

# Fisica con Arduino

Giovanni Organtini (giovanni.organtini@uniroma1.it)

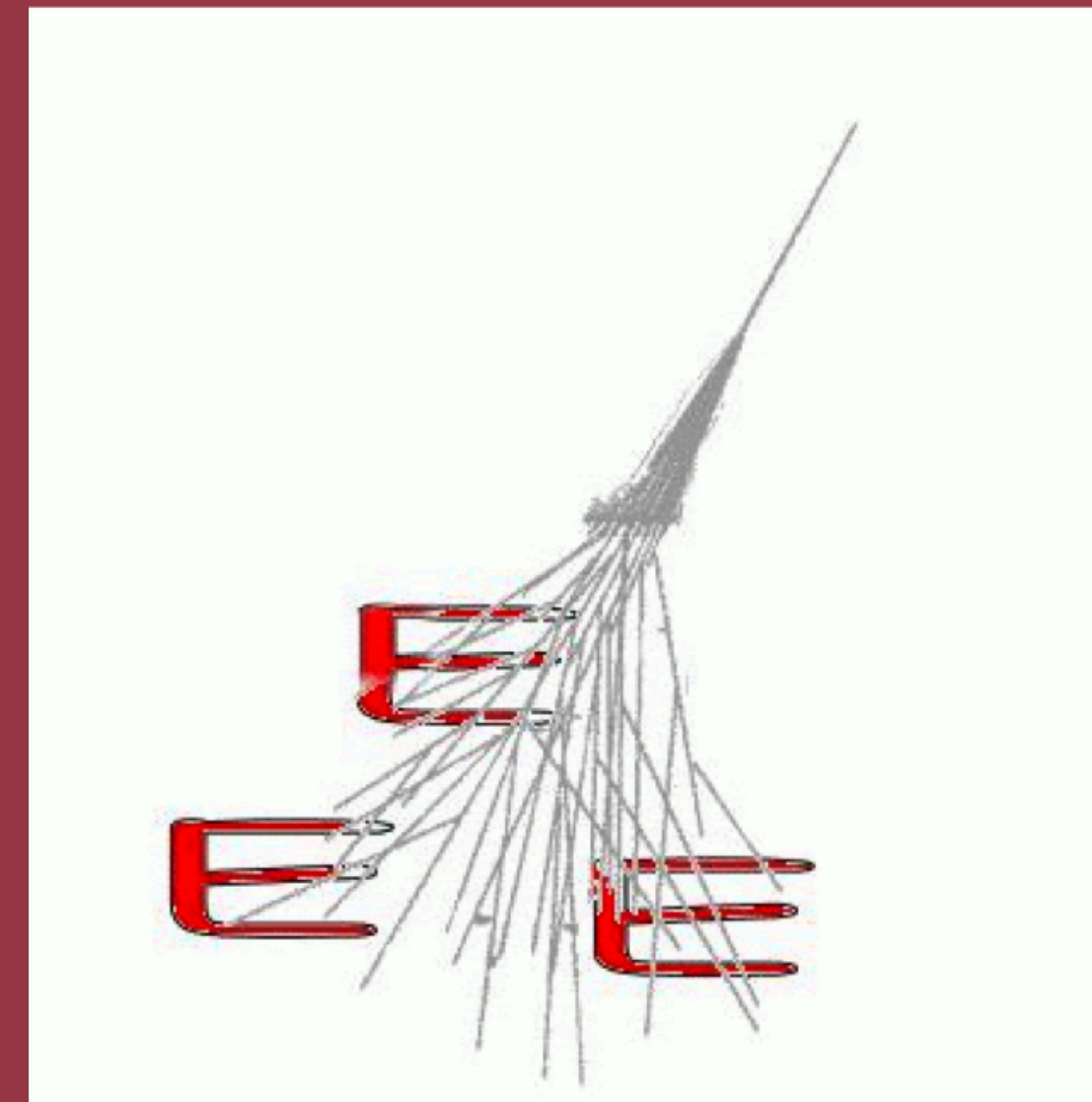
DIPARTIMENTO DI FISICA



SAPIENZA  
UNIVERSITÀ DI ROMA



CENTRO RICERCHE  
ENRICO FERMI



febbraio 2022

# Perché Arduino a scuola

## ■ La fisica a scuola

- formazione del cittadino

## ■ I laboratori scolastici

- attrezzature
- personale
- tempo

## ■ L'importanza del laboratorio

- da spettatori ad attori
- consolidamento delle conoscenze
- competenze trasversali

# Perché Arduino a scuola

## La fisica a scuola

- formazione del cittadino

## I laboratori scolastici

- attrezzature

- personale

- tempo

## L'importanza del laboratorio

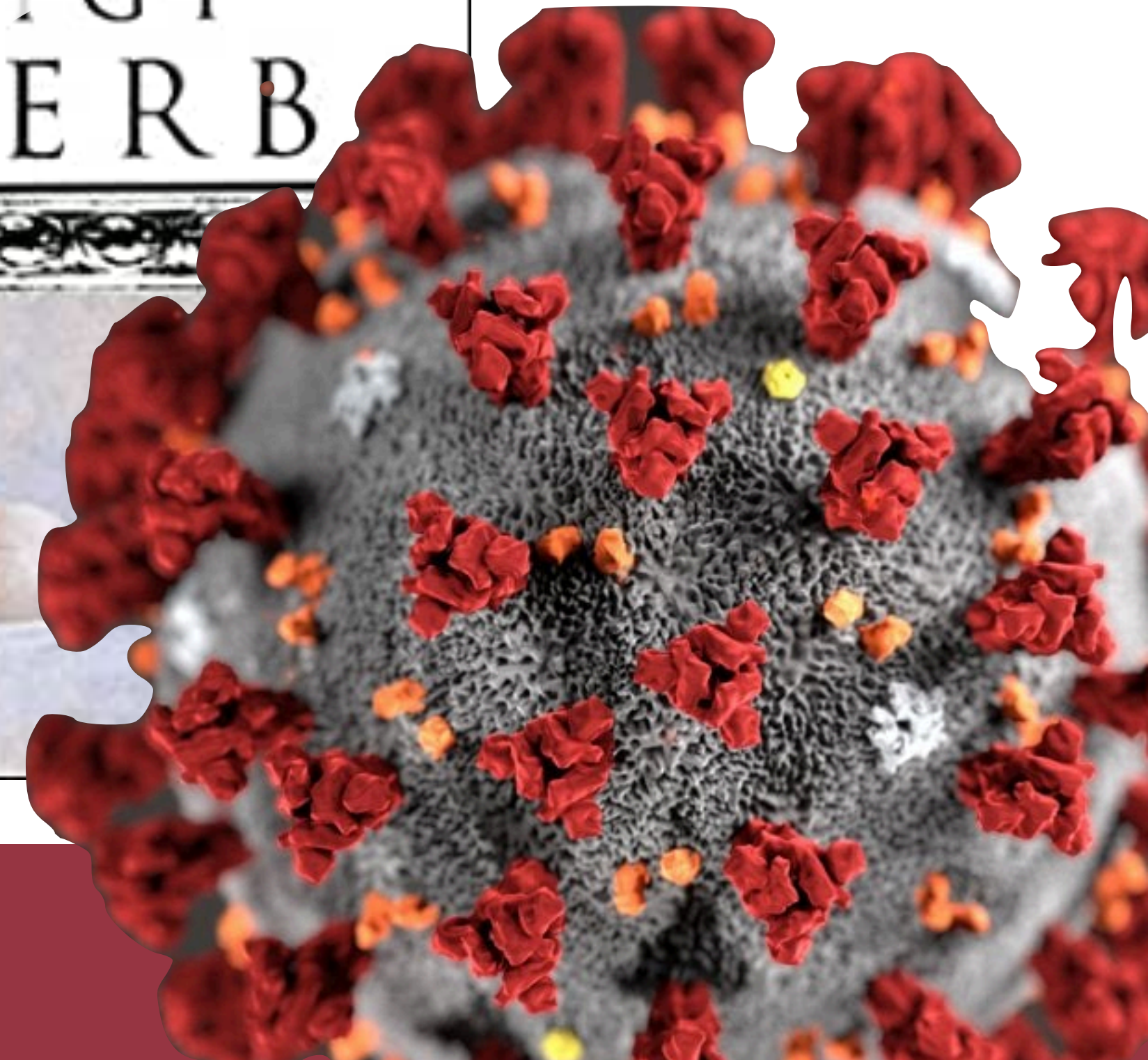
- da spettatori ad attori

- consolidamento delle conoscenze

- competenze trasversali



*Succede purtroppo che spesso i fatti smentiscono le ingegnose e confortevoli teorie mentre non si sono mai viste teorie che smentiscono i fatti*  
L.Malerba, "La Superficie di Eliane"



# Problema → Opportunità

## ■ Dispositivi digitali

- smartphone
- Arduino

## ■ Stimolanti

## ■ Costi molto contenuti

## ■ Promuove l'acquisizione di competenze

- coding
- elettronica
- manualità
- creatività
- ricerca
- problem-solving
- Comunicazione

# Problema → Opportunità

## Dispositivi digitali

- smartphone
- Arduino

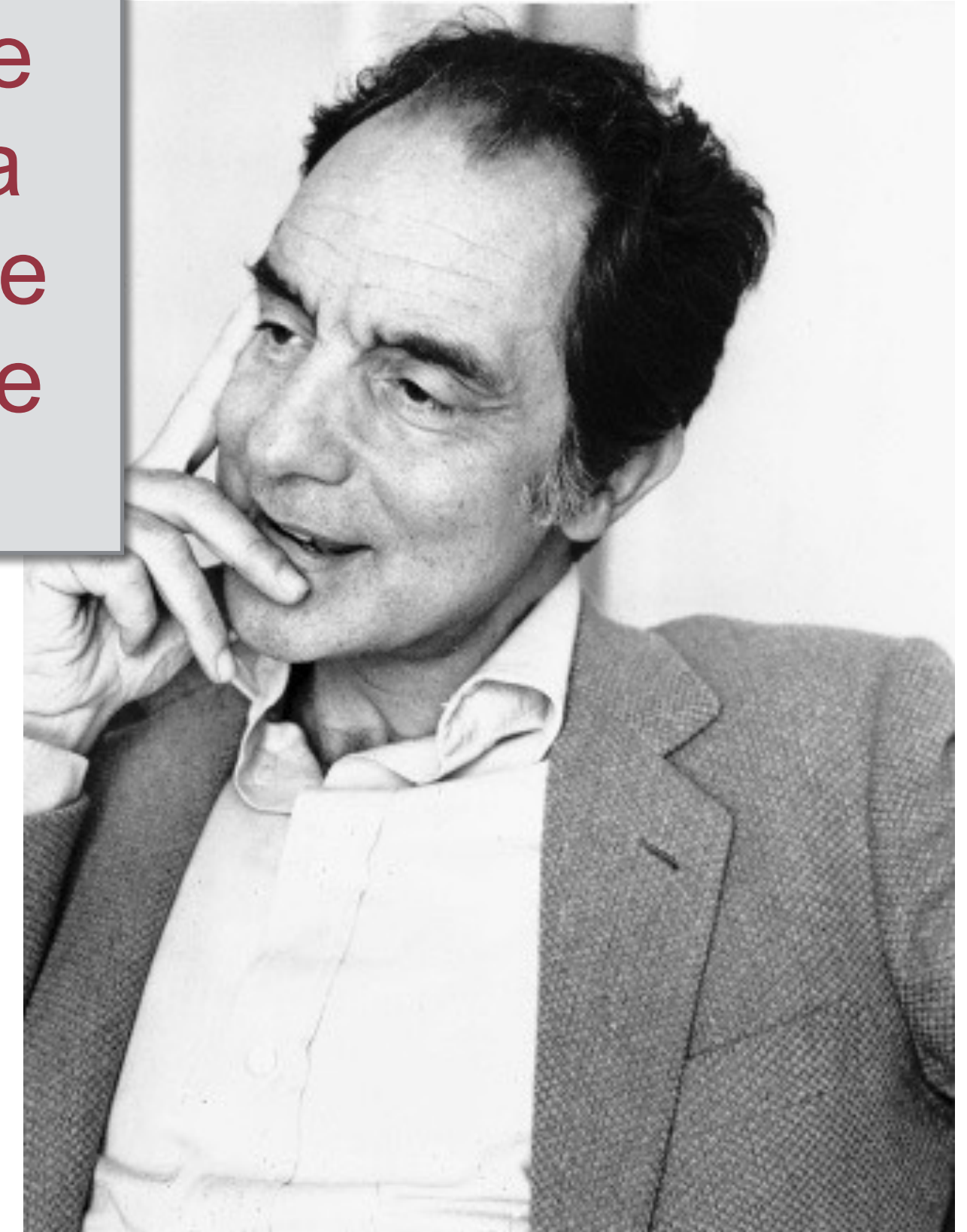
## Stimolanti

## Costi molto contenuti

## Promuove l'acquisizione di competenze

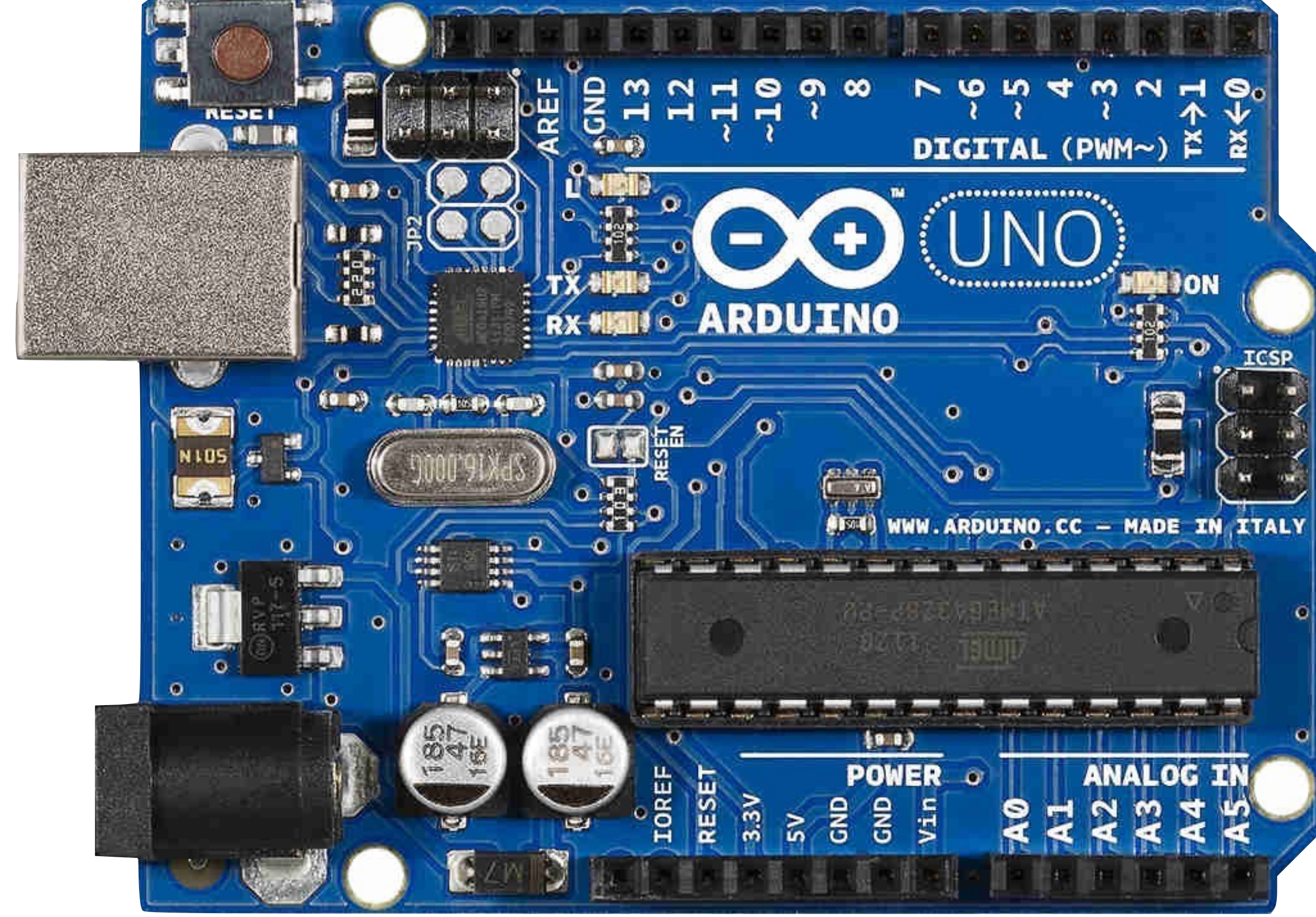
- coding
- elettronica
- manualità
- creatività
- ricerca
- problem-solving
- Comunicazione

è vero che il software non potrebbe esercitare i poteri della sua leggerezza se non mediante la pesantezza dell'hardware; ma **è il software che comanda**, che agisce sul mondo esterno e sulle macchine...

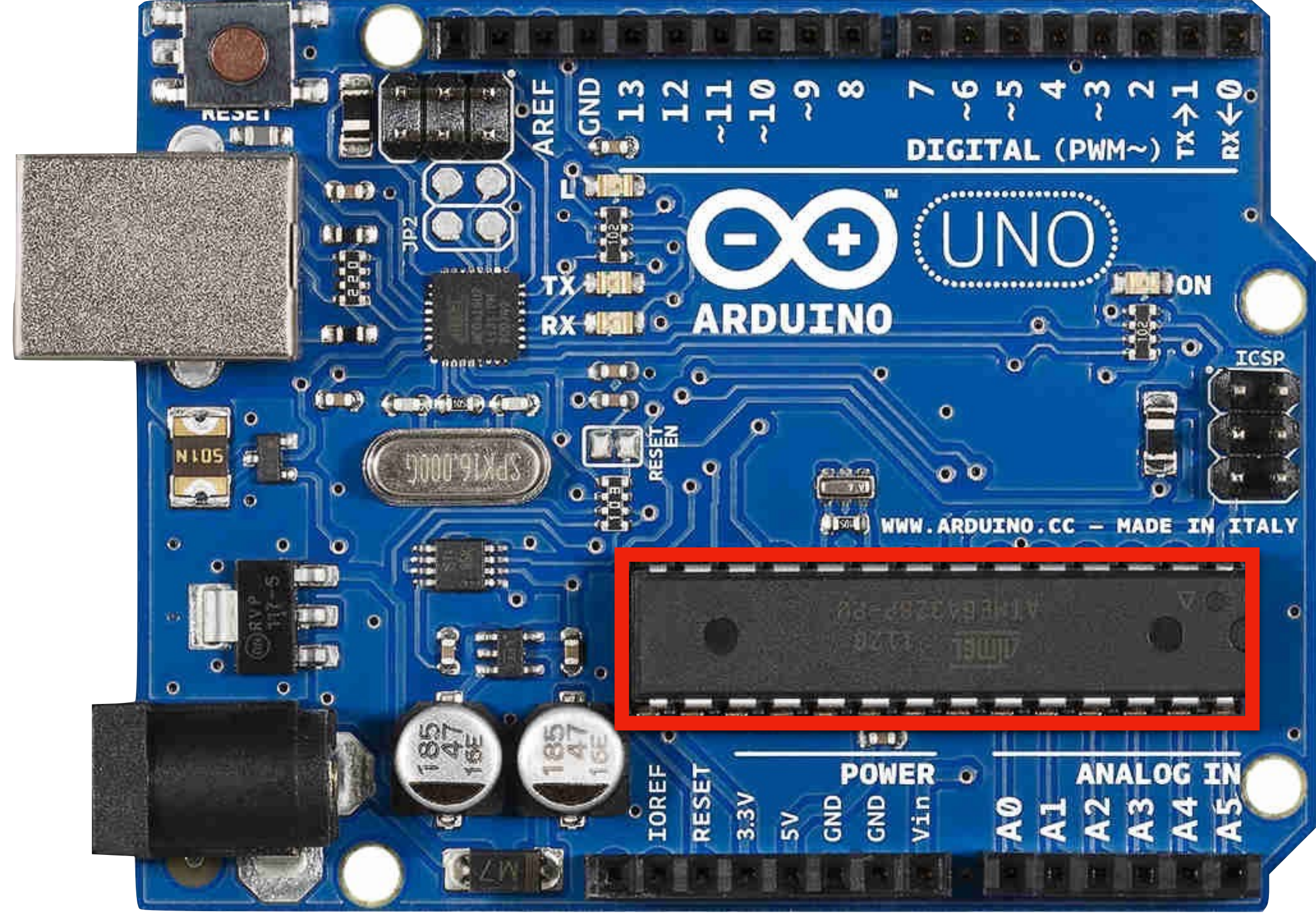


Italo Calvino - Lezioni americane (1988)

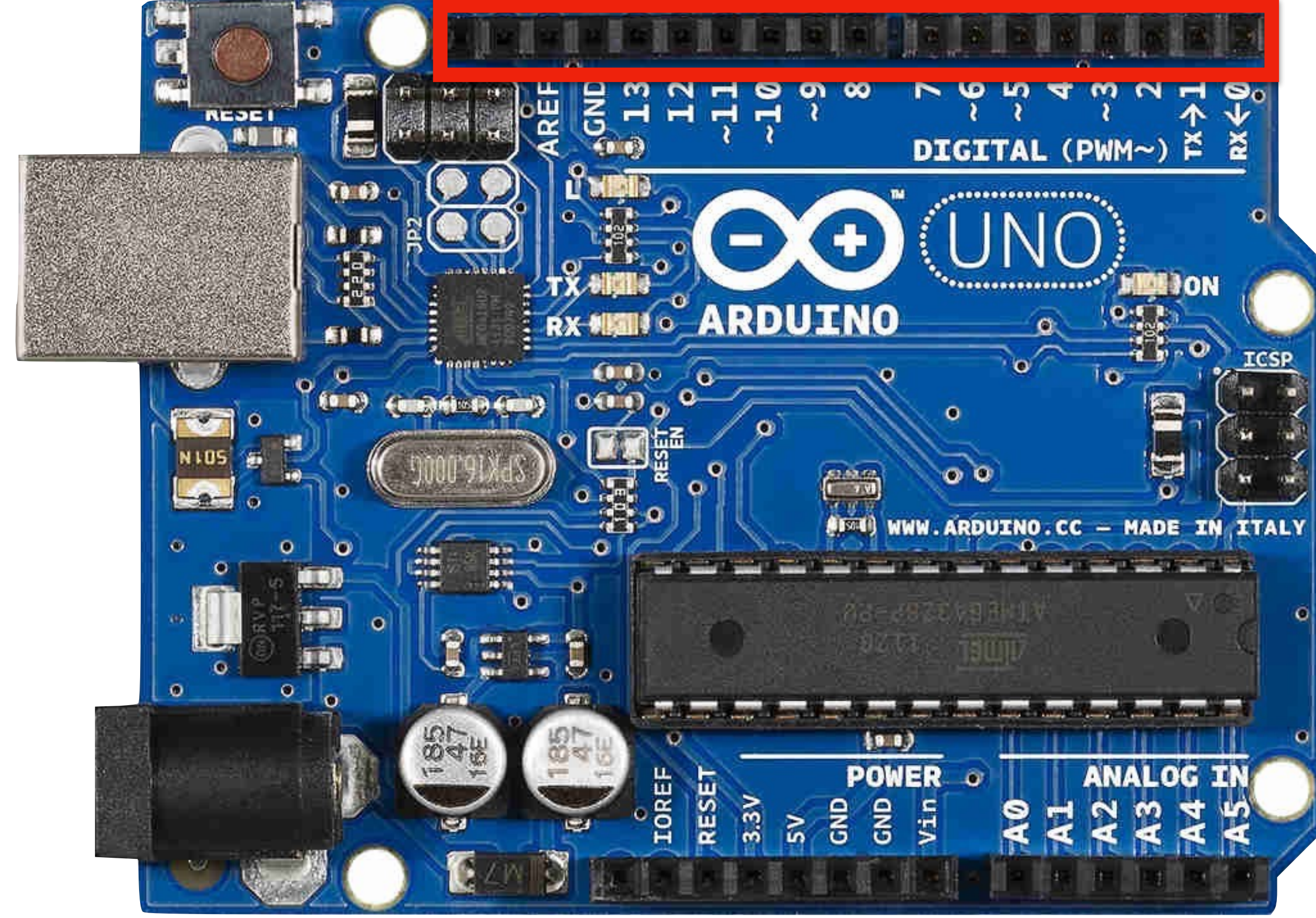
# Arduino



# Arduino

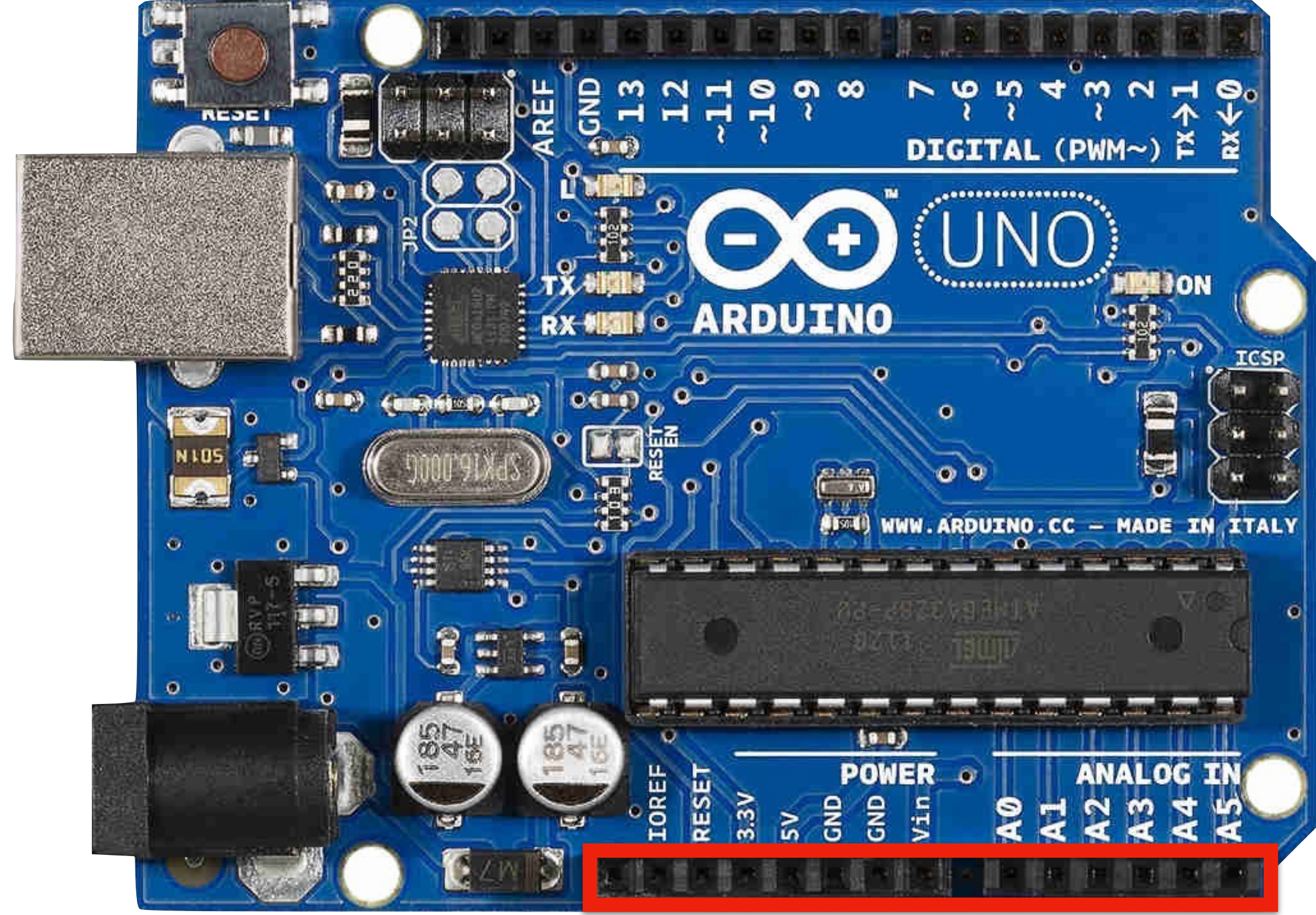


# Arduino

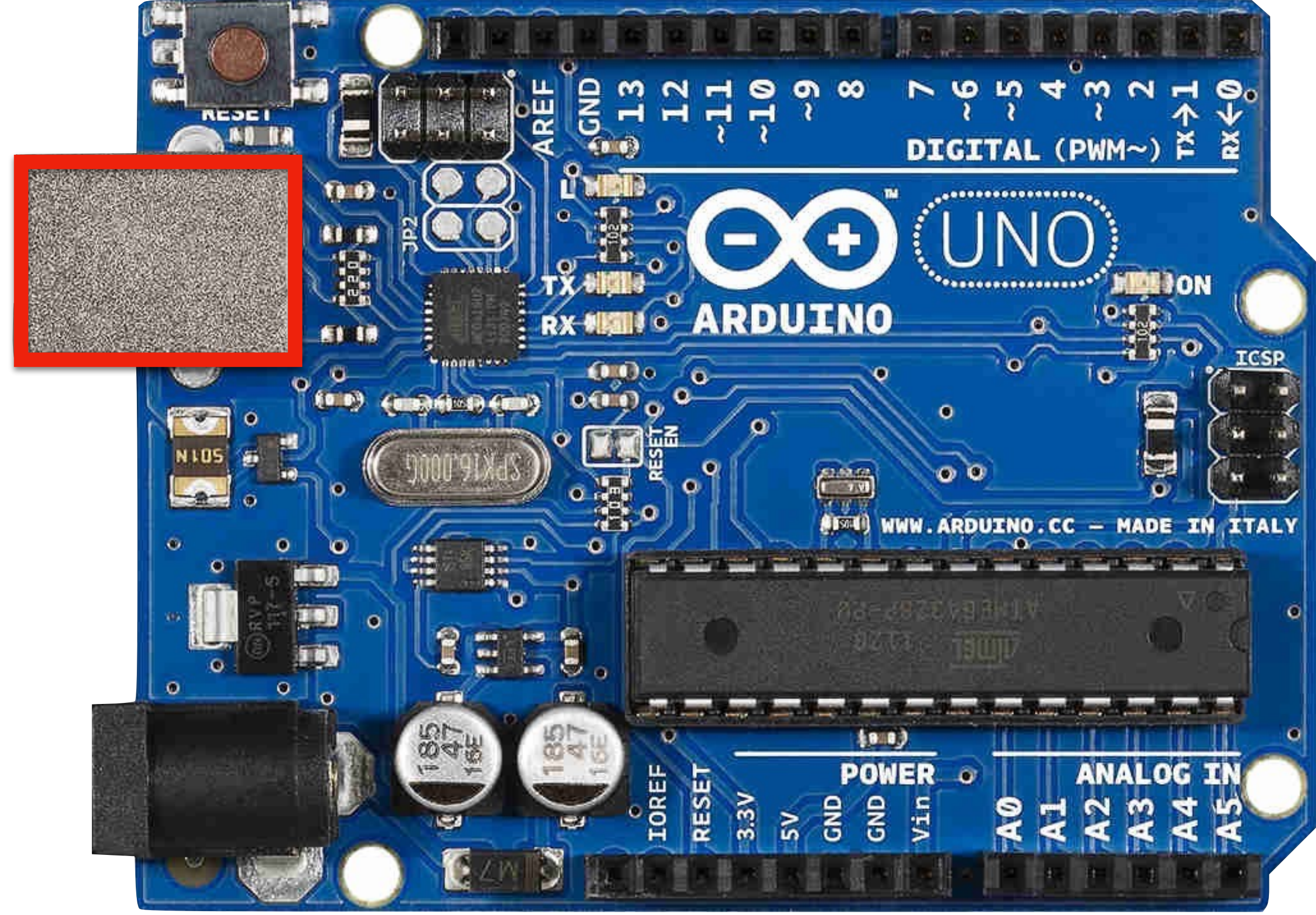




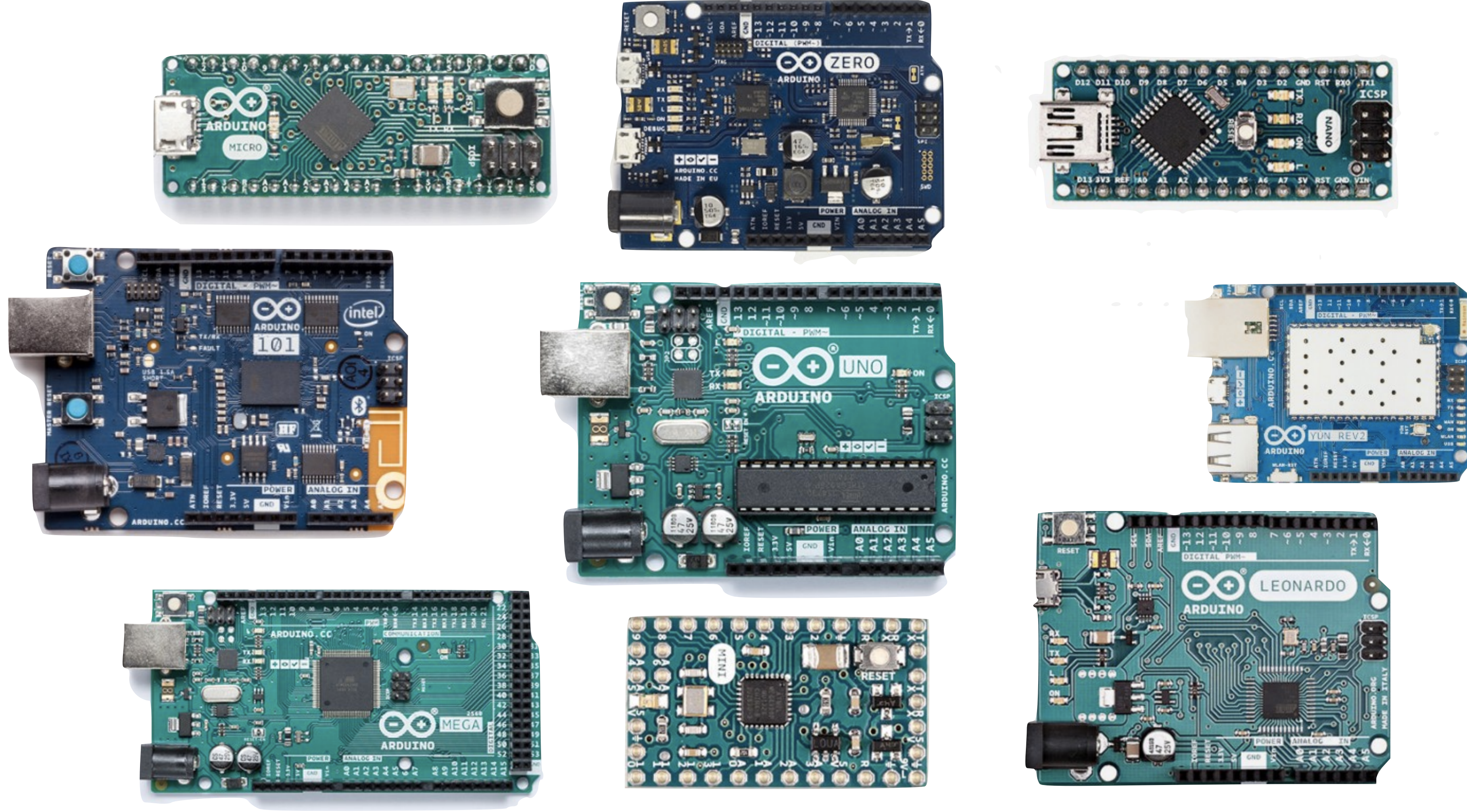
# Arduino



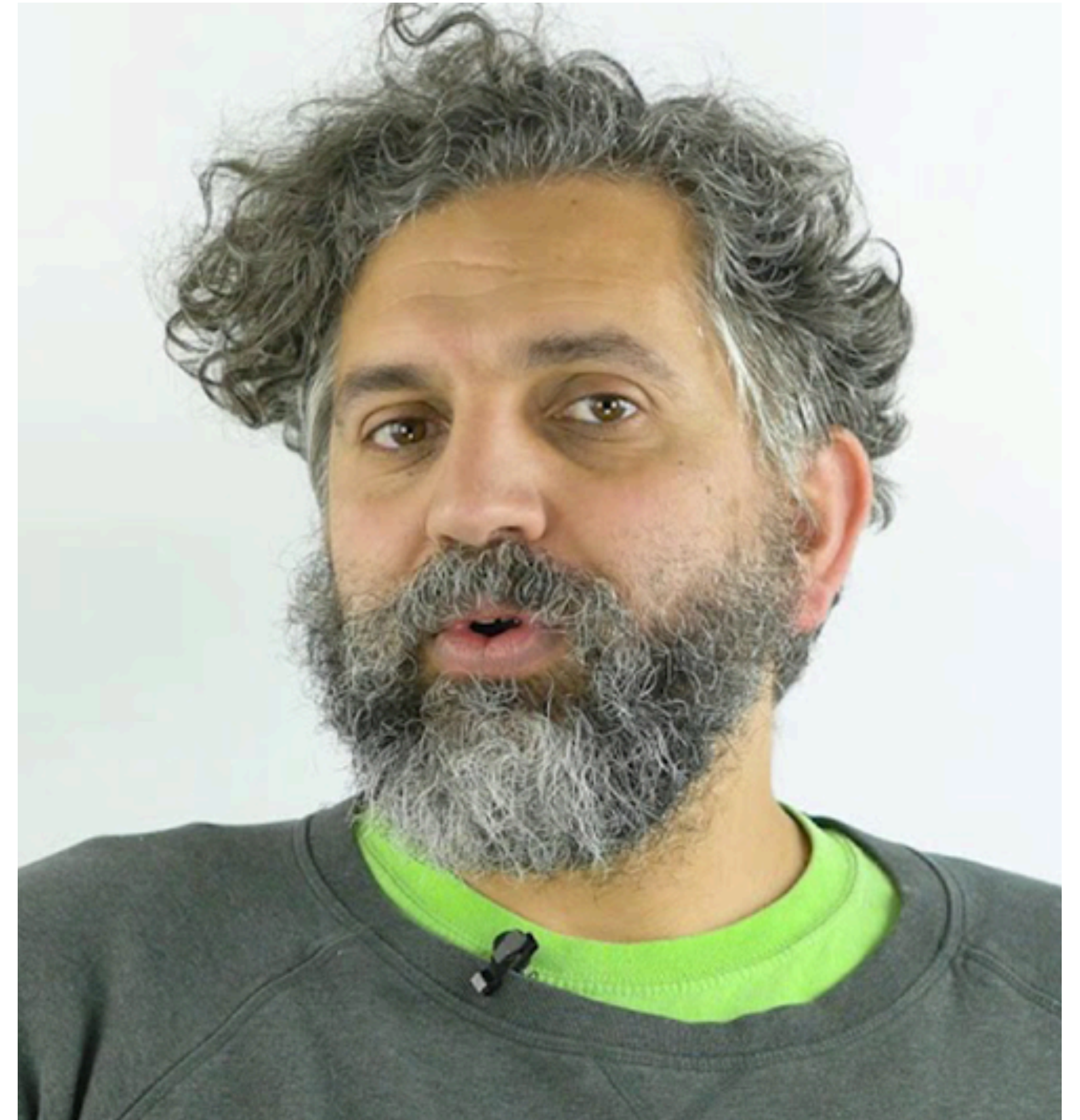
# Arduino



# La famiglia Arduino



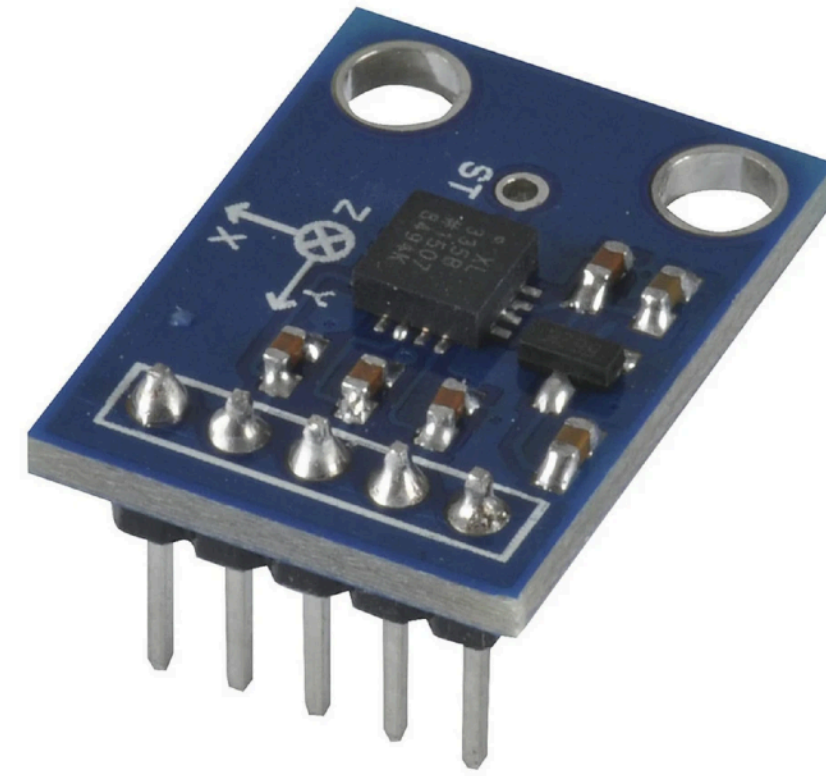
# Arduino



# L'ecosistema Arduino



termometri



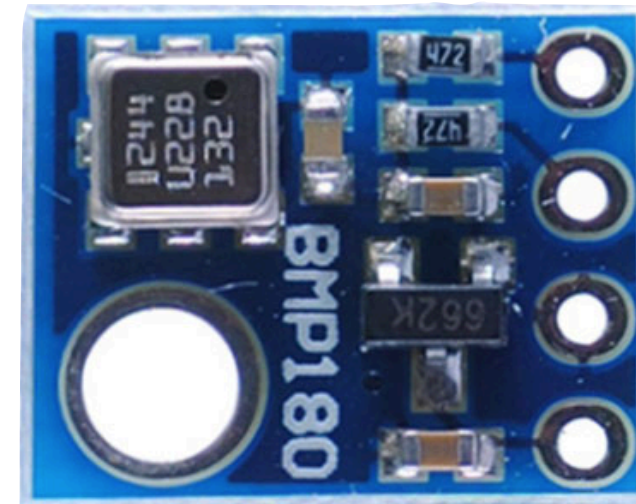
accelerometri  
magnetometri  
giroscopi



sensori ultrasonici



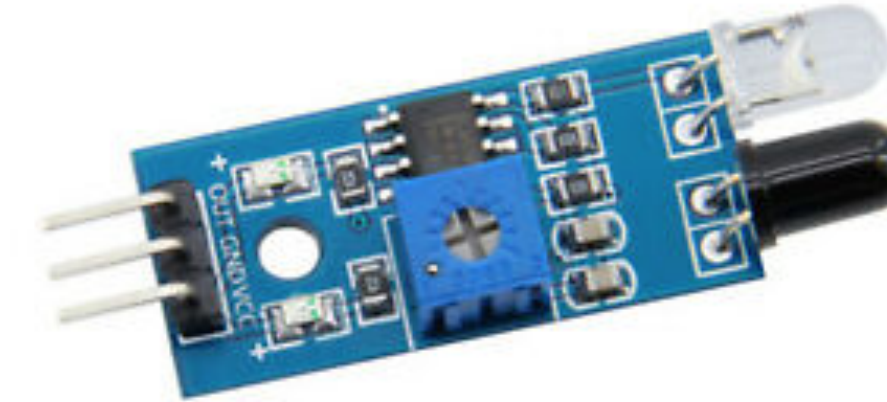
Sensori d'intensità  
luminosa



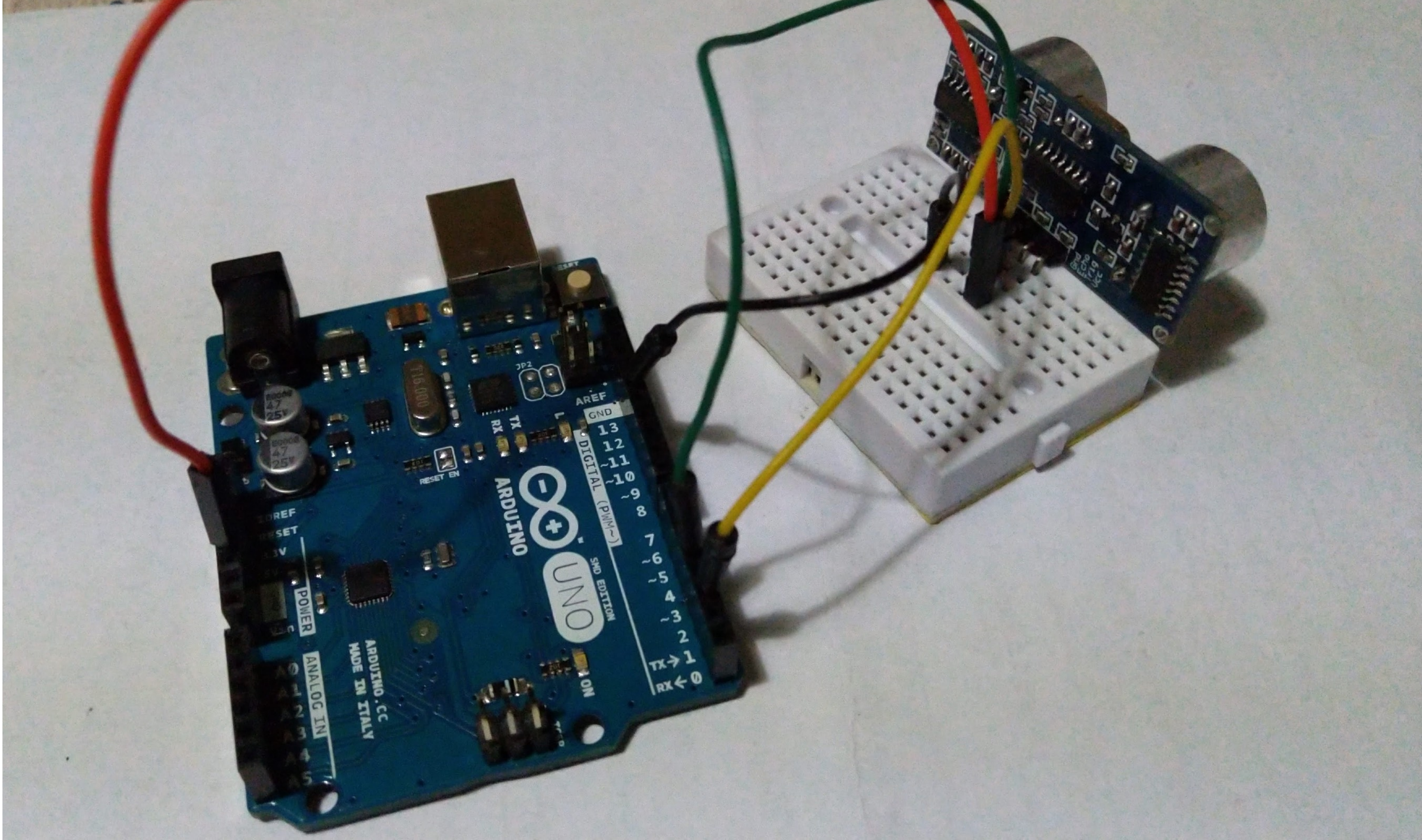
barometri



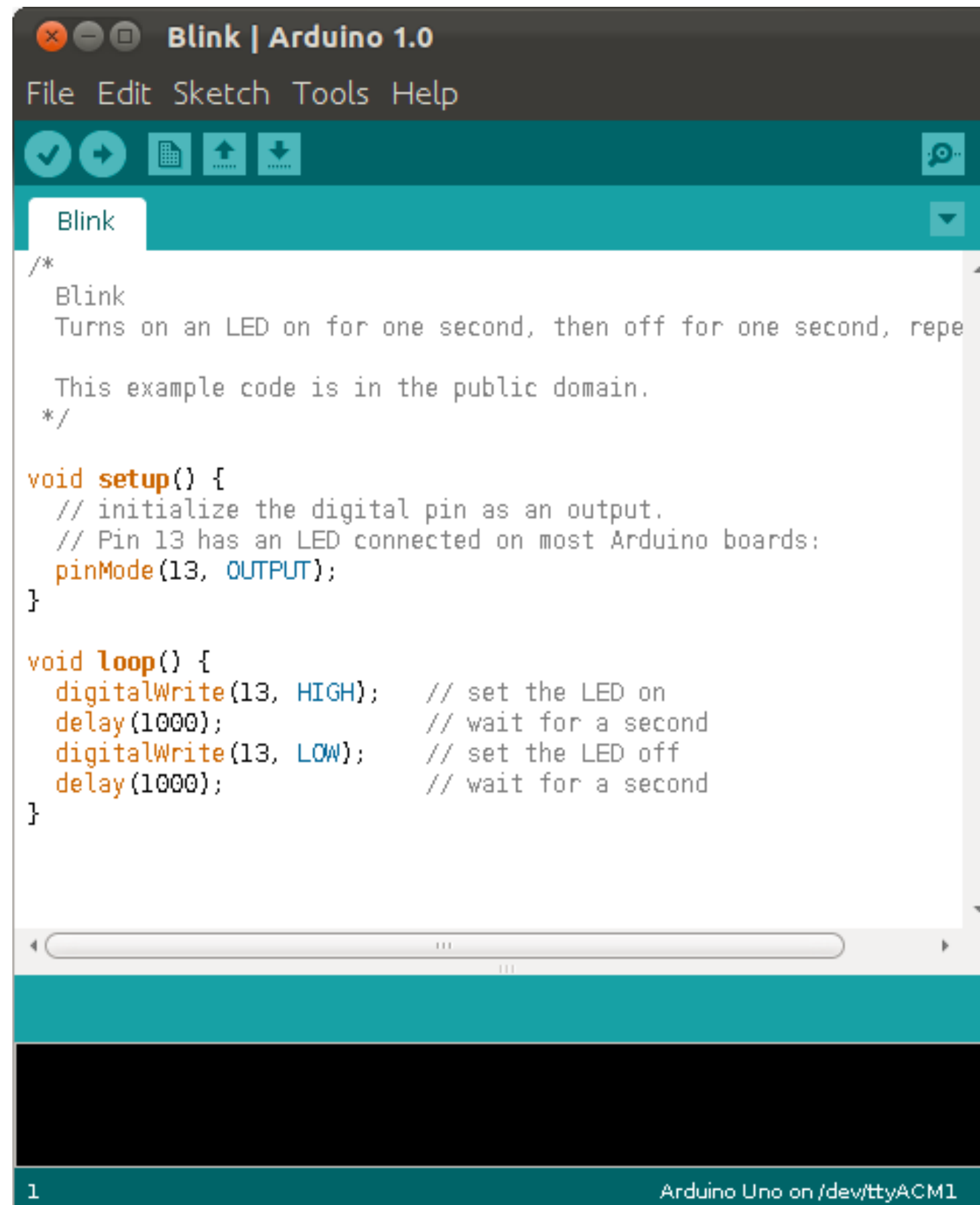
microfoni



fotorivelatori



# Arduino IDE



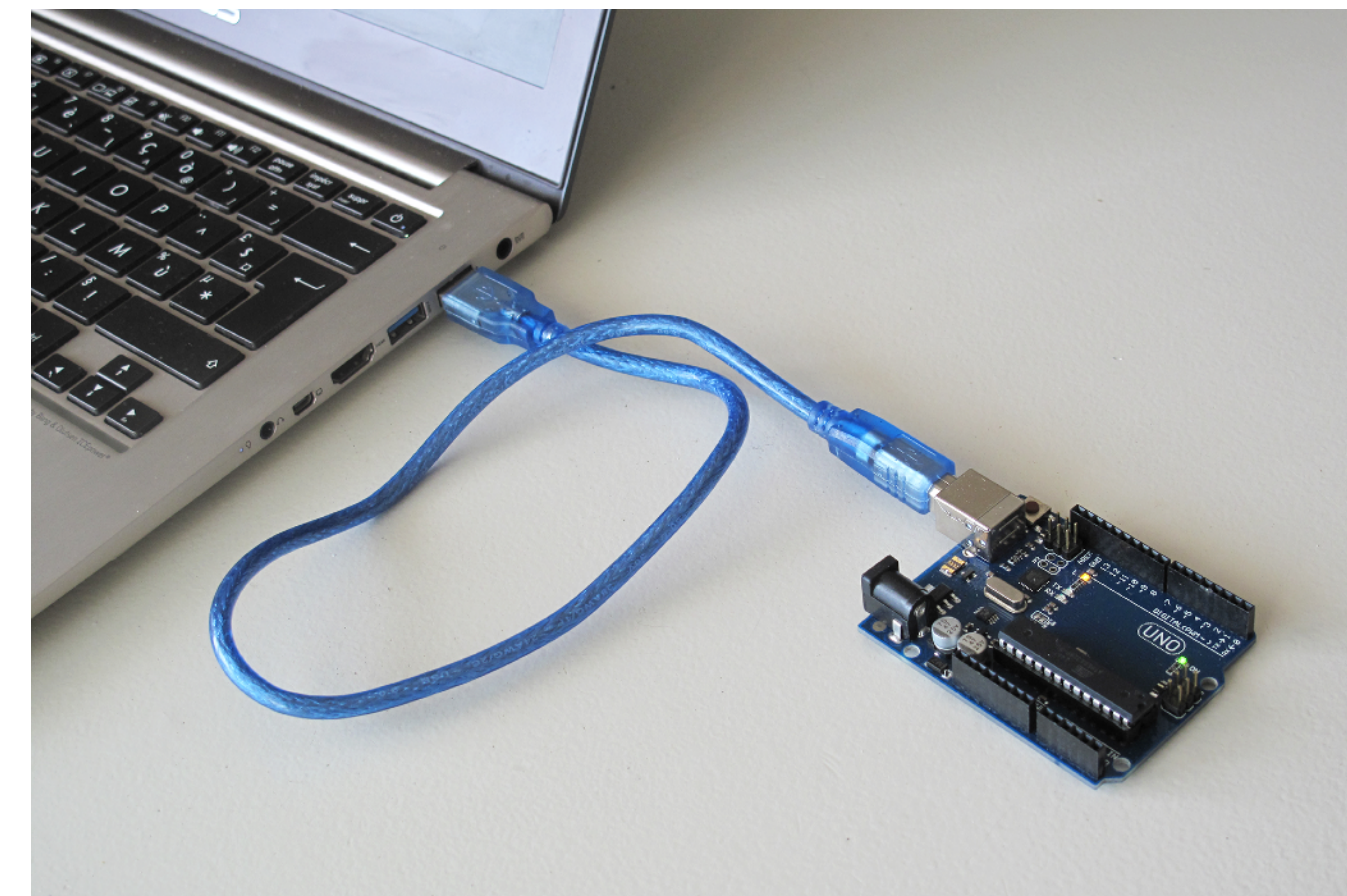
The screenshot shows the Arduino IDE window titled "Blink | Arduino 1.0". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for opening files, saving, and uploading. The main editor area displays the following code:

```
/*
 * Blink
 * Turns on an LED on for one second, then off for one second, repeats.
 *
 * This example code is in the public domain.
 */

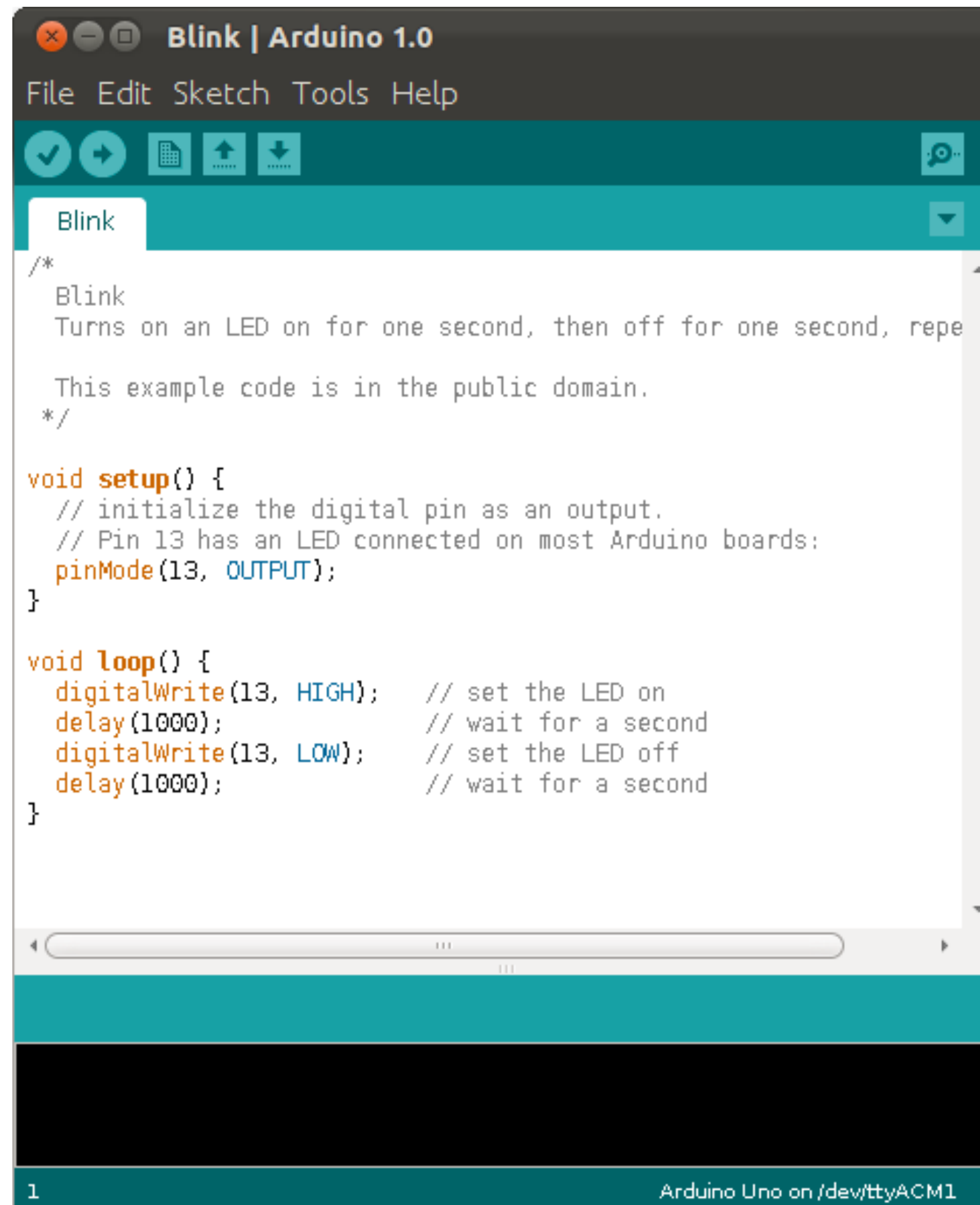
void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH); // set the LED on
  delay(1000);           // wait for a second
  digitalWrite(13, LOW); // set the LED off
  delay(1000);           // wait for a second
}
```

At the bottom of the IDE, a status bar shows "1" on the left and "Arduino Uno on /dev/ttyACM1" on the right.



# Arduino IDE

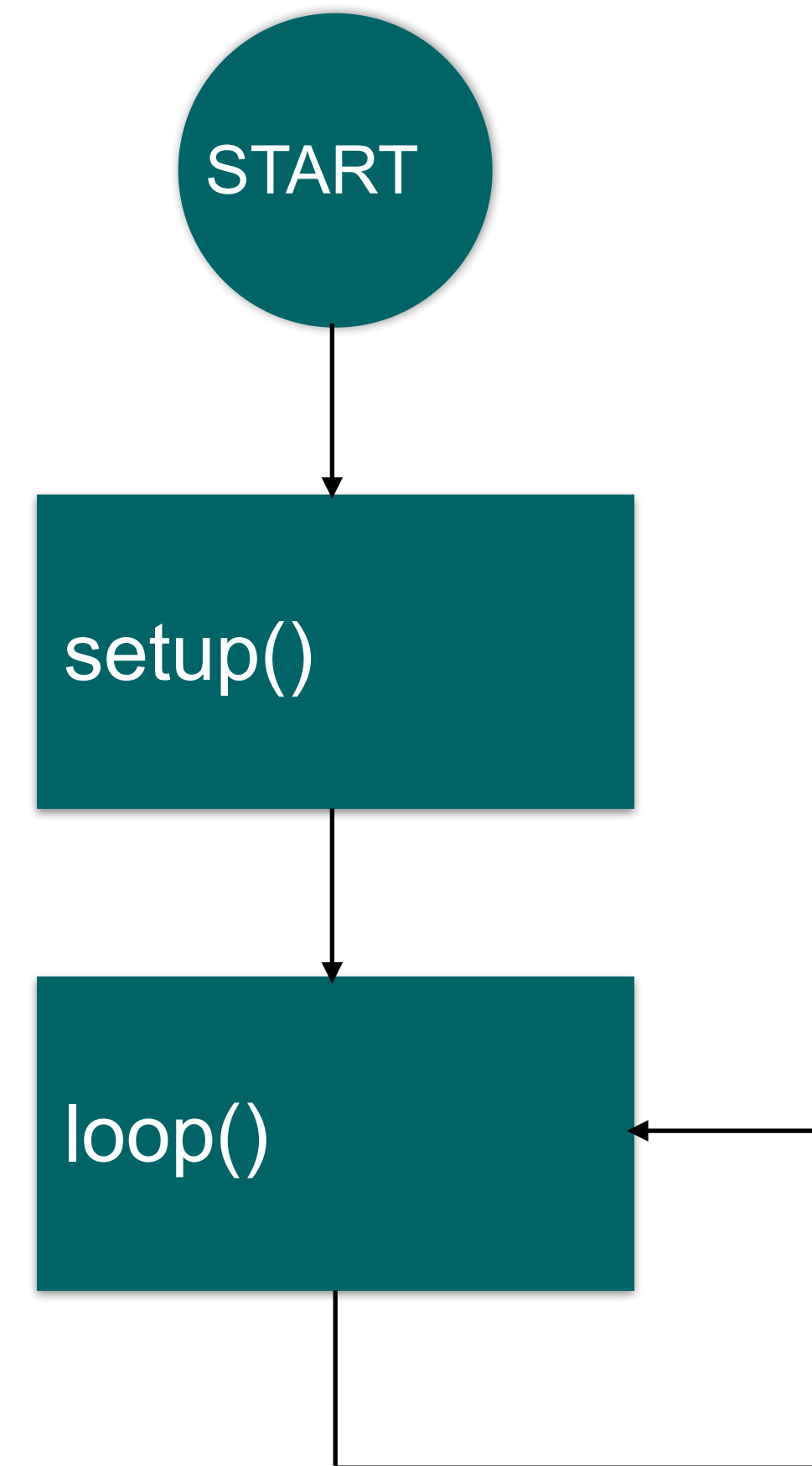


```
Arduino IDE - Blink | Arduino 1.0
File Edit Sketch Tools Help
Blink
/*
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 * Turns on an LED on for one second, then off for one second, repeats.
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void setup() {
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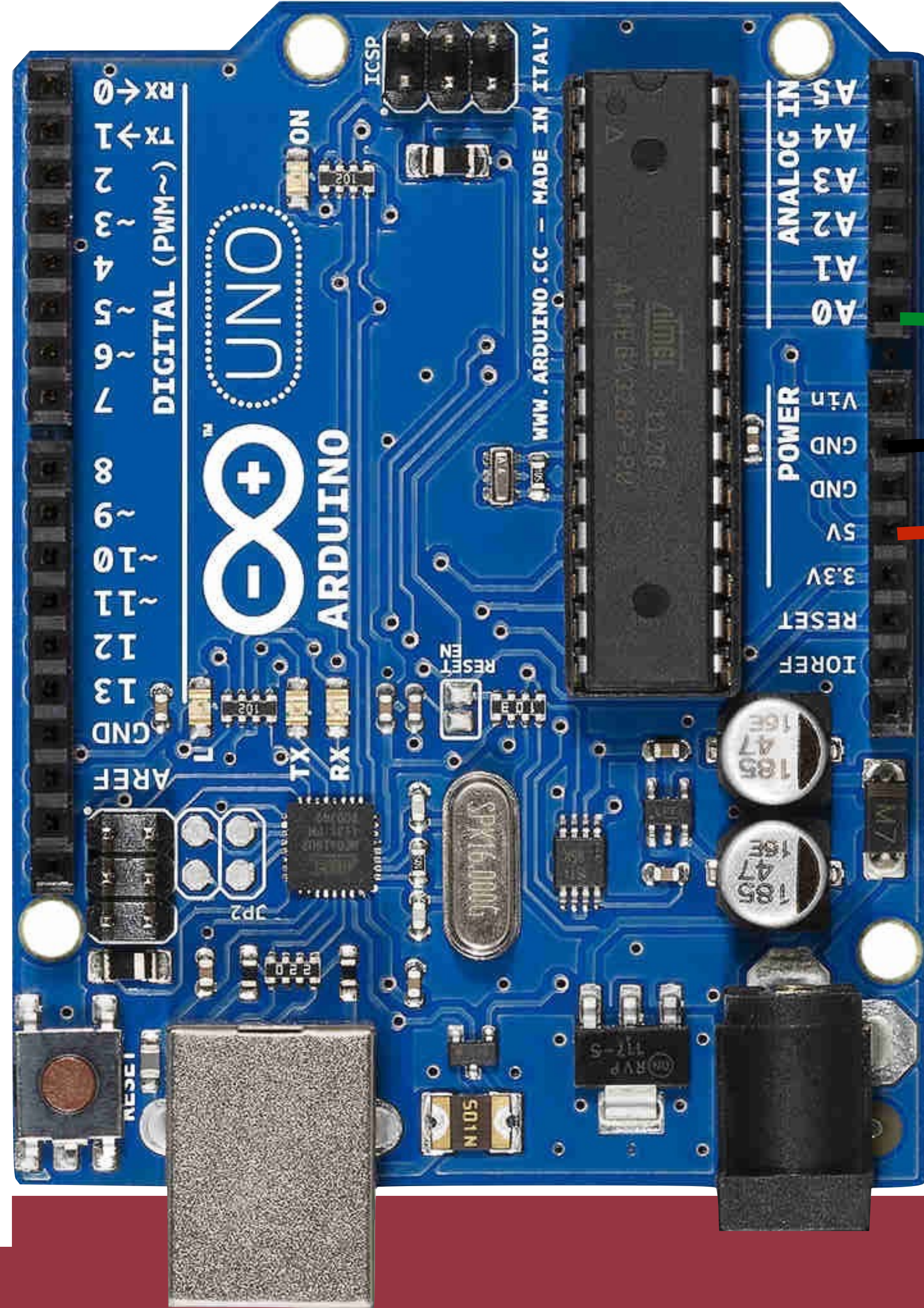
void loop() {
  digitalWrite(13, HIGH); // set the LED on
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1 Arduino Uno on /dev/ttyACM1
```

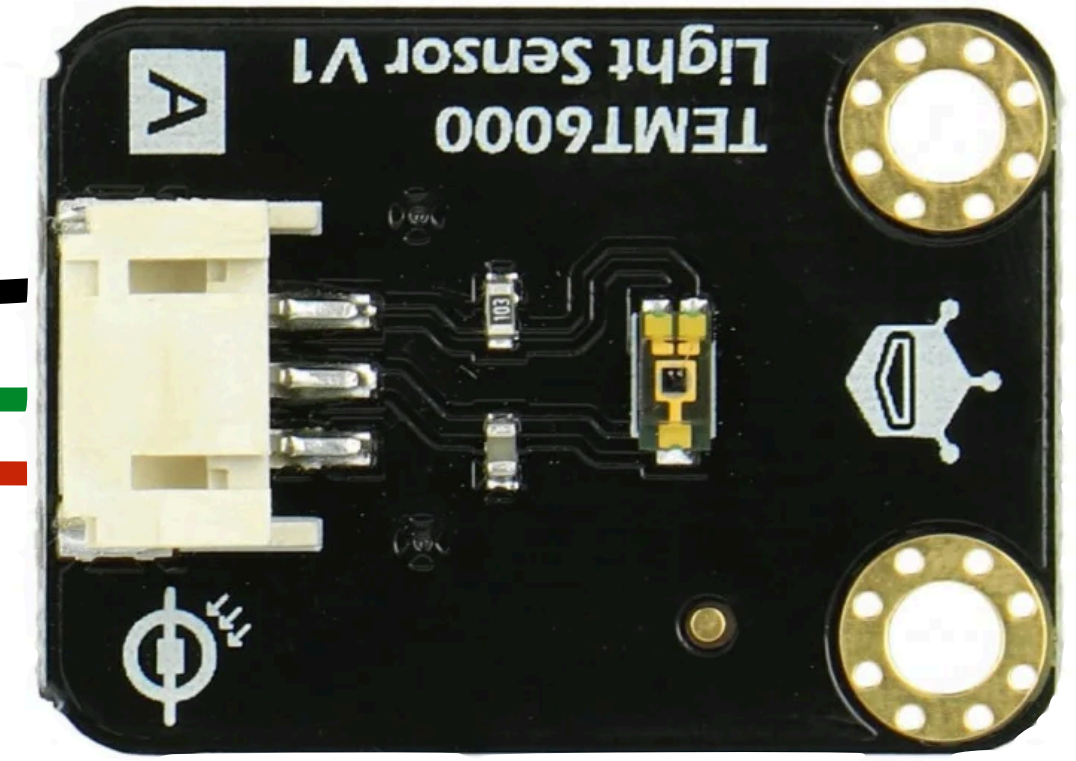




# An analog pin example



Light Intensity Analog Sensor

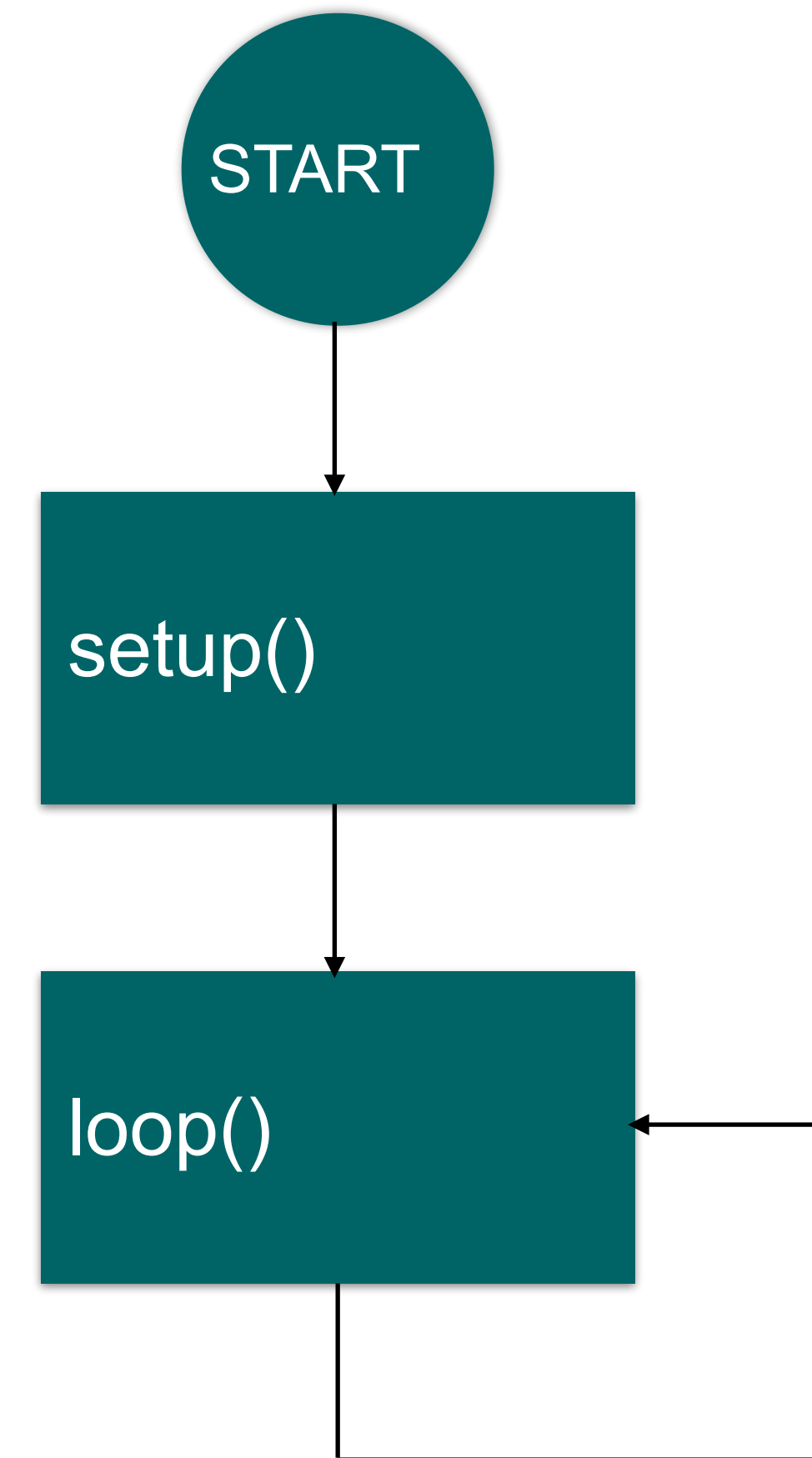


$$I = \alpha V$$

# Anatomia di uno *sketch*

funzione

```
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  int n = analogRead(A0);  
  float V = n*5./1023;  
  Serial.println(V);  
}
```



# Anatomia di uno *sketch*

```
void setup() {  
  Serial.begin(9600);  
}
```

attiva comunicazione USB  
velocità = 9600 baud  
fine istruzione = ;

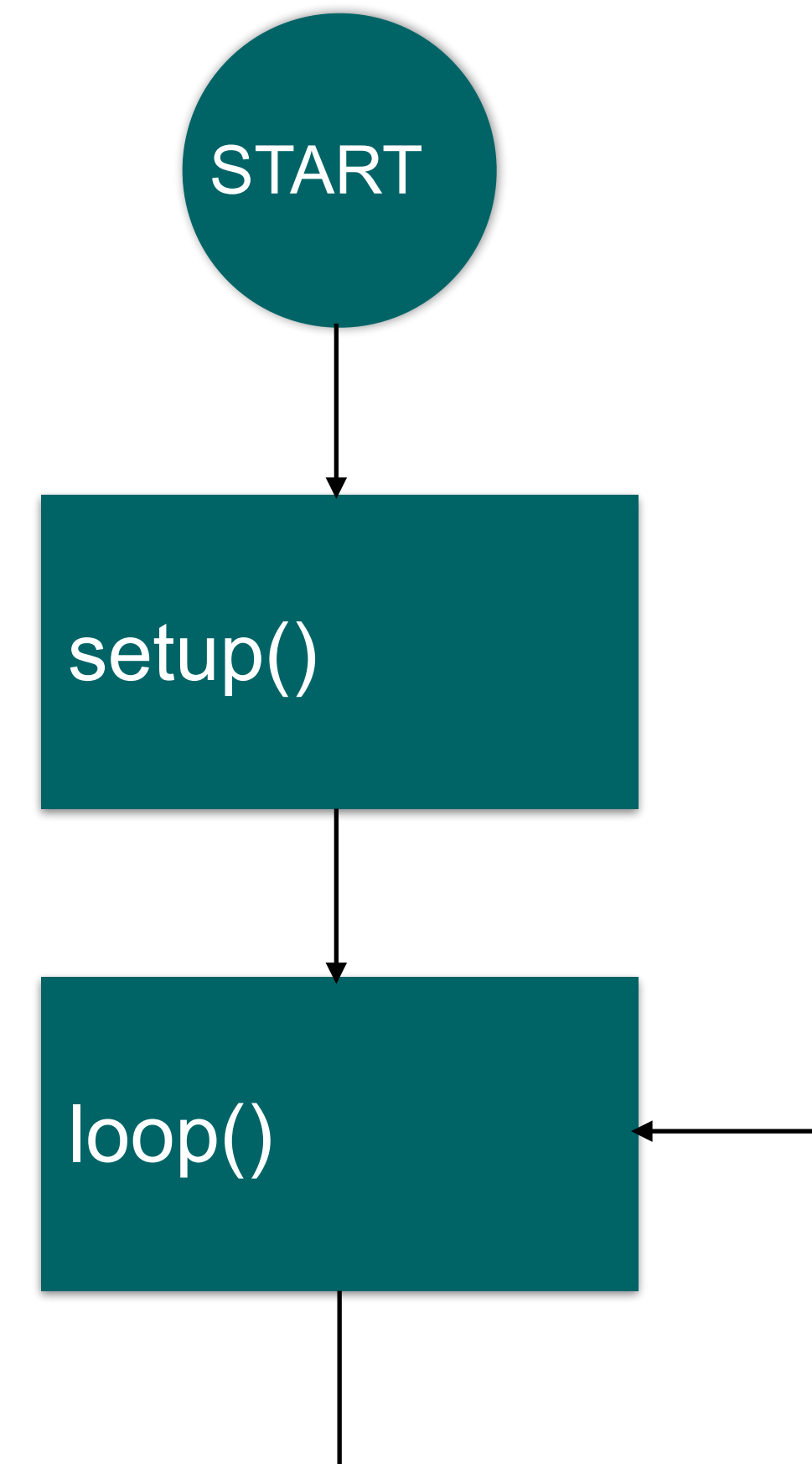
```
void loop() {  
  int n = analogRead(A0);  
  float V = n*5./1023;  
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}
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# Anatomia di uno *sketch*

```
void setup() {  
  Serial.begin(9600);  
}
```

funzione

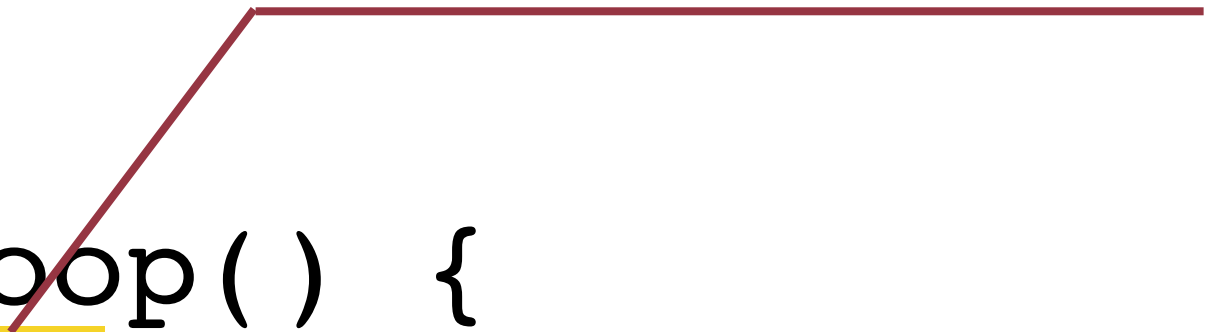
```
void loop() {  
  int n = analogRead(A0);  
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  Serial.println(V);  
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# Anatomia di uno *sketch*

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void setup() {  
    Serial.begin(9600);  
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    int n = analogRead(A0);  
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    Serial.println(V);  
}
```

dichiarazione



# Anatomia di uno *sketch*

```
void setup() {  
    Serial.begin(9600);  
}
```

```
void loop() {  
    int n = analogRead(A0);  
    float V = n*5./1023;  
    Serial.println(V);  
}
```

legge la tensione su A0  
 $n \in [0, 1023]$

# Anatomia di uno *sketch*

```
void setup() {  
  Serial.begin(9600);  
}
```

dichiarazione

```
void loop() {  
  int n = analogRead(A0);  
  float V = n*5./1023;  
  Serial.println(V);  
}
```

# Anatomia di uno *sketch*

```
void setup() {  
  Serial.begin(9600);  
}
```

```
void loop() {  
  int n = analogRead(A0);  
  float V = n*5./1023; ————— trasforma in V  
  Serial.println(V);  
}
```



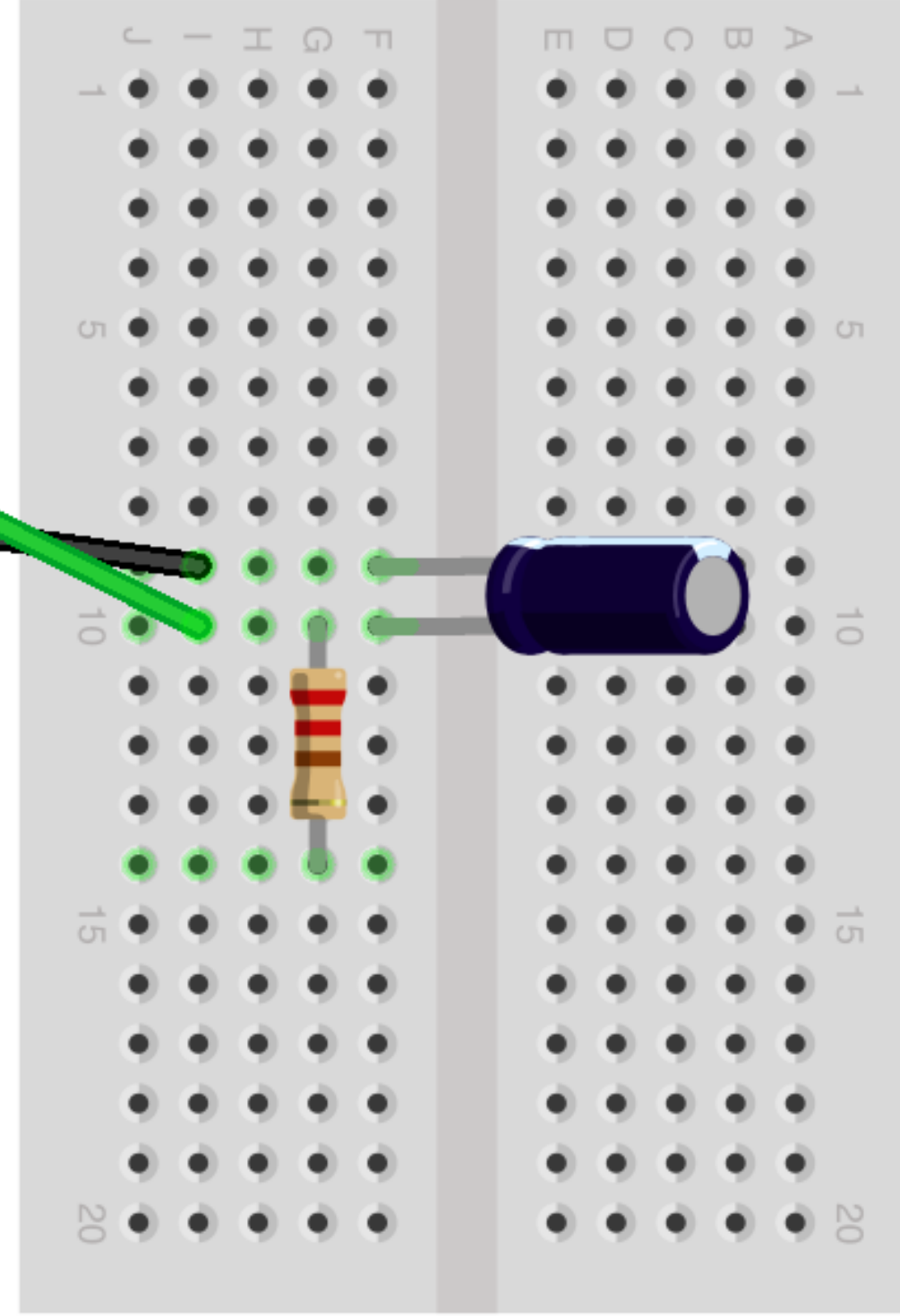
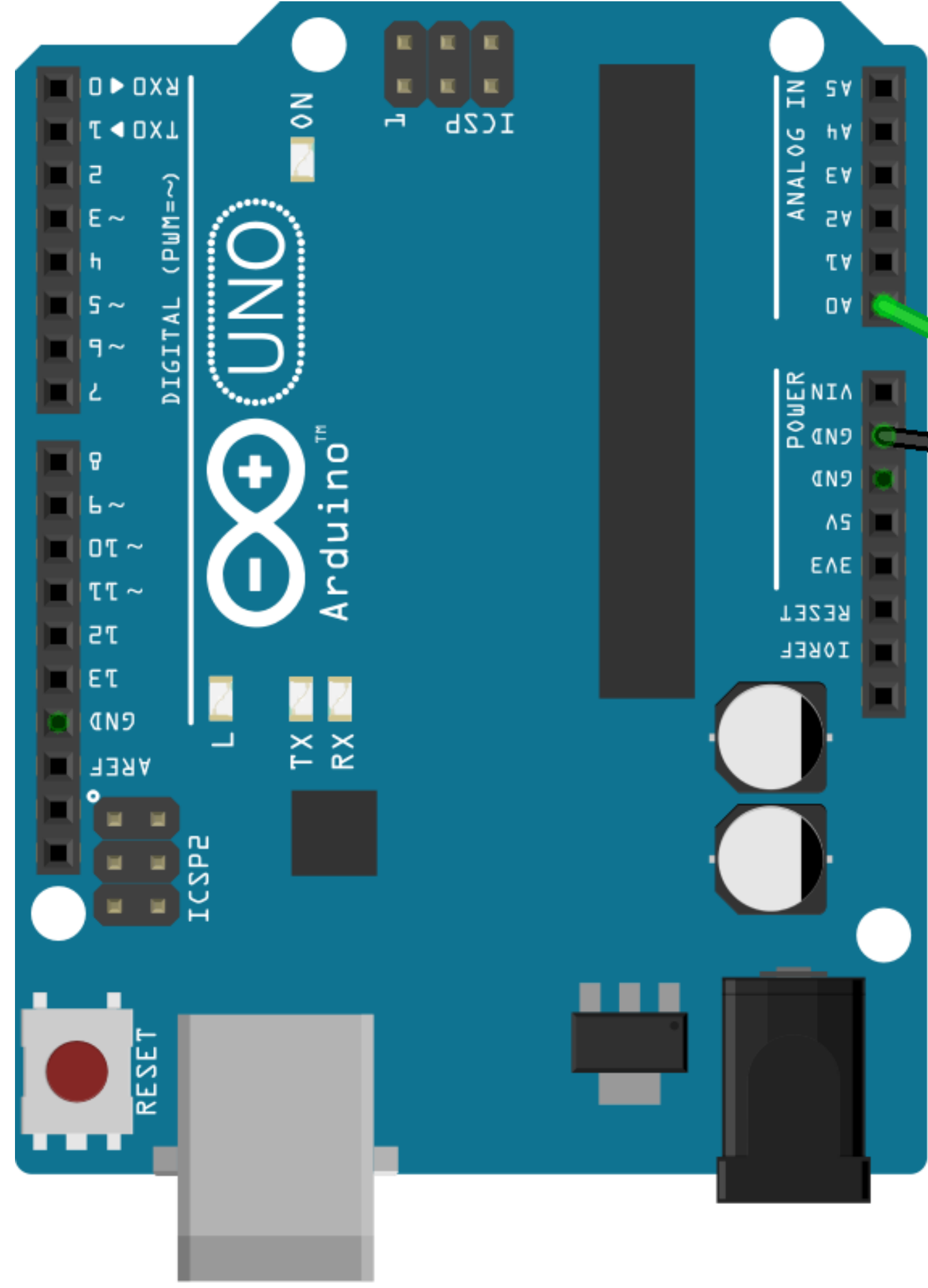
# Anatomia di uno *sketch*

```
void setup() {  
  Serial.begin(9600);  
}
```

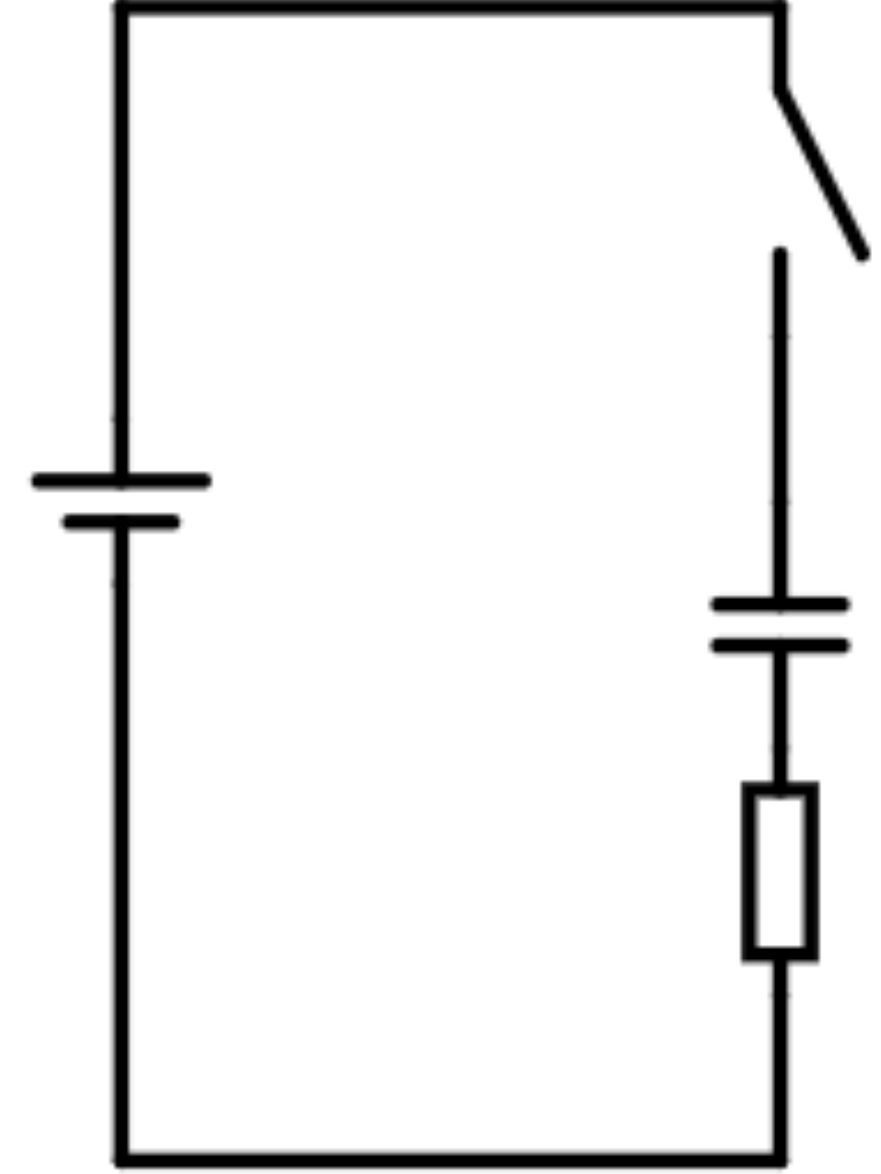
```
void loop() {  
  int n = analogRead(A0);  
  float V = n*5./1023;  
  Serial.println(V);  
}
```

invia alla USB

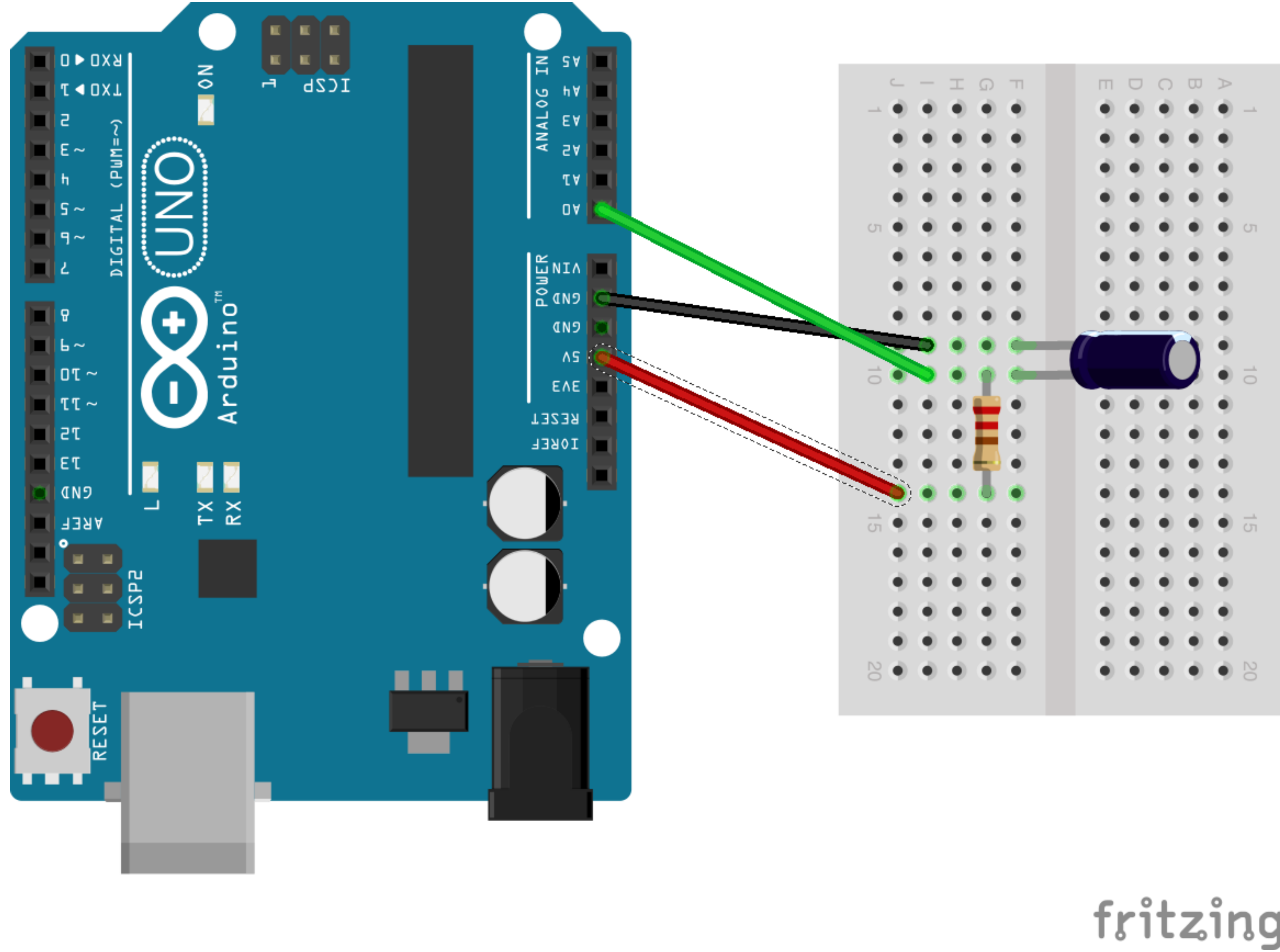
# Esempio di carica e scarica



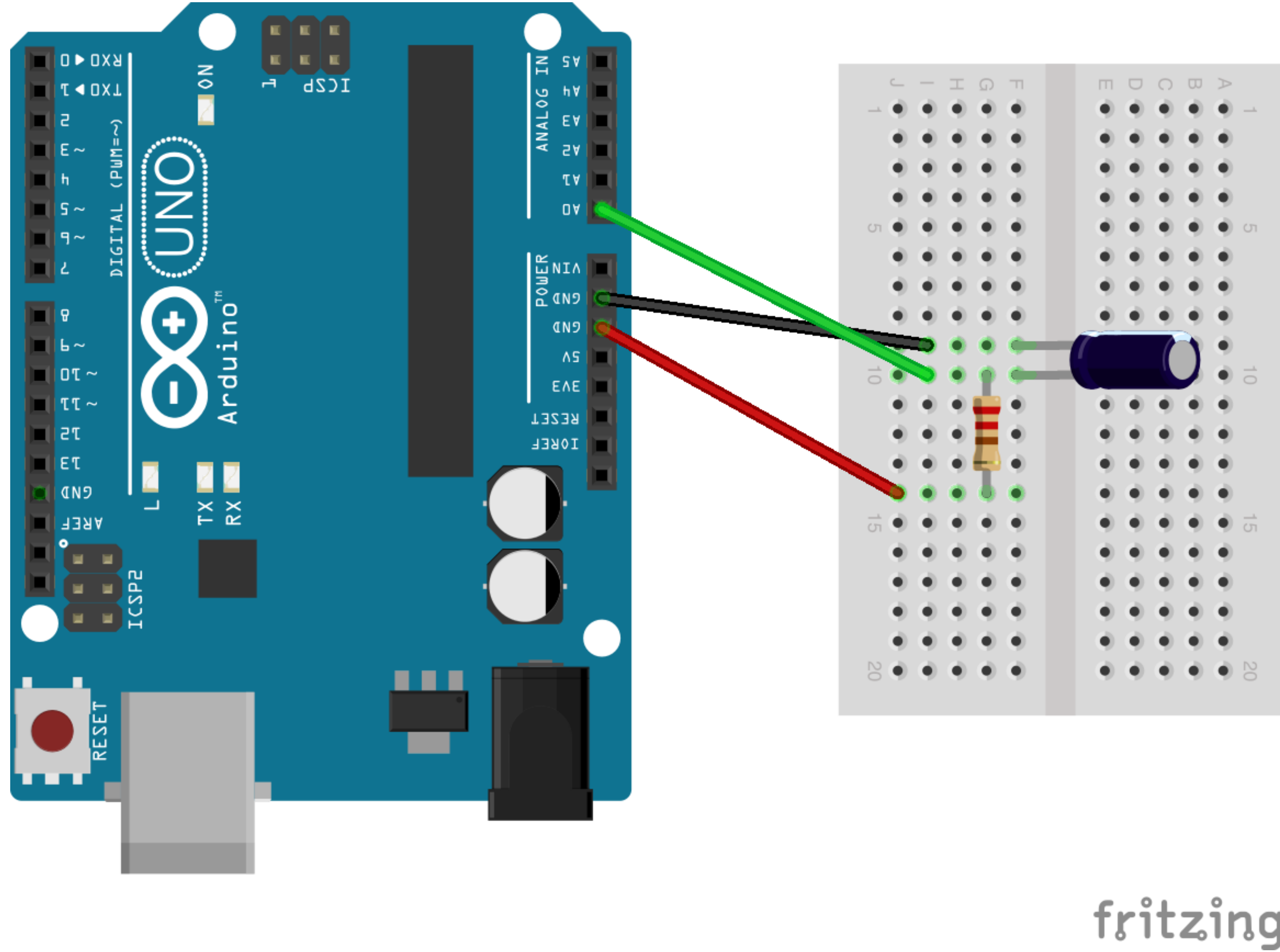
fritzing

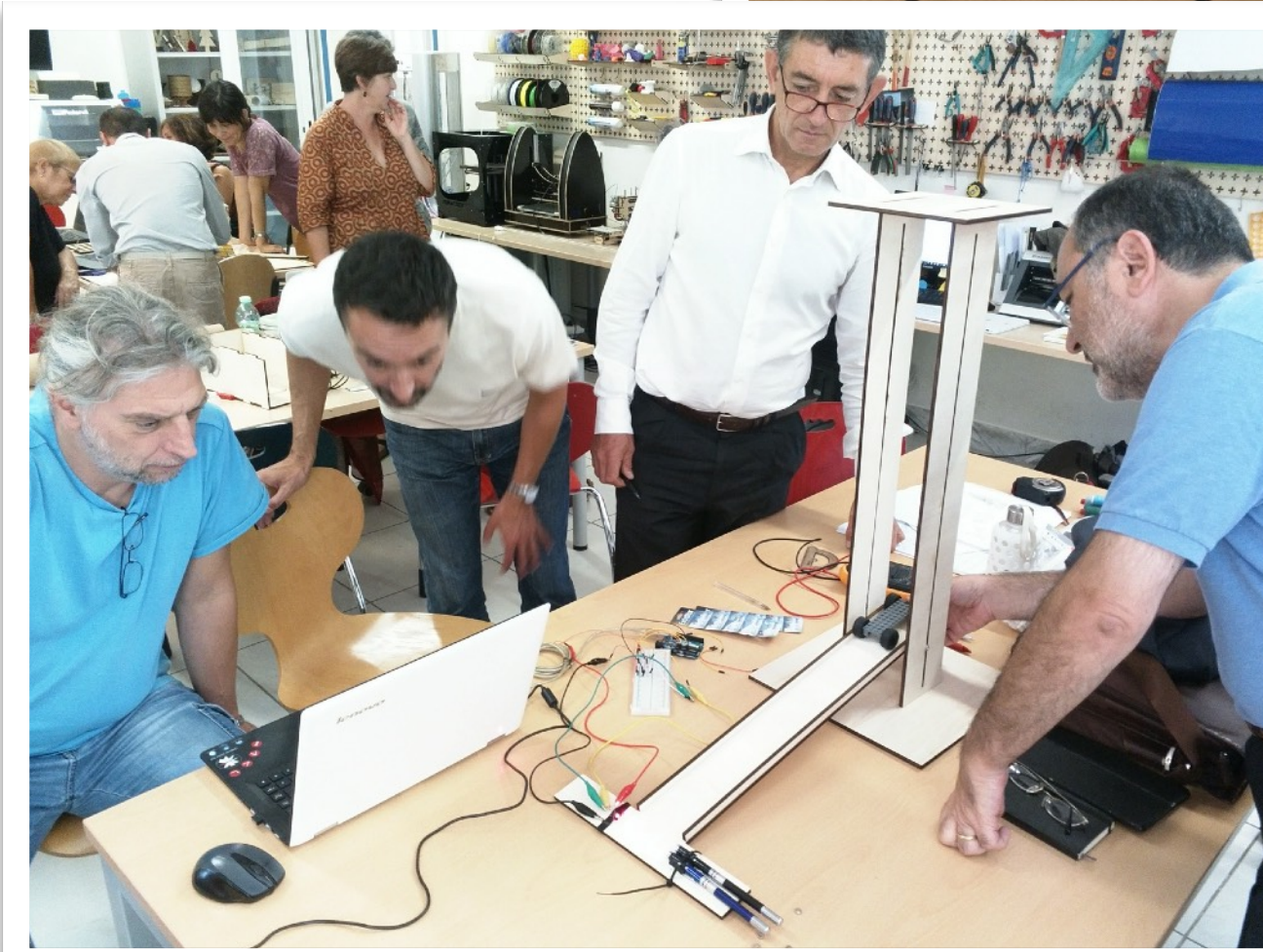
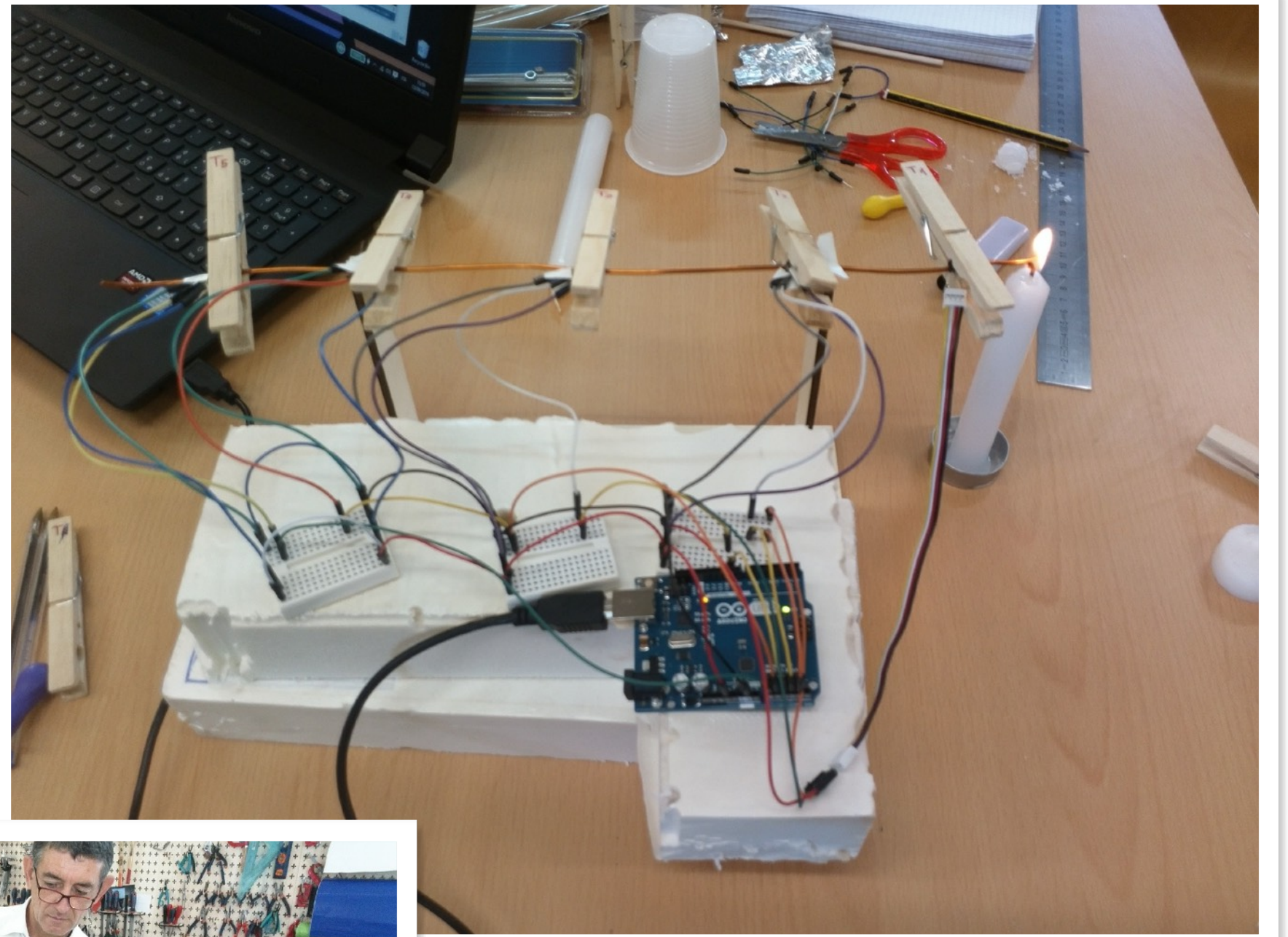
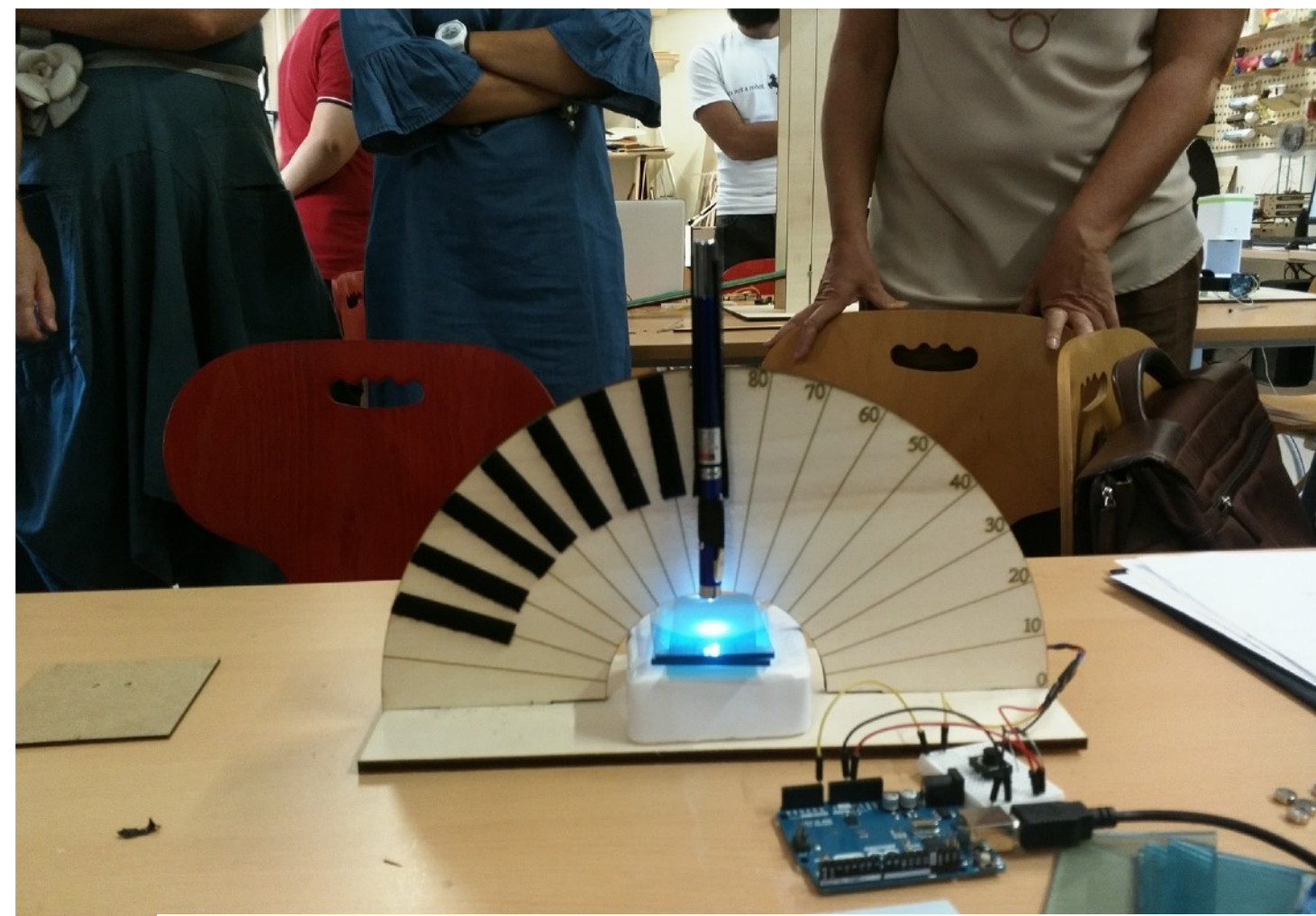


# Esempio di carica e scarica

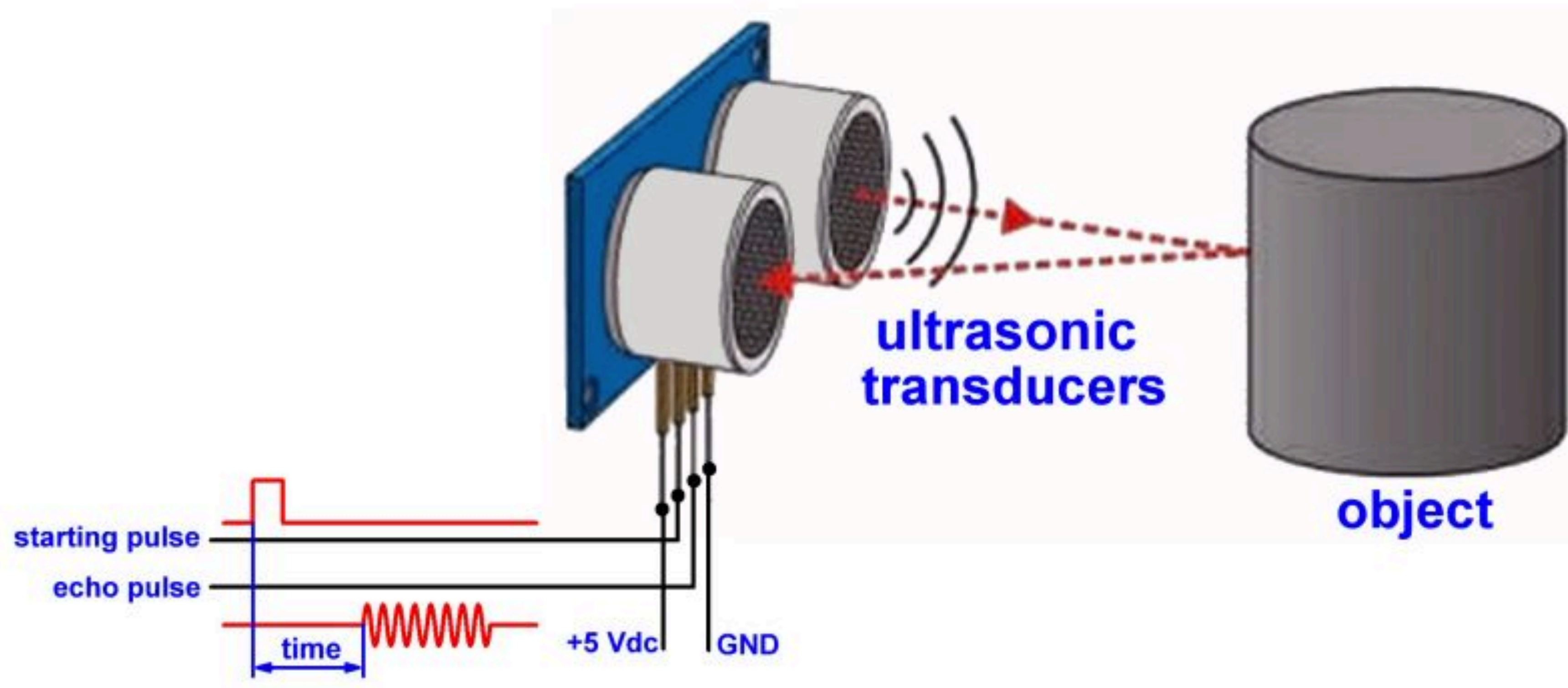


# Esempio di carica e scarica

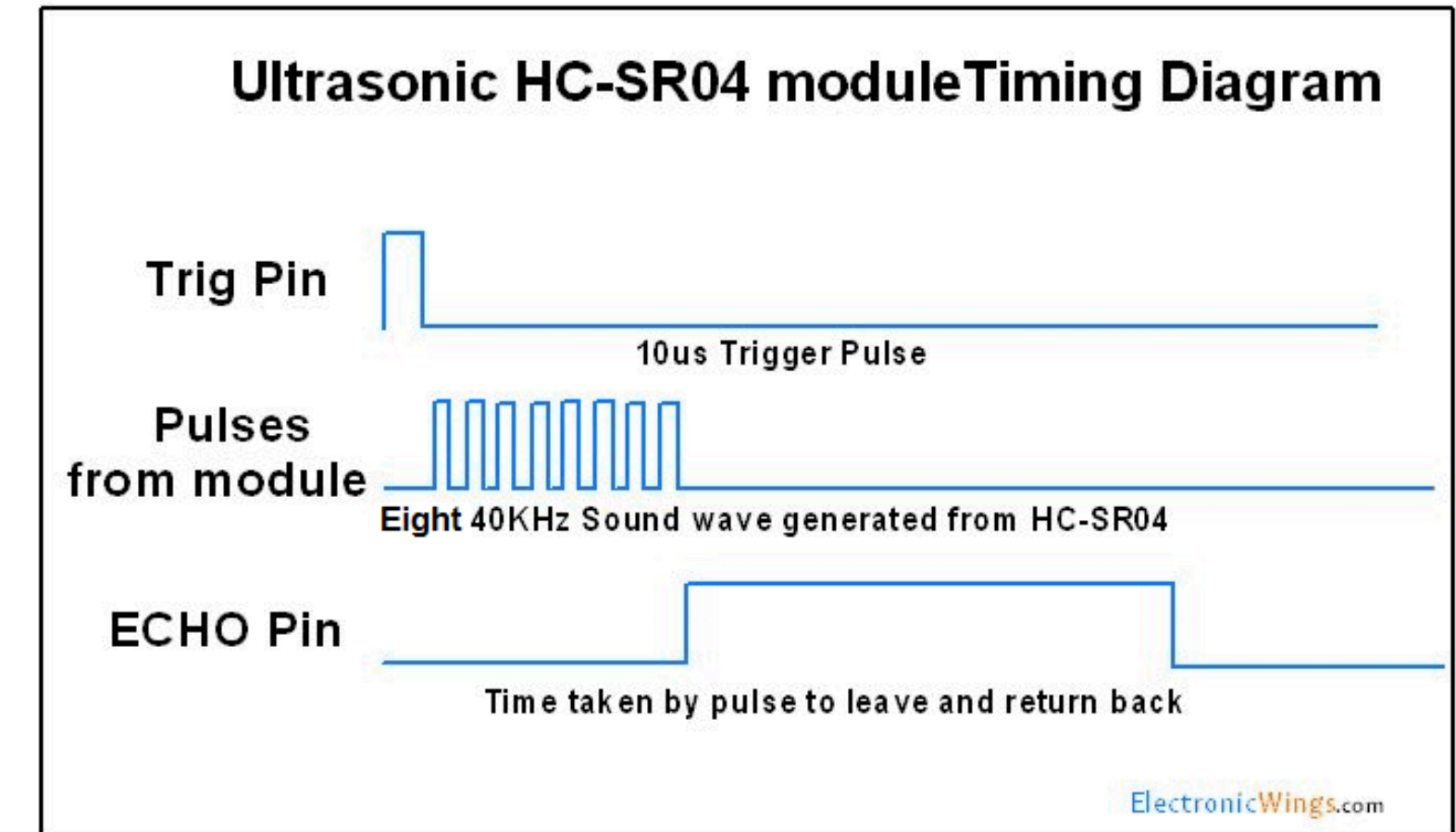
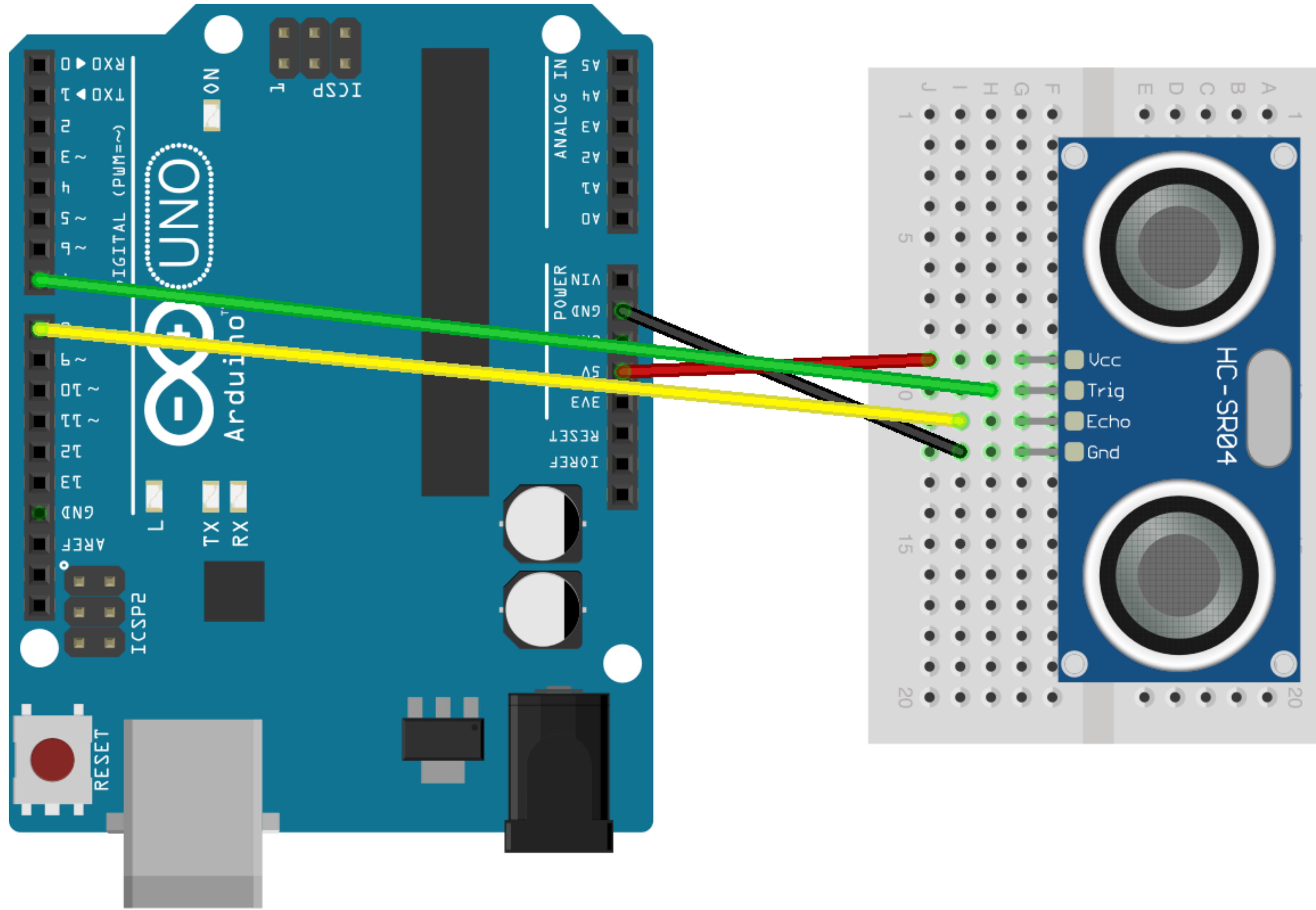




# Sensori ultrasonici



# Sensori ultrasonici



fritzing

# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}  
  
void loop() {  
  digitalWrite(7, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
}
```



# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}
```

modo del pin  
pin 7: TRIG  
pin 8: ECHO

```
void loop() {  
  digitalWrite(7, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
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```

# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}
```

stato del pin  
pin 7 (TRIG): 0 V

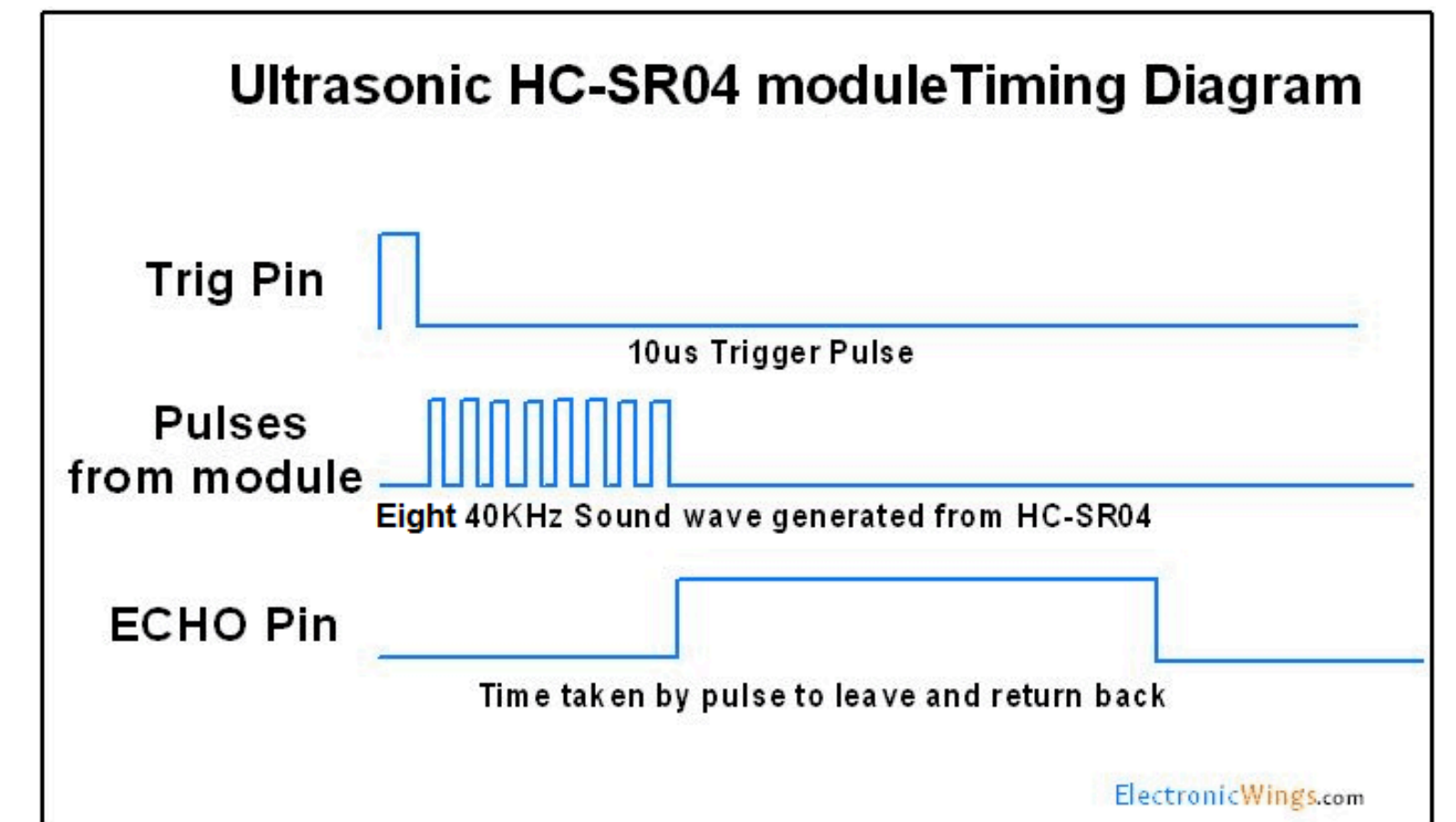
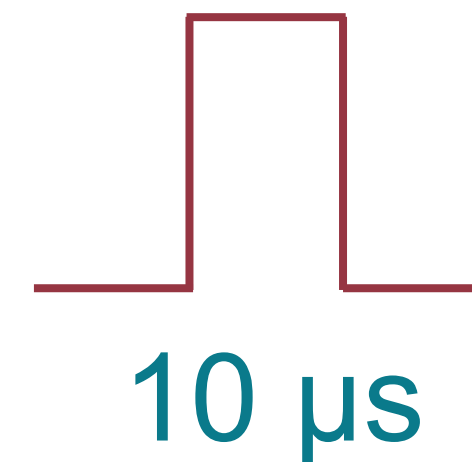
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  float d = 343.*t*1e-6/2;  
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# Esempio di sensore ultrasonico

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void setup() {  
  Serial.begin(9600);  
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void loop() {  
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  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
}
```

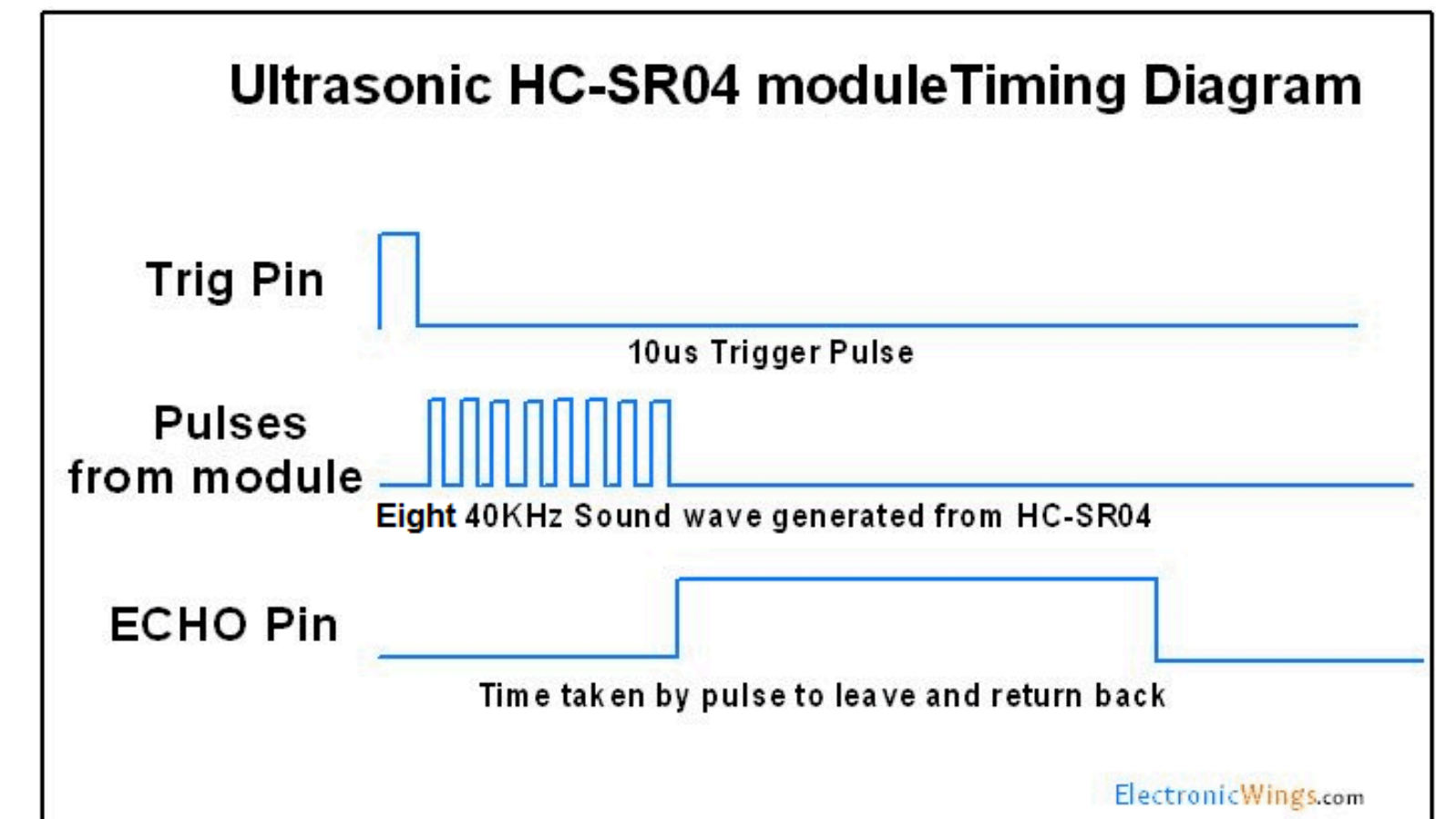
genera impulso di trigger



# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}
```

```
void loop() {  
  digitalWrite(7, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
}
```



restituisce il tempo di permanenza nello stato alto

# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}
```

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void loop() {  
  digitalWrite(7, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
}
```

calcola lo spazio percorso

# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
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```
void loop() {  
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  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d);  
  delay(50);  
}
```

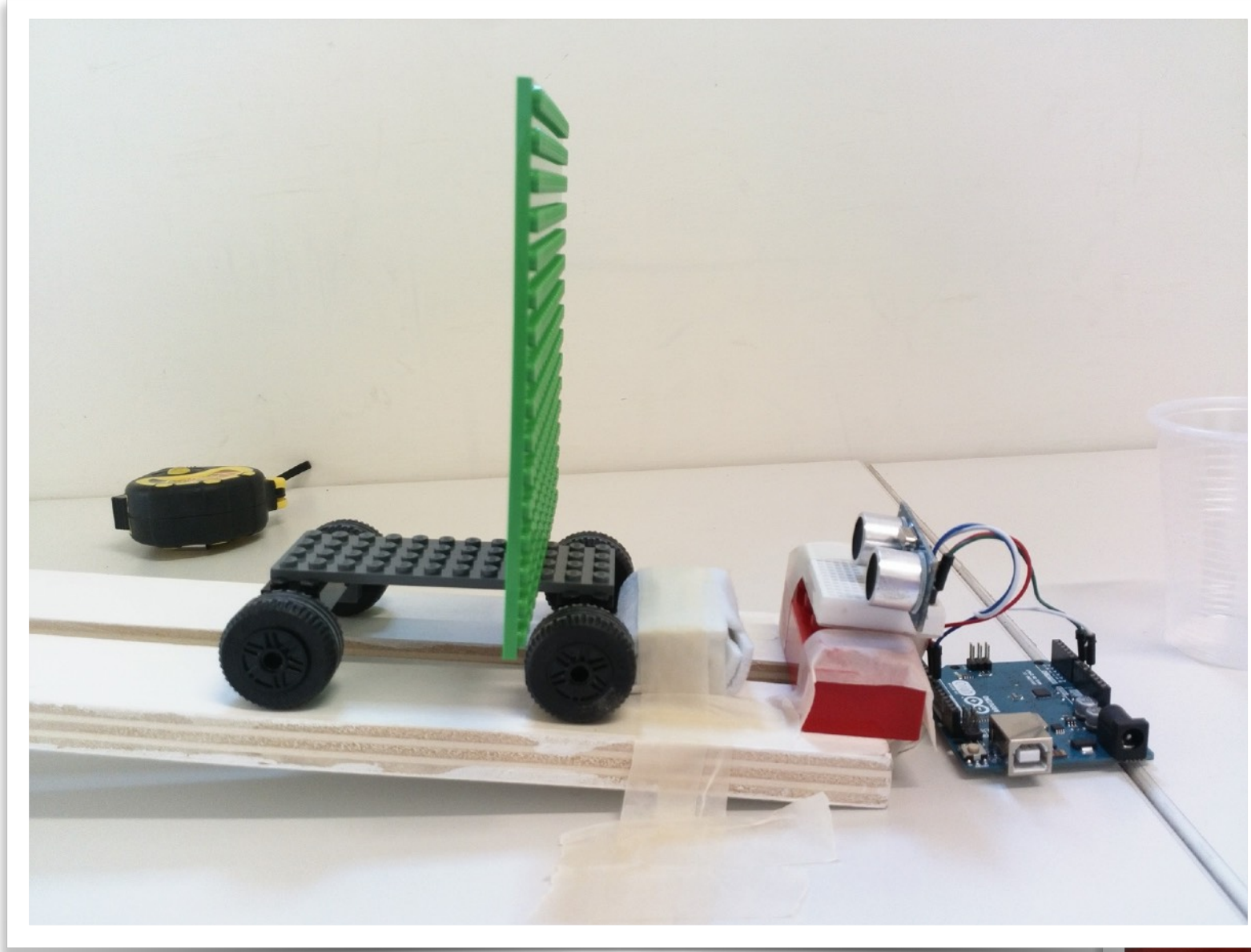
invia distanza alla USB

# Esempio di sensore ultrasonico

```
void setup() {  
  Serial.begin(9600);  
  pinMode(7, OUTPUT);  
  pinMode(8, INPUT);  
  digitalWrite(7, LOW);  
}
```

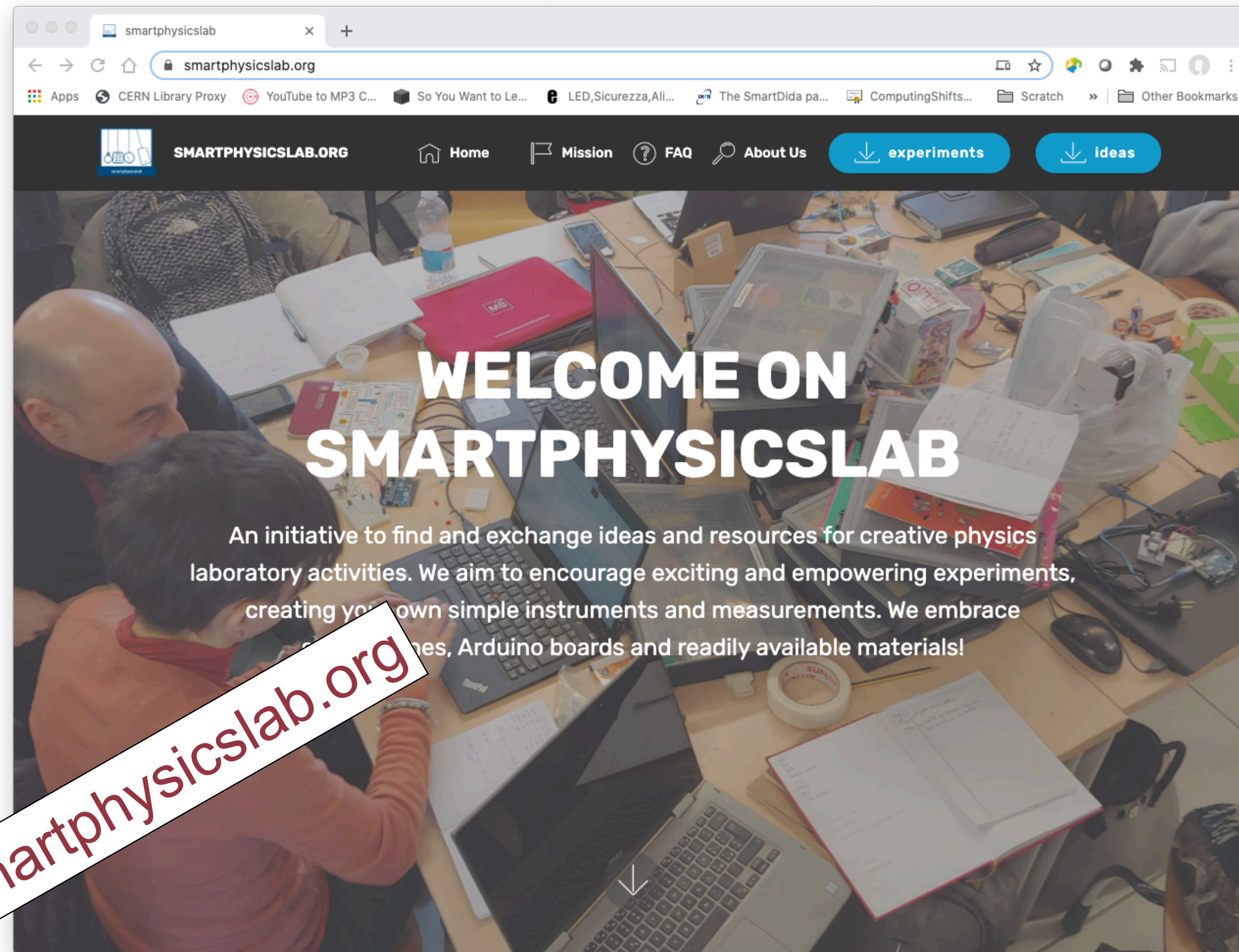
```
void loop() {  
  digitalWrite(7, HIGH);  
  delayMicroseconds(10);  
  digitalWrite(7, LOW);  
  unsigned long t = pulseIn(8, HIGH);  
  float d = 343.*t*1e-6/2;  
  Serial.println(d/2);  
  delay(50);  
}
```

attesa 50 ms



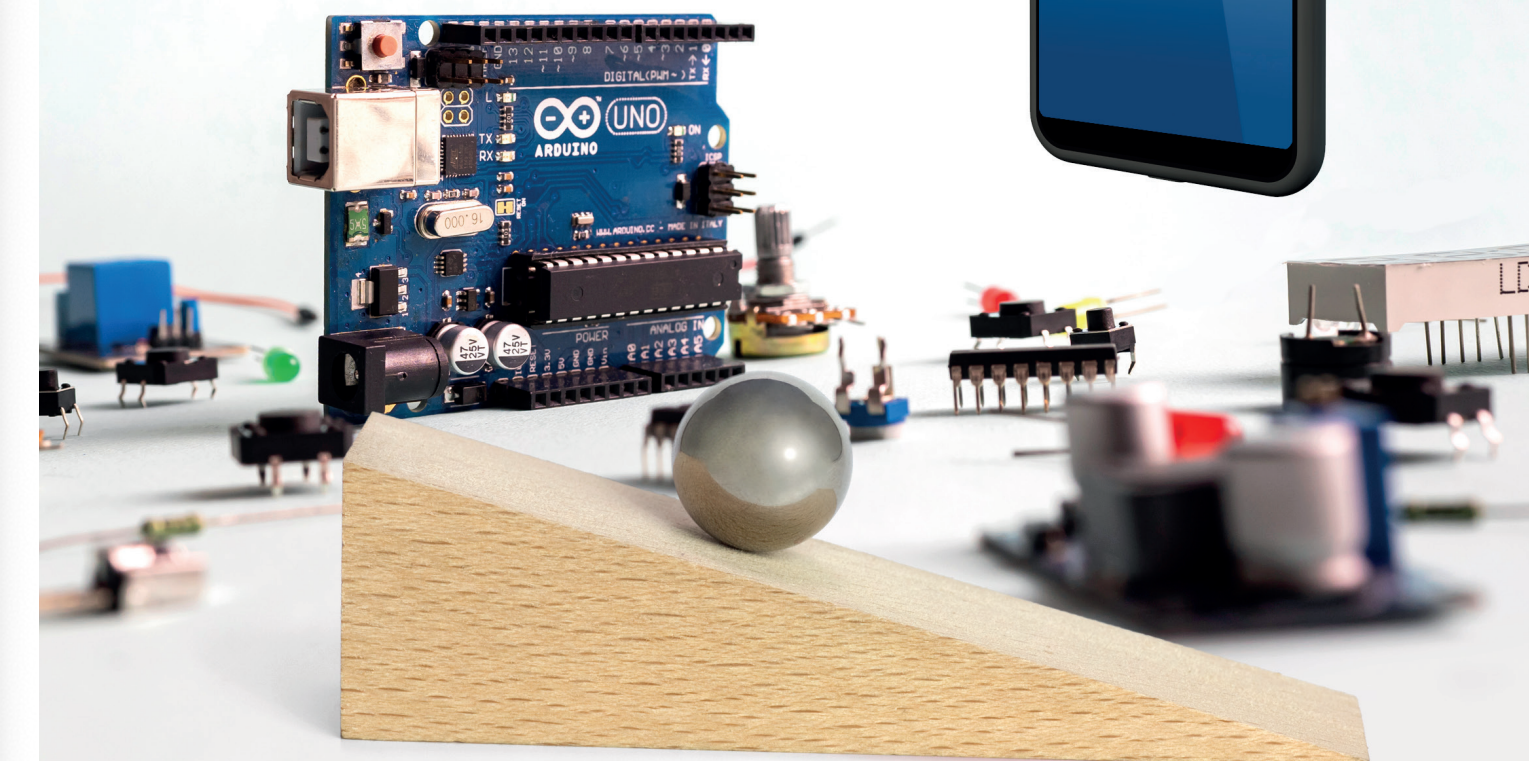


# Risorse



## Giovanni Organtini **Fisica con Arduino**

Dalla fisica ad Arduino, e ritorno	Un laboratorio alla portata di tutti
In laboratorio come un professionista	File di lavoro



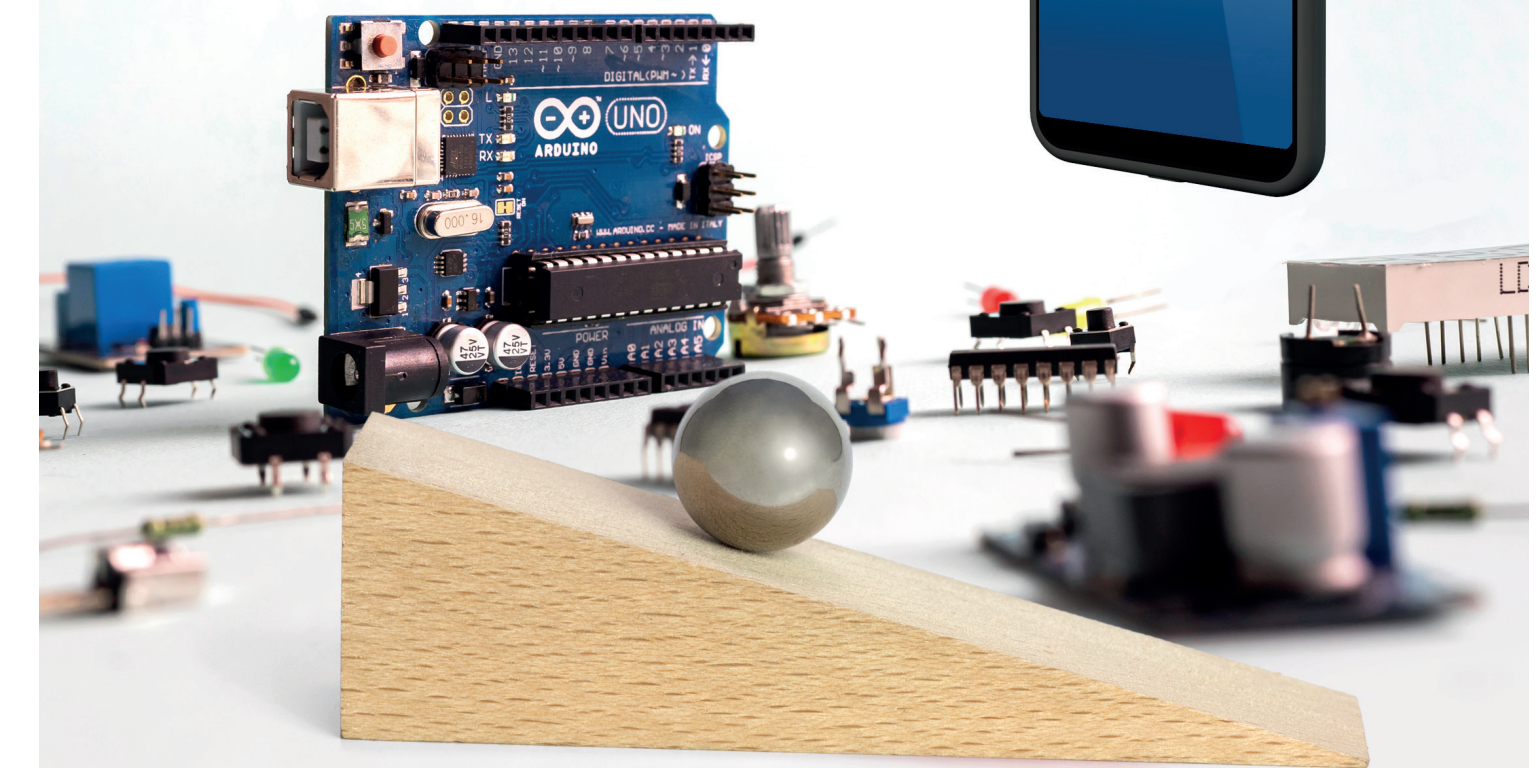
SCIENZE **ZANICHELLI**

# Risorse

The screenshot shows the website interface for 'Risorse per insegnare' on smartphysicslab.org. The page features a navigation bar with 'Home', 'Mission', 'FAQ', and 'About Us'. Below the title, there are language options: English, Deutsch, Espanol, Francais, Italiano. The main text describes the resources available, including PDFs, LaTeX files, and translations. A large watermark 'smartphysicslab.org' is overlaid on the page. Three resource cards are visible: 'Cadenza' (meccanica smartphone), 'La Legge di Stevino' (fluidi smartphone), and 'Pressione atmosferica' (fluidi smartphone).

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In laboratorio come un professionista	File di lavoro



SCIENZE ZANICHELLI