Microcontrollers for Ham Radio

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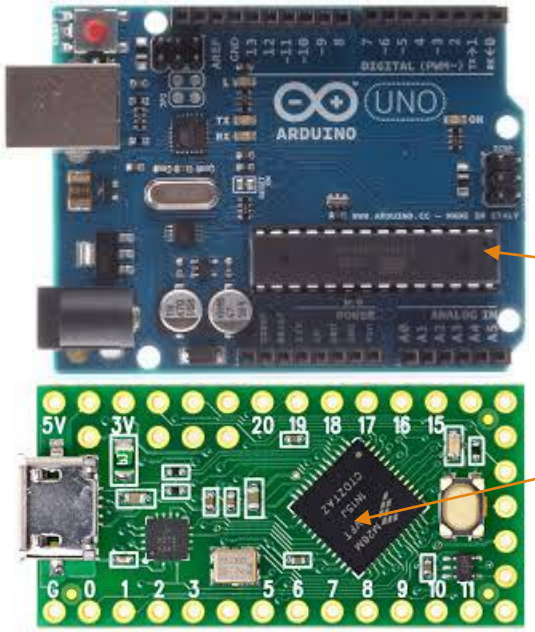
What is a Microcontroller?



- A micro-controller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals
- The chip itself is the microcontroller, but the board provides the needed pieces to provide clocking and serial interface for programming.
- Programming can be machine level or compiled languages like C, Python ,and even Java.
- The “Maker Community” has a lot of tutorials, projects, and sample code you can use to build upon.

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How is it different from a Microprocessor?

Raspberry Pi

High-end Server Board

- Terms are often used interchangeably, but the microprocessor is generally a more capable processor chip with 32 or 64 bit word sizes and designed to run an Operating System
- More complex to program but can handle the complex applications that sometimes we want to build.
- Require knowledge of LINUX derivative operating systems, C, Java, and high level programming, and interfaces with more complex protocols
- Can be used in place of a regular Windows machine for simple applications like FLDIGI, etc.

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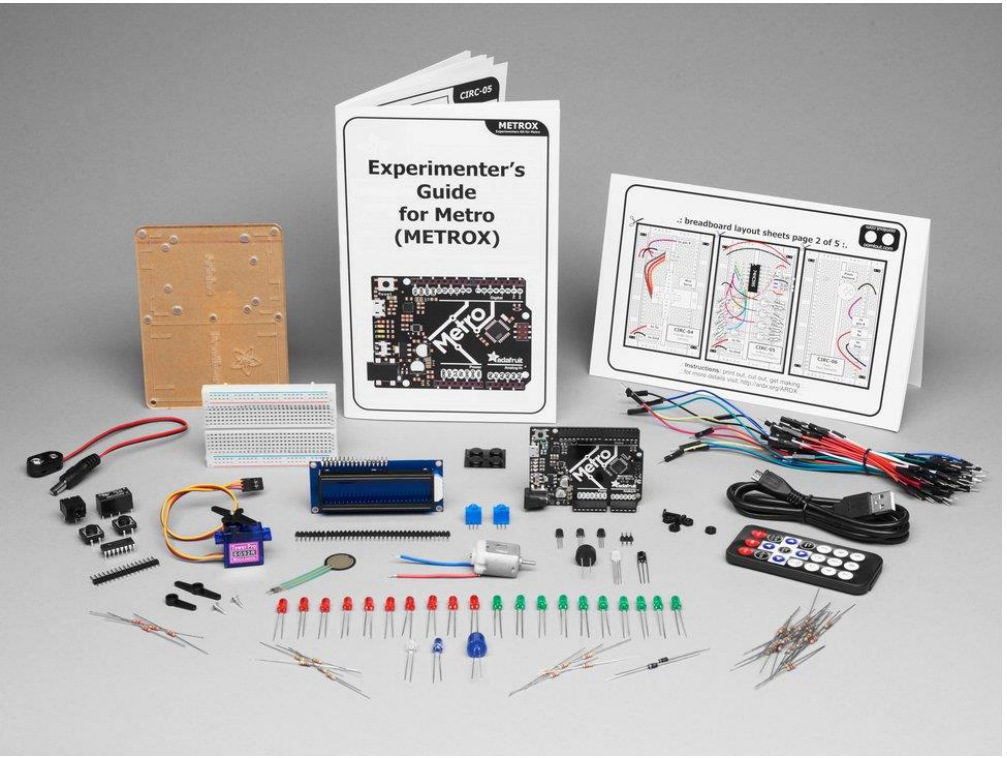
Why are these useful for projects?



- Price
  - Very inexpensive for the function it provides
  - Huge volumes of the chips are made for many products both consumer and industrial , like IoT. (billions of parts)
- Functionality
  - Incredible capability that includes analog and digital interfaces
  - Support for standards like SPI, I2C, Ethernet, and some have 802.X wireless
- Ecosystem
  - Lots of free tutorials, YouTube video, libraries for complex tasks, and lots of examples
  - User blogs, project sharing, and multivendor support.
  - Boards and kits ready to with all the parts you need
  - Experimenters kits run $40 to $100

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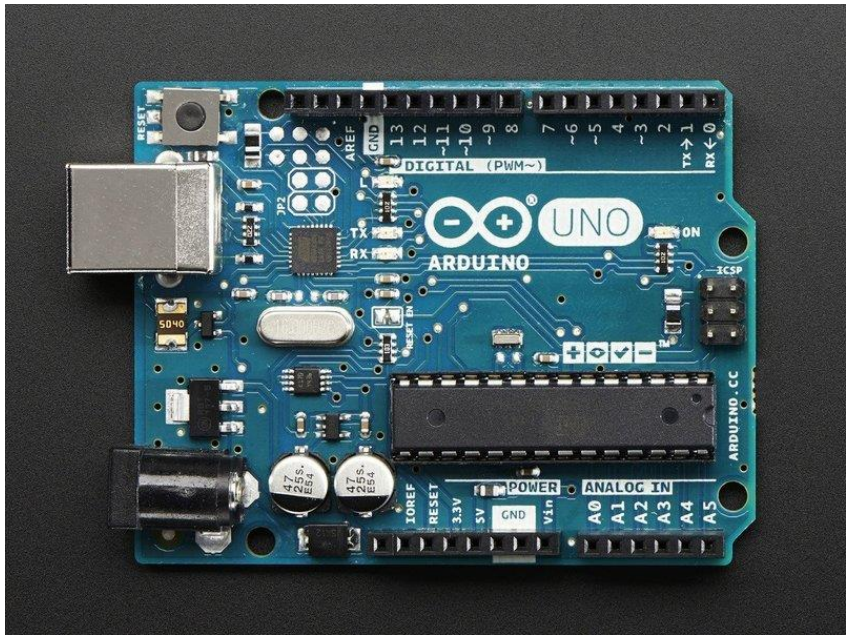
How do you ever get started?



References:
Wiring.org.co
Processing.org

- Focus on the easiest platform with the most instructional material and support
- Without any doubt, that is **Ardunio**.
- What is Arduino?
- Arduino is an **open-source** prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

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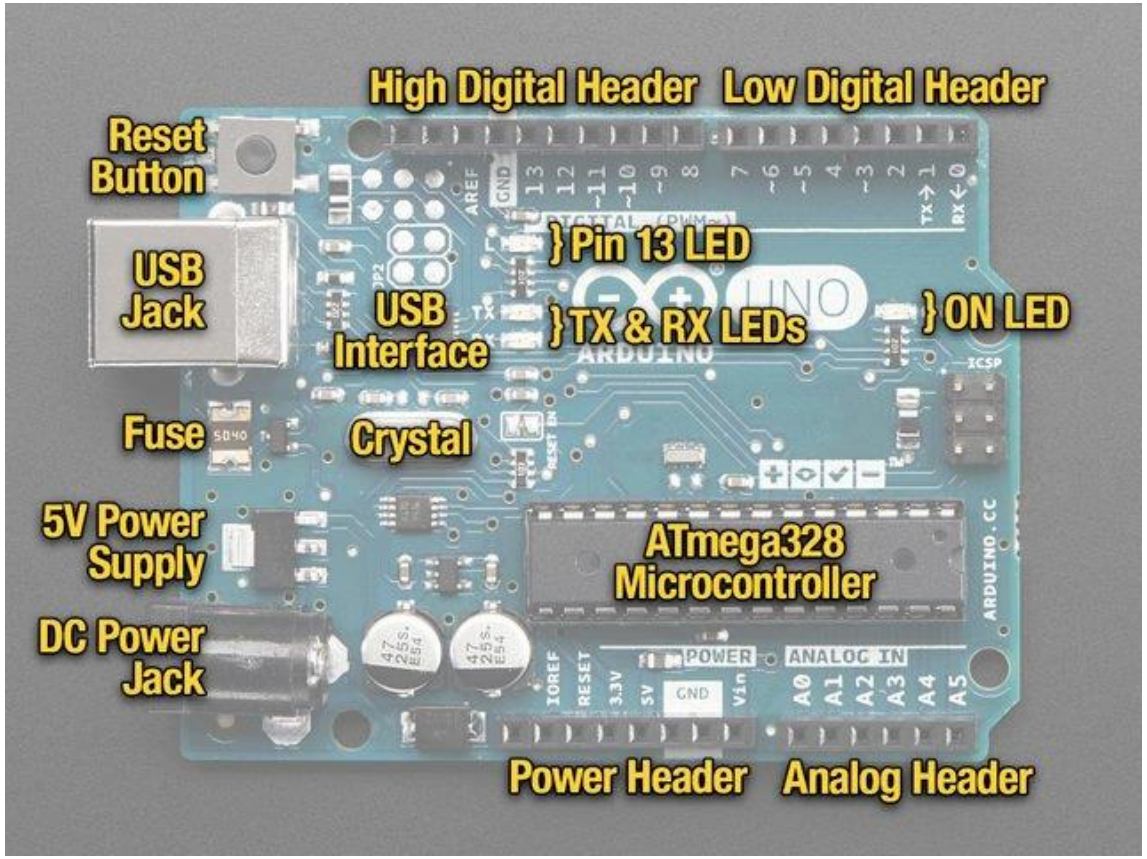
What's on these boards



Microcontroller – Atmel (Now Microchip)
- ATMega328 or similar

USB Interface

Crystal (clock oscillator, 16 MHz)

5v power regulator

Reset button

DC power jack

Connector for both Digital I/O and analog inputs. A/D converter

There are no true analog outputs. No D/A converter.

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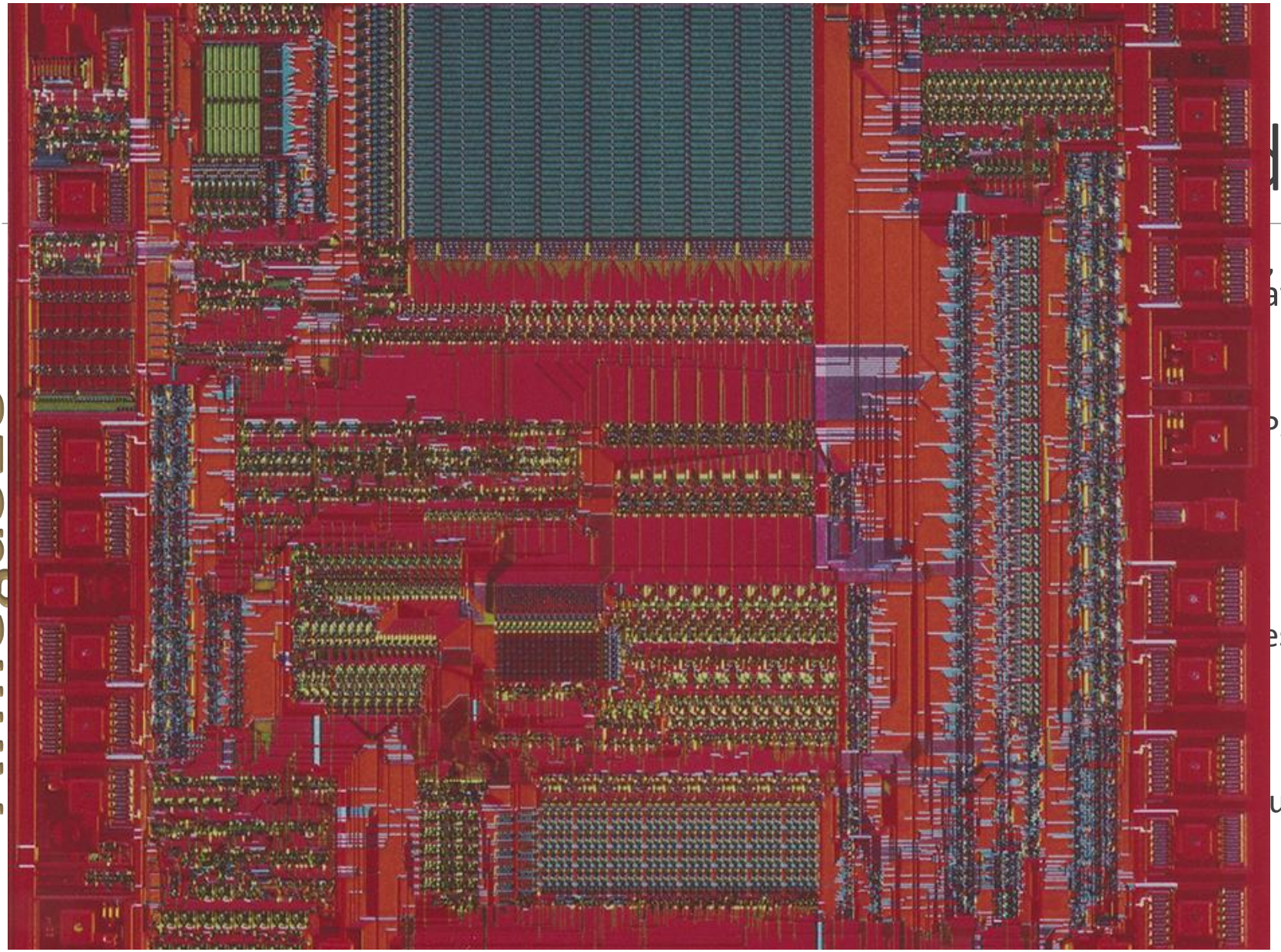

ATmega328

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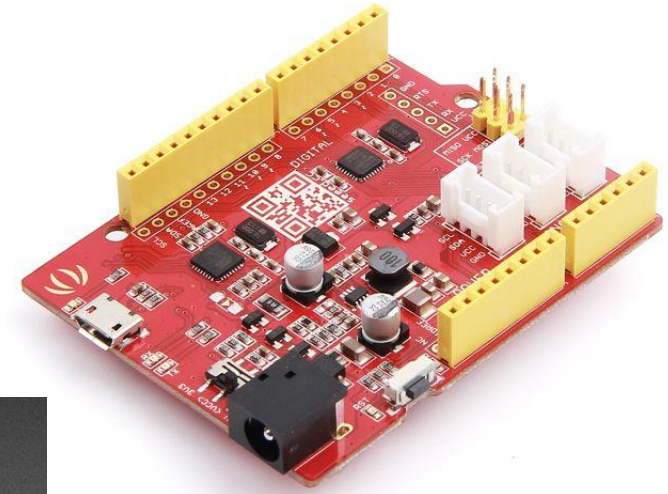
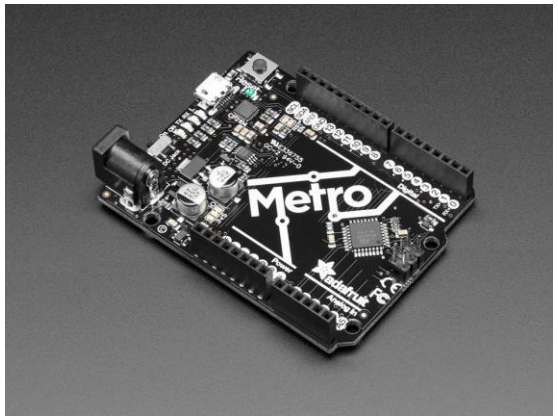
Sources for boards

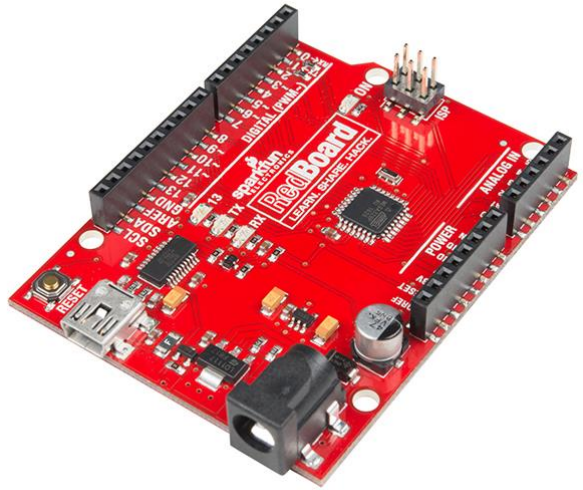
Original source is Arduino.cc/usa $22.00

Open sourced so many other great places:

- Adafruit.com
- Sparkfun.com
- Sainsmart.com
- SlicMicro.com
- SeeedStudio.com
- Lots! Of Chinese knockoffs for cheap
  - Be careful. Not all of these are compatible
- HamRadioWorkbench.com (mid year)







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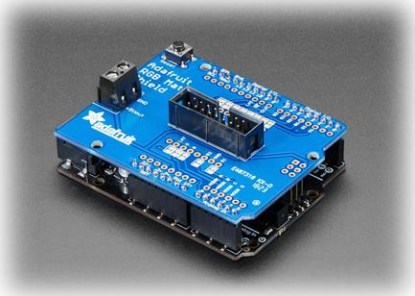
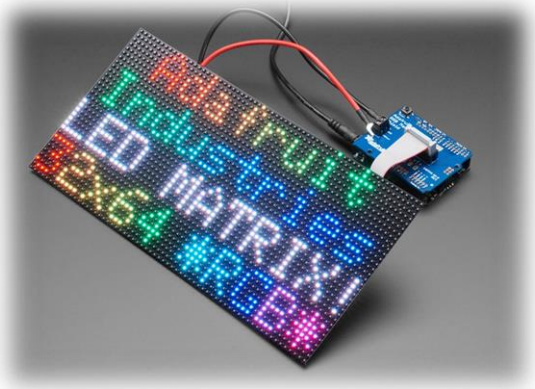
Accessorizing with Shields

Arduinos can have Shields (think daughter boards)





Bluetooth or other wireless like XBee

Motor control

Relay controls

Sound and audio

Displays

GPS and even GSM cellular

Power module w/ battery

Invent your own shield with proto boards

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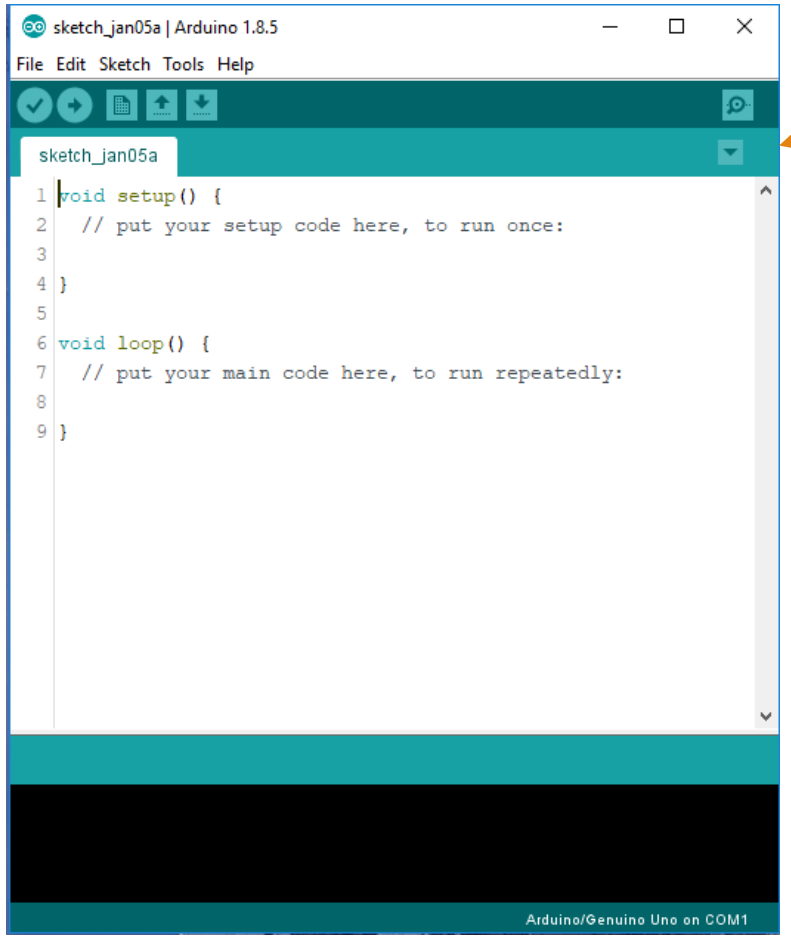
How do we program it?



Programing uses an IDE or Integrated Development Environment

Programs are entered into the IDE using a form of ‘C’ programming.

A Compiler takes the programming code, checks it for syntax errors and creates on upload file

The upload file is a binary file (1’s and 0’s) that is ‘uploaded’ to the Arduino board via a serial USB port.

The program will immediately start to run.

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Disclaimer

This presentation is not meant to be an Arduino Tutorial, but really just an introduction to one possible platform for building projects.

I will show a demo of Arduino because it is easiest to understand.

The club members have a lot of expertise with this platform.

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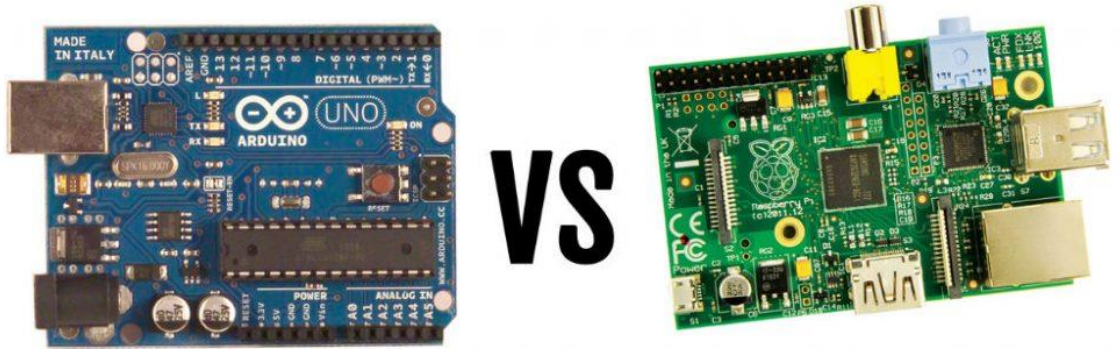
Other Possible Platforms

	Arduino Uno	Raspberry Pi Model B
Price	~~$30~~ $2-$14	$35
Size	7.6 x 1.9 x 6.4 cm	8.6cm x 5.4cm x 1.7cm
Memory	0.002MB	512MB
Clock Speed	16 MHz	700 MHz
On Board Network	None	10/100 wired Ethernet RJ45
Multitasking	No	Yes
Input voltage	7 to 12 V	5 V
Flash	32KB	SD Card (2 to 16G)
USB	One, input only	Two, peripherals OK
Operating System	None	Linux distributions
Integrated Development Environment	Arduino	Scratch, IDLE, anything with Linux support



We use different platforms for different reasons.
Consider what things you need to do and then decide
Simple control applications = Arduino or PIC
Larger software requirements and memory = RaspberryPi

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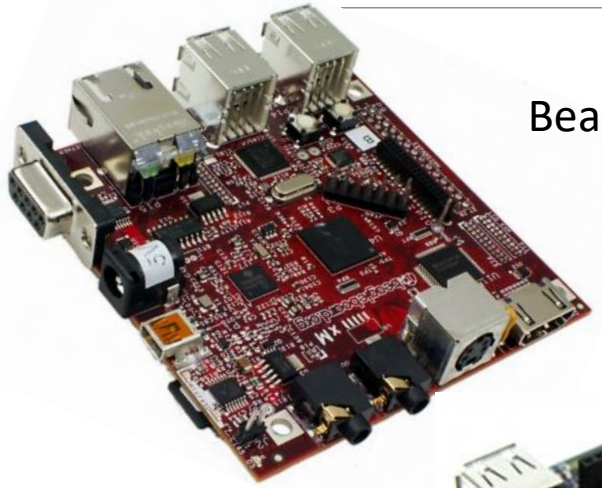
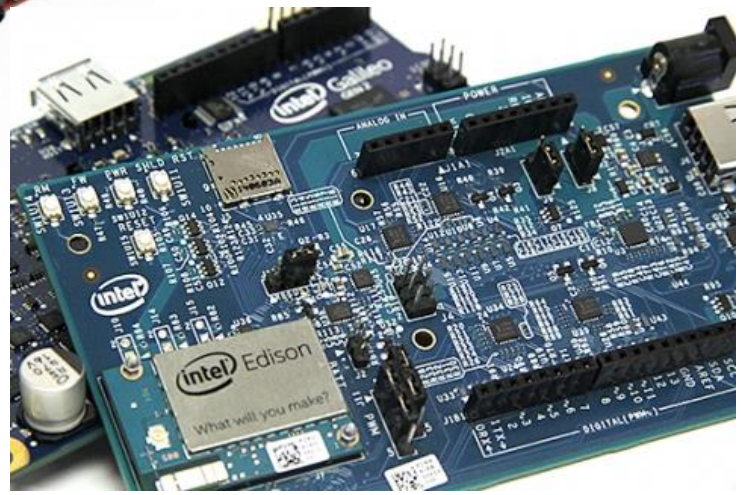
More platforms



BeagleBone

Intel
Edison and Galileo



Many of the other platforms require deeper knowledge of embedded systems and software development environments.

These are LINUX OS based and typically cost a bit more. ($50)

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Ham Radio Projects

There are 100's if not 1000's of projects

QST magazine – About 6-8 projects per year use a Microcontroller.

- August 2018 Antenna analyzer project
- October 2018 Station Switching Unit
- Nov 2018 issue Dummy Load and Watt Meter
- You get the picture….

Books with lots of projects

- Arduino Projects by Glen Popiel KW5GP
- I have the book here if you want to look at it.

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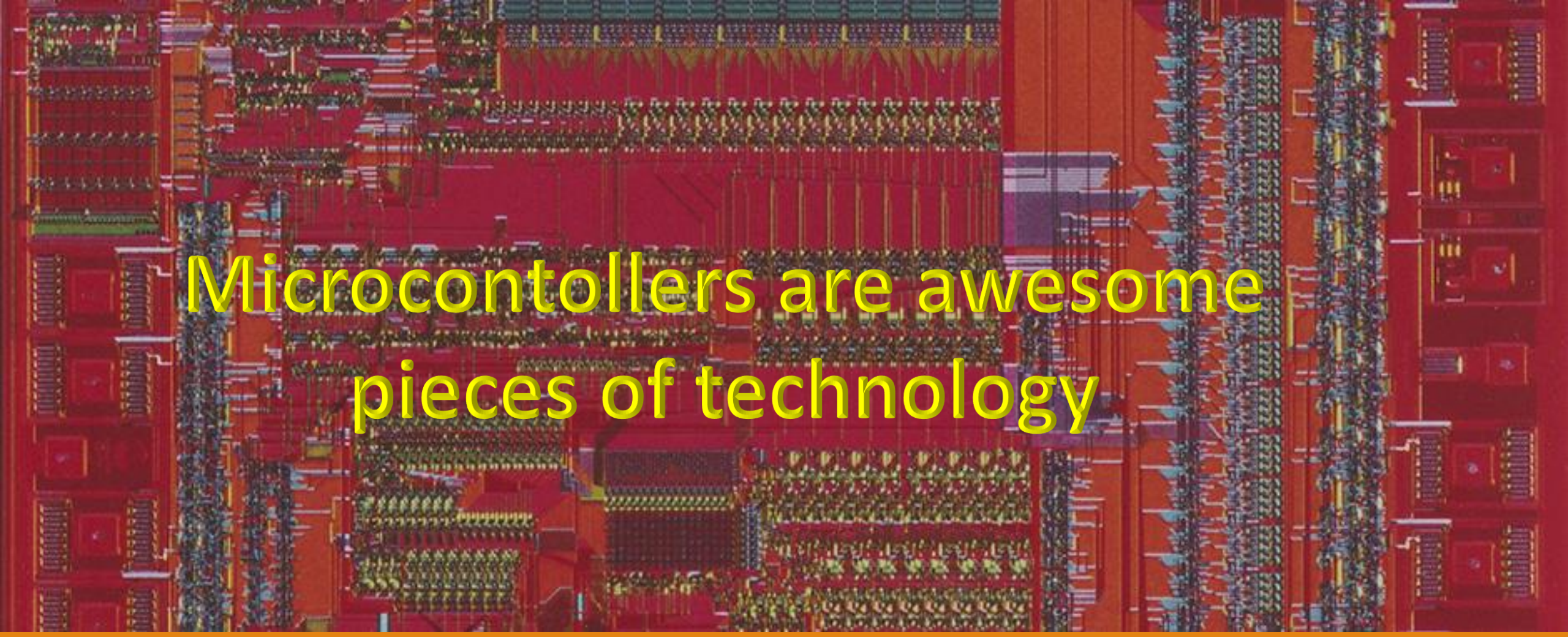

Questions

Arduino Live Demo

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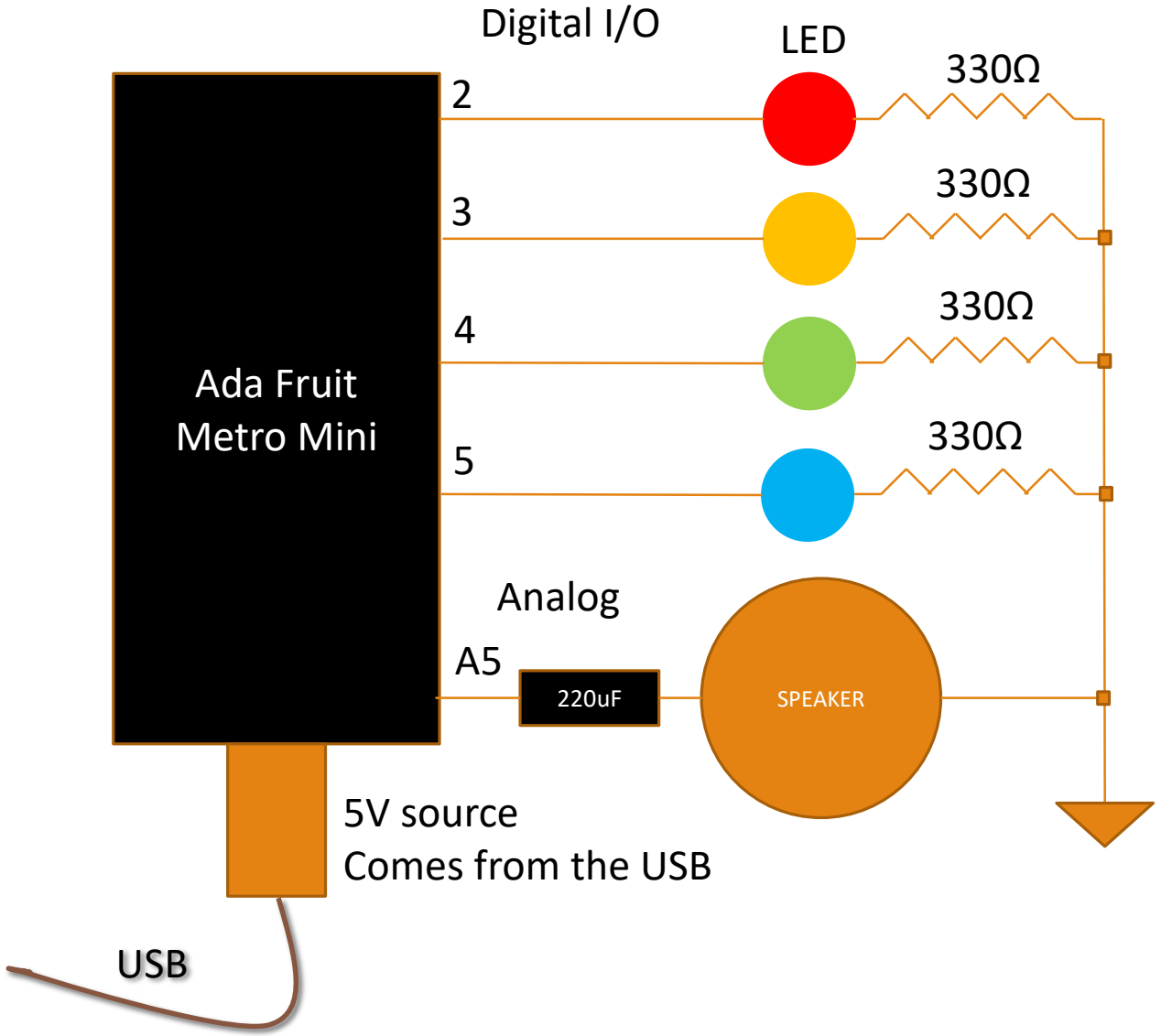

Simple design using 4 digital pins
Digital pins are programmed to be an OUTPUT Pin
Each LED has it's own current limiting resistor.
I = E/R 5V/330 Ω = 0.02A or 20 mA

We have individual control to each LED through software.

Speaker can also add sound using a PWM output signal

We can create the behavior we want with some simple instructions

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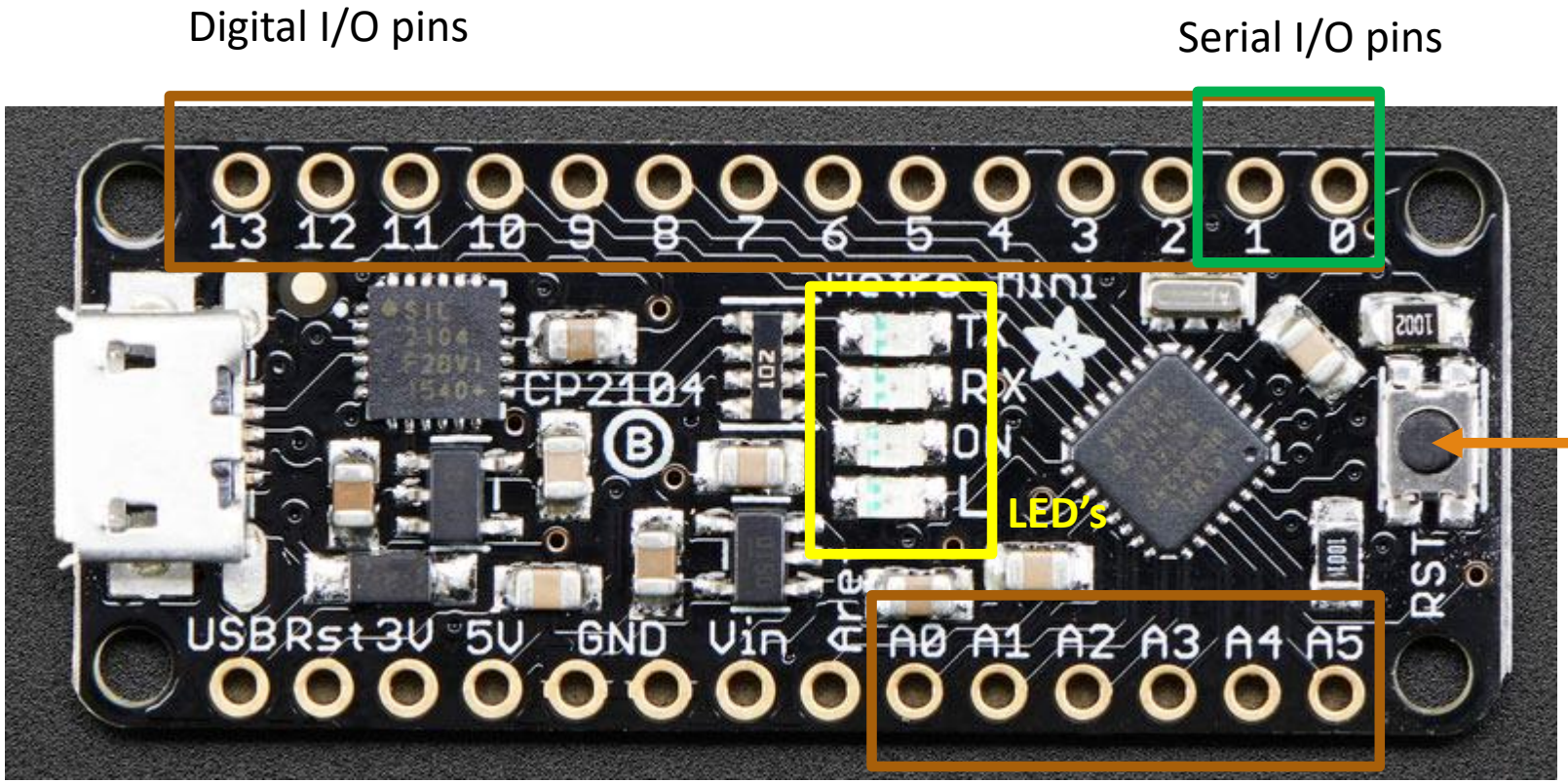
Ada Fruit Metro Mini Arduino Pin Assignments



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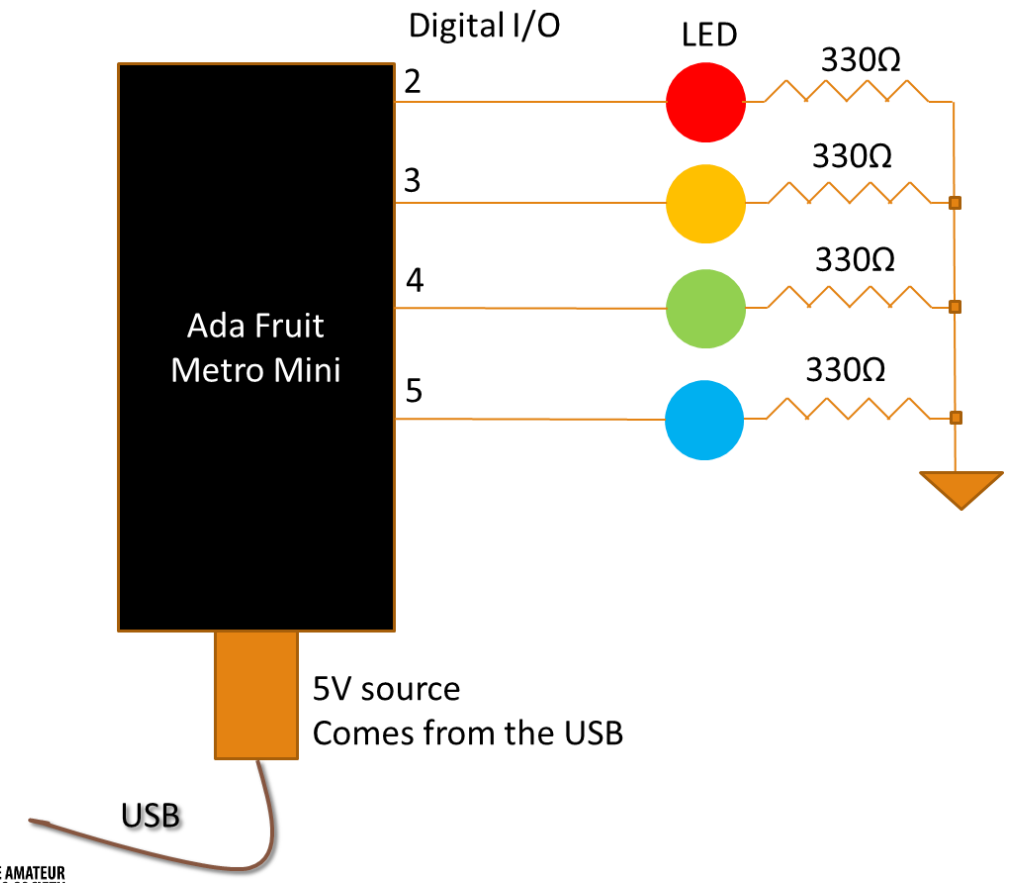
Controlling the pins



1. Tell the software what pins are being used and what purpose
2. Tell the software if they are inputs or outputs (both are possible, default is INPUT)
3. Decide what “behavior” we want on these pins
4. Write the code and check it for errors
5. Upload the compiled code to the Metro Mini and test our results.

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Program structure

Two main parts to an Arduino program setup() and loop()

```
void setup()
```

Setup is run once and only once at startup.

```
void loop()
```

Loop is what is sounds like. It will loop forever through your code.

Note: The word void here is part of the 'C' language and means that there is no value returned to anything calling this function. It is required here, but not really meaningful. The parentheses () are similar in that they are for passing in information to a function. For our purposes they are also not used, but required.

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A bit more detail

We tell the pins what they are with a command called pinMode

- pinMode(pin,mode); // pin is the digital pin number, mode is direction INPUT or OUTPUT
- Example:
- pinMode(2,OUTPUT);

- Since these need only be run once, they are always put in the setup() function.
- Example
  - `void setup() {`
  - `  pinMode(2,OUTPUT);`
  - `  pinMode(3,OUTPUT);`
  - `}`

The open and close braces tell the software the boundary of the function or other instructions

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Control the pin

We use special commands to control the pin.

digitalWrite(pin, value) to write values to a OUTPUT pin

digitalRead(pin) to read a value from an INPUT pin

Example

```
void loop() {
  digitalWrite(2,HIGH); // sets the output pin high (1) logic 1 is 5 Volts
  digitalWrite(2,LOW);  //set the output pin low (0) logic 0 is 0 Volts
}
```

Live Demo

Lab time after lunch will allow interested people to EXPERIMENT a bit wit the platform and know how to set up their own

Objectives:

1. First make the RED LED blink on and off at a 1 second rate.
2. Next add an additional color to the blinking.
3. Blink 1 LED at a time at a constant rate.
4. Blink 1 LED at a time in a constantly increasing rate
5. For special effects we can add sound as well using a speaker and tone output.