# Engineering Design - II(Buggy)

# Course Introduction

Subject: Engineering Design - II (Buggy)

Course Code: UTA014

Credit: 6.0

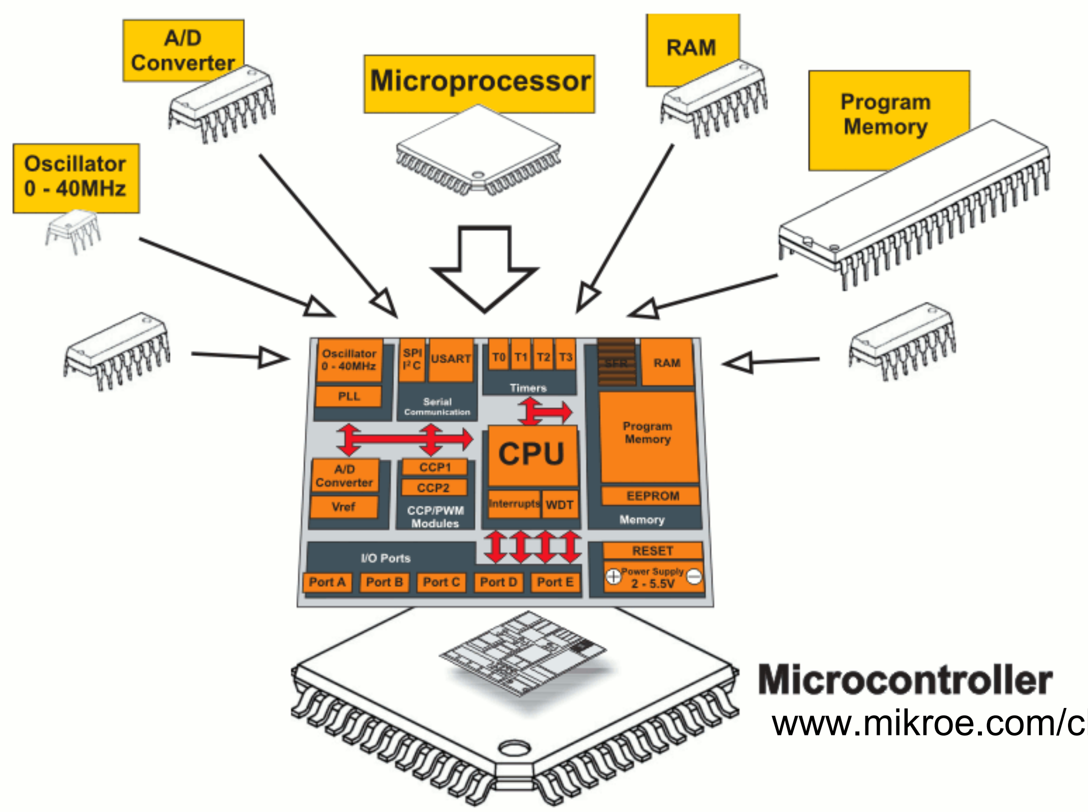
## Evaluation Criteria:

- Quizzes
- Lab Evaluation
- Demonstration of Three different Challenges (Bronze, Silver and Gold)
- End Term Exam

# Resources

- http://www.tutorialspoint.com/arduino/
- https://www.arduino.cc/en/Tutorial/HomePage
- https://www.tutorialspoint.com/csharp/
- http://www.completecsharptutorial.com/

# What is a Microcontroller

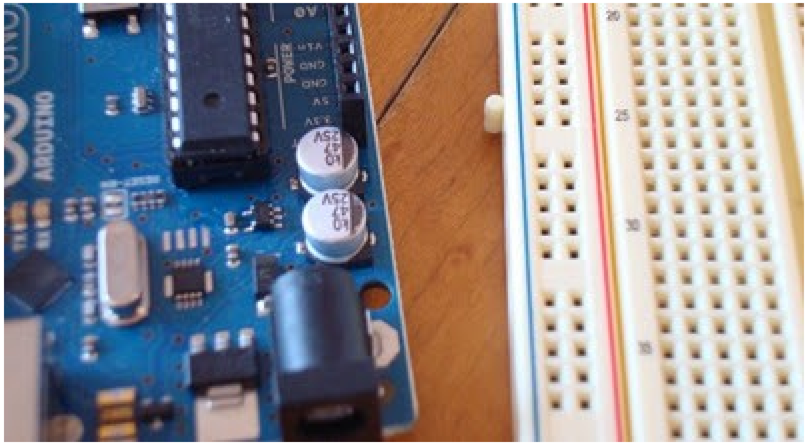


www.mikroe.com/chapters/view/1

Fig. 0-1 Microcontroller versus Microprocessor

- A small computer on a single chip
  - containing a processor, memory, and input/output
- Typically "**embedded**" inside some device that they control
- A microcontroller is often small and low cost

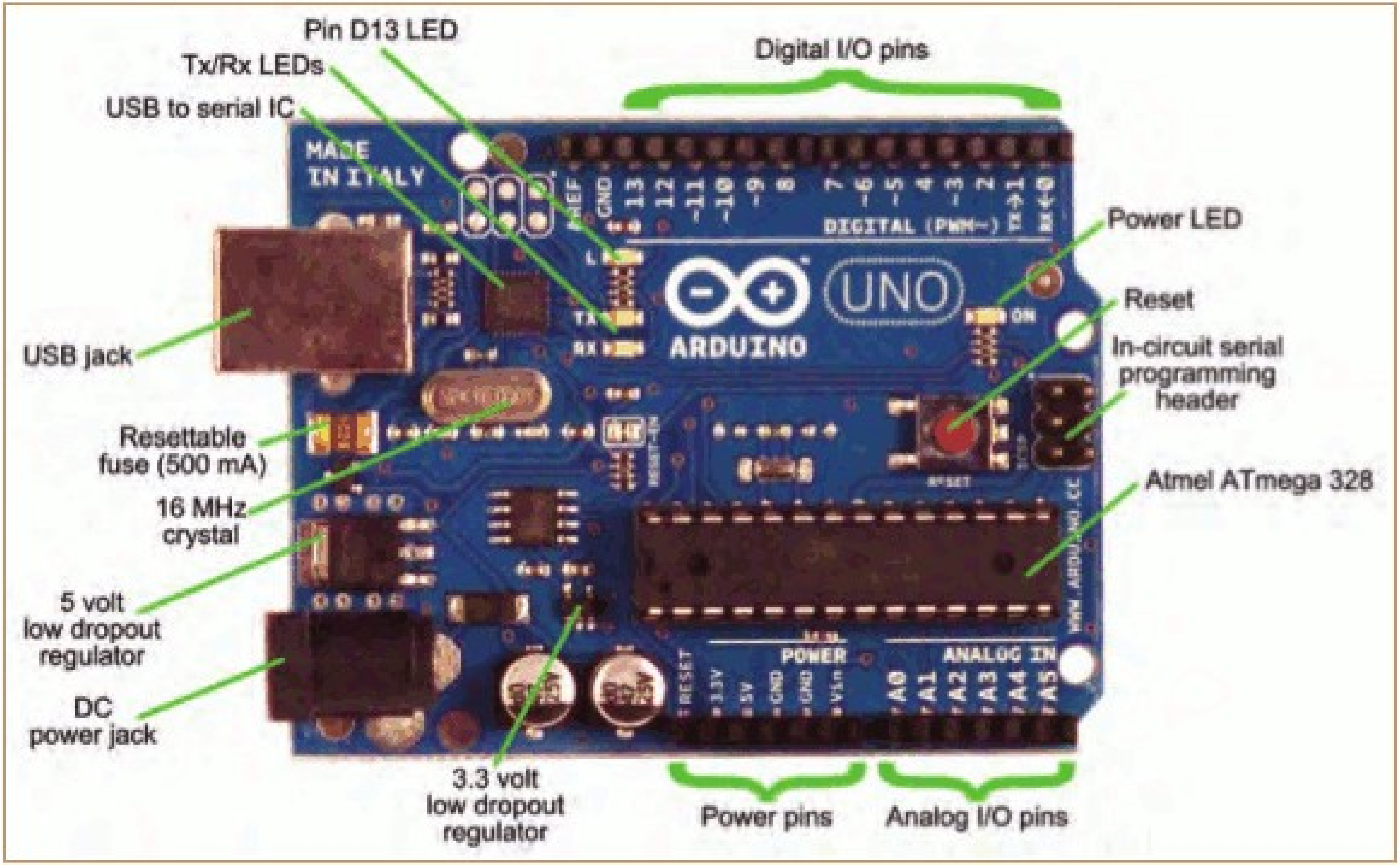
# What is a Development Board



- A printed circuit board designed to facilitate work with a particular microcontroller.

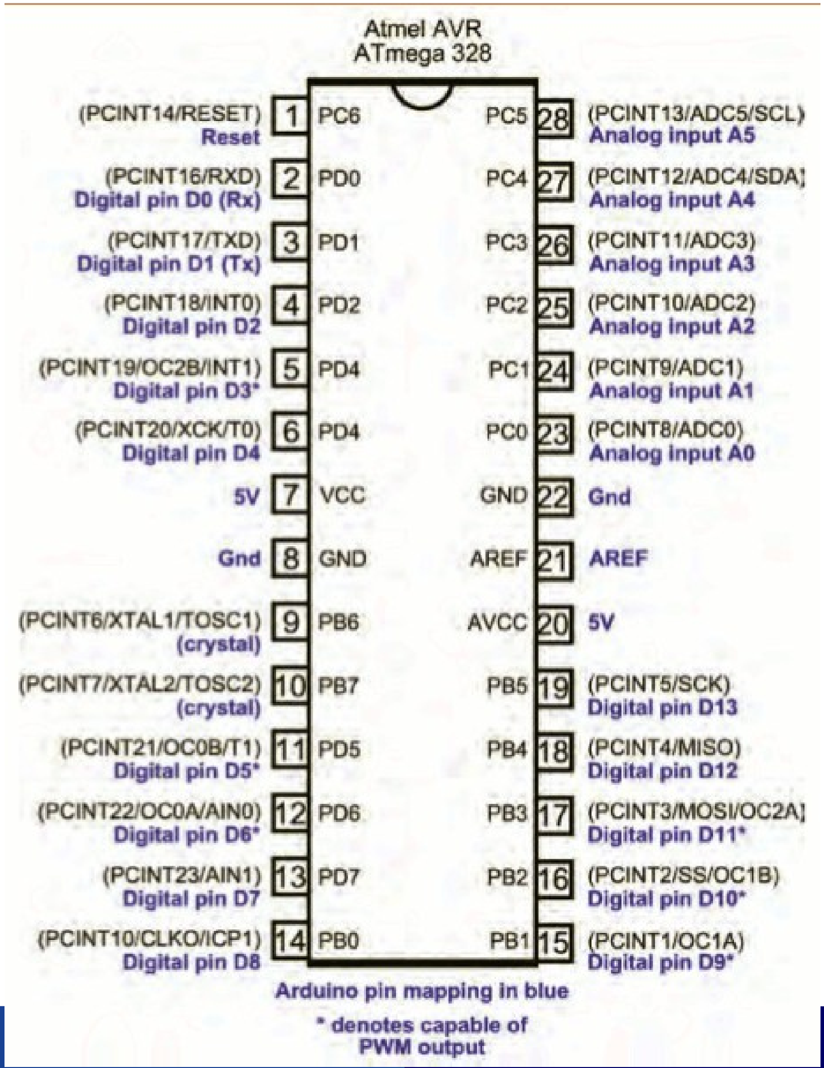
- Typical components include:
  - power circuit
  - programming interface
  - basic input; usually buttons and LEDs
  - I/O pins

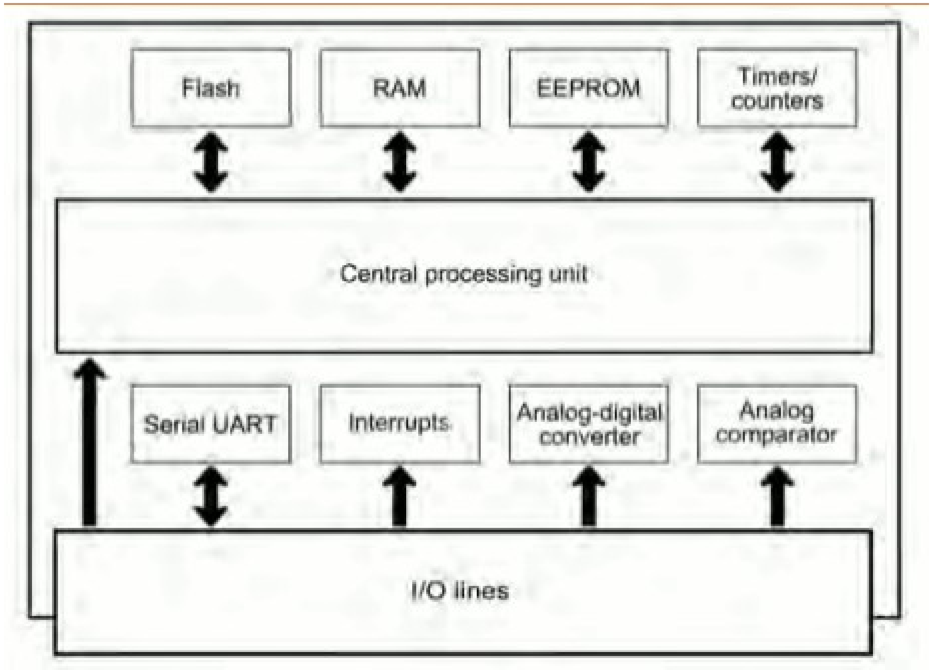
# The Arduino Development Board



Making-robots-with-arduino.pdf

# The Arduino Microcontroller: Atmel ARV Atmega 328


Atmel AVR
ATmega 328
(PCINT14/RESET) Reset 1 PC6
(PCINT16/RXD) Digital pin D0 (Rx) 2 PD0
(PCINT17/TXD) Digital pin D1 (Tx) 3 PD1
(PCINT18/INT0) Digital pin D2 4 PD2
(PCINT19/OC2B/INT1) Digital pin D3* 5 PD4
(PCINT20/XCK/T0) Digital pin D4 6 PD4
5V 7 VCC
Gnd 8 GND
(PCINT6/XTAL1/TOSC1) (crystal) 9 PB6
(PCINT7/XTAL2/TOSC2) (crystal) 10 PB7
(PCINT21/OC0B/T1) Digital pin D5* 11 PD5
(PCINT22/OC0A/AIN0) Digital pin D6* 12 PD6
(PCINT23/AIN1) Digital pin D7 13 PD7
(PCINT10/CLKO/ICP1) Digital pin D8 14 PB0
PC5 28 (PCINT13/ADC5/SCL) Analog input A5
PC4 27 (PCINT12/ADC4/SDA) Analog input A4
PC3 26 (PCINT11/ADC3) Analog input A3
PC2 25 (PCINT10/ADC2) Analog input A2
PC1 24 (PCINT9/ADC1) Analog input A1
PC0 23 (PCINT8/ADC0) Analog input A0
GND 22 Gnd
AREF 21 AREF
AVCC 20 5V
PB5 19 (PCINT5/SCK) Digital pin D13
PB4 18 (PCINT4/MISO) Digital pin D12
PB3 17 (PCINT3/MOSI/OC2A) Digital pin D11*
PB2 16 (PCINT2/SS/OC1B) Digital pin D10*
PB1 15 (PCINT1/OC1A) Digital pin D9*
Arduino pin mapping in blue
* denotes capable of PWM output



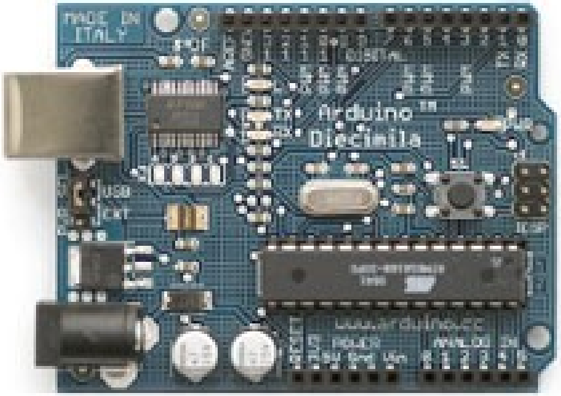
Specification

Making-robots-with-arduino.pdf

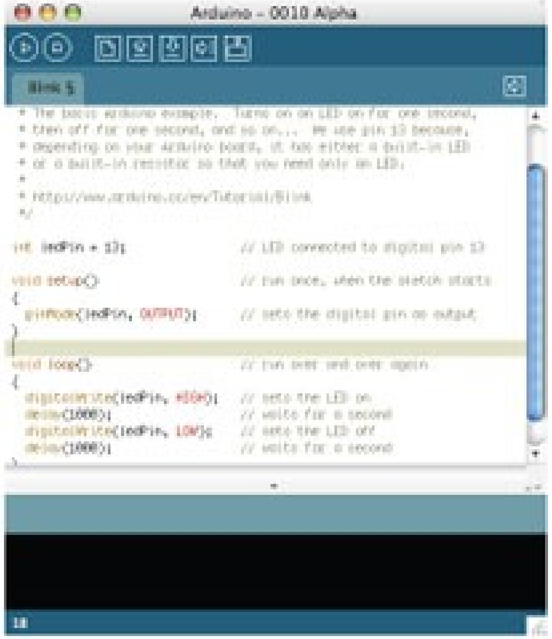
# What is the Arduino

The word "Arduino" can mean 3 things

A physical piece of hardware



A programming environment



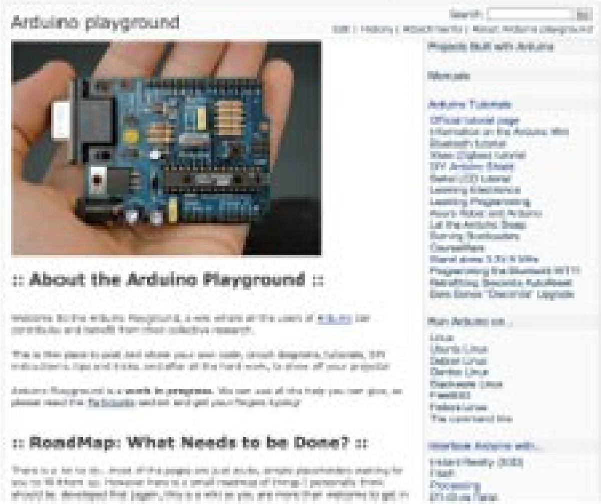
```
 * The basic Arduino example.  Turns on an LED on for one second,
 * then off for one second, and so on...  We use pin 13 because,
 * depending on your Arduino board, it has either a built-in LED
 * or a built-in resistor so that you need only an LED.
 *
 * http://www.arduino.cc/en/Tutorial/Blink
 */

int ledPin = 13;                // LED connected to digital pin 13

void setup()                    // run once, when the sketch starts
{
  pinMode(ledPin, OUTPUT);      // sets the digital pin as output
}

void loop()                     // run over and over again
{
  digitalWrite(ledPin, HIGH);   // sets the LED on
  delay(1000);                  // waits for a second
  digitalWrite(ledPin, LOW);    // sets the LED off
  delay(1000);                  // waits for a second
}
```

A community & philosophy



Arduino playground

:: About the Arduino Playground ::

Welcome to the Arduino Playground, a wiki where all the users of Arduino can contribute and benefit from their collective research.

This is the place to post and share your own code, circuit diagrams, tutorials, DIY instructions, tips and tricks, and after all the hard work, to show off your projects!

Arduino Playground is a **work in progress**. We can use all the help you can give, so please read the Participate section and get your fingers typing!

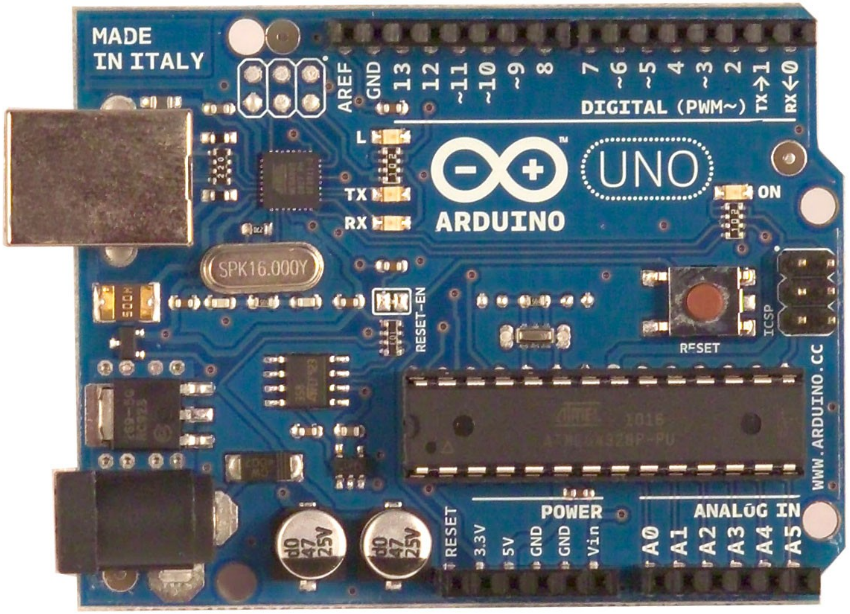
:: RoadMap: What Needs to be Done? ::

There is a lot to do... most of the pages are just stubs, simple placeholders waiting for you to fill them up. However there is a small roadmap of things I personally think should be developed first [illegible]

todbot.com/blog/bionicarduino

# What is an Arduino ?

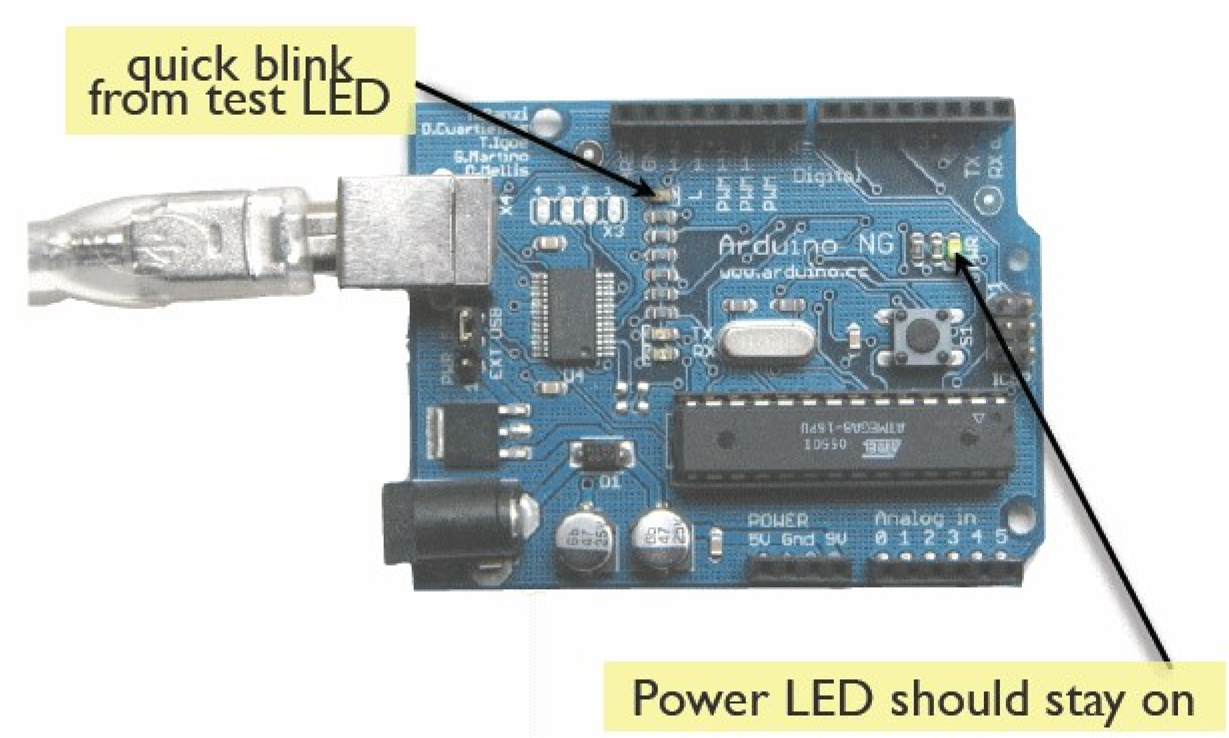
- **Open Source** electronic prototyping **platform** based on flexible **easy to use** hardware and software.



# Getting Started

- Check out: http://arduino.cc/en/Guide/HomePage
  1. **Download & install the Arduino environment (IDE)**
  2. **Connect the board to your computer via the UBS cable**
  3. **If needed, install the drivers**
  4. **Launch the Arduino IDE**
  5. **Select your board**
  6. **Select your serial port**
  7. **Open the program code**
  8. **Upload the program**

# Try It: Connect the USB Cable



quick blink from test LED

Power LED should stay on

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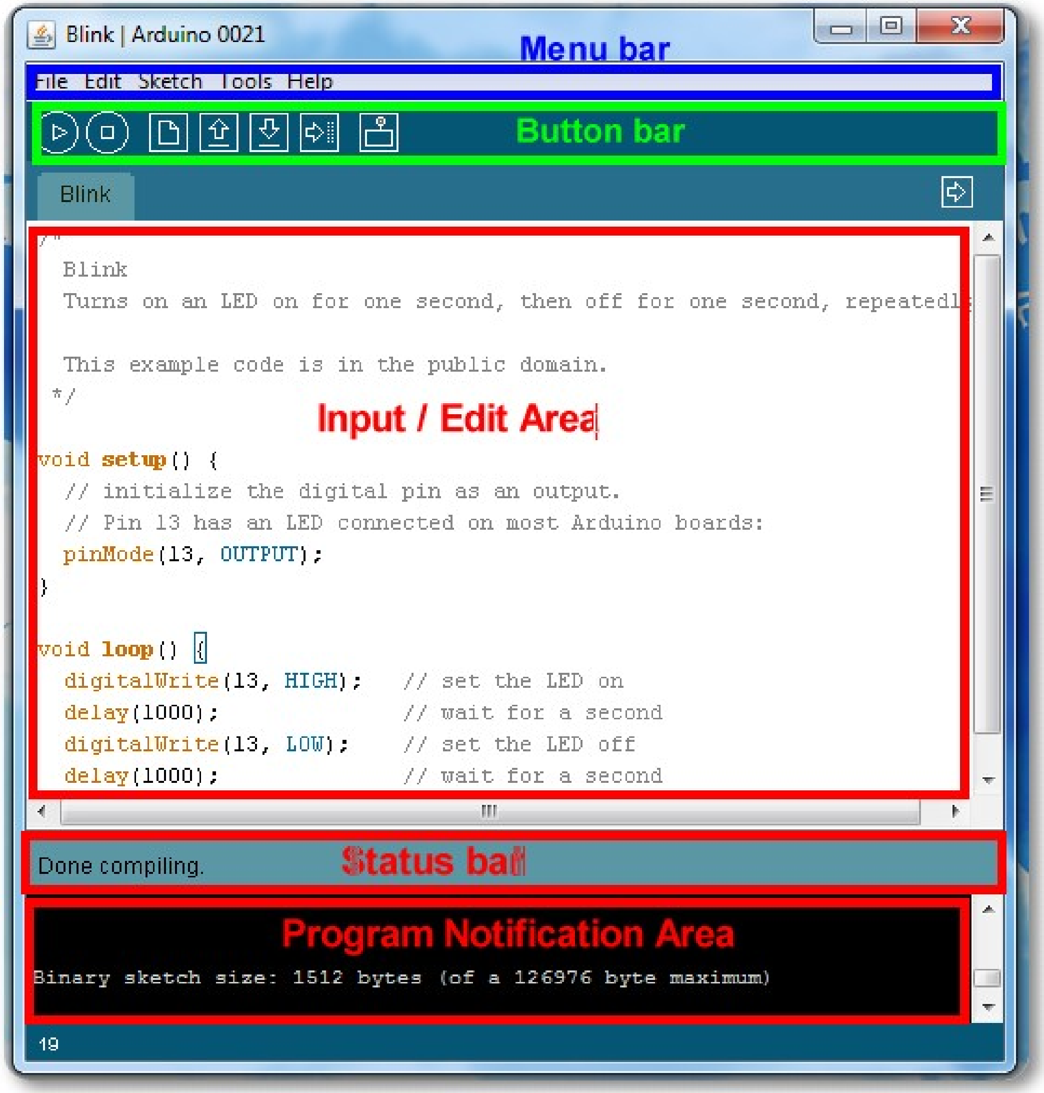
# Arduino IDE



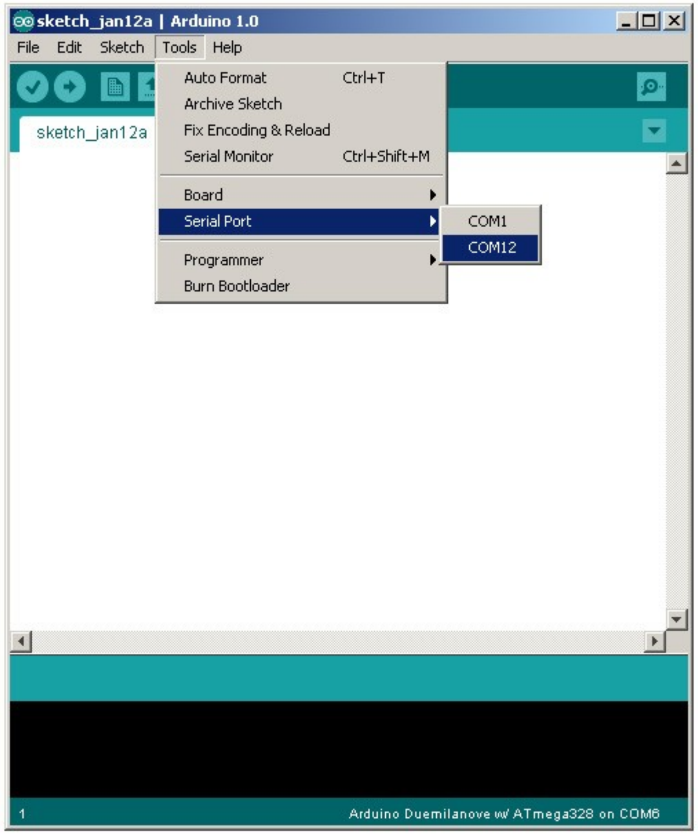
```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedl

  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
```

Done compiling.

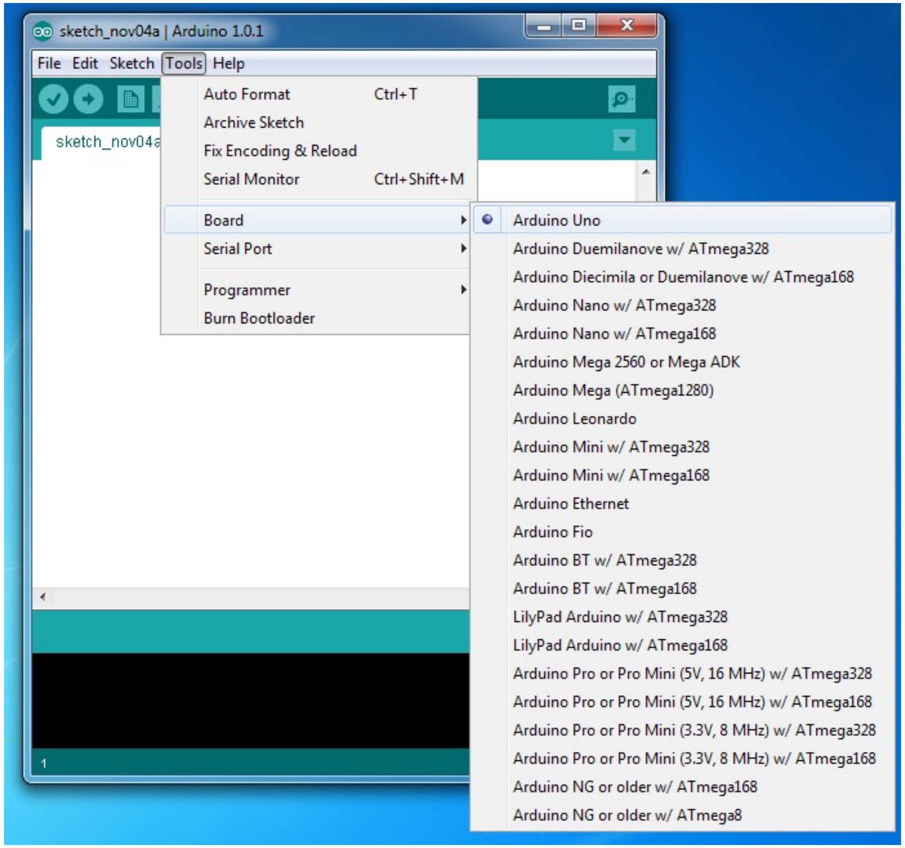
```
Binary sketch size: 1512 bytes (of a 126976 byte maximum)
```

See: http://arduino.cc/en/Guide/Environment for more information

# Select Serial Port and Board

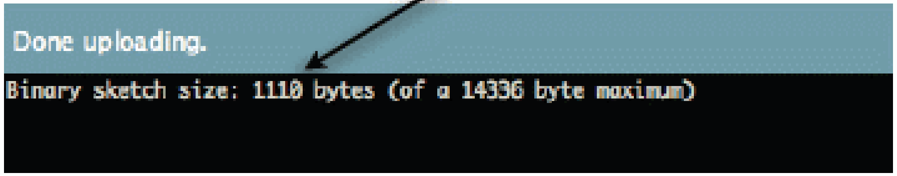


Arduino Duemilanove w/ ATmega328 on COM6


sketch_nov04a | Arduino 1.0.1
File
Edit
Sketch
Tools
Help
sketch_nov04a
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board
Serial Port
Programmer
Burn Bootloader
Arduino Uno
Arduino Duemilanove w/ ATmega328
Arduino Diecimila or Duemilanove w/ ATmega168
Arduino Nano w/ ATmega328
Arduino Nano w/ ATmega168
Arduino Mega 2560 or Mega ADK
Arduino Mega (ATmega1280)
Arduino Leonardo
Arduino Mini w/ ATmega328
Arduino Mini w/ ATmega168
Arduino Ethernet
Arduino Fio
Arduino BT w/ ATmega328
Arduino BT w/ ATmega168
LilyPad Arduino w/ ATmega328
LilyPad Arduino w/ ATmega168
Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega328
Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega168
Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega328
Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega168
Arduino NG or older w/ ATmega168
Arduino NG or older w/ ATmega8
1

# Status Messages

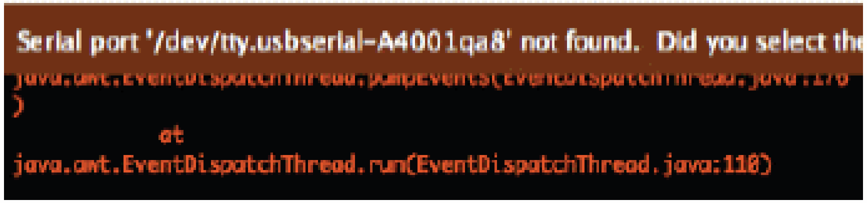
Uploading worked



Size depends on complexity of your sketch

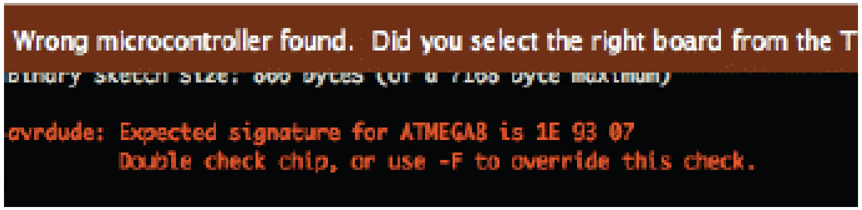
```
Done uploading.
Binary sketch size: 1110 bytes (of a 14336 byte maximum)
```

Wrong serial port selected



```
Serial port '/dev/tty.usbserial-A4001qa8' not found.  Did you select the
java.awt.EventDispatchThread.pumpEvents(EventDispatchThread.java:170
)
            at
java.awt.EventDispatchThread.run(EventDispatchThread.java:110)
```

Wrong board selected



```
Wrong microcontroller found.  Did you select the right board from the T
Binary sketch size: 666 bytes (of a 7168 byte maximum)

avrdude: Expected signature for ATMEGA8 is 1E 93 07
         Double check chip, or use -F to override this check.
```

nerdy cryptic error messages

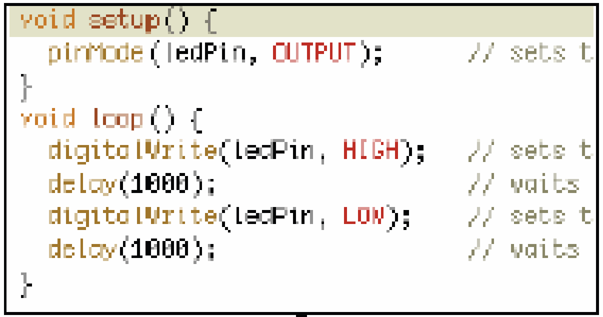
todbot.com/blog/bionicarduino

# Using Arduino

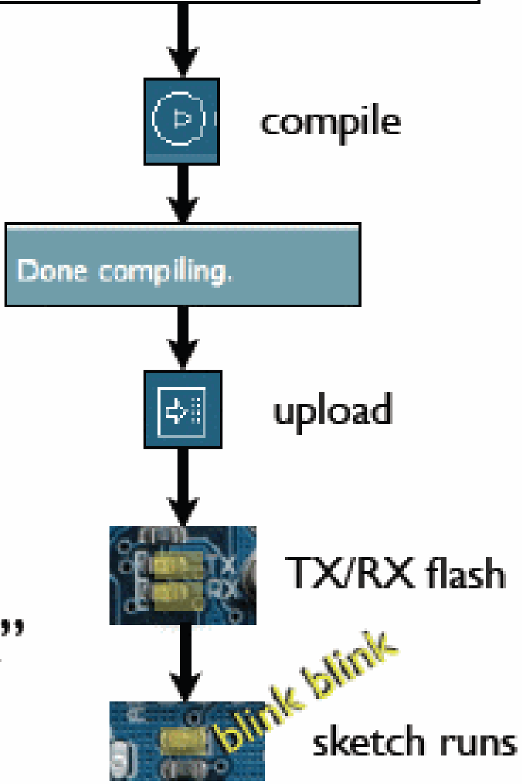
- Write your sketch
- Press Compile button (to check for errors)
- Press Upload button to program Arduino board with your sketch

Try it out with the "Blink" sketch!

Load "File/Sketchbook/Examples/Digital/Blink"



```
void setup() {
  pinMode(ledPin, OUTPUT);      // sets t
}
void loop() {
  digitalWrite(ledPin, HIGH);   // sets t
  delay(1000);                  // waits
  digitalWrite(ledPin, LOW);    // sets t
  delay(1000);                  // waits
}
```



Done compiling.

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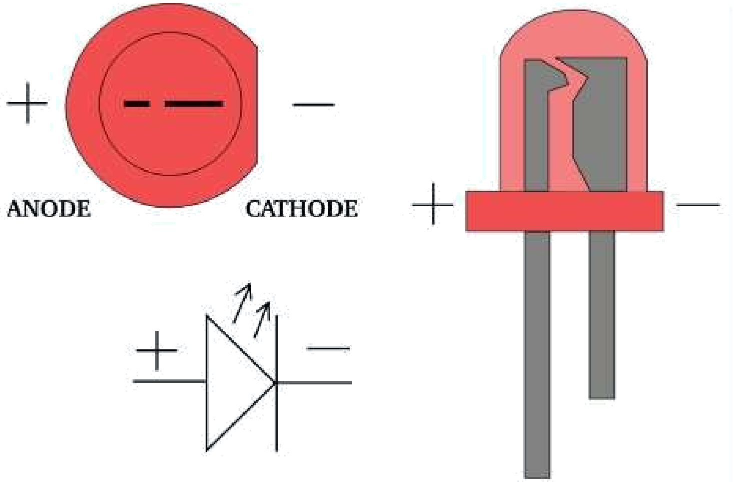
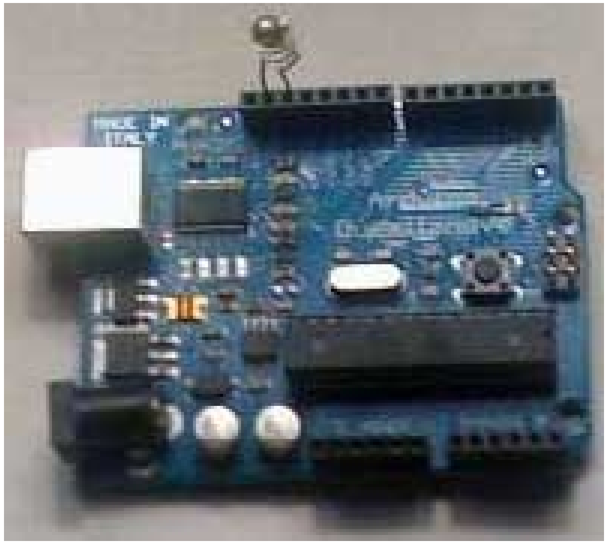
# Add an External LED to pin 13

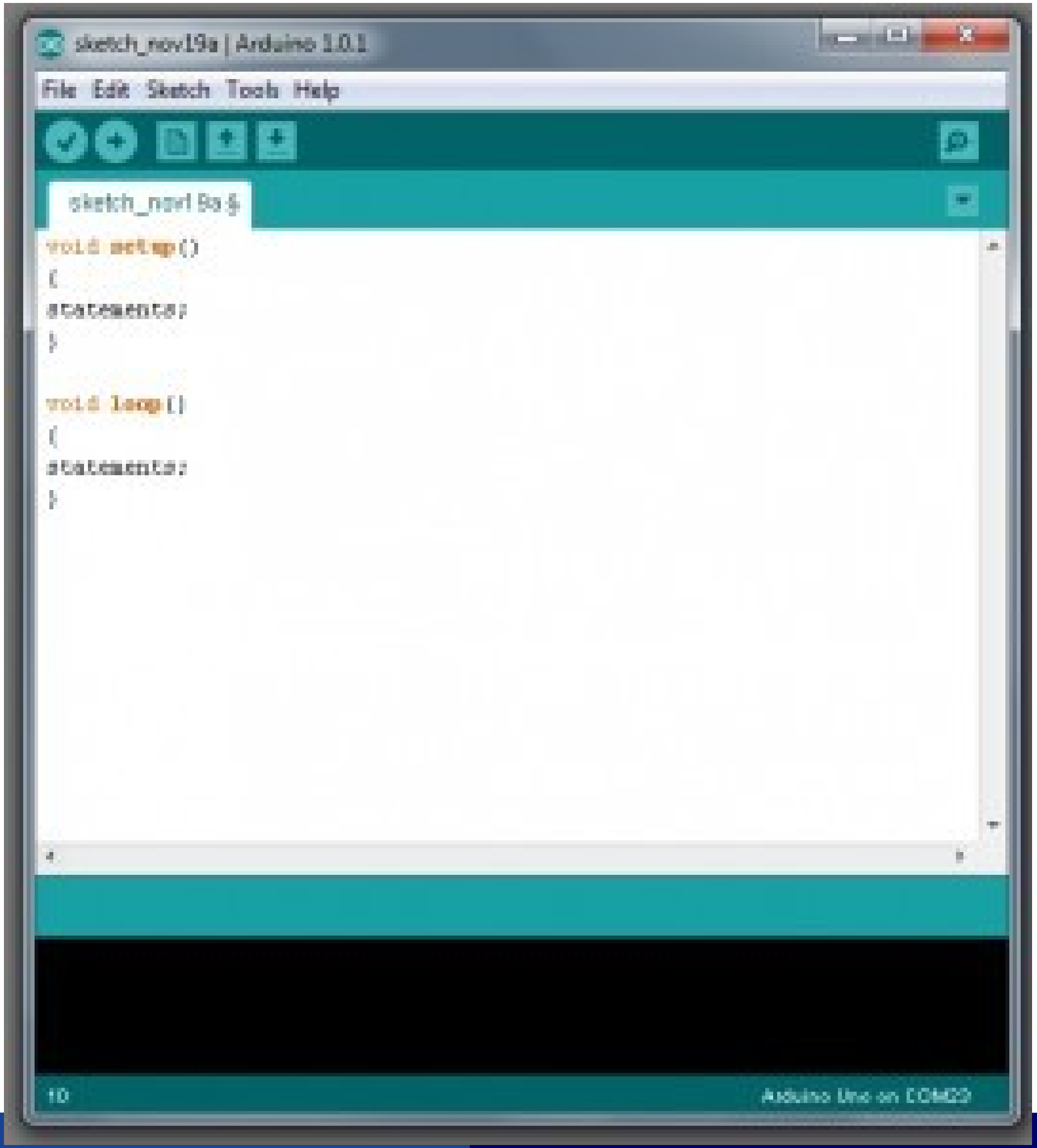
- **File > Examples > Digital > Blink**
- LED's have polarity
  - Negative indicated by flat side of the housing and a short leg



www.instructables.com



# A Little Bit About Programming

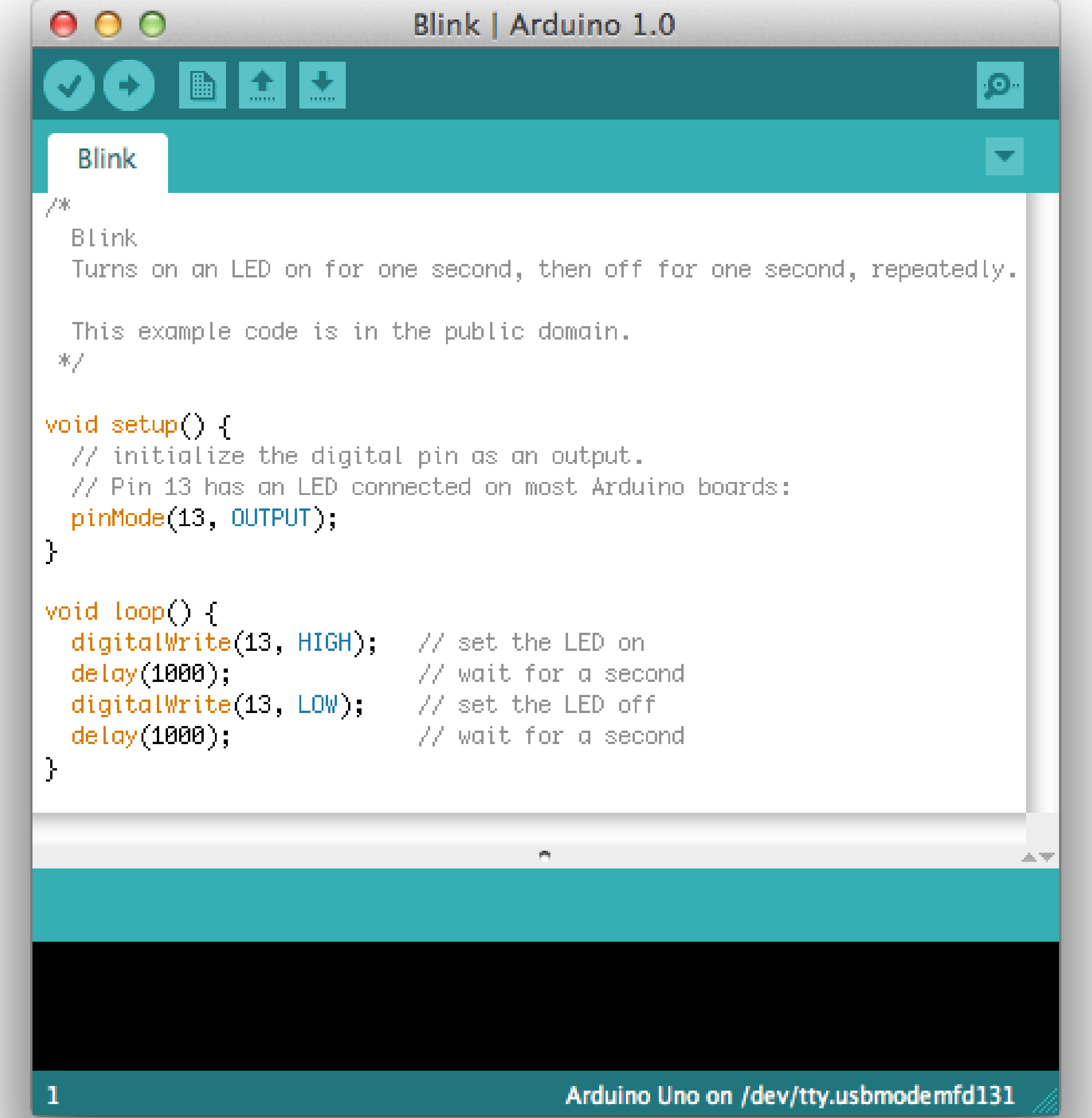


```
void setup()
{
statements;
}

void loop()
{
statements;
}
```

- Code is case sensitive
- Statements are commands and must end with a semi-colon
- Comments follow a // or begin with /* and end with */
- loop and setup

# Our First Program



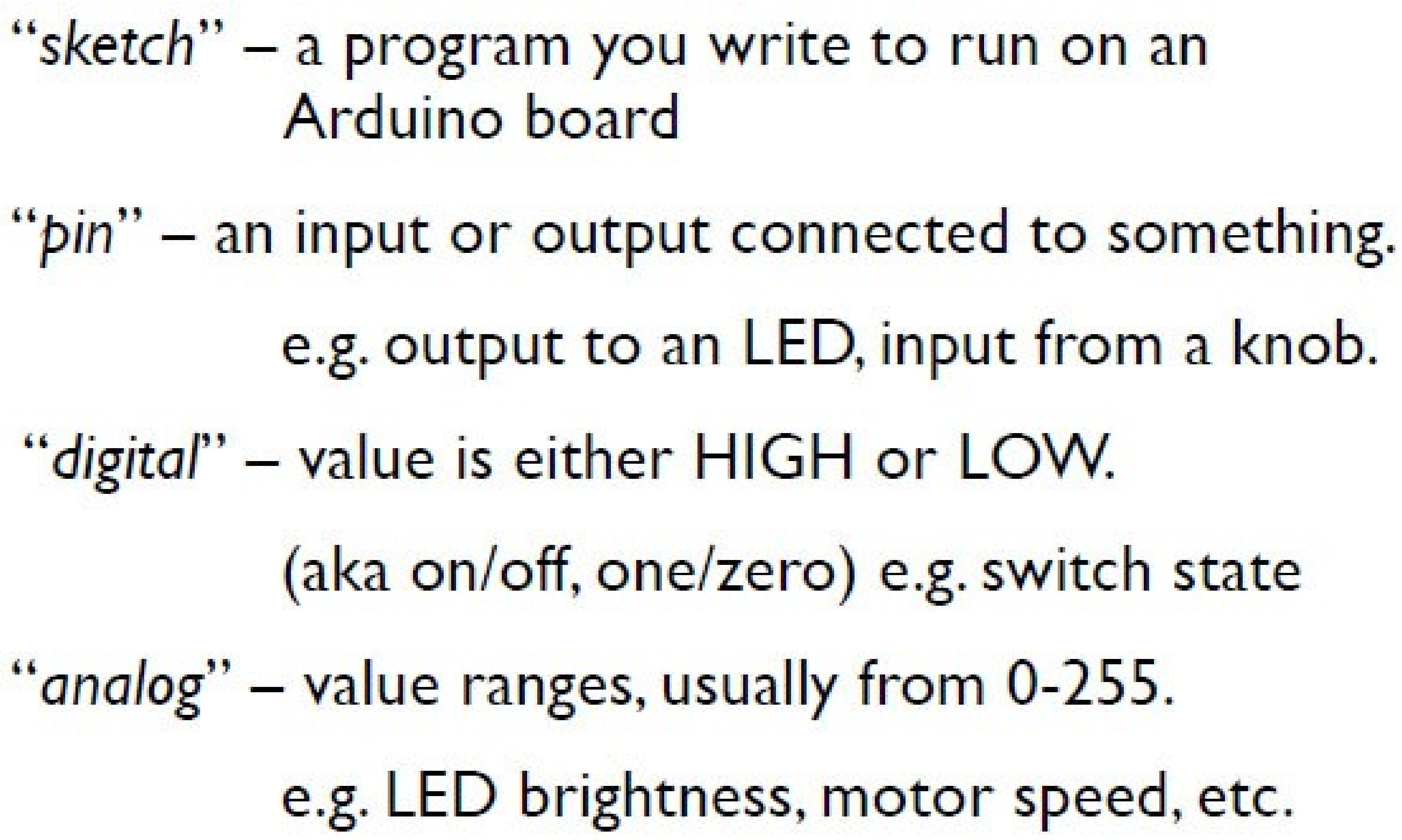
```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  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
}
```

# *Terminology*



"*sketch*" – a program you write to run on an Arduino board

"*pin*" – an input or output connected to something.

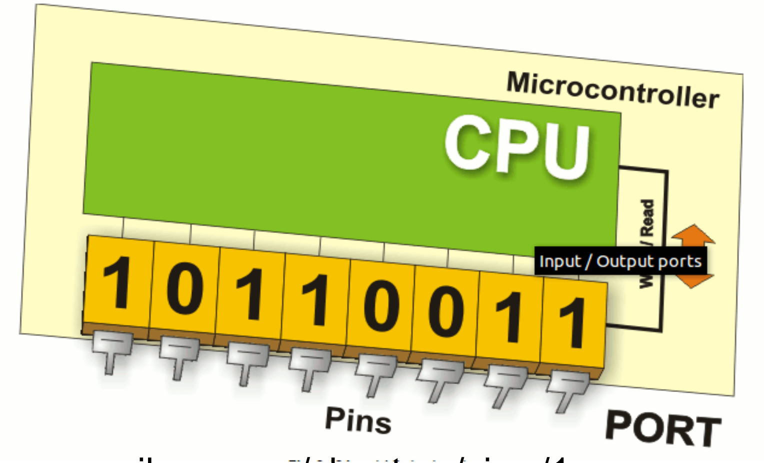
e.g. output to an LED, input from a knob.

"*digital*" – value is either HIGH or LOW.

(aka on/off, one/zero) e.g. switch state

"*analog*" – value ranges, usually from 0-255.

e.g. LED brightness, motor speed, etc.



www.mikroe.com/chapters/view/1

# *Digital I/0*

pinMode(*pin*, *mode*)

Sets pin to either INPUT or OUTPUT

digitalRead(*pin*)

Reads HIGH or LOW from a pin

digitalWrite(*pin*, *value*)

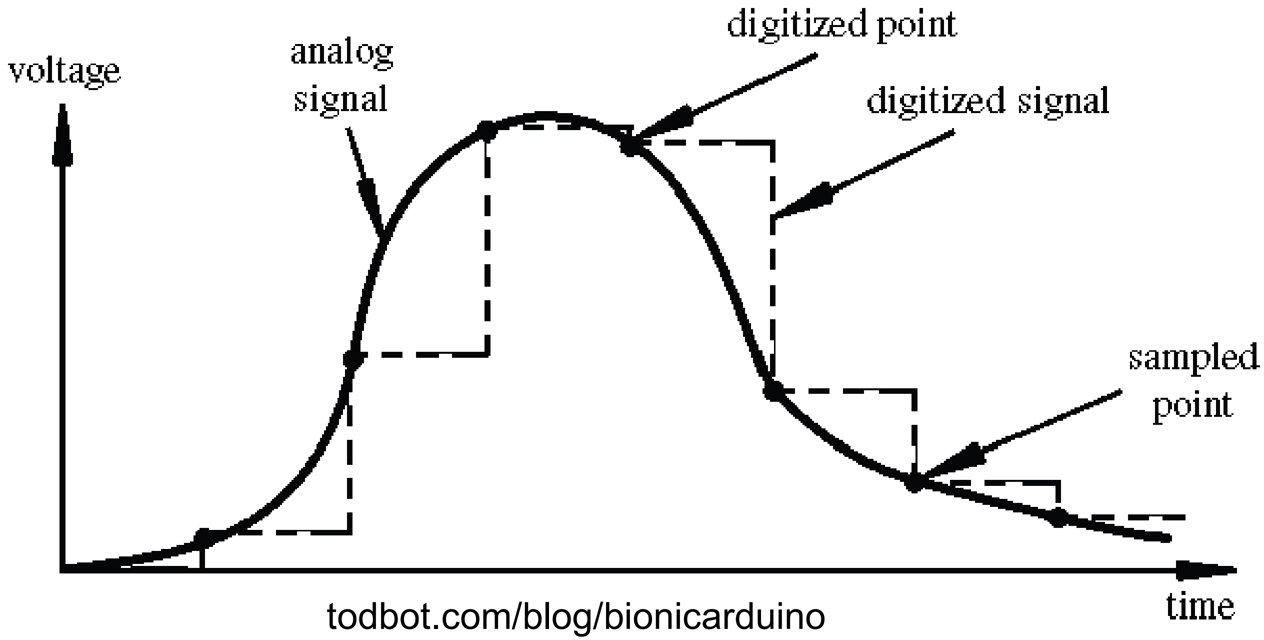
Writes HIGH or LOW to a pin

# Arduino Timing

- `delay(`*ms*`)`
  - Pauses for a few milliseconds
- `delayMicroseconds(`*us*`)`
  - Pauses for a few microseconds

# *Digital? Analog?*

- Digital has two values: **on** and **off**
- Analog has many (infinite) values
- Computers don't really do analog, they ***quantize***
- Remember the 6 analog input pins---here's how they work



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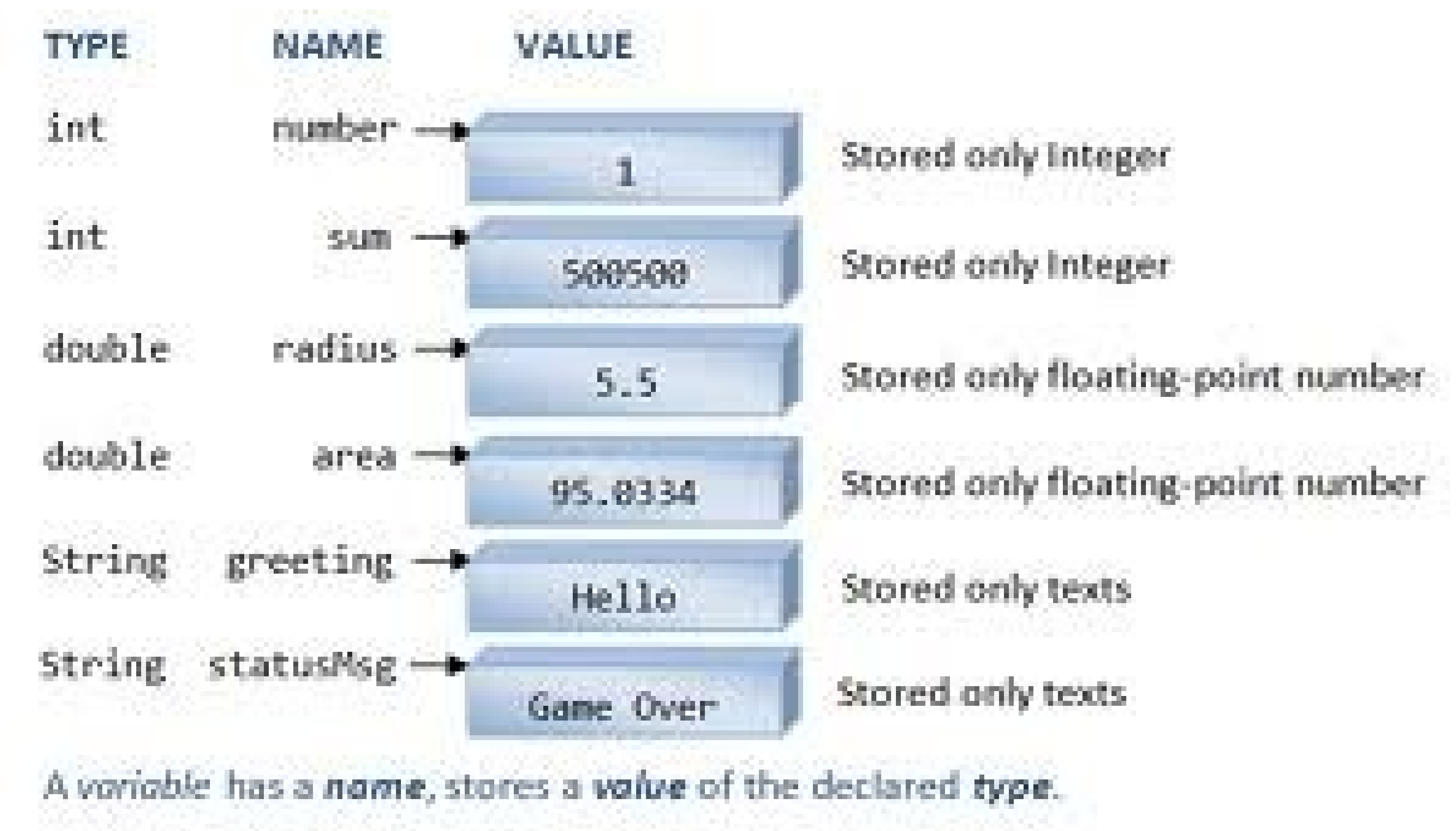
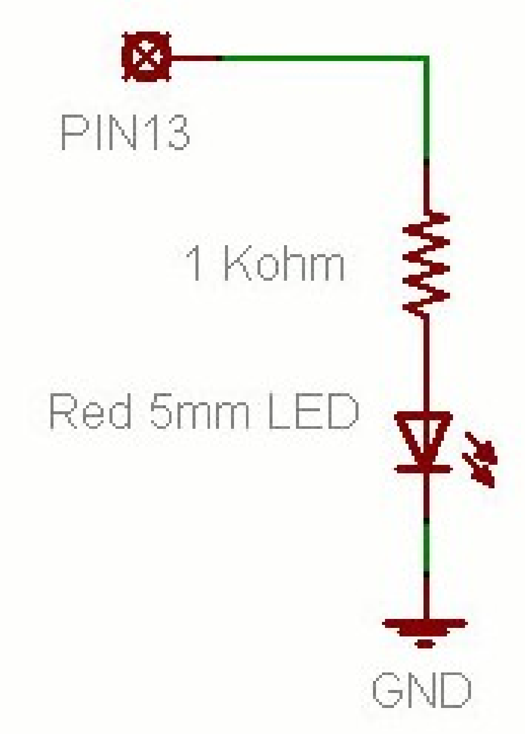
# Variables



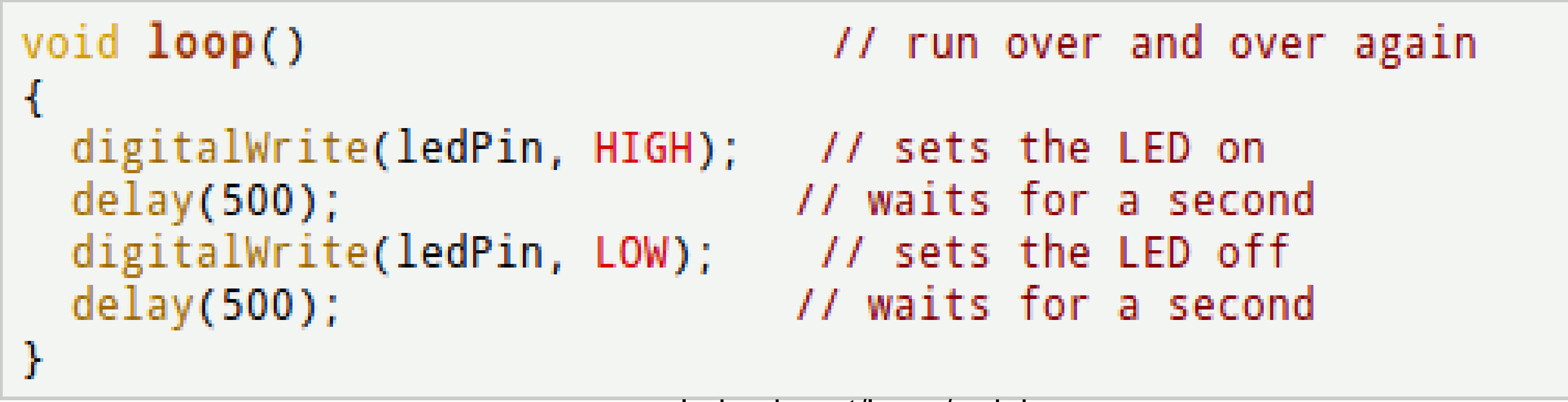
| TYPE | NAME | VALUE | |
|---|---|---|---|
| int | number | 1 | Stored only Integer |
| int | sum | 500500 | Stored only Integer |
| double | radius | 5.5 | Stored only floating-point number |
| double | area | 95.0334 | Stored only floating-point number |
| String | greeting | Hello | Stored only texts |
| String | statusMsg | Game Over | Stored only texts |

A variable has a ***name***, stores a ***value*** of the declared ***type***.

# Putting It Together



- Complete the sketch (program) below.
- What output will be generated by this program?
- What if the schematic were changed? ➔



```
void loop()                         // run over and over again
{
  digitalWrite(ledPin, HIGH);   // sets the LED on
  delay(500);                  // waits for a second
  digitalWrite(ledPin, LOW);    // sets the LED off
  delay(500);                  // waits for a second
}
```

www.ladyada.net/learn/arduino

# Analog to Digital Coversion

- 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

- 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);