Arduino : Introduction & Programming

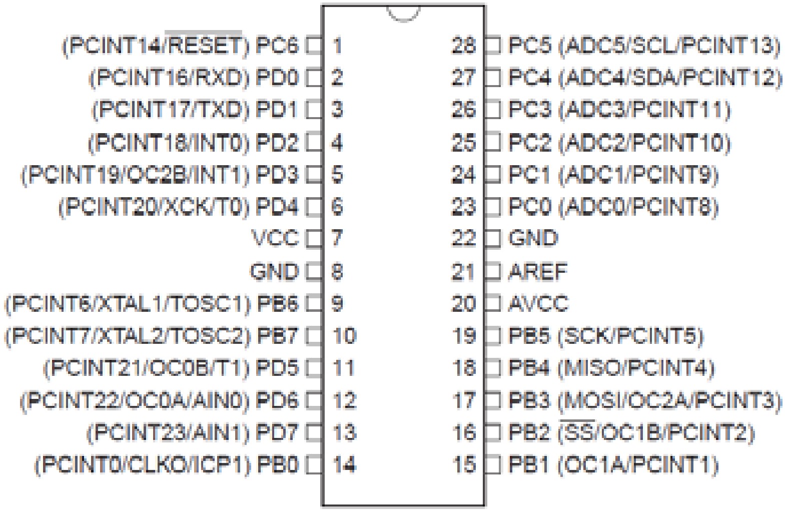
IoT and Robotics Club

What is a Microcontroller (µC, MCU)

- Computer on a single integrated chip
  - Processor (CPU)
  - Memory (RAM / ROM / Flash)
  - I/O ports (USB, I2C, SPI, ADC)
- Common microcontroller families:
  - Intel: 4004, 8008, etc.
  - Atmel: AT and AVR
  - Microchip: PIC
  - ARM: (multiple manufacturers)
- Used in:
  - Cellphones,
  - Toys
  - Household appliances
  - Cars
  - Cameras

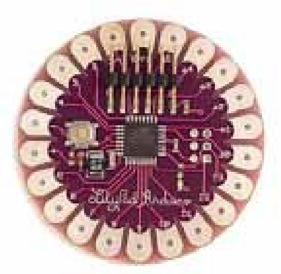
The ATmega328P Microcontroller (used by the Arduino)

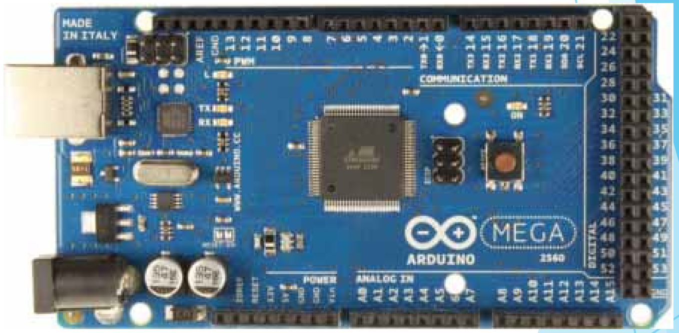
- AVR 8-bit Architecture
- Available in DIP package
- Up to 20 MHz clock
- 32kB flash memory
- 1 kB SRAM
- 23 programmable I/O
- channels
- Six 10-bit ADC inputs
- Three timers/counters
- Six PWM outputs

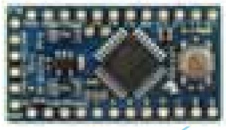

(PCINT14/RESET) PC6 1 — 28 PC5 (ADC5/SCL/PCINT13)
(PCINT16/RXD) PD0 2 — 27 PC4 (ADC4/SDA/PCINT12)
(PCINT17/TXD) PD1 3 — 26 PC3 (ADC3/PCINT11)
(PCINT18/INT0) PD2 4 — 25 PC2 (ADC2/PCINT10)
(PCINT19/OC2B/INT1) PD3 5 — 24 PC1 (ADC1/PCINT9)
(PCINT20/XCK/T0) PD4 6 — 23 PC0 (ADC0/PCINT8)
VCC 7 — 22 GND
GND 8 — 21 AREF
(PCINT6/XTAL1/TOSC1) PB6 9 — 20 AVCC
(PCINT7/XTAL2/TOSC2) PB7 10 — 19 PB5 (SCK/PCINT5)
(PCINT21/OC0B/T1) PD5 11 — 18 PB4 (MISO/PCINT4)
(PCINT22/OC0A/AIN0) PD6 12 — 17 PB3 (MOSI/OC2A/PCINT3)
(PCINT23/AIN1) PD7 13 — 16 PB2 (SS/OC1B/PCINT2)
(PCINT0/CLKO/ICP1) PB0 14 — 15 PB1 (OC1A/PCINT1)

The Many Flavors of Arduino

- Arduino Uno
- Arduino Leonardo
- Arduino LilyPad
- Arduino Mega
- Arduino Nano
- Arduino Mini
- Arduino Mini Pro

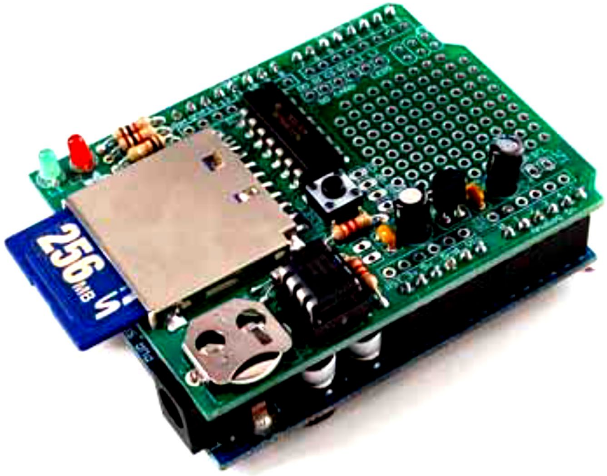






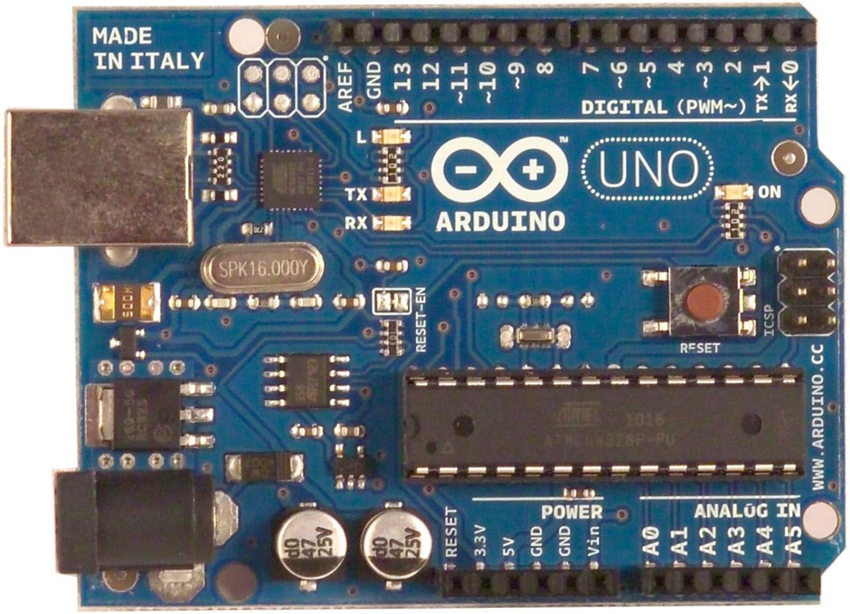
Arduino Add-ons (Shields)

- TFT Touch Screen
- Data logger
- Motor/Servo shield
- Ethernet shield
- Audio wave shield
- Cellular/GSM shield
- WiFi shield
- Proto-shield
- ...many more



What is an Arduino ?

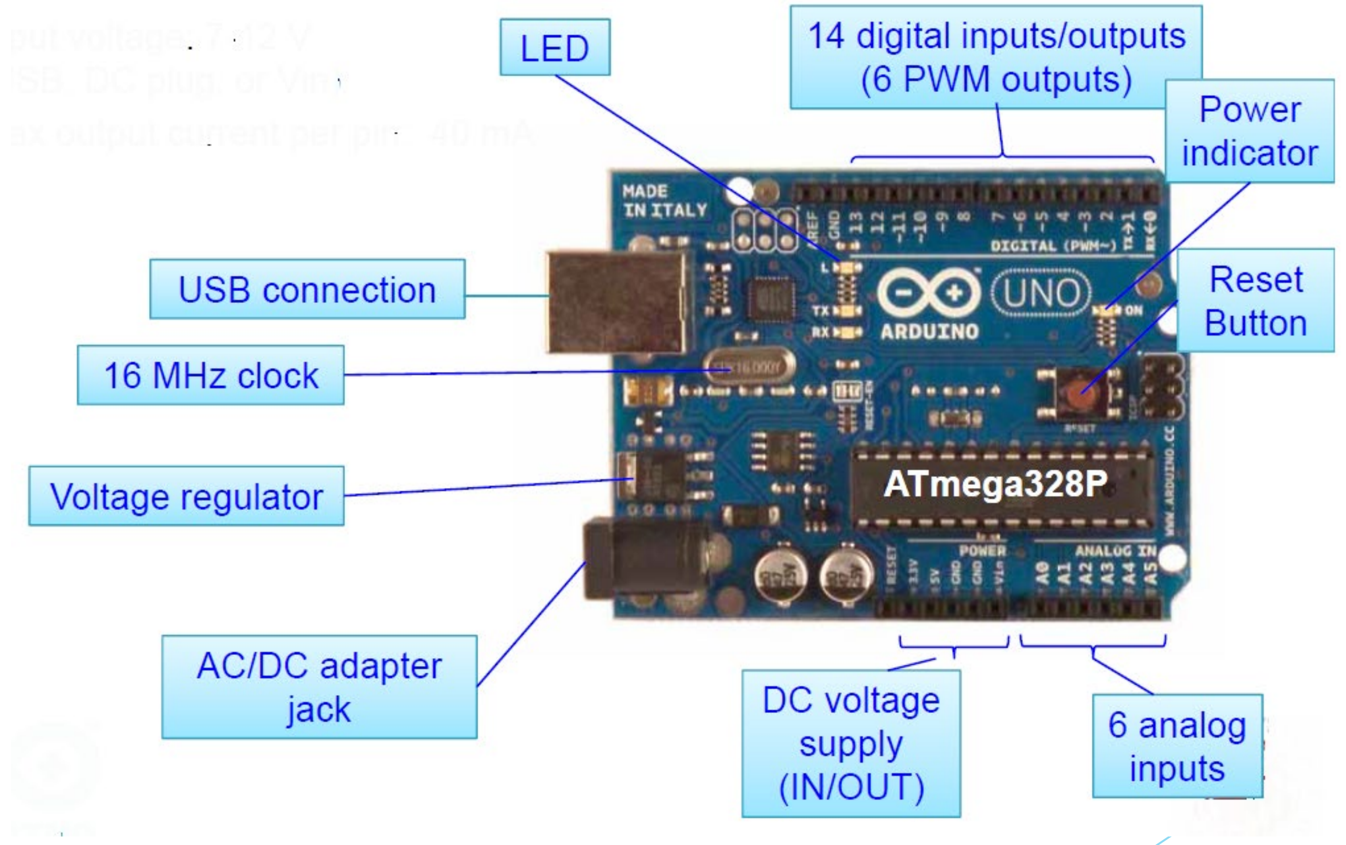
- **Open Source** electronic prototyping **platform** based on flexible **easy to use** hardware and software.



Getting to know the Arduino: Electrical Inputs and Outputs

- Input voltage: 7-12 V (USB, DC plug, or Vin)
- Max output current per pin: 40 mA

Getting to know the Arduino: Electrical Inputs and Outputs



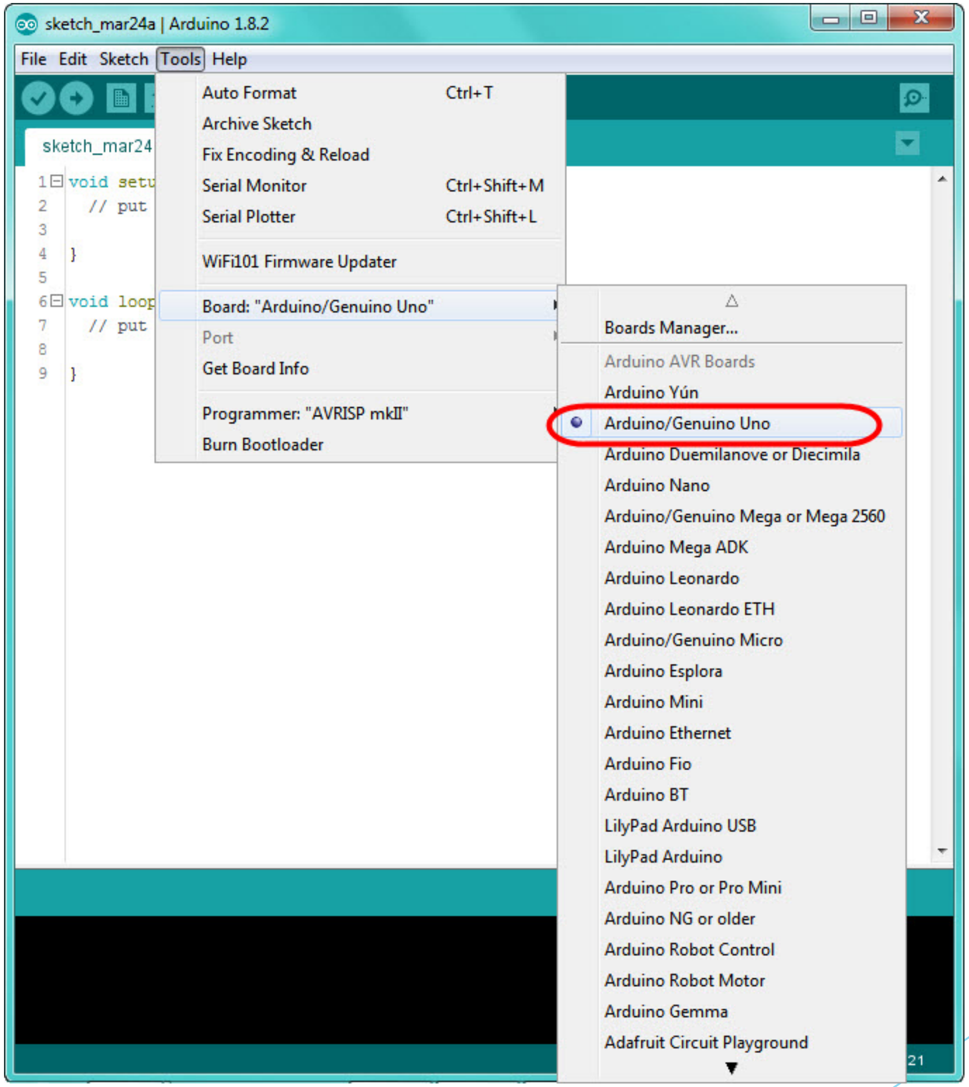
Download and Install

- Download Arduino compiler and development environment from:

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

- Available for:
  - Windows
  - MacOX
  - Linux
- ***Before running Arduino***, plug in your board using USB cable (external power is not necessary)
- When USB device is not recognized, navigate to and select the appropriate driver from the installation directory
- Run Arduino

Select your Board



```
void setu
  // put

}

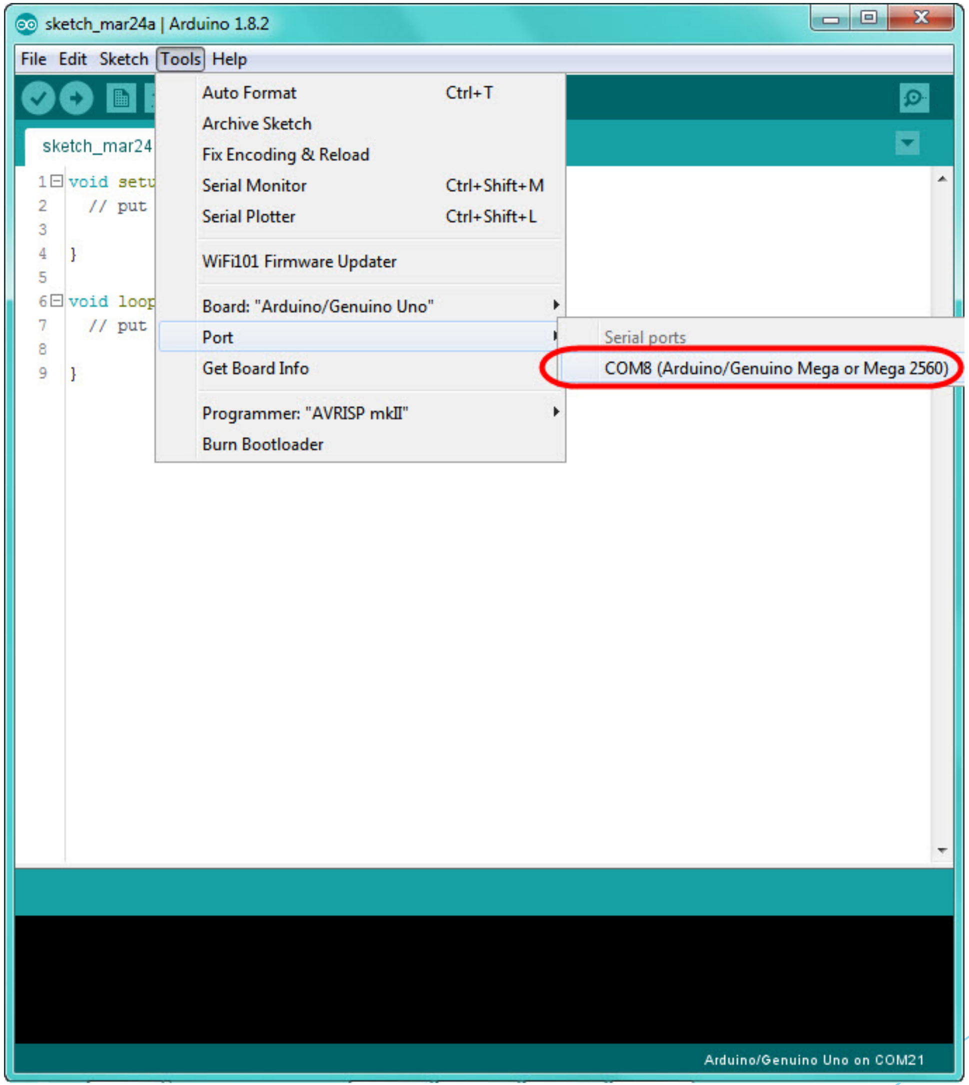
void loop
  // put

}
```

Board: "Arduino/Genuino Uno"

Programmer: "AVRISP mkII"

Select Serial Port


sketch_mar24a | Arduino 1.8.2
File Edit Sketch Tools Help
sketch_mar24
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 Firmware Updater
Board: "Arduino/Genuino Uno"
Port
Get Board Info
Programmer: "AVRISP mkII"
Burn Bootloader
Serial ports
COM8 (Arduino/Genuino Mega or Mega 2560)
Arduino/Genuino Uno on COM21

```
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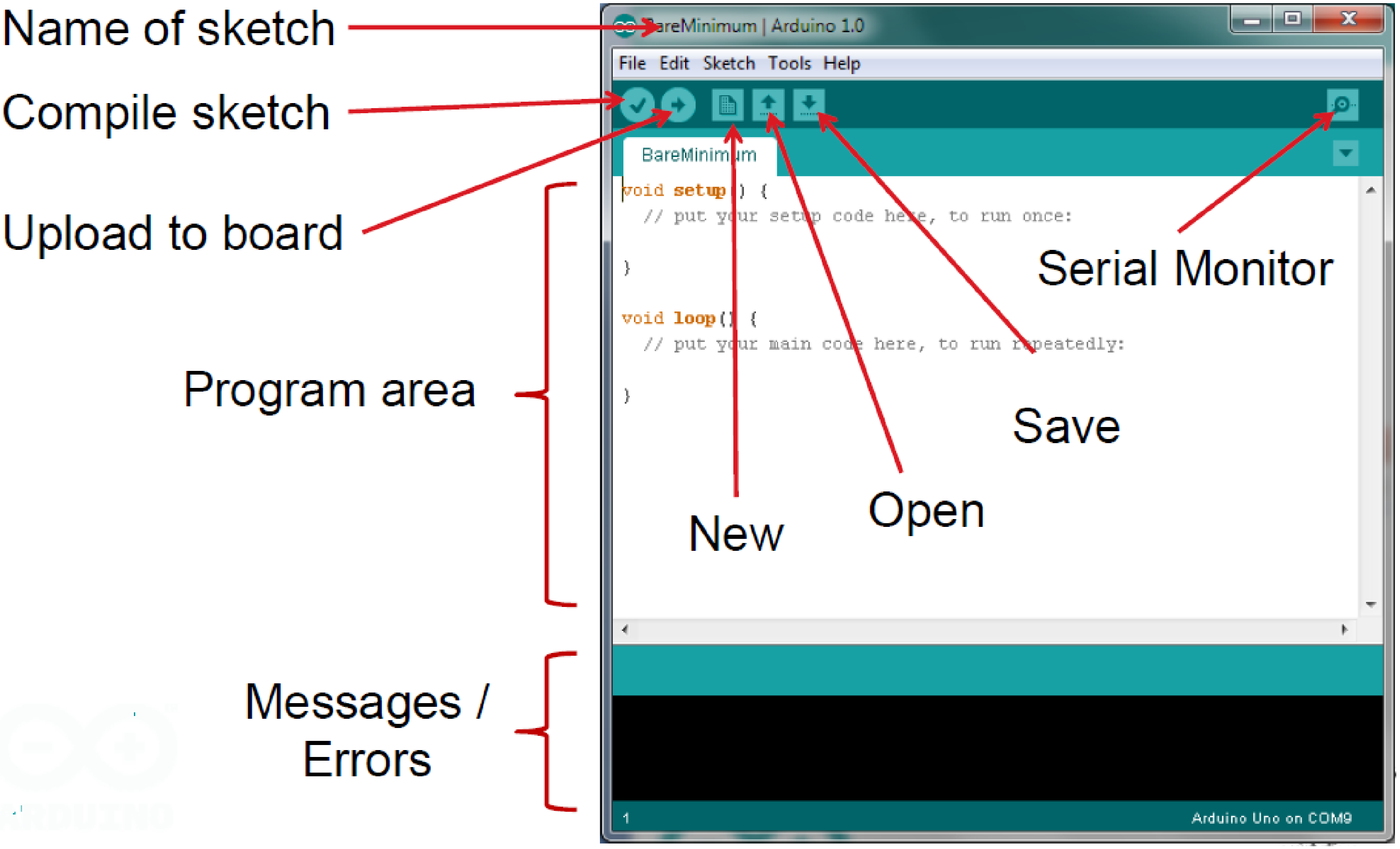
Using the Arduino IDE



Name of sketch

Compile sketch

Upload to board

Program area

Messages / Errors

New

Open

Save

Serial Monitor

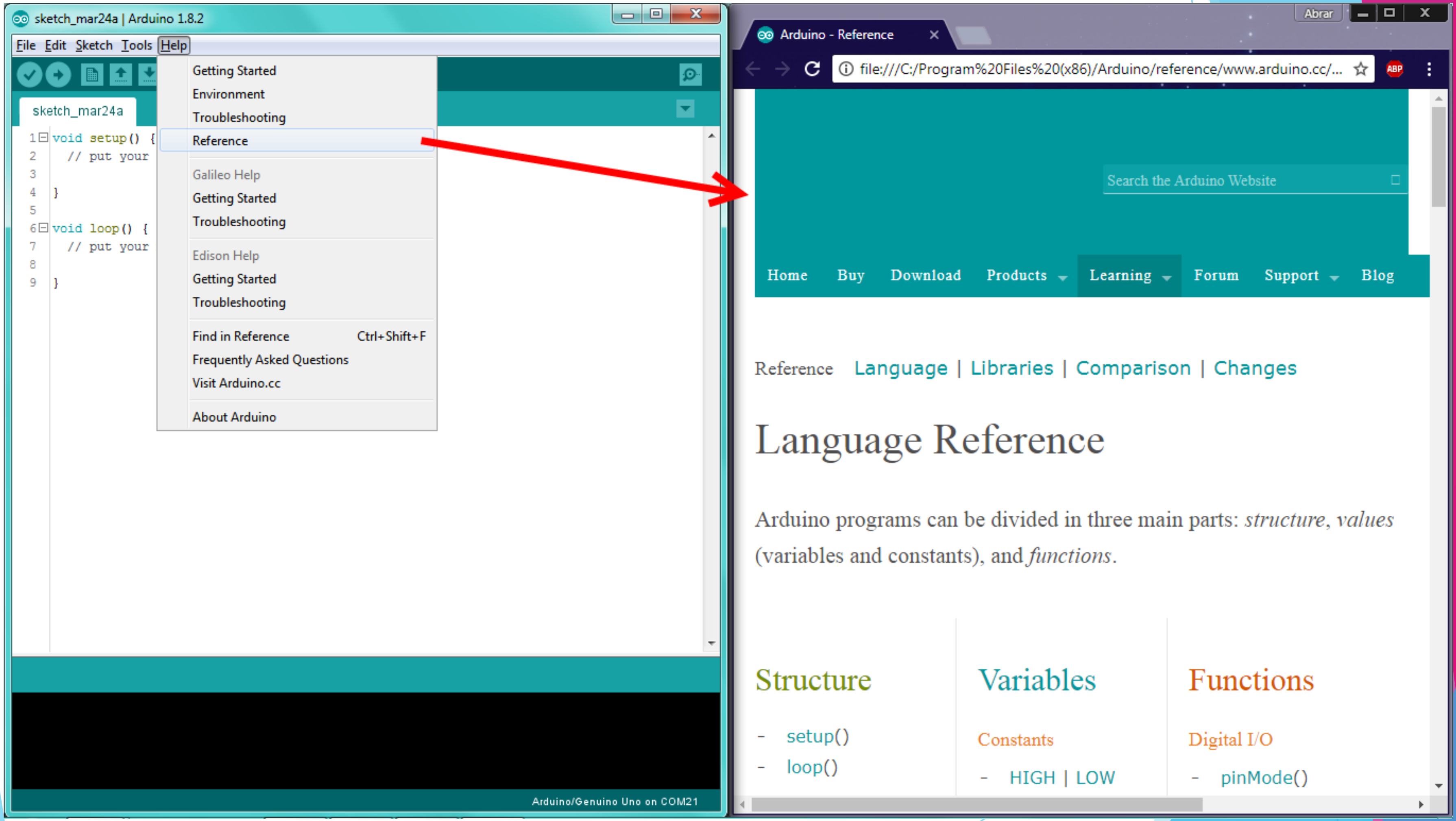
```
void setup() {
  // put your setup code here, to run once:

}

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

}
```

Arduino Reference



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

}

void loop() {
  // put your

}
```

Reference Language | Libraries | Comparison | Changes

Language Reference

Arduino programs can be divided in three main parts: *structure*, *values* (variables and constants), and *functions*.

Structure

- setup()
- loop()

Variables

Constants

- HIGH | LOW

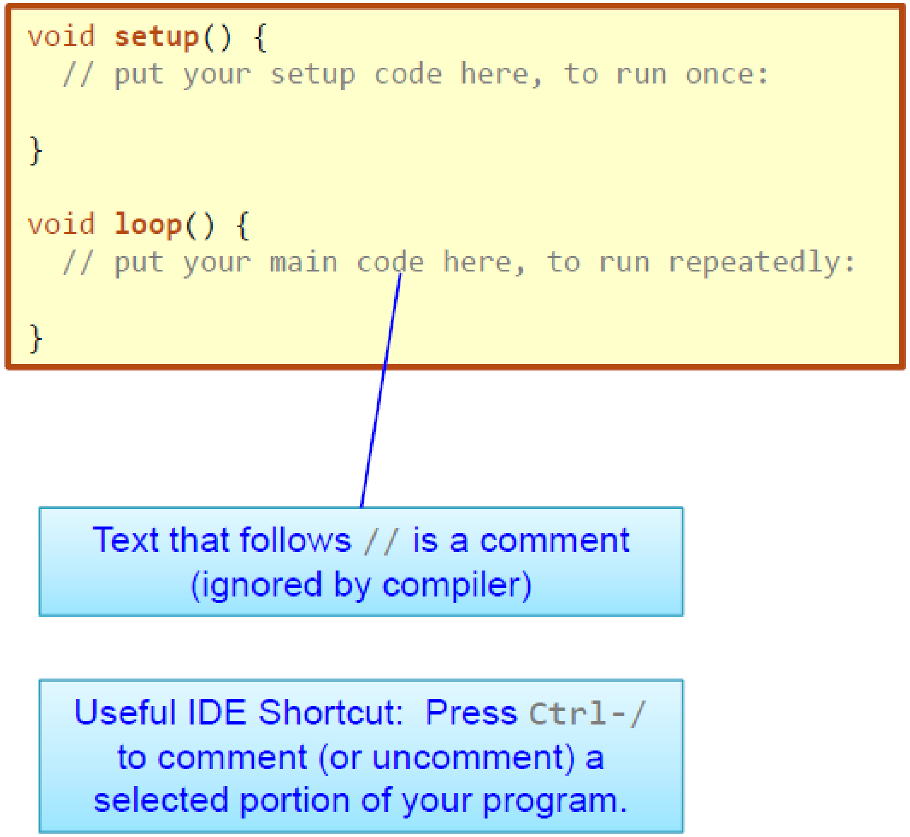
Functions

Digital I/O

- pinMode()

Arduino Sketch Structure

- void **setup**()
  - Will be executed only when the program begins (or reset button is pressed)
- void **loop**()
  - Will be executed repeatedly



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

}

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

}
```

Text that follows // is a comment (ignored by compiler)

Useful IDE Shortcut: Press Ctrl-/ to comment (or uncomment) a selected portion of your program.

Bare minimum code

- Setup : It is called only when the Arduino is powered on or reset. It is used to initialize variables and pin modes

- Loop : The loop functions runs continuously till the device is powered off. The main logic of the code goes here. Similar to while (1) for micro-controller programming.

PinMode

- A pin on arduino can be set as input or output by using pinMode function.
- pinMode(13, OUTPUT); // sets pin 13 as output pin
- pinMode(13, INPUT); // sets pin 13 as input pin

Reading/writing digital values

- digitalWrite(13, LOW); // Makes the output voltage on pin 13 , 0V

- digitalWrite(13, HIGH); // Makes the output voltage on pin 13 , 5V

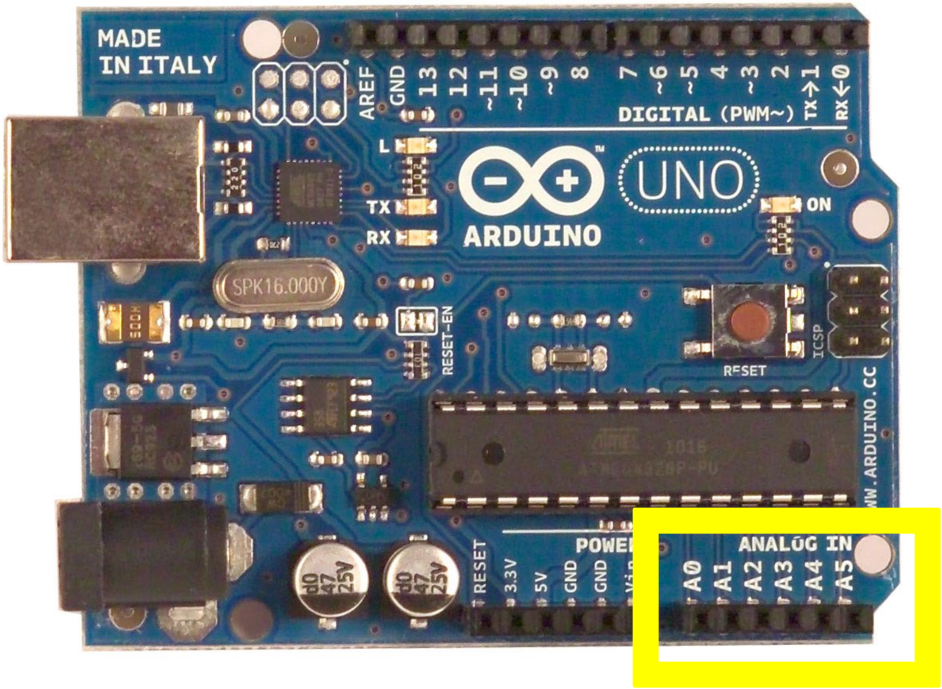
- int buttonState = digitalRead(2); // reads the value of pin 2 in buttonState

Analog to Digital Conversion

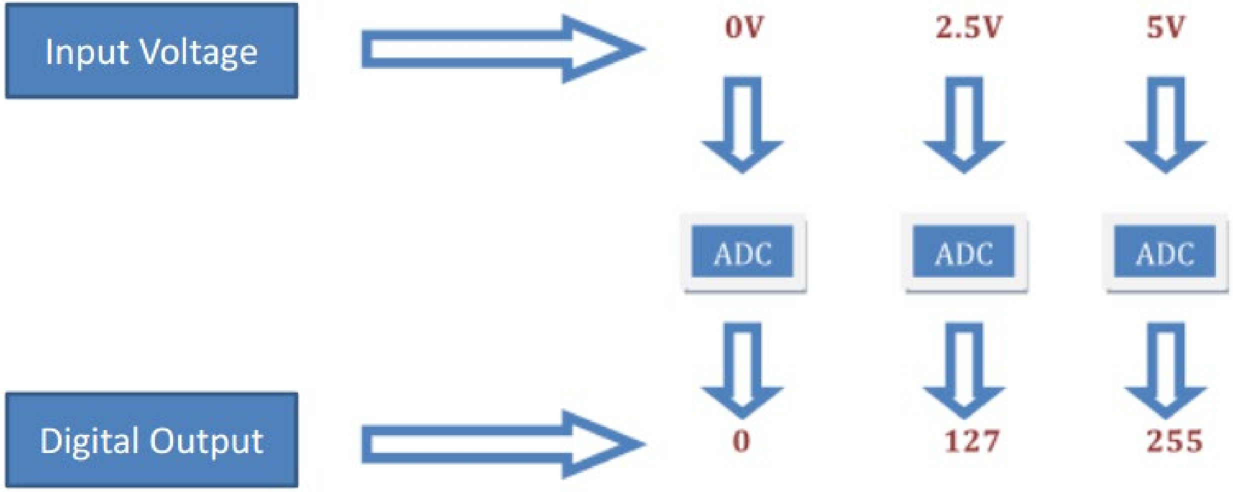
- What is analog ?
- It is continuous range of voltage values (not just 0 or 5V)

- Why convert to digital ?
- Because our microcontroller only understands digital.

ADC in Arduino Uno



Converting Analog Value to Digital



Input Voltage

0V

2.5V

5V

ADC

ADC

ADC

Digital Output

0

127

255

ADC in Arduino

- The Arduino Uno board contains 6 pins for ADC

- 10-bit analog to digital converter

- This means that it will map input voltages between 0 and 5 volts into integer values between 0 and 1023

Reading/Writing Analog Values

- analogRead(A0); // used to read the analog value from the pin A0

- analogWrite(2,128);