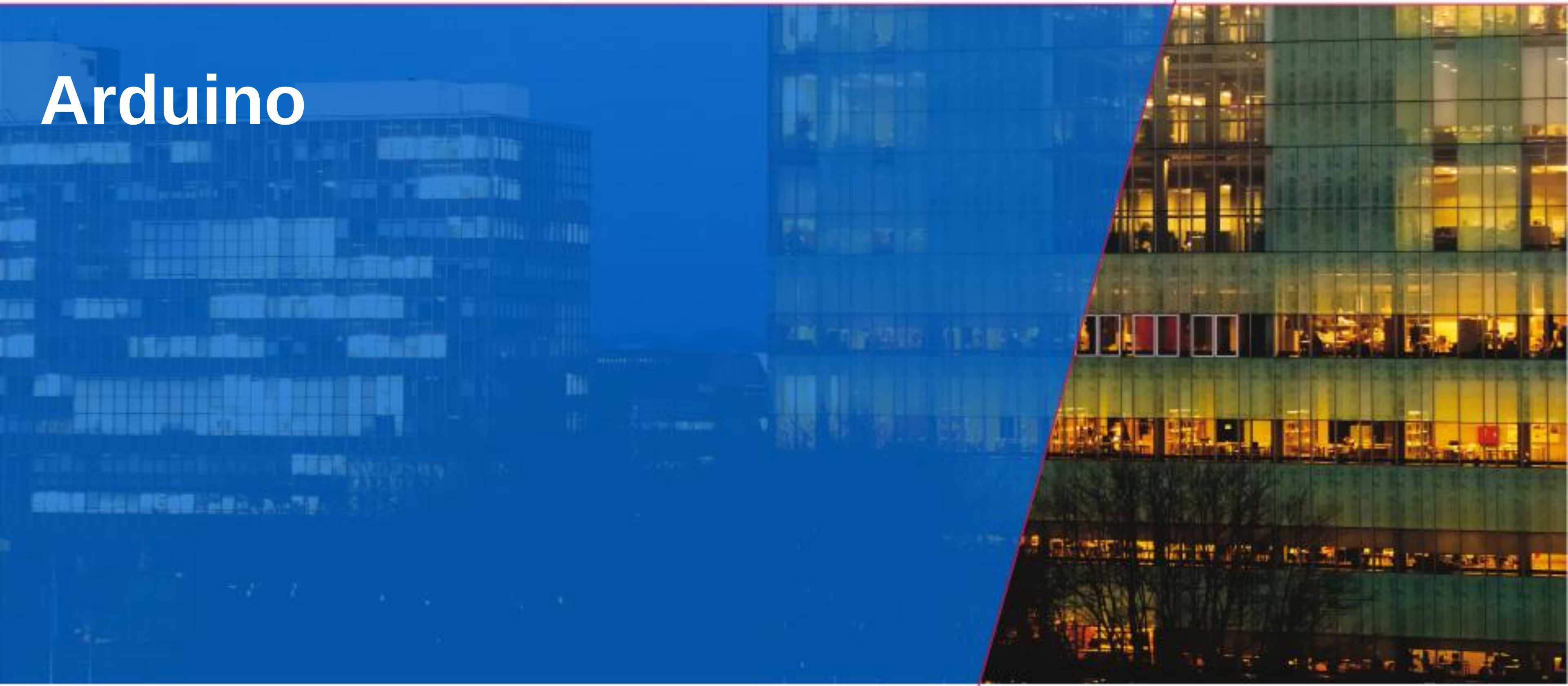
Arduino



TU/e Technische Universiteit **Eindhoven** University of Technology

Where innovation starts

- **Arduino Hardware**
- **Blink an LED**
- **Digital Input**
- **Analog Input**
- **Analog Output**
- **Serial Communication**
- **Taking to Processing**

Why Arduino?

- **Physical Computing**
  - **uses electronics**
  - **to prototype new materials**
  - **for designers and artists.**
- **Tinkering**
- **Patching**
- **Community**
  - **Blog, Forum, Playground (wiki)**

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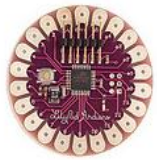
Hardware


Arduino Uno


Arduino LilyPad


Arduino Ethernet


Arduino Nano


Arduino BT


Arduino Mini

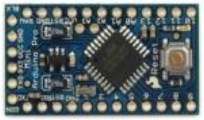

Arduino Mega 2560


Arduino Fio


Arduino BT


Arduino Mini


USB/Serial Light Adapter

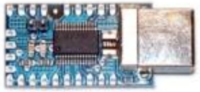

Arduino Pro Mini


Arduino Mega ADK


Arduino Pro


USB/Serial Light Adapter


Arduino Pro Mini



UNO

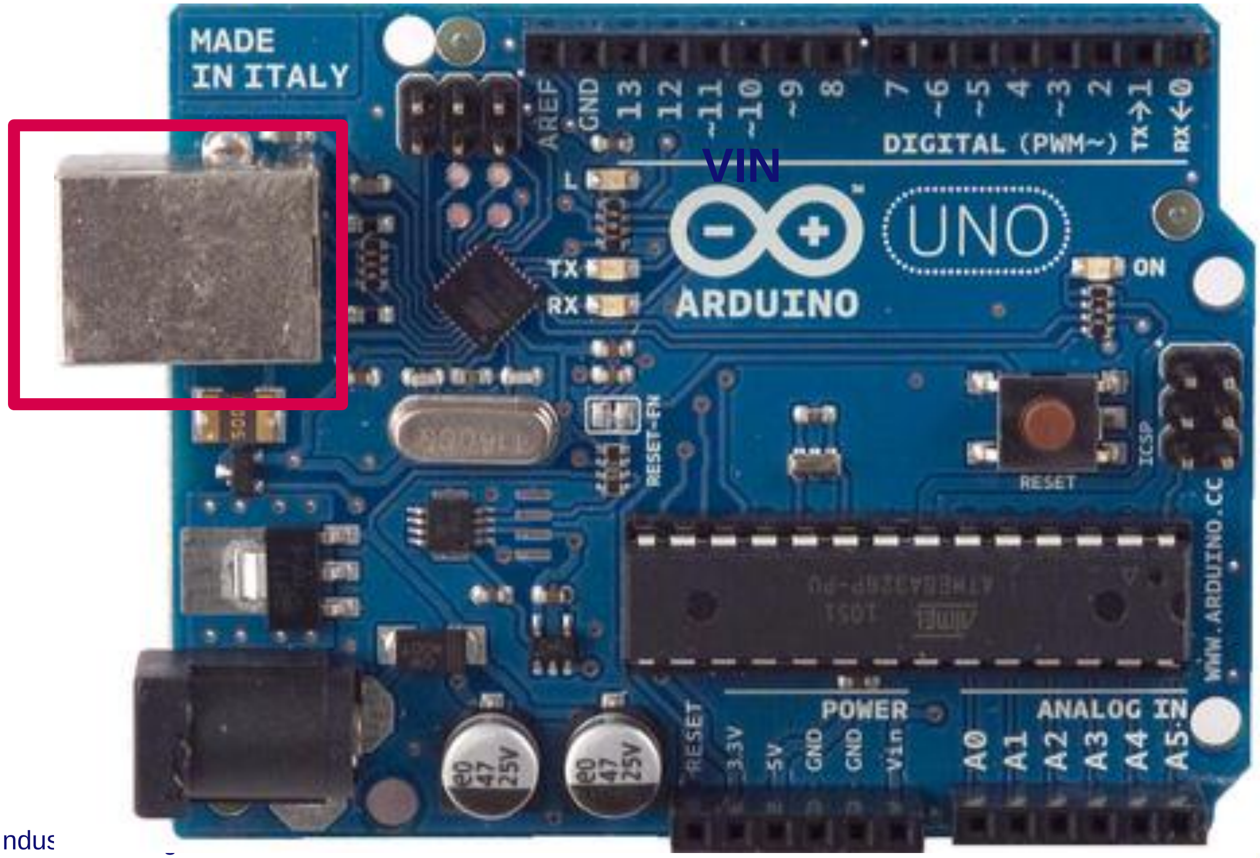

MADE
IN ITALY
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM~)
L
TX
RX
ARDUINO
UNO
ON
RESET-EN
RESET
ICSP
WWW.ARDUINO.CC
POWER
RESET
3.3V
5V
GND
GND
Vin
ANALOG IN
A0
A1
A2
A3
A4
A5

UNO

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (VIN) (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM (Static RAM)	2 KB (ATmega328)
EEPROM (Electrically erasable programmable ROM)	1 KB (ATmega328)
Clock Speed	16 MHz

UNO

- **Power: USB Power supply (5V)**



UNO

- **Power: external power supply (7V-12V)**

UNO

- **Power: VIN, input or supply, depending on external power source. (7-12V)**

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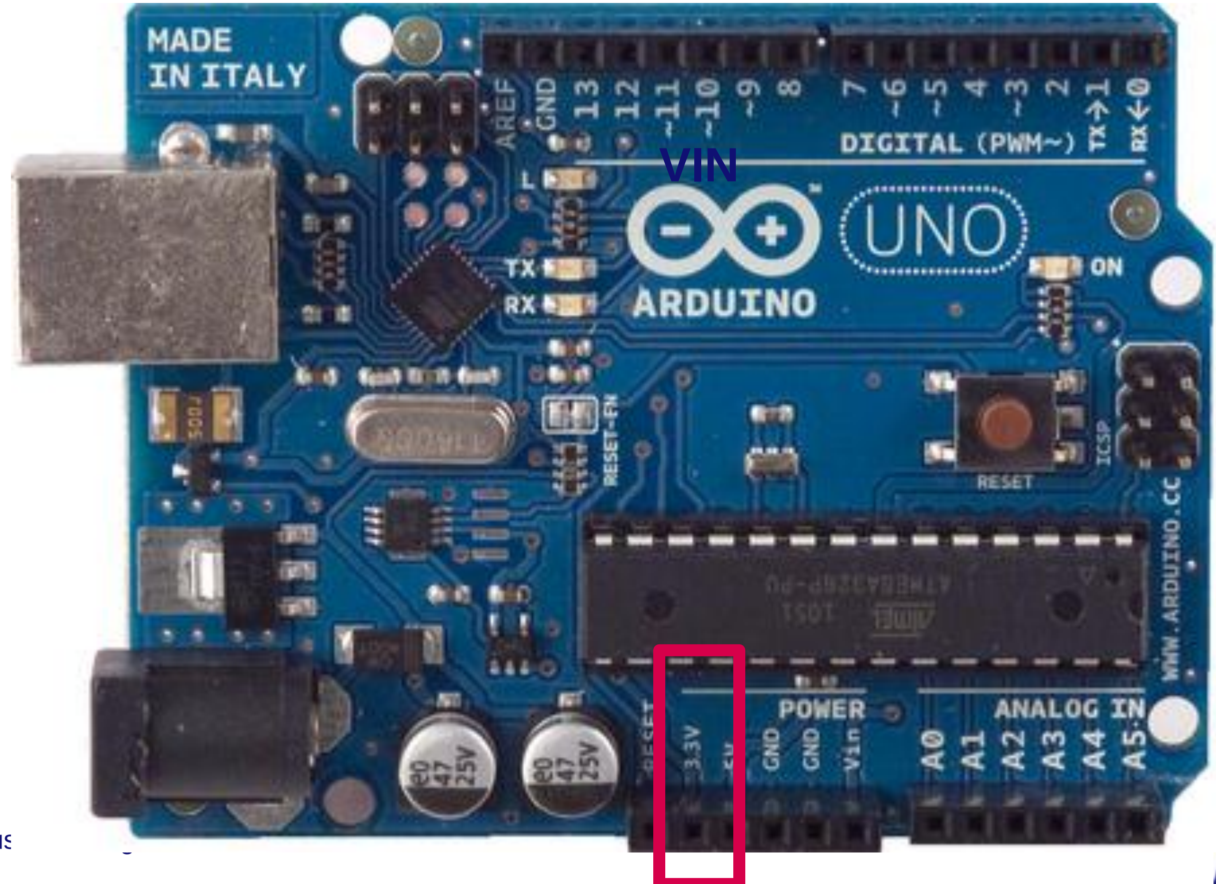
UNO

- **Power: 5V supply**

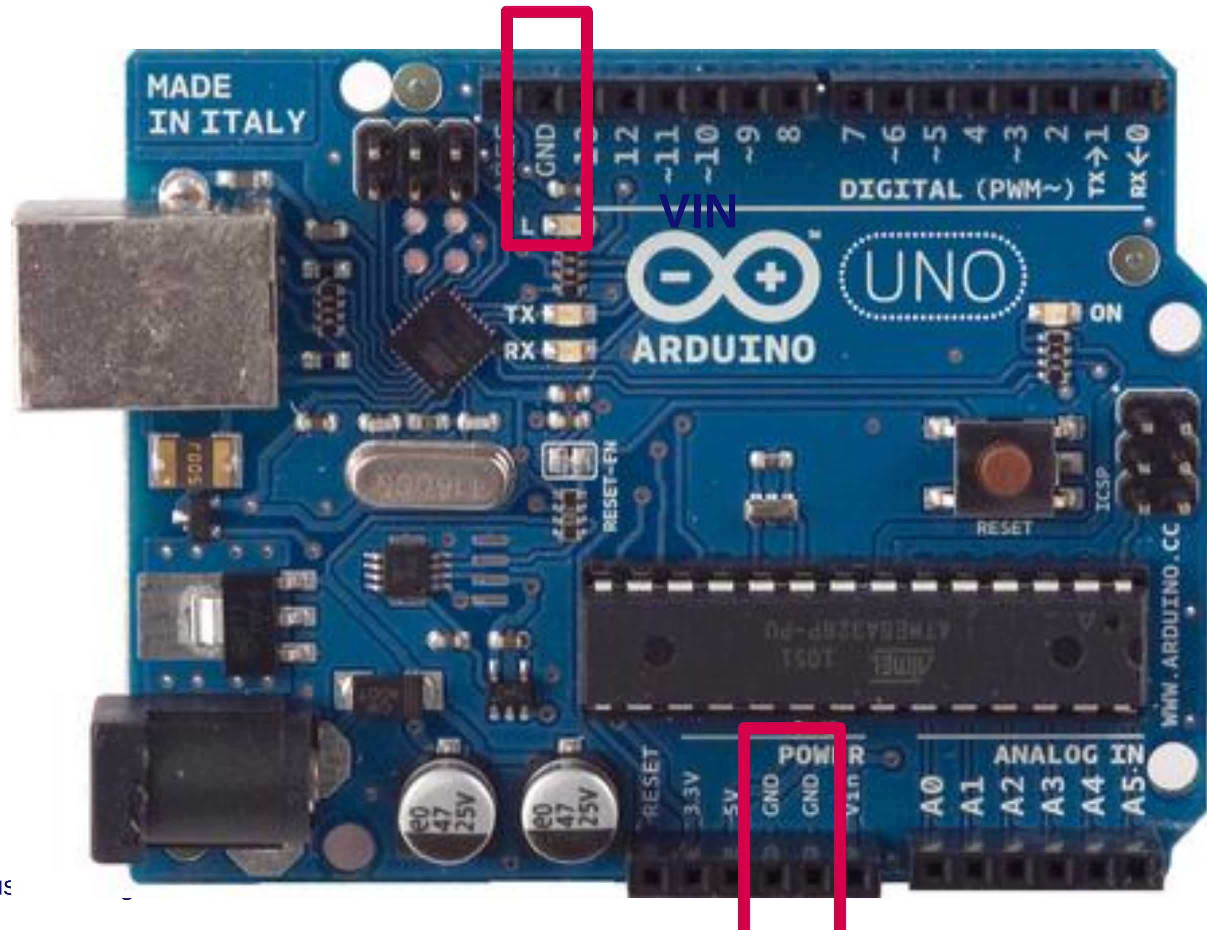
UNO

- **Power: 3.3V supply**



UNO

- **Power: GND pins**

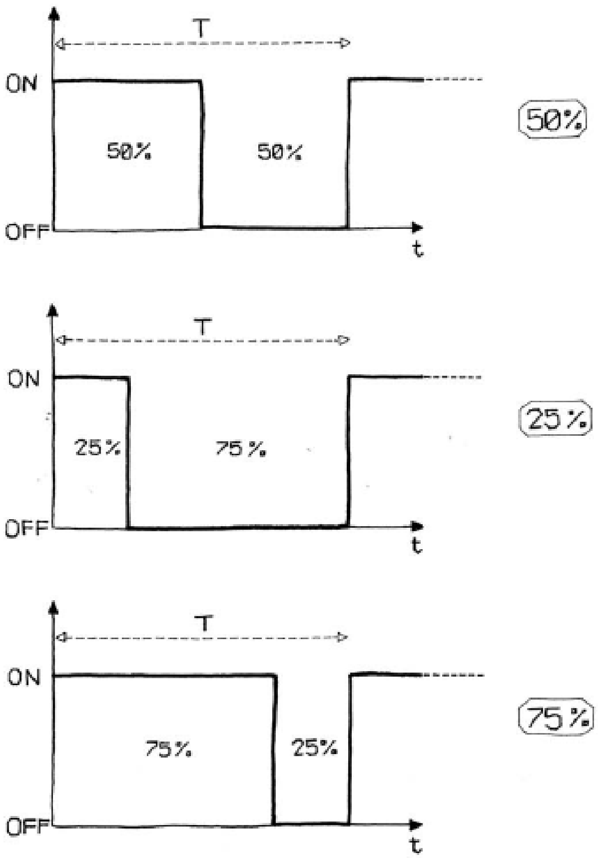


UNO

- **Digital I/O Pins 14 (of which 6 provide PWM output)**

UNO

- **Digital I/O Pins 14 (of which 6 provide PWM output)**
  - **PWM (Pulse-width modulation)**

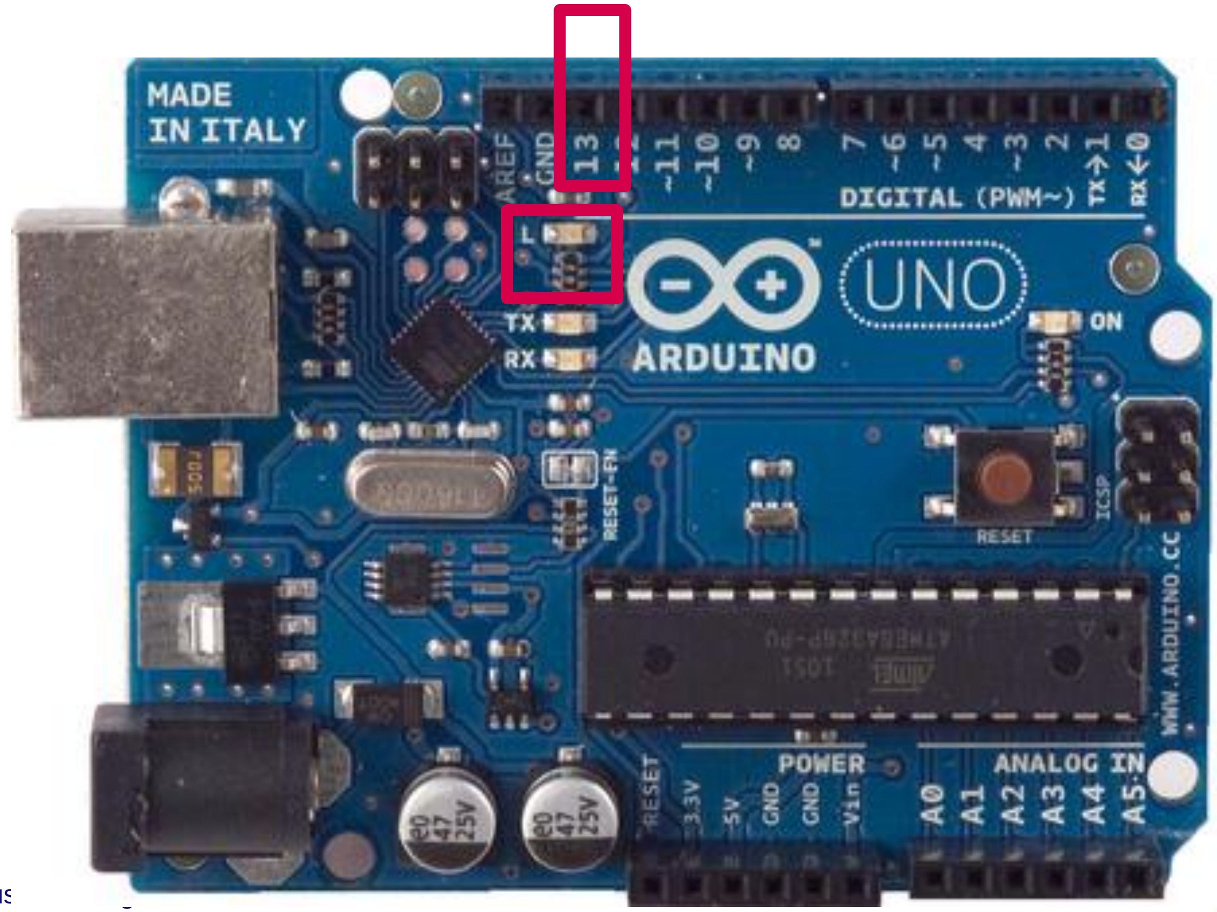


UNO

- **Serial: 0 (RX) and 1 (TX)**

UNO

- **LED: 13**



MADE IN ITALY
AREF
GND
13
~11
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TX→1
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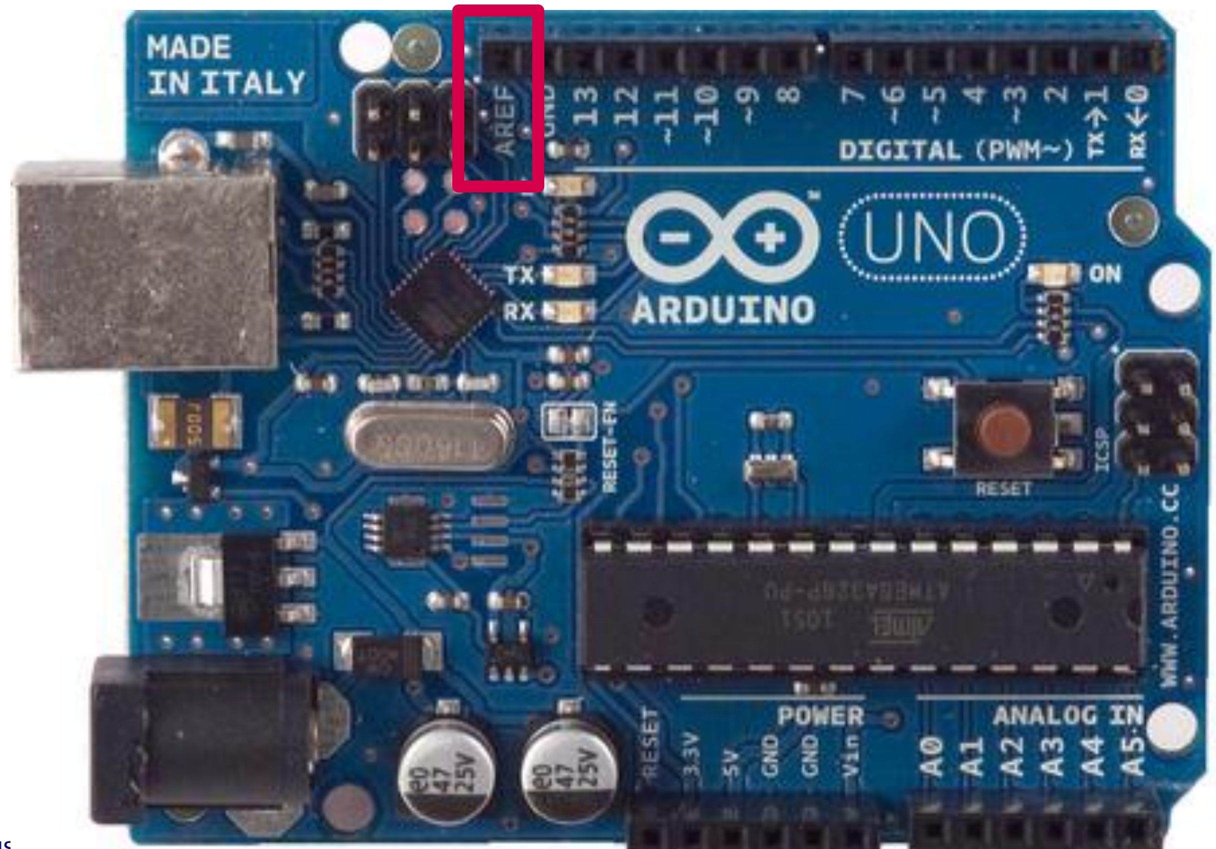
POWER
RESET
3.3V
5V
GND
GND
Vin
ANALOG IN
A0
A1
A2
A3
A4
A5

UNO

- **6 analog inputs, 10 bits of resolution (i.e. 1024 different values)**

UNO

- **AREF: Reference voltage for the analog inputs**



UNO

- **Reset. LOW to reset the microcontroller**

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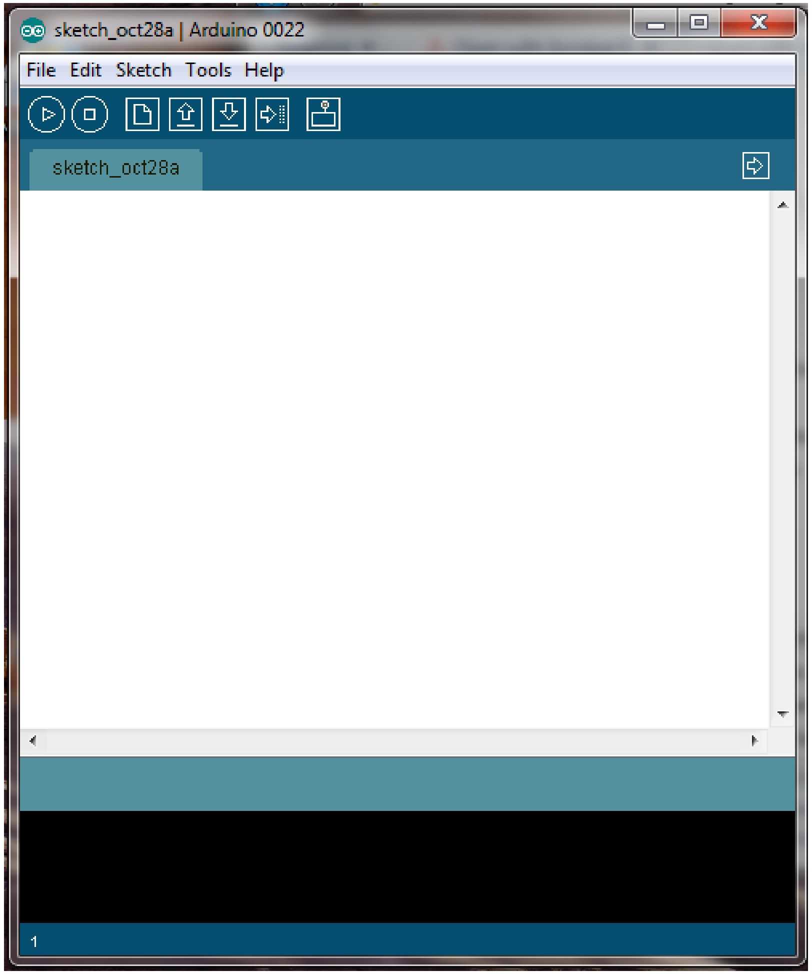
Software: IDE

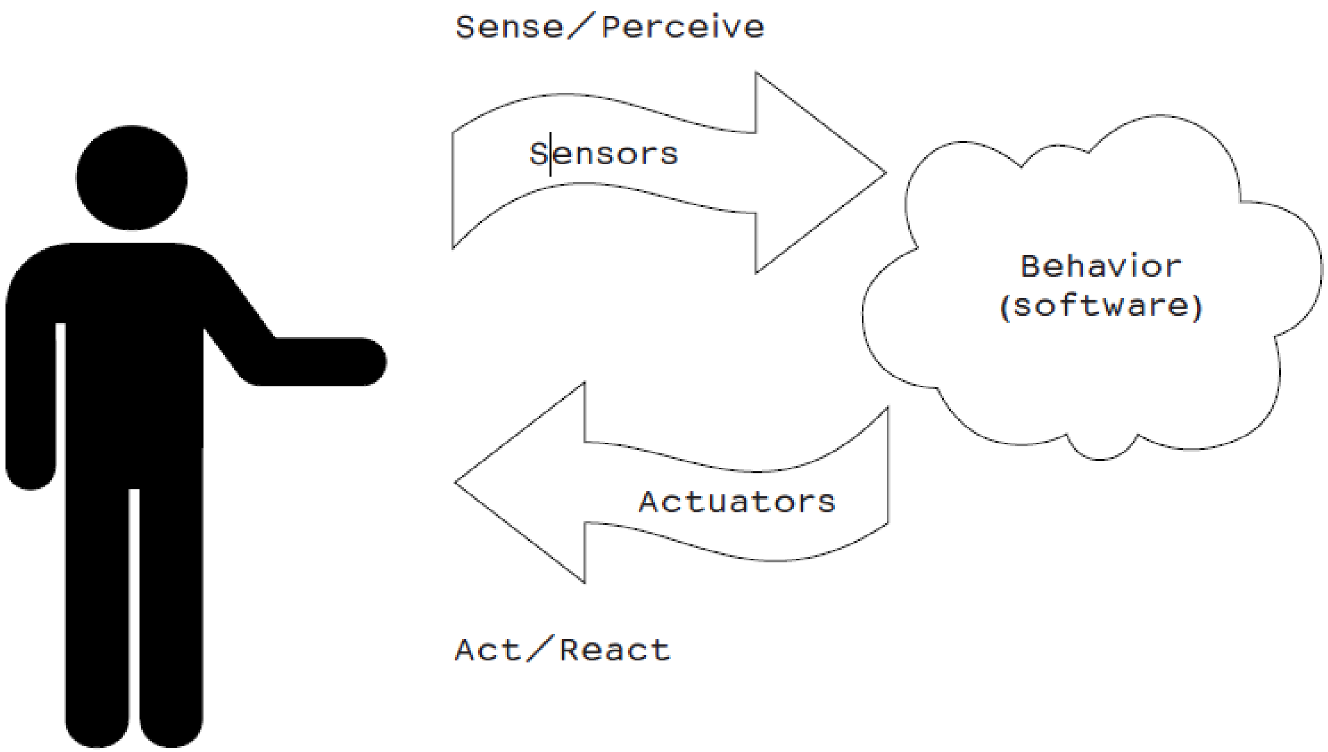
- http://arduino.cc/en/Main/Software



Driver Installation and Port Identification

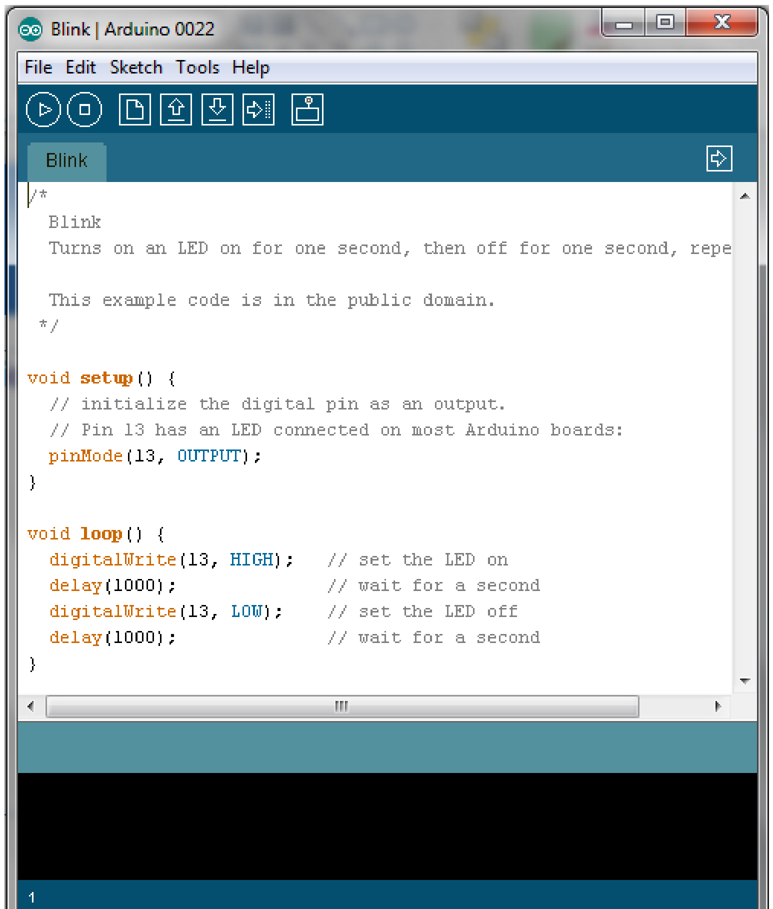
- **Refer to the instructions in**
  - **"Getting Started with Arduino", page 23-26**

Really getting started

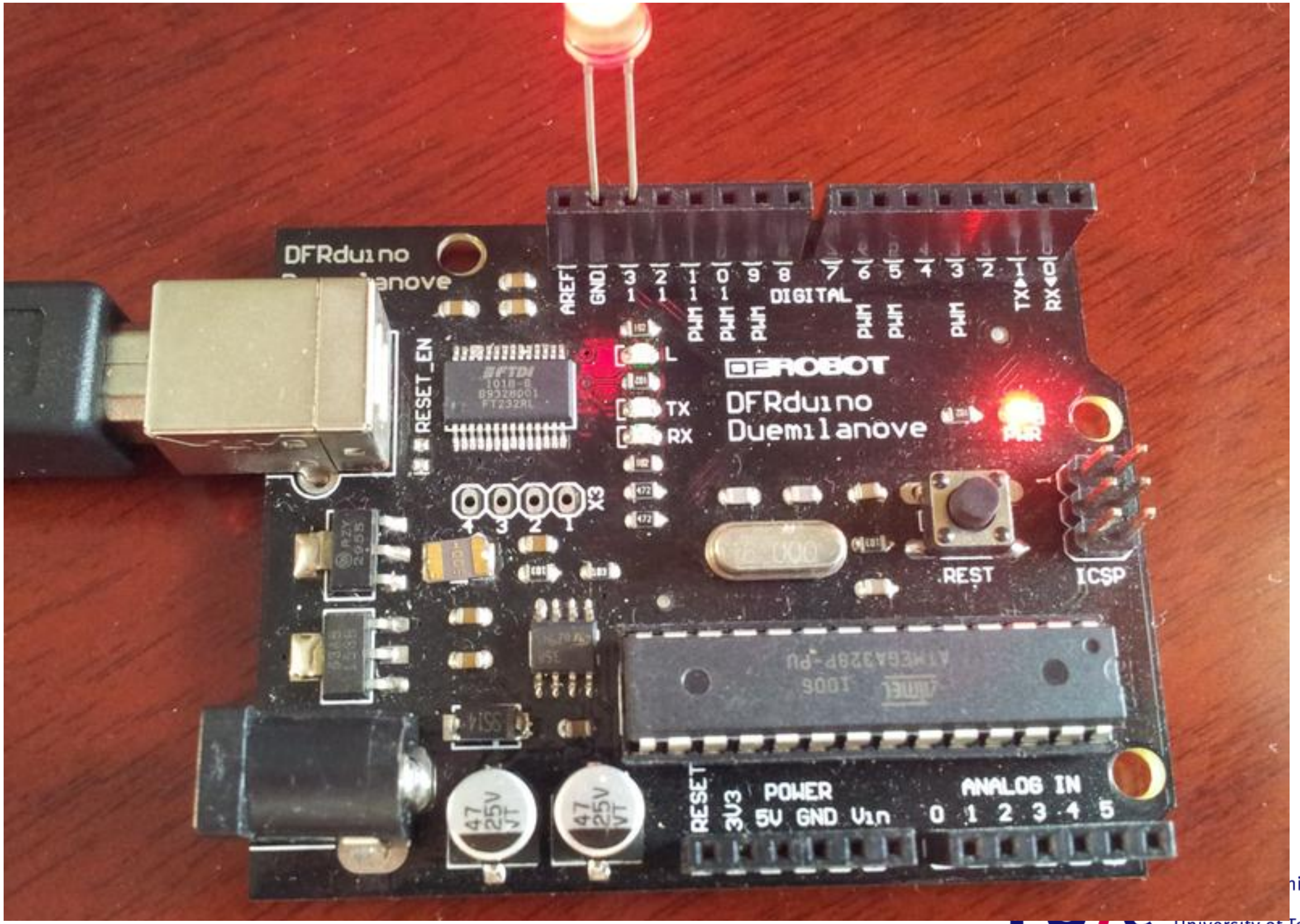


Blinking an LED

- **File>Examples>Basics>Blink**
  - **LED: light-emitting diode**



Blinking an LED



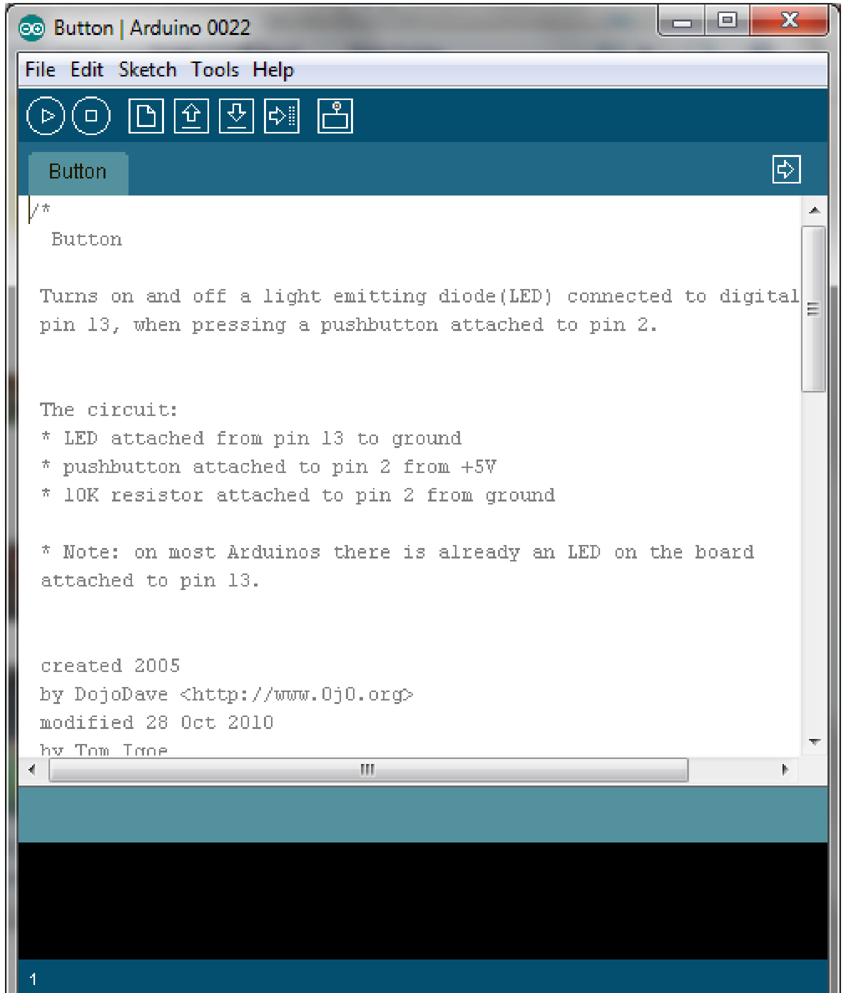
Blink an LED

- **#define LED 13**

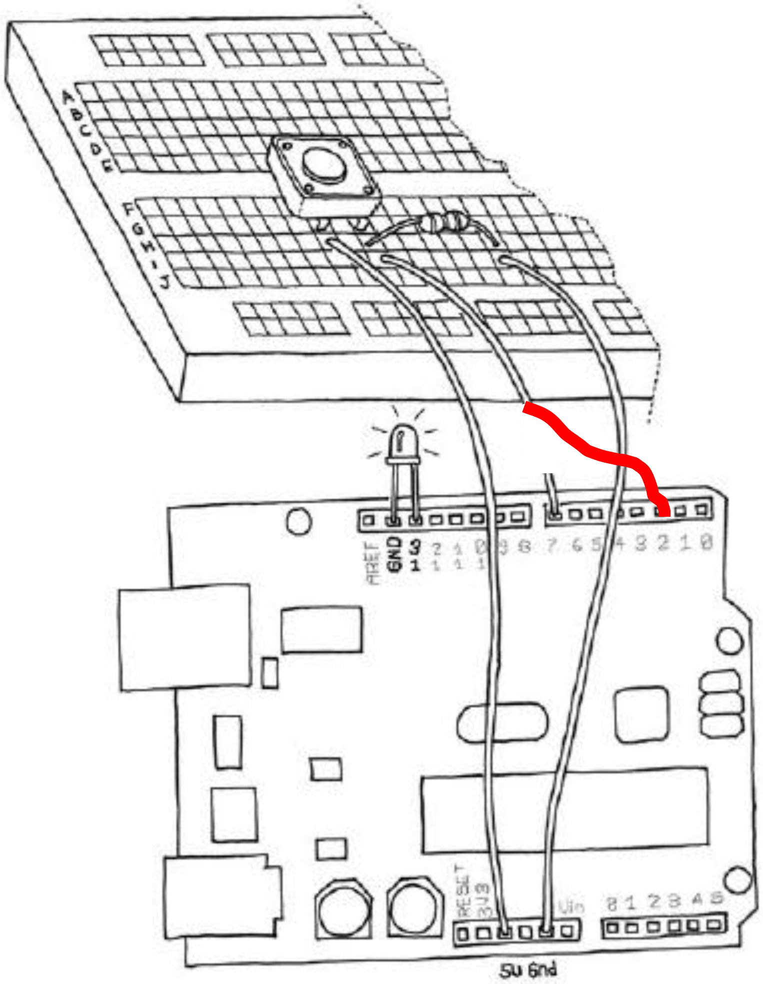
```
#define LED 13

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

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

Button to control the LED

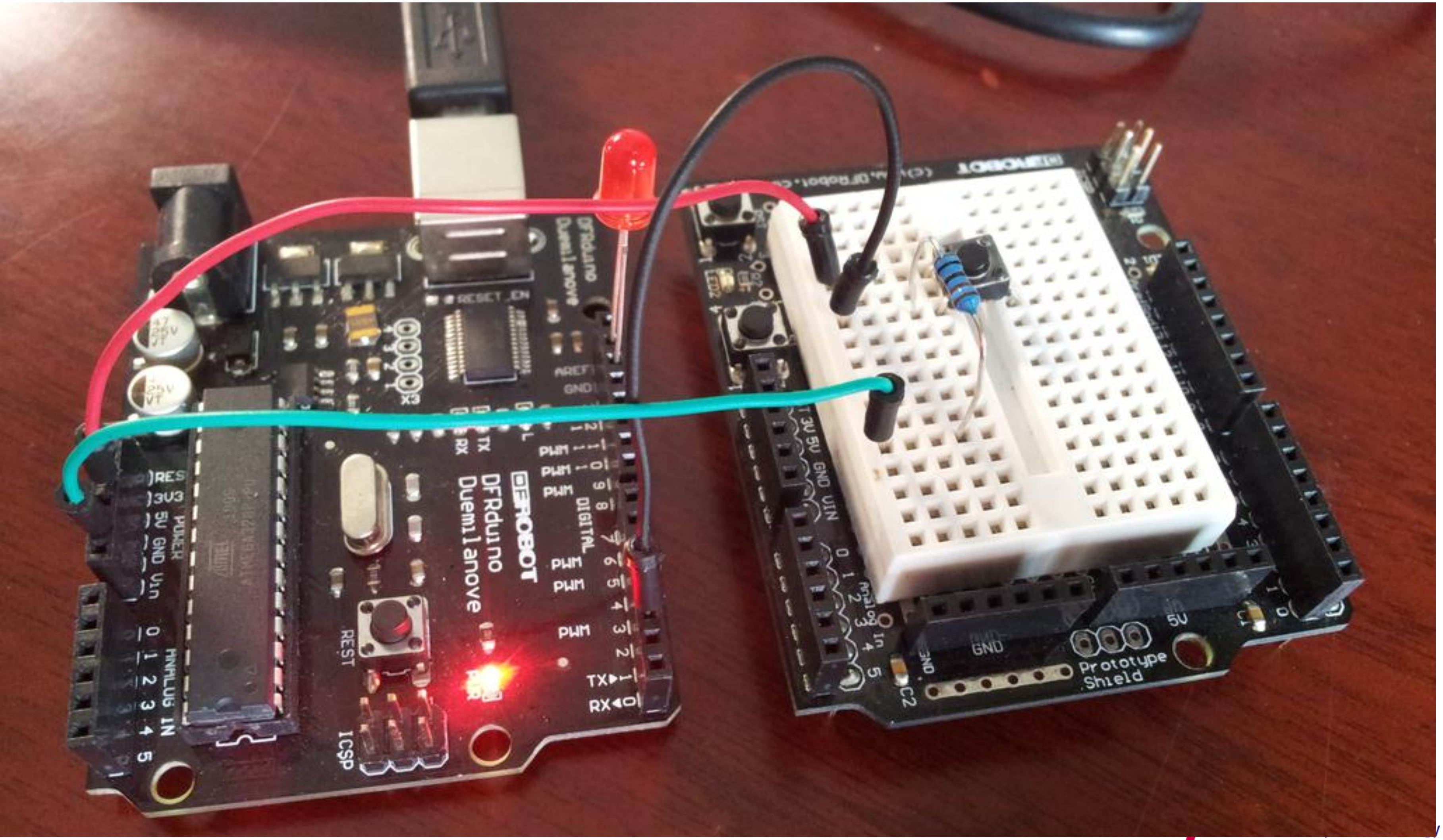
- **File>Examples>Digital>Button**



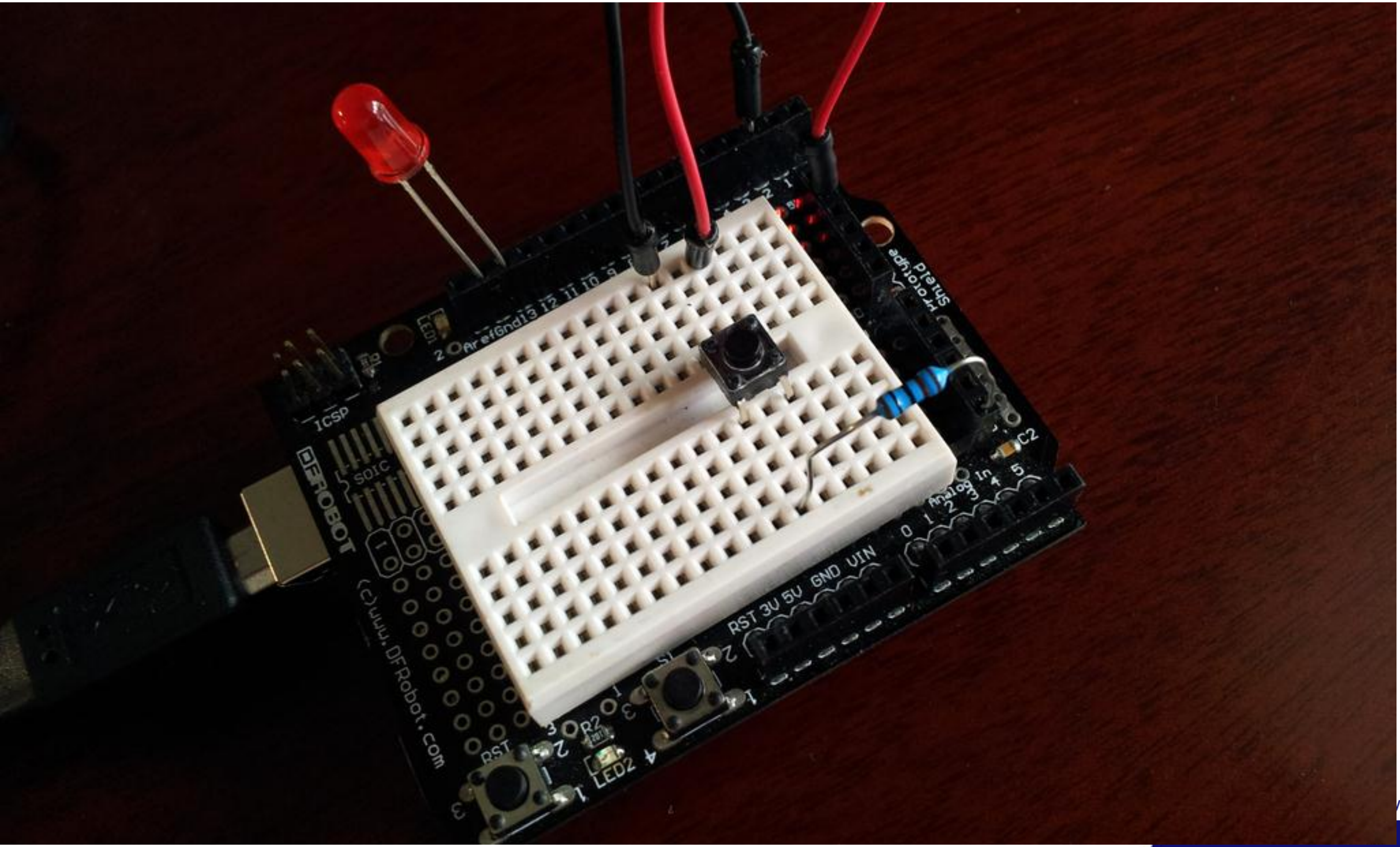
Button to control the LED



Button to control the LED



Button to control the LED



Button to control the LED

```
// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 2;     // the number of the pushbutton pin
const int ledPin =  13;      // the number of the LED pin

// variables will change:
int buttonState = 0;         // variable for reading the pushbutton status

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}
```

Button to control the LED

```
void loop(){
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
  // if it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);
  }
  else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

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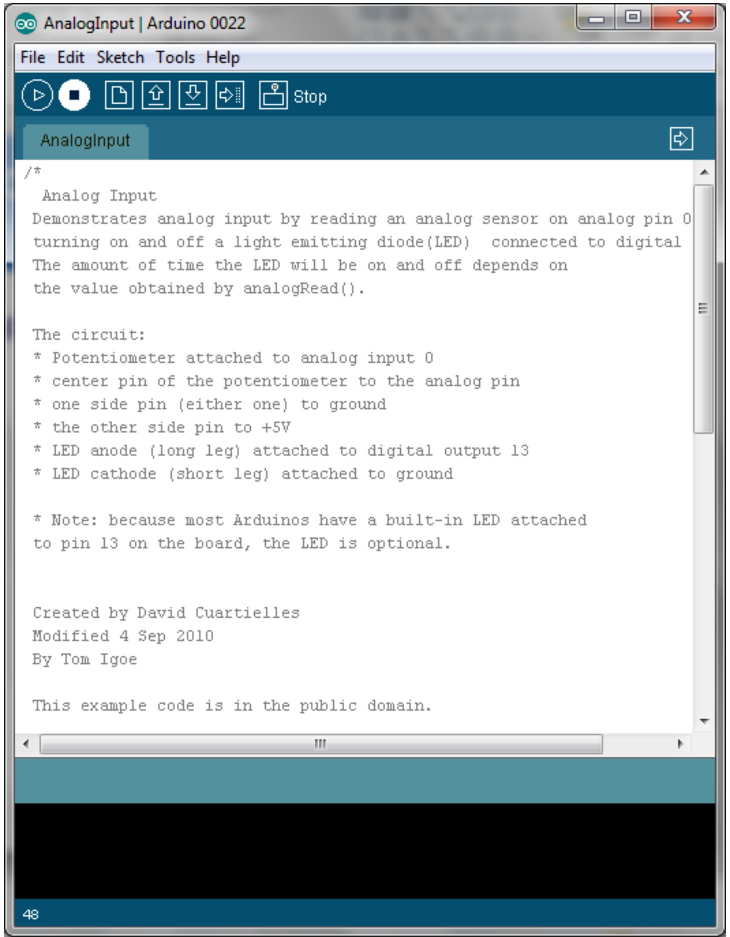
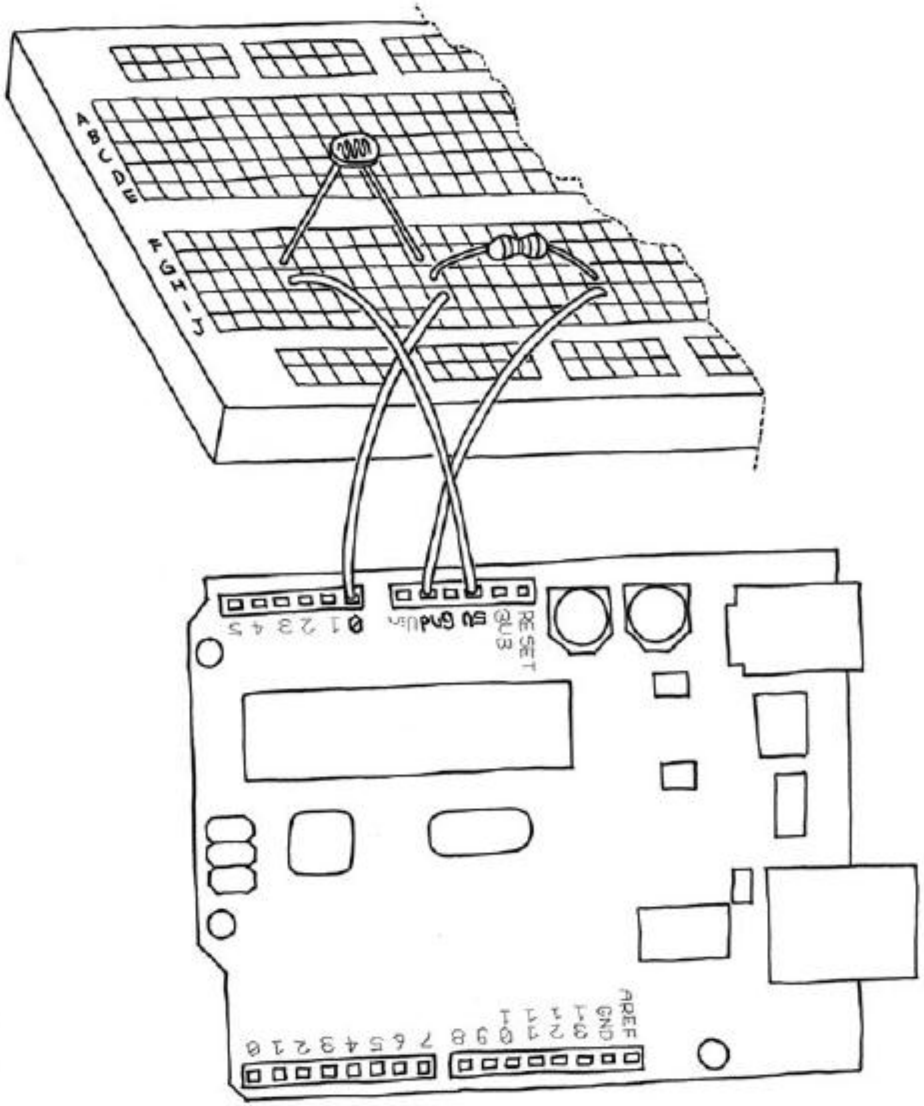
Analog I/O

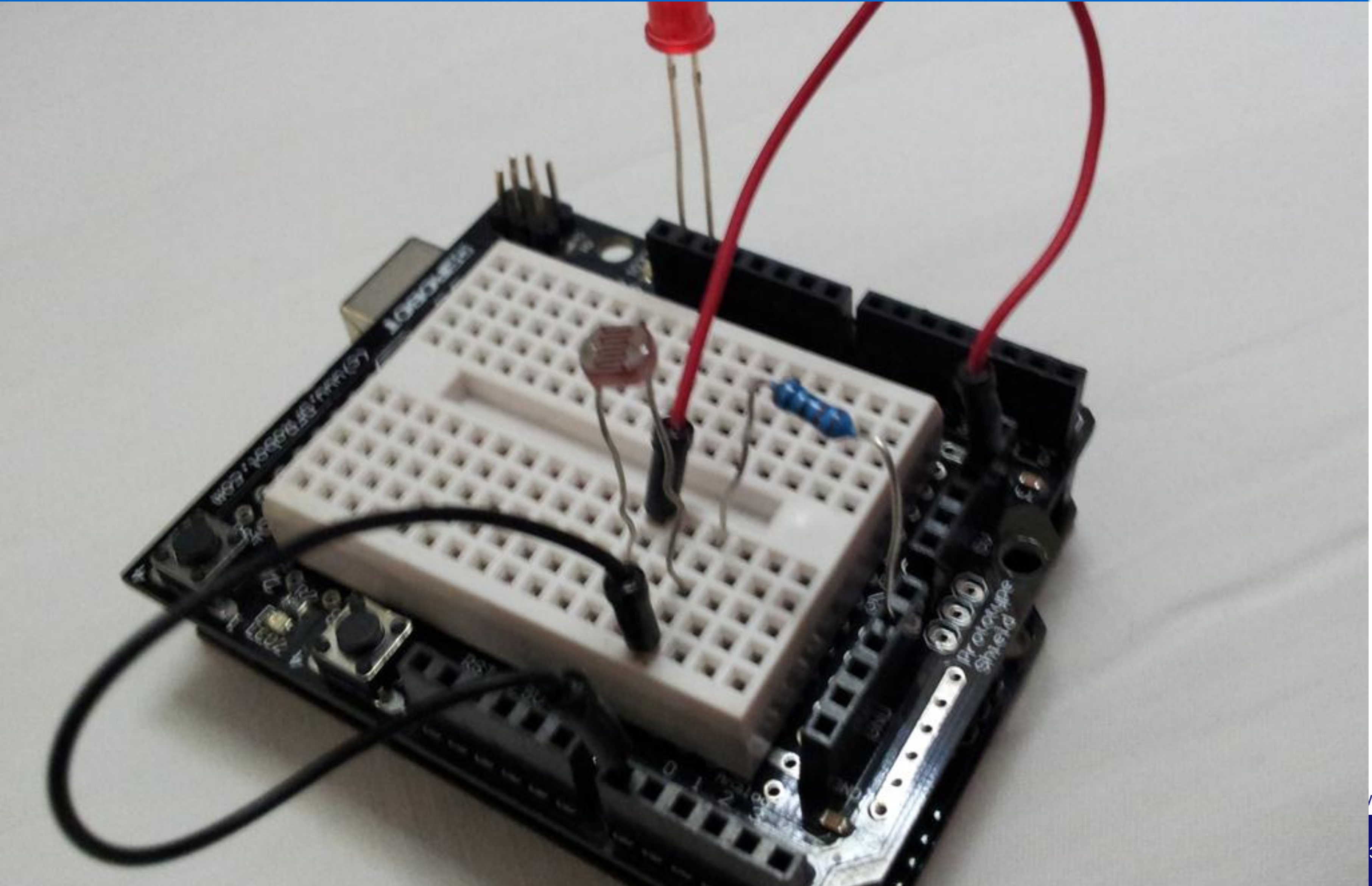
- **File>Examples>Analog>AnalogInput**
  - **Instead of a potentiometer, we use a light sensor**



Analog I/O



Analog I/O



Analog I/O

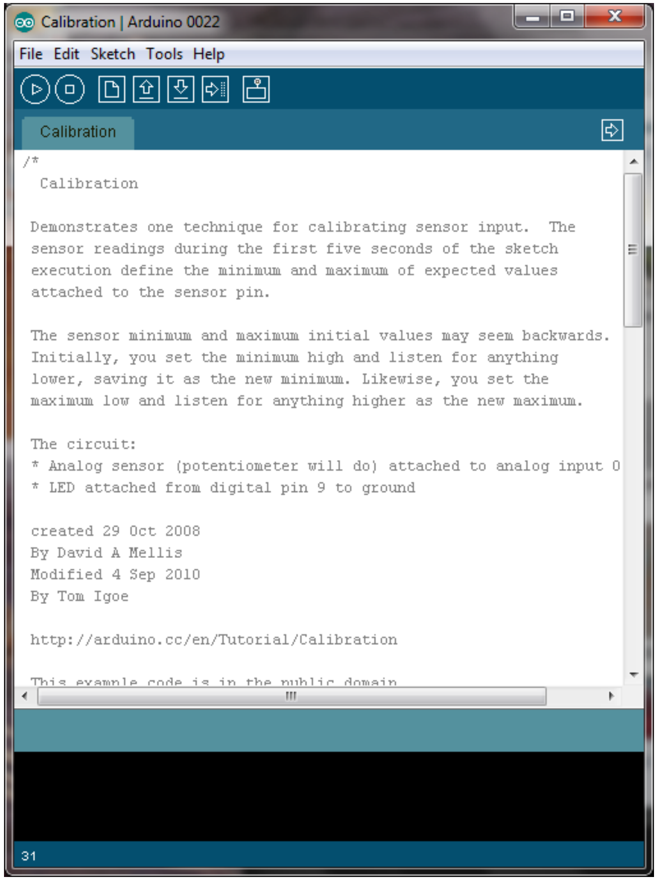
```
int sensorPin = A0;    // select the input pin for the potentiometer
int ledPin = 13;      // select the pin for the LED
int sensorValue = 0;  // variable to store the value coming from the sensor

void setup() {
  // declare the ledPin as an OUTPUT:
  pinMode(ledPin, OUTPUT);
}

void loop() {
  // read the value from the sensor:
  sensorValue = analogRead(sensorPin);
  // turn the ledPin on
  digitalWrite(ledPin, HIGH);
  // stop the program for <sensorValue> milliseconds:
  delay(sensorValue);
  // turn the ledPin off:
  digitalWrite(ledPin, LOW);
  // stop the program for for <sensorValue> milliseconds:
  delay(sensorValue);
}
```

Analog I/O

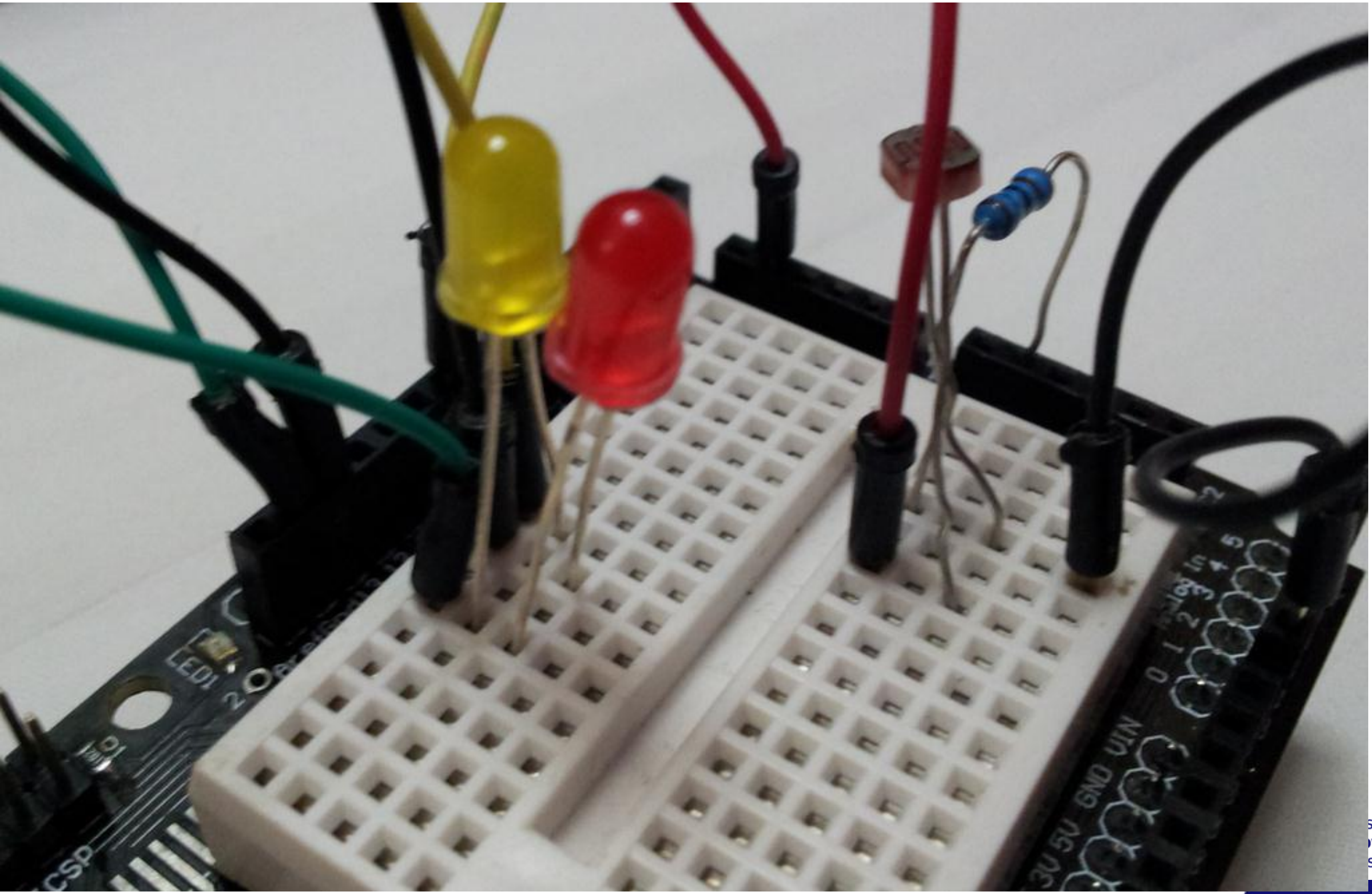
```
int sensorPin = A0;    // select the input pin
int ledPin = 11;       // select the pin for the LED
int sensorValue = 0;  // variable to store the value coming from the sensor

void setup() {
  // declare the ledPin as an OUTPUT:
  pinMode(ledPin, OUTPUT);
}

void loop() {
  // read the value from the sensor:
  sensorValue = analogRead(sensorPin);
  // turn the ledPin on
  analogWrite(ledPin, sensorValue/4);
}
```

Analog Input Calibration

- File>Examples>Analog>Calibration
  - Connect an LED to pin 9, and the other to pin 13.



Analog Input Calibration



Analog Input Calibration

```
// These constants won't change:
const int sensorPin = A0;    // pin that the sensor is attached to
const int ledPin = 9;        // pin that the LED is attached to

// variables:
int sensorValue = 0;         // the sensor value
int sensorMin = 1023;        // minimum sensor value
int sensorMax = 0;           // maximum sensor value
```

Analog Input Calibration

```
void setup() {
  // turn on LED to signal the start of the calibration period:
  pinMode(13, OUTPUT);
  digitalWrite(13, HIGH);

  // calibrate during the first five seconds
  while (millis() < 5000) {
    sensorValue = analogRead(sensorPin);

    // record the maximum sensor value
    if (sensorValue > sensorMax) {
      sensorMax = sensorValue;
    }

    // record the minimum sensor value
    if (sensorValue < sensorMin) {
      sensorMin = sensorValue;
    }
  }

  // signal the end of the calibration period
  digitalWrite(13, LOW);
}
```

Analog Input Calibration

```
void loop() {
  // read the sensor:
  sensorValue = analogRead(sensorPin);

  // apply the calibration to the sensor reading
  sensorValue = map(sensorValue, sensorMin, sensorMax, 0, 255);

  // in case the sensor value is outside the range seen during calibration
  sensorValue = constrain(sensorValue, 0, 255);

  // fade the LED using the calibrated value:
  analogWrite(ledPin, sensorValue);
}
```

Serial Communication

- **We use the same example for Calibration**

Serial Communication

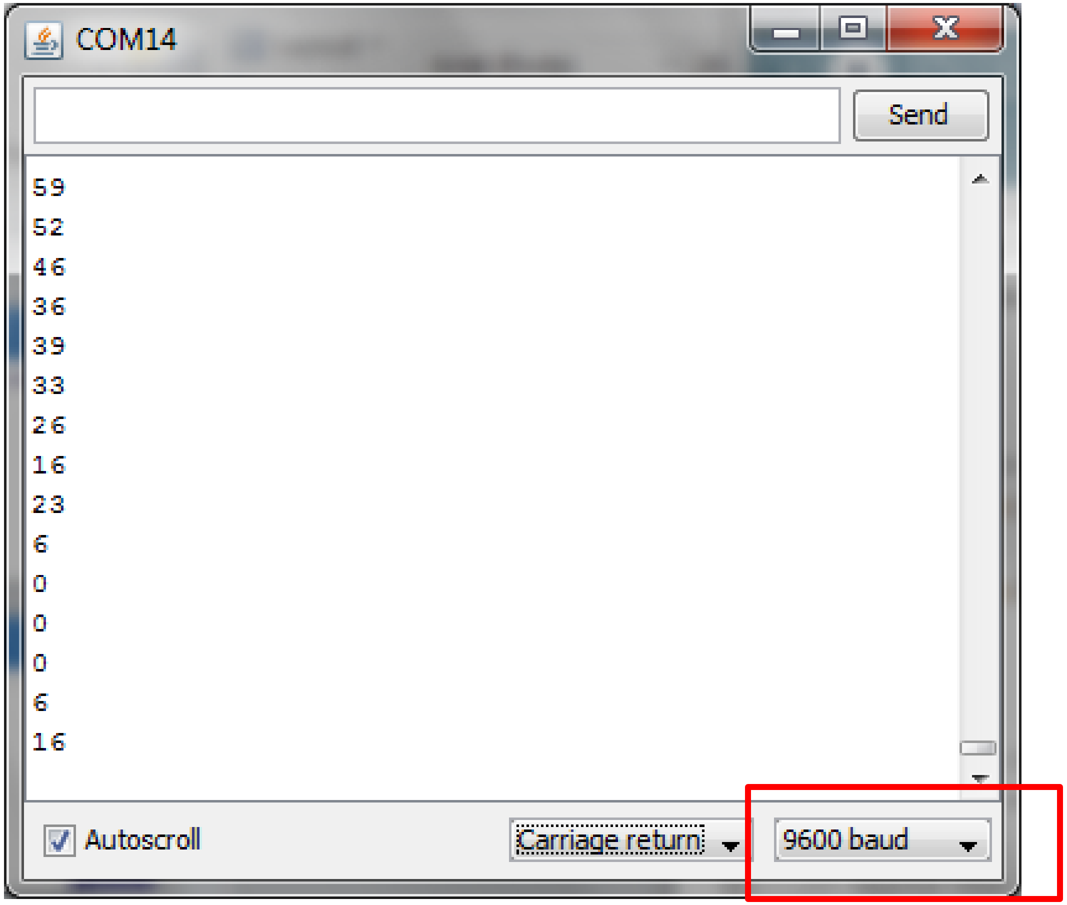
```
void setup() {
  // turn on LED to signal the start of the calibration period:

  pinMode(13, OUTPUT);
  digitalWrite(13, HIGH);

  // calibrate during the first five seconds
  while (millis() < 5000) {
    sensorValue = analogRead(sensorPin);

    // record the maximum sensor value
    if (sensorValue > sensorMax) {
      sensorMax = sensorValue;
    }

    // record the minimum sensor value
    if (sensorValue < sensorMin) {
      sensorMin = sensorValue;
    }
  }

  // signal the end of the calibration period
  digitalWrite(13, LOW);

  Serial.begin(9600);
}
```

Serial Communication

```
void loop() {
  // read the sensor:
  sensorValue = analogRead(sensorPin);

  // apply the calibration to the sensor reading
  sensorValue = map(sensorValue, sensorMin, sensorMax, 0, 255);

  // in case the sensor value is outside the range seen during calibration
  sensorValue = constrain(sensorValue, 0, 255);

  // fade the LED using the calibrated value:
  analogWrite(ledPin, sensorValue);

  Serial.println(sensorValue);
  delay(100);
}
```

Serial Communication

- **Try it out.**



Serial Communication

- **Now change it a bit. Try again the Serial Monitor**

```
void loop() {
  // read the sensor:
  sensorValue = analogRead(sensorPin);

  // apply the calibration to the sensor reading
  sensorValue = map(sensorValue, sensorMin, sensorMax, 0, 255);

  // in case the sensor value is outside the range seen during calibration
  sensorValue = constrain(sensorValue, 0, 255);

  // fade the LED using the calibrated value:
  analogWrite(ledPin, sensorValue);

  Serial.write(sensorValue);
  delay(100);
}
```

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Serial Communication

- Now try to receive the sensor input from Processing
- In Processing
  - File>Examples>Books>Chapter 11>Ex_11_07

Serial Communication

```
import processing.serial.*;

Serial port;  // Create object from Serial class
float val;    // Data received from the serial port

void setup() {
  size(440, 220);
  // IMPORTANT NOTE:
  // The first serial port retrieved by Serial.list()
  // should be your Arduino. If not, uncomment the next
  // line by deleting the // before it. Run the sketch
  // again to see a list of serial ports. Then, change
  // the 0 in between [ and ] to the number of the port
  // that your Arduino is connected to.
  println(Serial.list());
  String arduinoPort = Serial.list()[1];
  port = new Serial(this, arduinoPort, 9600);
}
```

Serial Communication

```
void draw() {
  background(255);
  if (port.available() > 0) { // If data is available,
    val = port.read();         // read it and store it in val
    val = map(val, 0, 255, 0, height);  // Convert the value
  }
  rect(40, val-10, 360, 20);
}
```

Serial Communication

- Now use the same hardware, try out
- In Processing
  - File>Examples>Books>Chapter 11>Ex_11_08

- **That was Arduino.**