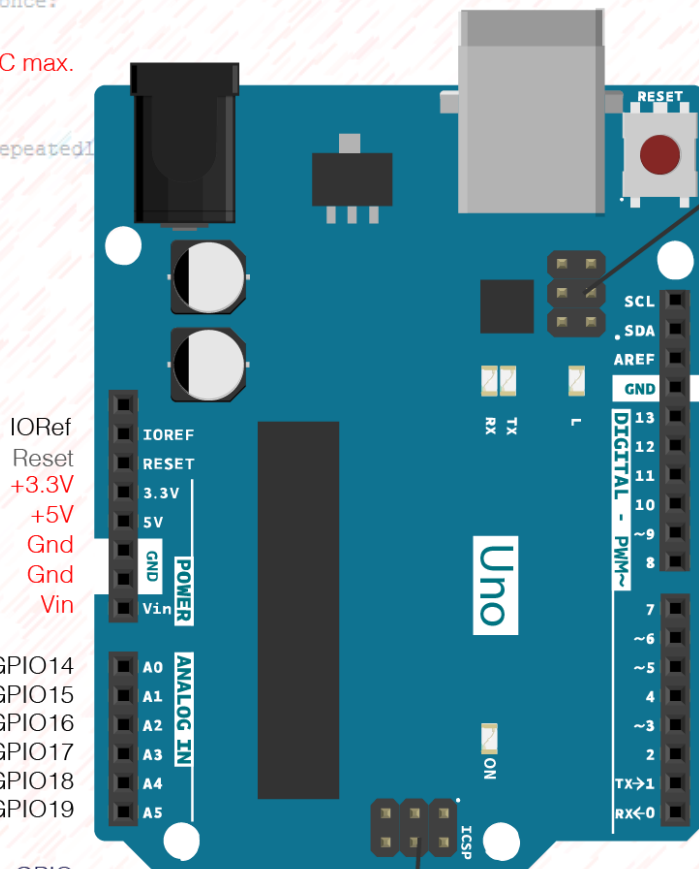
arduino UNO pinout

```
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```

I_{OREf}: 5V

V_{in}: 7-12V DC max.



Serial: Serial is attached to pins 0 and 1, and to the USB-Serial microcontroller on board.

The Uno has a second microcontroller on board to handle USB-to-serial communications. This is the ICSP header for that microcontroller.

ADC0 GPIO14
ADC1 GPIO15
ADC2 GPIO16
ADC3 GPIO17
SDA ADC4 GPIO18
SCL ADC5 GPIO19

Comm. ADC GPIO

GPIO18 ADC4 SDA
GPIO19 ADC5 SCL
AREF

Gnd
GPIO13 SCK LED
GPIO12 MISO
GPIO11 MOSI PWM11
GPIO10 CS PWM10
GPIO9 PWM9
GPIO8
GPIO7
GPIO6 PWM6
GPIO5 PWM5
GPIO4
GPIO3 PWM3 INT1
GPIO2 INTO
GPIO1 TX
GPIO0 RX

ICSP:
Reset
Gnd
MISO
MOSI
+5V

GPIO ADC Comm. PWM Interrupts

Programmation arduino

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:
```

```
}  
  
void loop() {  
  // put your main code here, to run repeatedly:
```

Arduino est « ***un langage commun*** » (syntaxe C++)
indépendant des langages bas-niveau permettant de
prototyper rapidement des applications physiques.

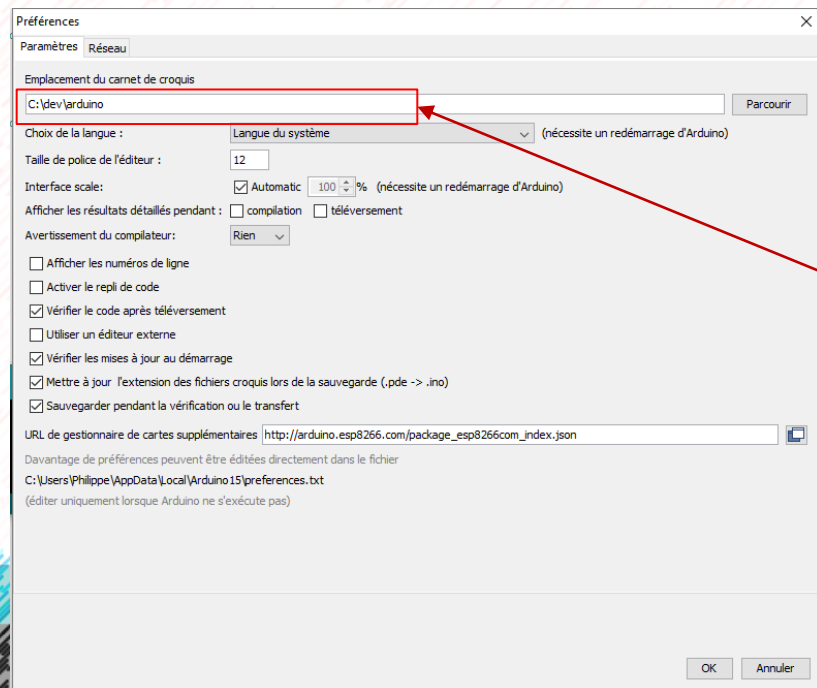
La base du programme arduino est le « *sketch* »
(programme, prototype)
L'extension est le « **.ino** »

Structure

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Les « sketches » (programmes) sont localisés dans le répertoire « préférences »



sketch_may09a | Arduino 1.6.8

Fichier Édition Croquis Outils Aide

Nouveau	Ctrl+N
Ouvrir...	Ctrl+O
Ouvert récemment	>
Carnet de croquis	>
Exemples	>
Fermer	Ctrl+W
Enregistrer	Ctrl+S
Enregistrer sous...	Ctrl+Maj+S
Mise en page	Ctrl+Maj+P
Imprimer	Ctrl+P
Préférences	Ctrl+Virgule
Quitter	Ctrl+Q

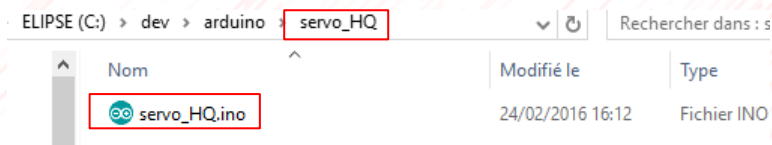
Structure

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- un sketch est composé de :
 - Au moins un fichier « .ino » (cela peut être plus – un par classe objet).
Le fichier principal doit avoir le même nom que le répertoire du sketch



Deux fonctions basiques

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- **setup** : exécuté une seule fois au démarrage – permet d'initialiser les variables du programme

```
void setup() {  
  Serial.begin(9600);  
  Serial.println("16 channel Servo test!");  
  
  pwm.begin();  
  pwm.setPWMFreq(60); // Analog servos run at ~60 Hz updates  
  yield();  
}
```

- **loop** : c'est la boucle de traitement des capteurs exécutée « à l'infini » (*mainloop*)

sketch_feb08a

Arduino - Reference

← → ↺ arduino.cc/en/Reference/HomePage

Philippe



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Structure

- setup()
- loop()

Control Structures

- if
- if...else
- for
- switch case
- while
- do... while
- break
- continue
- return
- goto

Further Syntax

- ; (semicolon)
- {} (curly braces)
- // (single line comment)
- /* */ (multi-line comment)
- #define
- #include

Arithmetic Operators

- = (assignment operator)
- + (addition)
- - (subtraction)
- * (multiplication)
- / (division)
- % (modulo)

Variables

Constants

- HIGH | LOW
- INPUT | OUTPUT | INPUT_PULLUP
- LED_BUILTIN
- true | false
- integer constants
- floating point constants

Data Types

- void
- boolean
- char
- unsigned char
- byte
- int
- unsigned int
- word
- long
- unsigned long
- short
- float
- double
- string - char array
- String - object
- array

Conversion

- char()
- byte()

Functions

Digital I/O

- pinMode()
- digitalWrite()
- digitalRead()

Analog I/O

- analogReference()
- analogRead()
- analogWrite() - PWM

Due only

- analogReadResolution()
- analogWriteResolution()

Advanced I/O

- tone()
- noTone()
- shiftOut()
- shiftIn()
- pulseIn()

Time

- millis()
- micros()
- delay()
- delayMicroseconds()

Math

- min()
- max()

Un premier exemple

```
void setup() {  
  // put your setup code here,  
}  
  
void loop() {  
  // put your main code here, t  
}
```

Blink | Arduino 1.6.7

Fichier Édition Croquis Outils Aide



Blink

```
/*  
  Blink  
  Turns on an LED on for one second, then off for one second, repeatedly.  
  
  This example code is in the public domain.  
  */  
  
// Pin 13 has an LED connected on most Arduino boards.  
// Pin 11 has the LED on Teensy 2.0  
// Pin 6 has the LED on Teensy++ 2.0  
// Pin 13 has the LED on Teensy 3.0  
// give it a name:  
int led = 13;  
  
// the setup routine runs once when you press reset:  
void setup() {  
  // initialize the digital pin as an output.  
  pinMode(led, OUTPUT);  
}  
  
// the loop routine runs over and over again forever:  
void loop() {  
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)  
  delay(1000);             // wait for a second  
  digitalWrite(led, LOW);  // turn the LED off by making the voltage LOW  
  delay(1000);             // wait for a second  
}
```

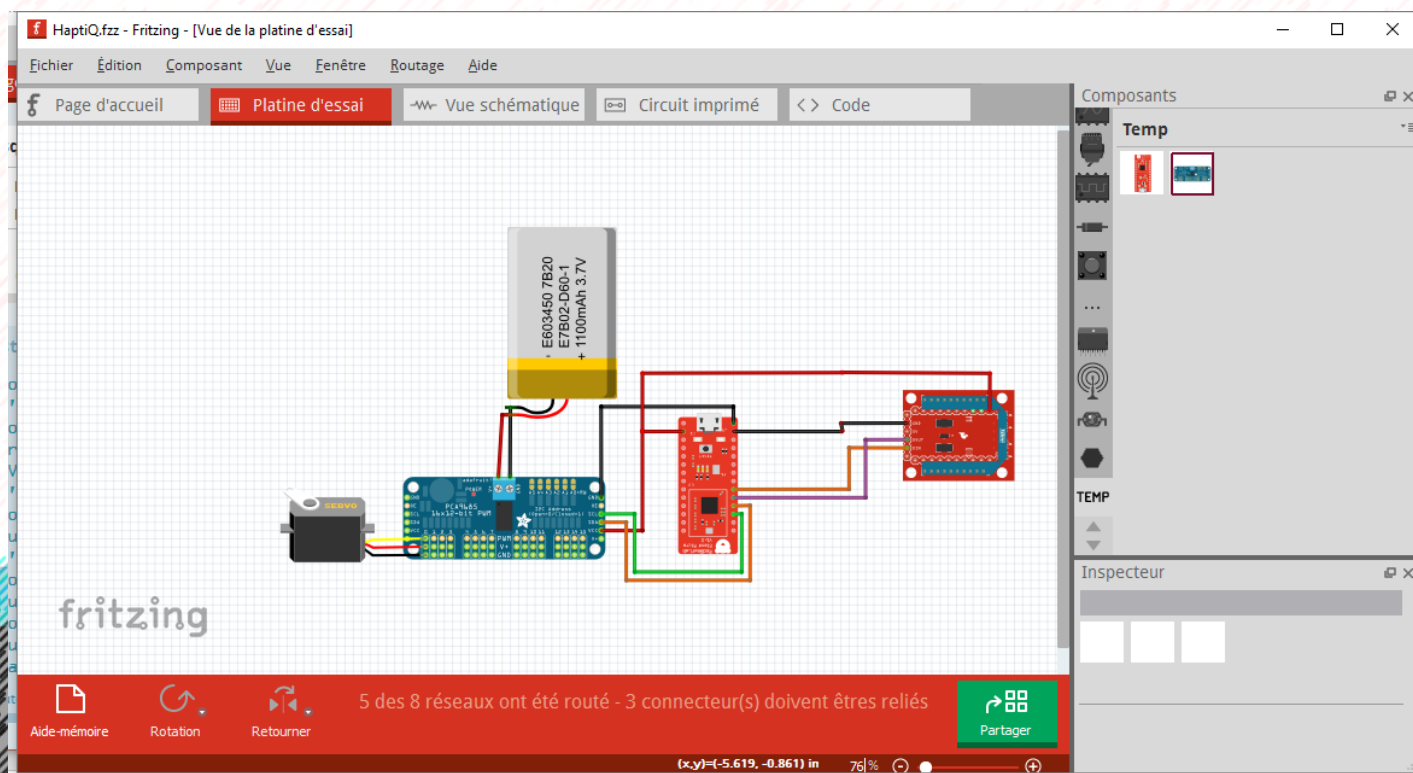

Un outil d'aide au montage

sketch_feb08a

```
void setup() {
  // put your setup code here, to run once:
}
```

```
void loop() {
  // put your main code here, to run repeatedly:
}
```

- **Fritzing** - <https://fritzing.org> (payant depuis 2019)
<https://www.softpedia.com/get/Science-CAD/Fritzing.shtml#download>



Un simulateur en ligne

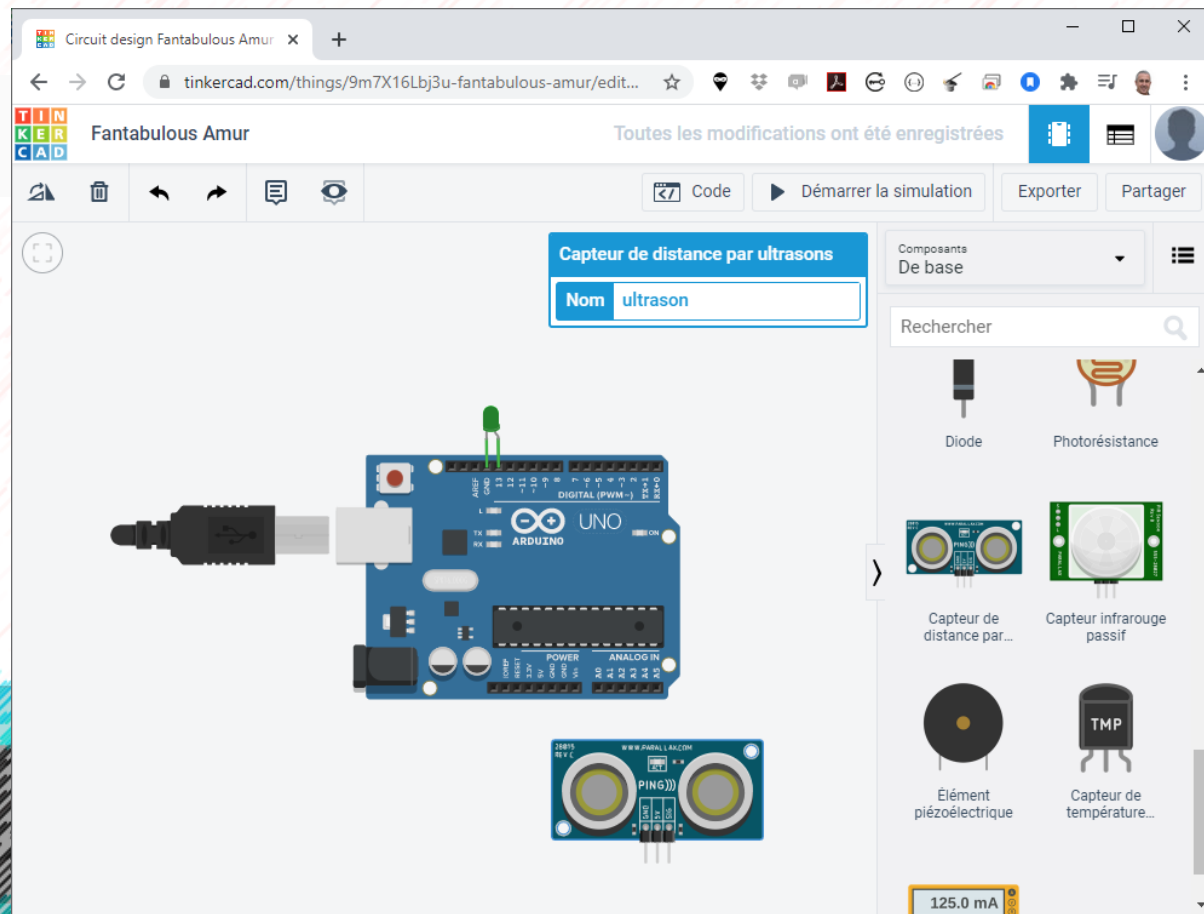
sketch_feb08a

```
void setup() {
  // put your setup code here, to run once:
}
```

```
void loop() {
  // put your main code here, to run repeatedly:
}
```

- <https://www.tinkercad.com/dashboard>

- Choisir **Circuits**



Exercices de chauffe

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

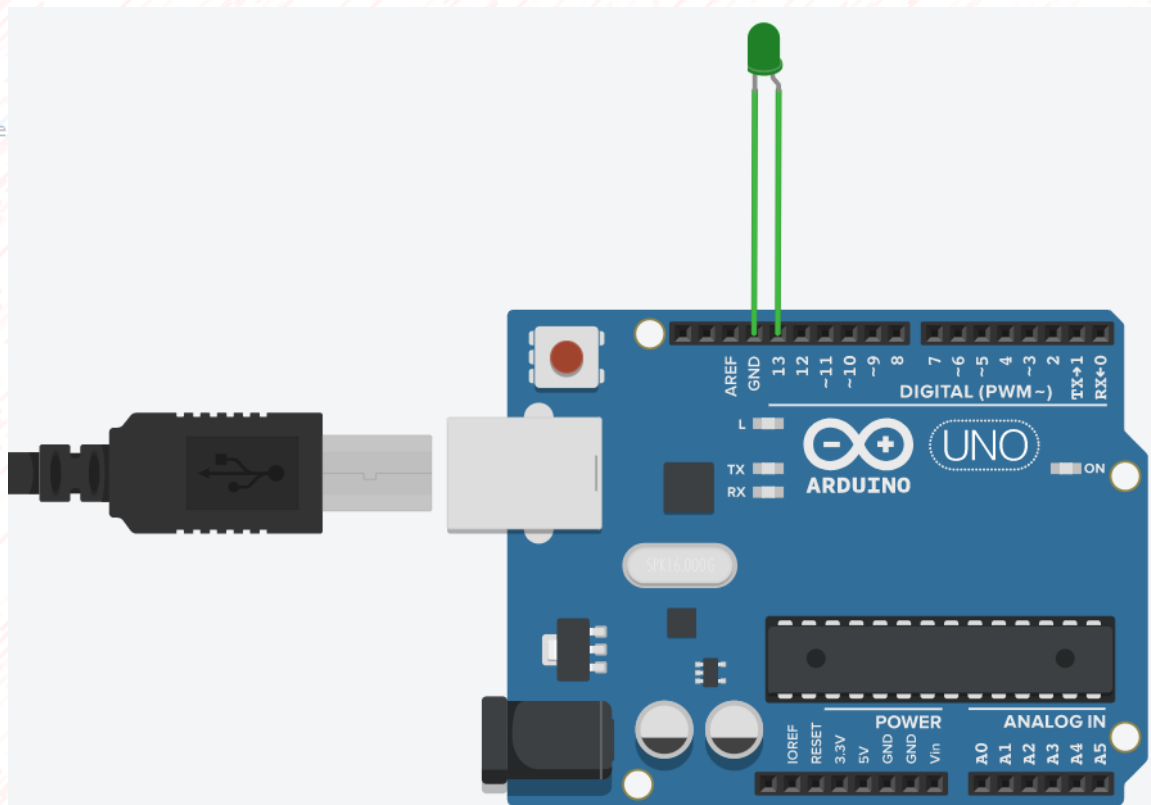
- Des leds
- Un capteur de distance

Led

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here  
}
```



Capteur de distance

sketch_feb08a

```
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```



0.3 CM
RESOLUTION



<15°
ANGLE



<2MA
CURRENT

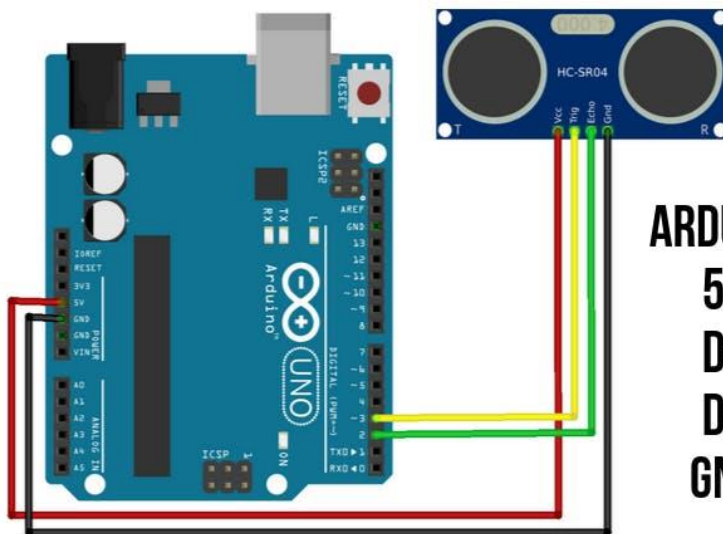


2-450CM
DETECTION RANGE







1 2 3 4

1. VCC
2. TRIG
3. ECHO
4. GND



ARDUINO >> HC-SR04

5V		VCC
D2		ECHO
D3		TRIG
GND		GND

Liaison série

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- interruption

```
void serialEvent() { // instructions }
```

!/ Ne fonctionne pas pour tous les arduino

Machine à états

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  typedef enum {ETEINT=LOW, ALLUME=HIGH} MAE; //  
  l'énumération est définie sous le type MAE  
  
  MAE mae;  
  
  ...  
  
  void loop() {  
    switch(mae) {  
      case ALLUME: ...
```


Exercices de démarrage

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



- ***Allumer/Eteindre une led***

Ouvrir **Fichier** | **Exemples** | **01.Basics** | **Blink**
LED_BUILTIN → Pin 13 sur l'Arduino UNO

→ Modifier la durée du clignotement

Exercices de démarrage

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

→ Modifier le programme et envoyer l'état de la LED sur la liaison série

```
Serial.begin(rapidity_modulation)  
Serial.println()
```

→ Modifier le programme pour piloter l'état de la LED depuis le PC

Exercices de démarrage

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



- Utiliser une librairie externe → capteur ultrason HC-SR04
 - https://bitbucket.org/teckel12/arduino-new-ping/downloads/NewPing_v1.9.7.zip (ou via la bibliothèque)

Please Notice This



Pour être utilisable sur ESP32, il faut le modèle HC-SR04P ou modifier le capteur (<https://www.instructables.com/Modify-Ultrasonic-Sensors-for-3-Volts-Logic-prepar/>)



Exercices de démarrage

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



→ Écrire un programme qui envoie sur le port série la distance perçue par l'arduino avec le plus proche objet et allume la led **LED_BUILTIN** si la distance est inférieure à 20 cm

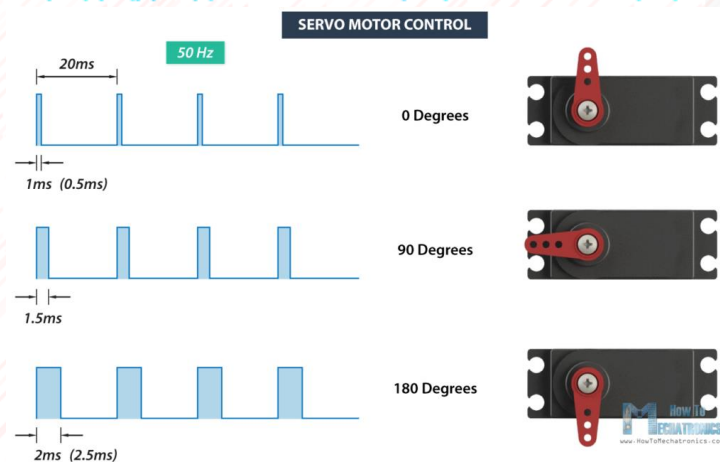
Exercices de démarrage

sketch_feb08a

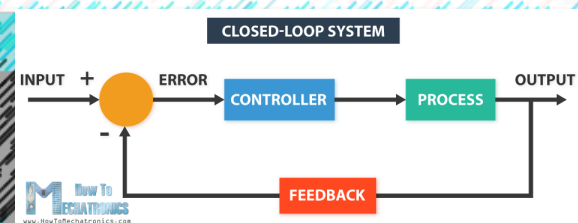
```
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```

- Servomoteur et PWM
(**P**ulse **W**idth **M**odulation)



→ Écrire un programme qui permet de tourner un servomoteur entre 0 et 180° suivant la distance perçue entre 10 et 60 cm (15 cm = 0° et 60 cm = 180°)



Capteur T° et Humidité

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



- **DHT** – capteur de T° et d'humidité

DHT sensor library

by **Adafruit** Version 1.4.1 **INSTALLED**

Arduino library for DHT11, DHT22, etc Temp & Humidity Sensors

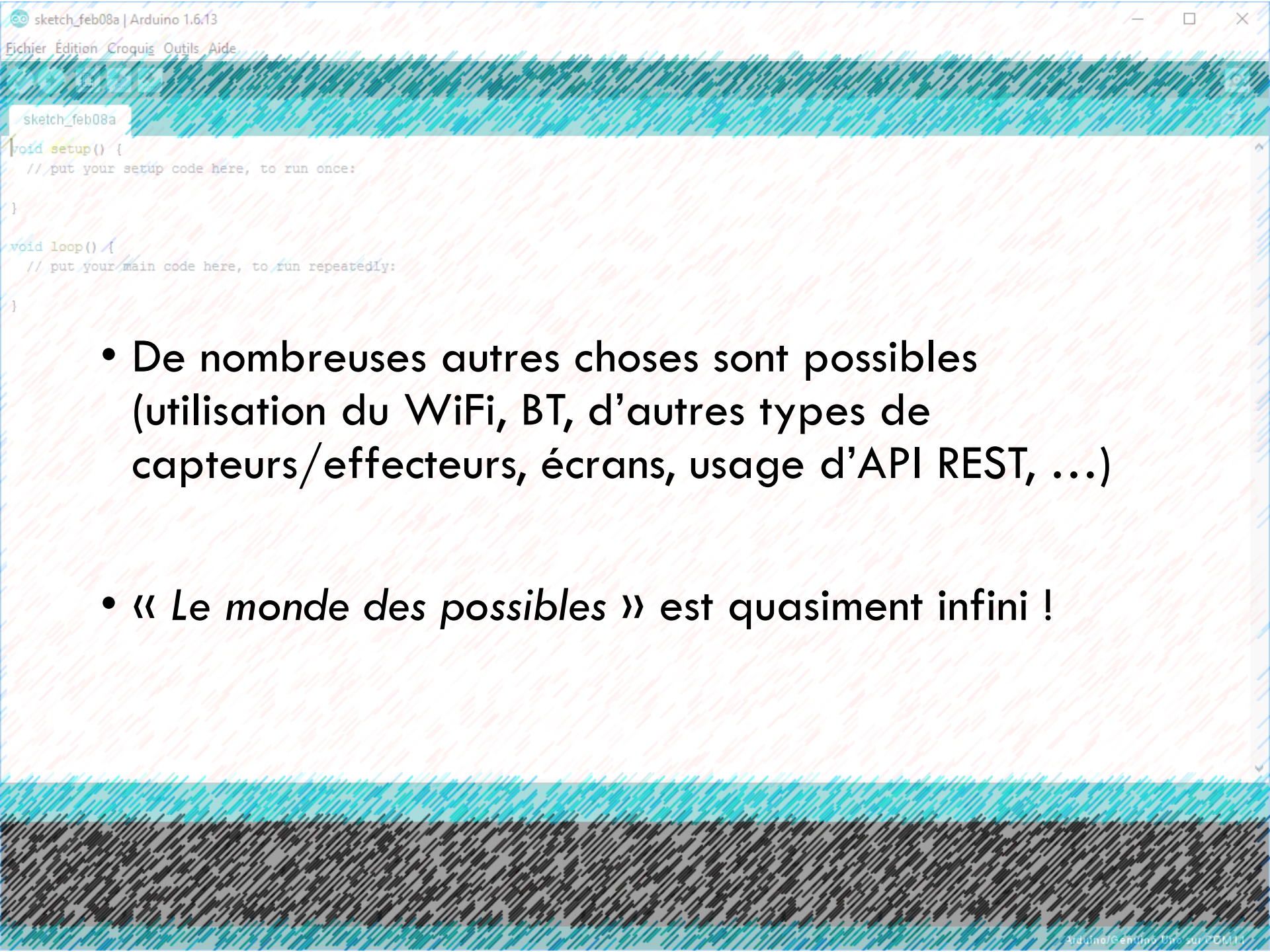
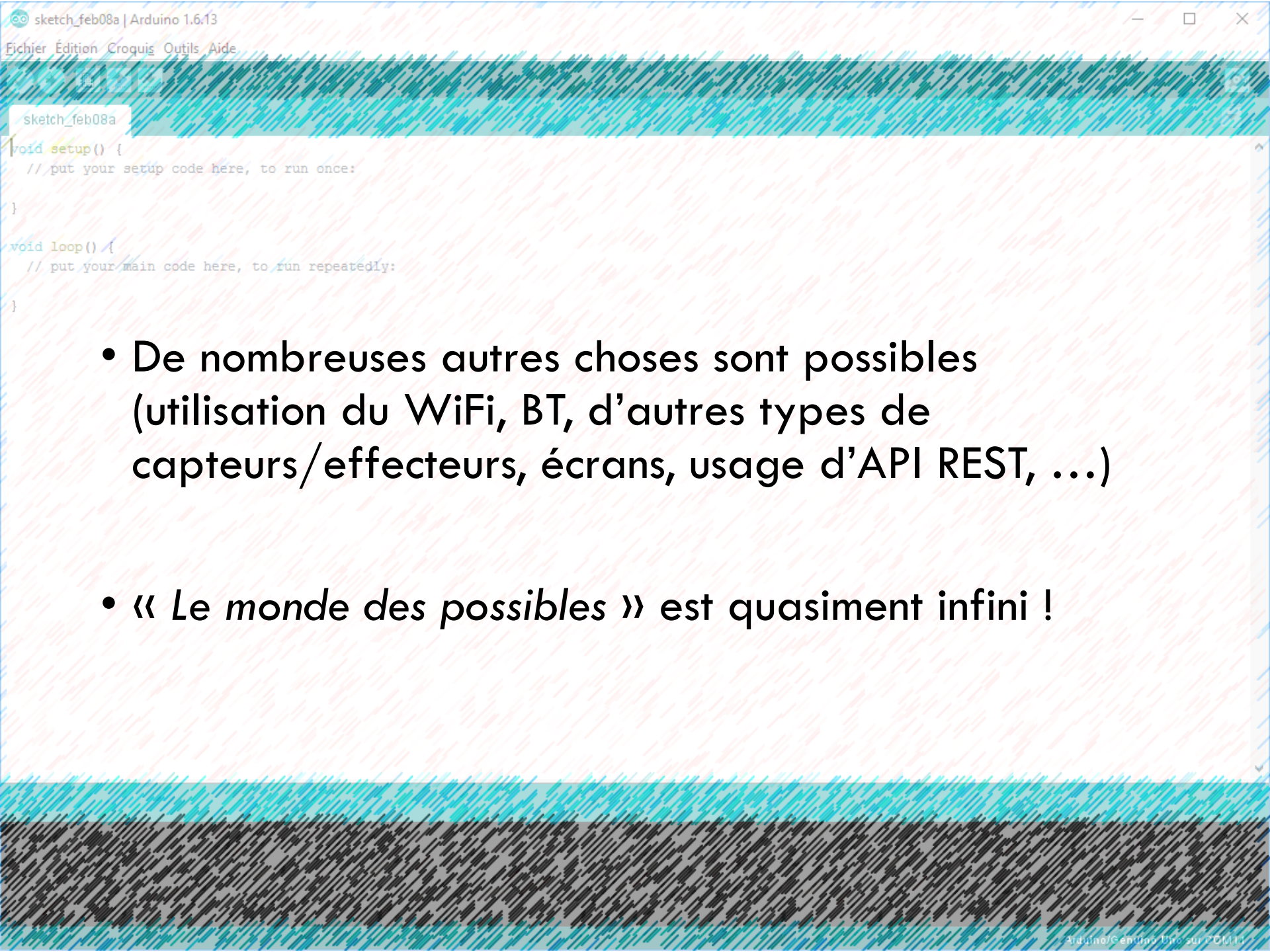
[More info](#)

Sélectionner une version ▾

Installer

DHT sensor library for ESP8266

→ Ecrire un programme qui renvoie la température et l'humidité quand on appuie sur une touche sur le PC



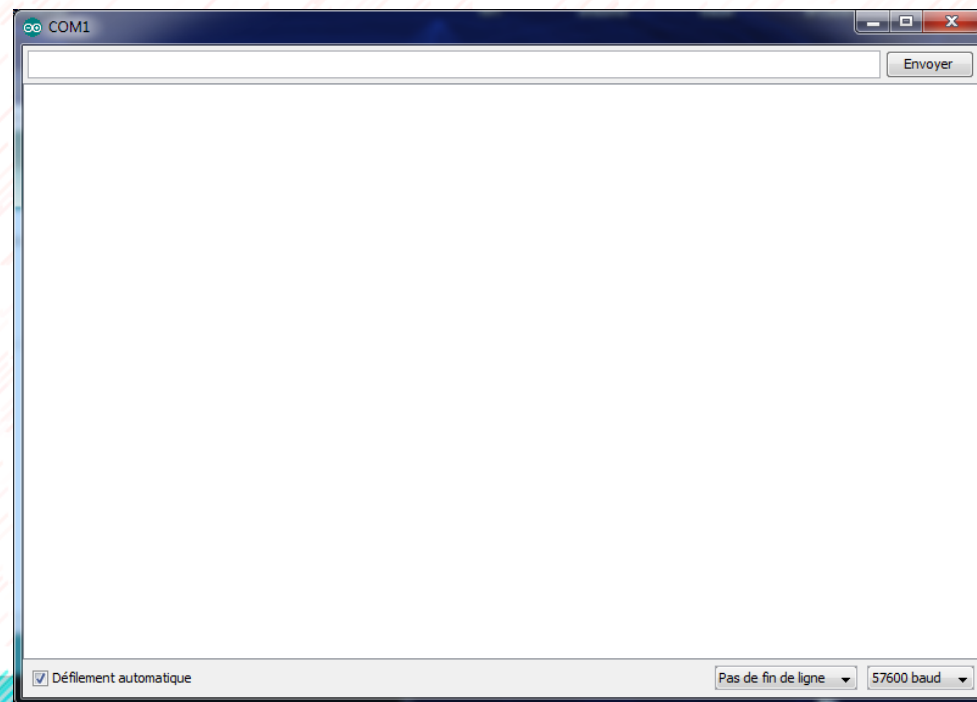
- De nombreuses autres choses sont possibles (utilisation du WiFi, BT, d'autres types de capteurs/effecteurs, écrans, usage d'API REST, ...)
- « *Le monde des possibles* » est quasiment infini !

« Astuces »

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Outils | Moniteur série



ESP32

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- ESP32 est une série de micro-contrôleurs intégrant la gestion du wifi et du bluetooth (jusqu'à BLE)
- Il est peu cher et très apprécié dans le domaine de l'IoT !

Installer ESP8266 et ESP32

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

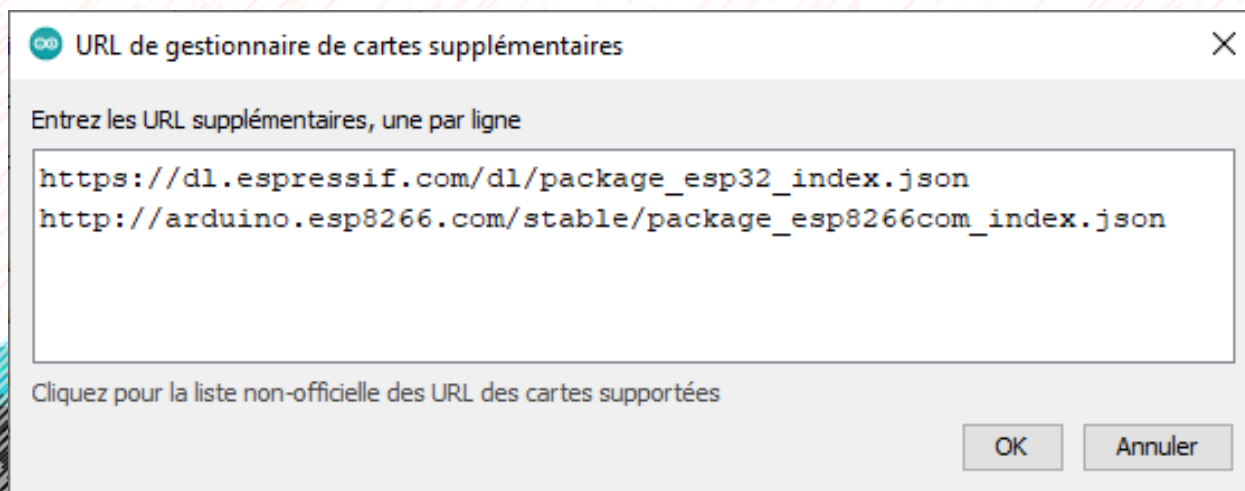
```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Dans Fichier | Préférences

URL de gestionnaire de cartes supplémentaires

https://dl.espressif.com/dl/package_esp32_index.json

http://arduino.esp8266.com/stable/package_esp8266com_index.json

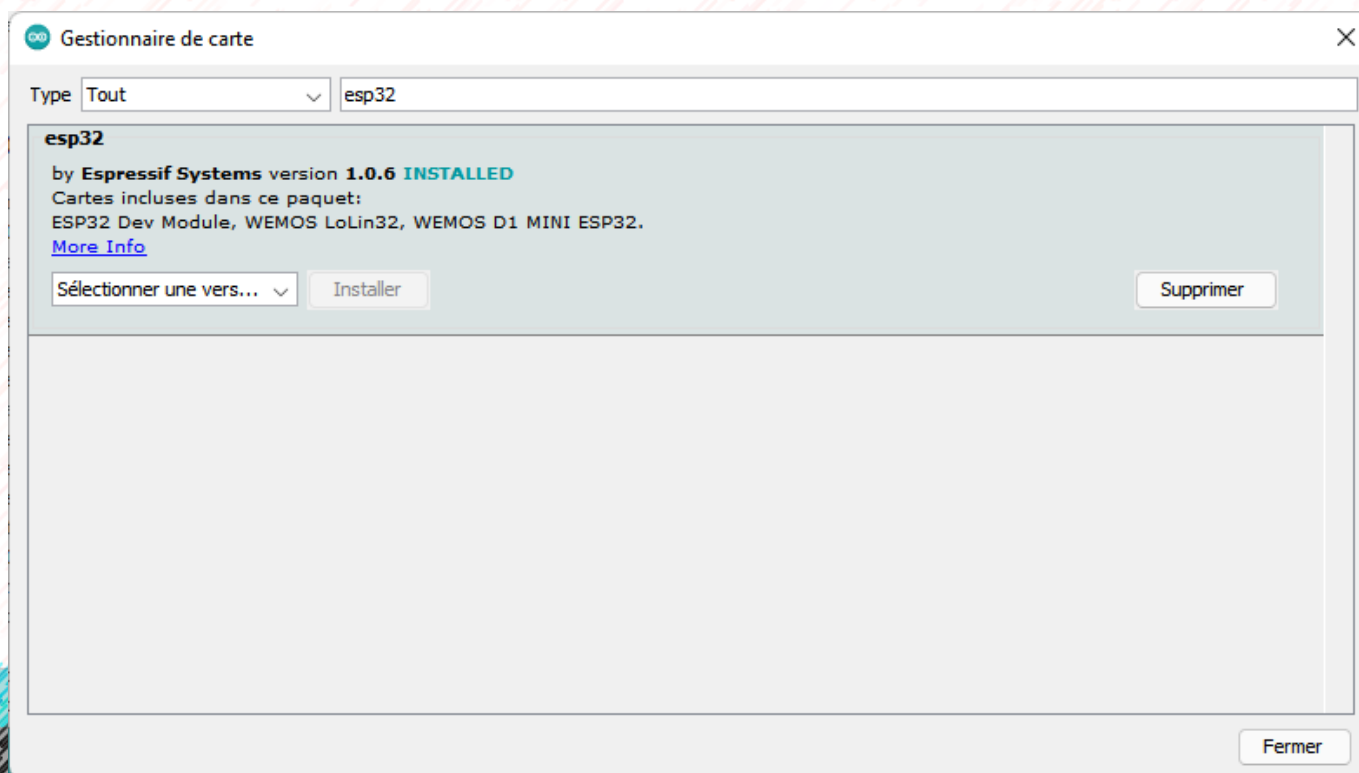


Installer ESP8266 et ESP32

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Dans Outils | Type de carte | Gestionnaire de carte

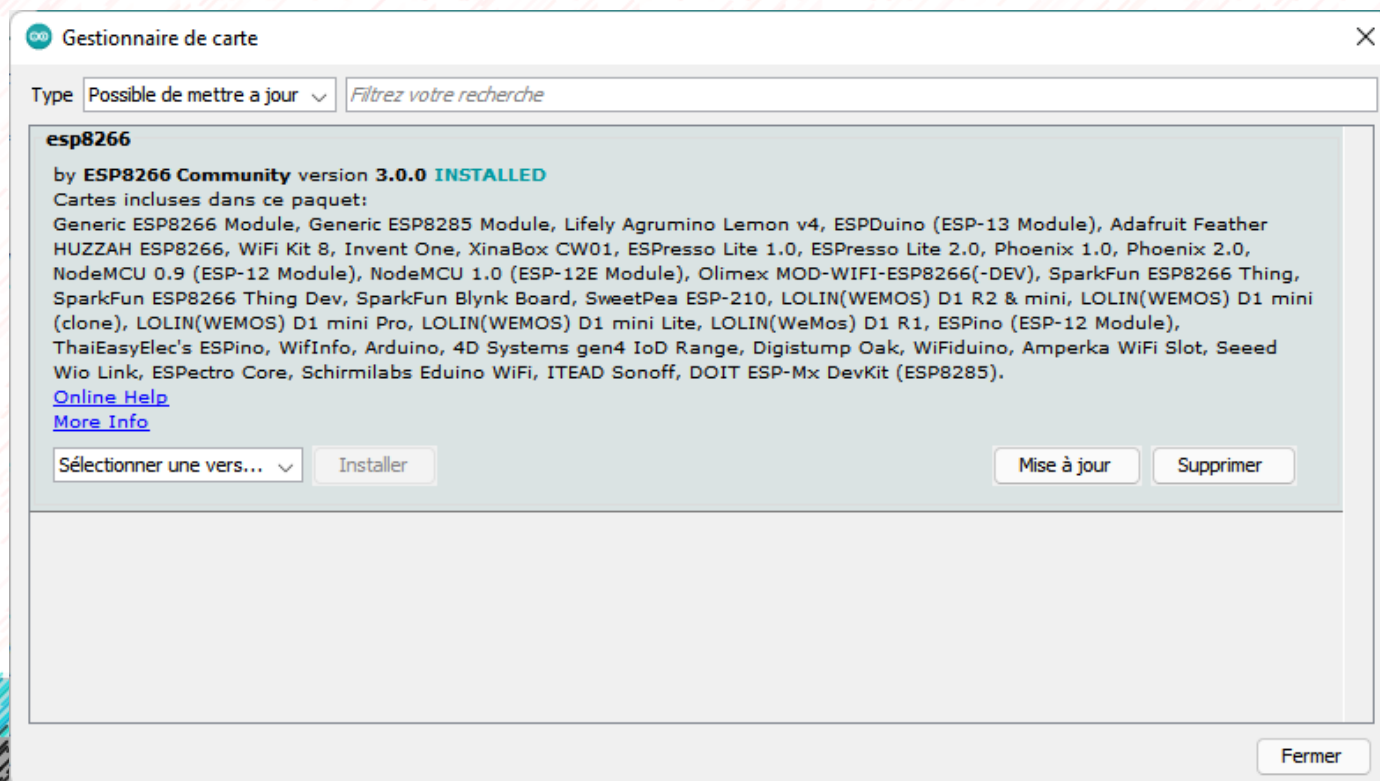


Installer ESP8266 et ESP32

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- Dans Outils | Type de carte | Gestionnaire de carte



Installer ESP8266 et ESP32

sketch_feb08a

```
void setup() {
  // put your setup code here
```

```
void loop() {
  // put your main code here
```

```
}
```

Blink

Blink

Turns an LED on

Most Arduinos have

it is attached to

the correct LED

If you want to know

model, check the

<https://www.arduino.cc>

modified 8 May 2015

by Scott Fitzgerald

modified 2 Sep 2015

by Arturo Guadalquivir

modified 8 Sep 2015

by Colby Newman

This example code is in the public domain.

Téléversement terminé

Leaving...

Hard resetting via RTS pin...

1

DOIT ESP32 DEVKIT V1, 80MHz, 921600, No

Formatage automatique

Ctrl+T

Archiver le croquis

Réparer encodage & recharger

Gérer les bibliothèques

Ctrl+Maj+I

Moniteur série

Ctrl+Maj+M

Traceur série

Ctrl+Maj+L

WiFi101 / WiFININA Firmware Updater

Type de carte: "DOIT ESP32 DEVKIT V1"

Upload Speed: "921600"

Flash Frequency: "80MHz"

Core Debug Level: "Rien"

Port: "COM6"

Récupérer les informations de la carte

Programmeur

Graver la séquence d'initialisation

Gestionnaire de carte

Arduino AVR Boards >

Arduino i586 Boards >

ESP32 Arduino

ESP8266 Boards (3.0.2) >

NodeMCU-32S

MH ET LIVE ESP32DevKIT

MH ET LIVE ESP32MiniKit

ESP32vn IoT Uno

• DOIT ESP32 DEVKIT V1

DOIT ESPduino32

OLIMEX ESP32-EVB

OLIMEX ESP32-GATEWAY

OLIMEX ESP32-PoE

OLIMEX ESP32-PoE-ISO

OLIMEX ESP32-DevKit-LiPo

ThaiEasyElec's ESPino32

M5Stack-Core-ESP32

M5Stack-FIRE

M5Stick-C

M5Stack-ATOM

M5Stack-Core2

M5Stack-Timer-CAM

M5Stack-CoreInk

ODROID ESP32

Heltec WiFi Kit 32

Heltec WiFi LoRa 32

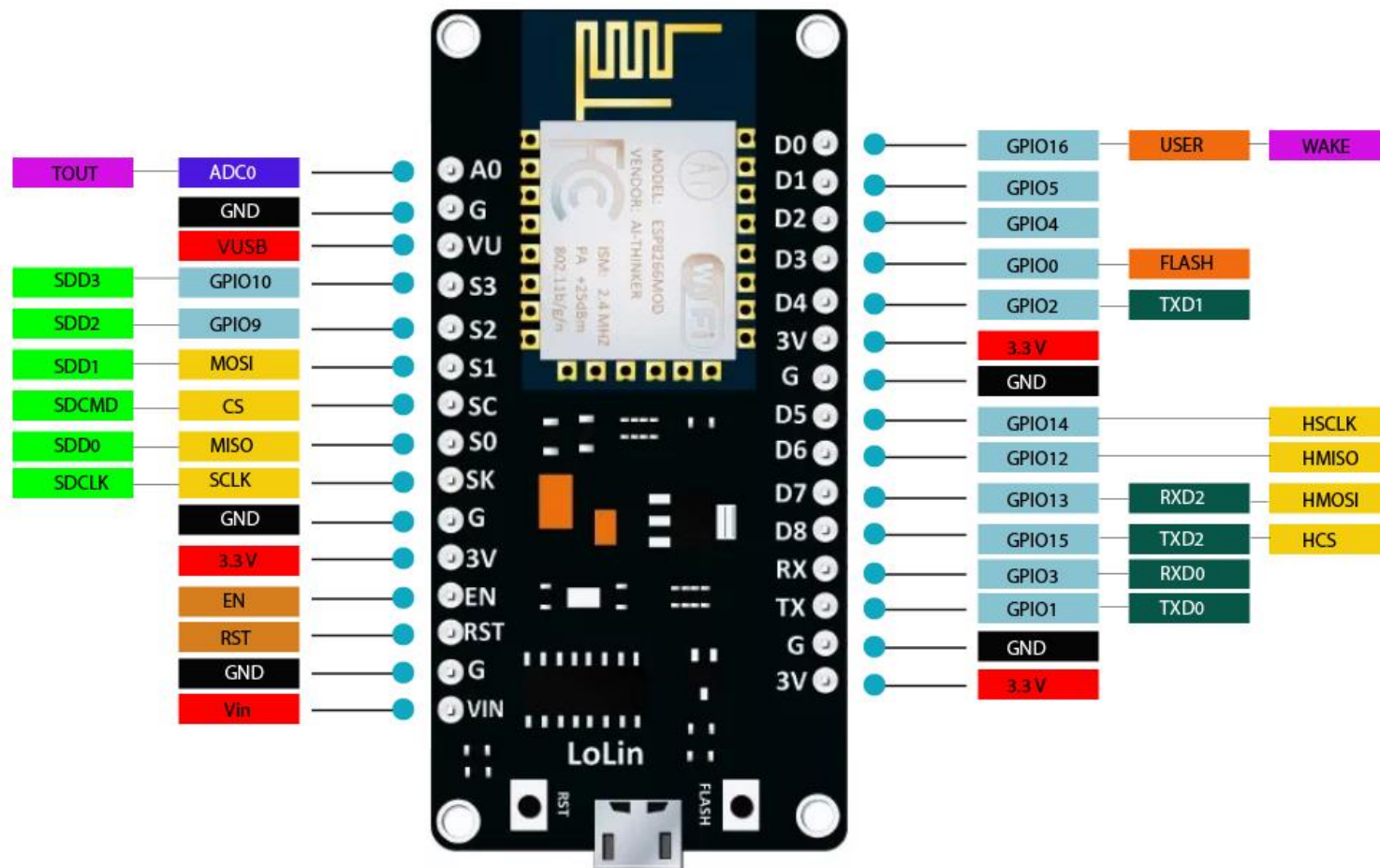
Heltec WiFi LoRa 32(V2)

Heltec Wireless Stick

Heltec Wireless Stick Lite

ESP8266 pinout

sketch_feb08a



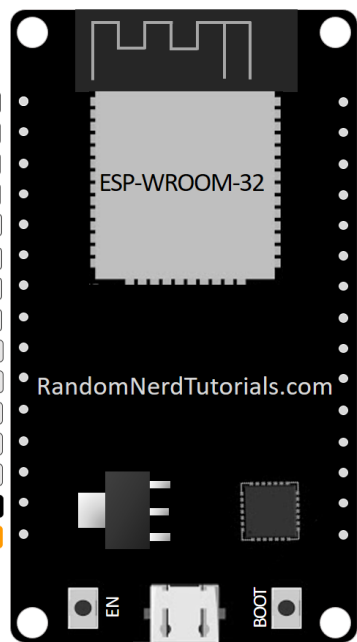
NodeMCU V3 Pinout

www.TheEngineeringProjects.com

D0 GPIO16
D1 GPIO05
D2 GPIO04
D3 GPIO00
D4 GPIO02
D5 GPIO14
D6 GPIO12
D7 GPIO13
D8 GPIO15
D9 GPIO03
D10 GPIO01

sketch_feb08a

ESP32 DEVKIT V1 – DOIT



ESP32 pinout

sketch_feb08a

```
void set
// put

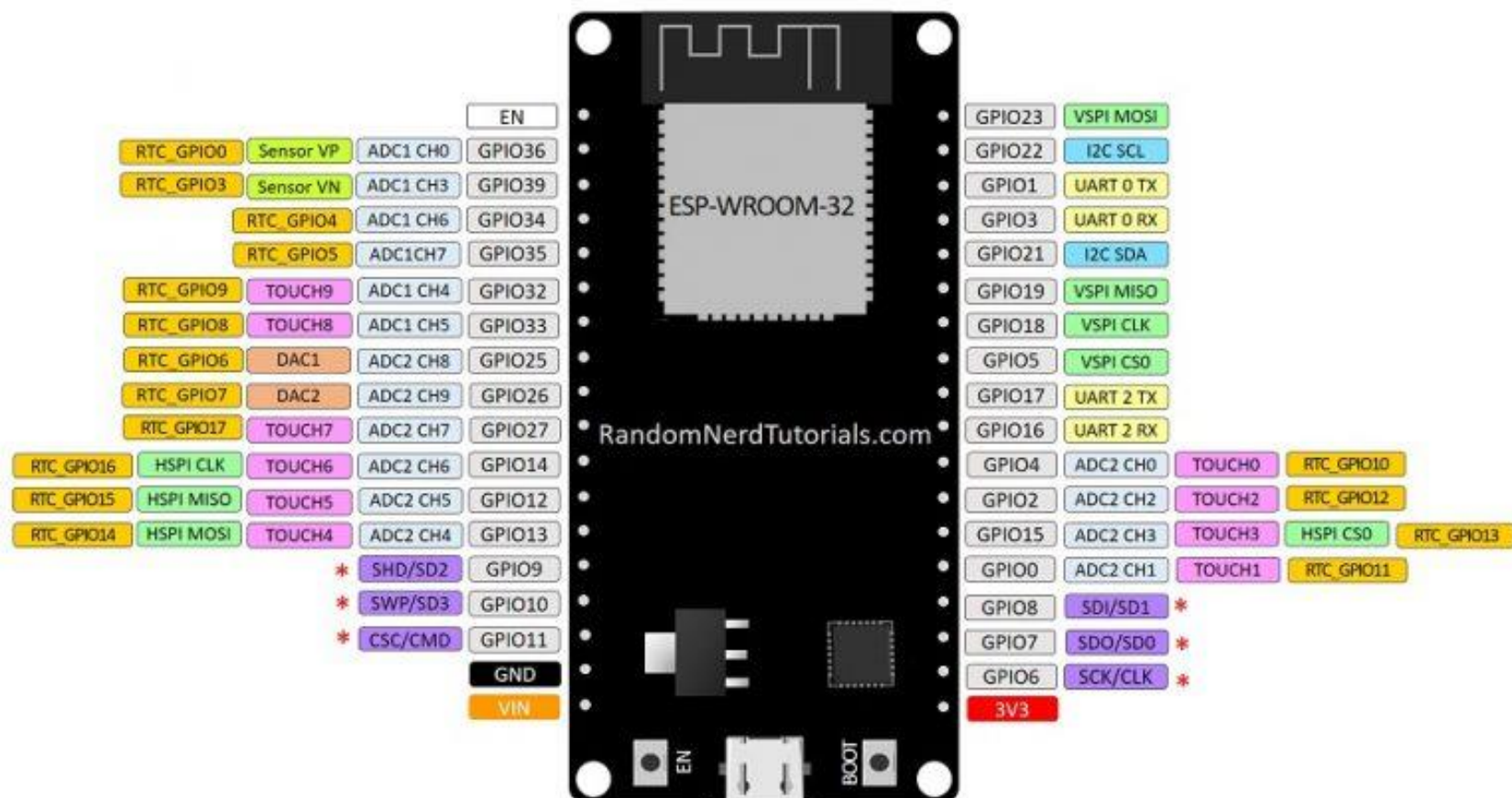
}

void loop
// put

}
```

ESP32 DEVKIT V1 – DOIT

version with 36 GPIOs



* Pins SCK/CLK, SDO/SD0, SDI/SD1, SHD/SD2, SWP/SD3 and SCS/CMD, namely, GPIO6 to GPIO11 are connected to the integrated SPI flash integrated on ESP-WROOM-32 and are not recommended for other uses.

ESP32

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}
```

```
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

- 3 interfaces UART (liaisons série)
- 10 capteurs capacitifs
- 18 entrées analogiques
- 16 sorties PWM
- interfaces I2C, SPI
- ...

Neopixel

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



- **Adafruit Neopixel** – des pixels RGB

Adafruit NeoPixel

by Adafruit Version 1.7.0 **INSTALLED**

Arduino library for controlling single-wire-based LED pixels and strip. Arduino library for controlling single-wire-based LED pixels and strip.

[More info](#)

Sélectionner une version ▾

Installer

→ Modifier le code de telle manière que l'on puisse changer de couleur (aléatoire) quand on utilise un capteur de toucher

Lecteur NFC

sketch_feb08a

```
void setup() {  
  // put your setup code here, to run once:  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```



- **RFID-522** – Un lecteur NFC

MFRC522

by GithubCommunity Version 1.4.7 **INSTALLED****Arduino RFID Library for MFRC522 (SPI)** Read/Write a RFID Card or Tag using the ISO/IEC 14443A/MIFARE interface.[More info](#)

Sélectionner une version ▾

Installer

SDA	GPIO21
SCK	GPIO18
MOSI	GPIO23
MISO	GPIO19
IRQ	NOT USED
GND	GND
RST	GPIO22
3v3	3v3

→ Modifier le code fourni qui permet d'allumer/éteindre une LED quand on présente une carte NFC spécifique