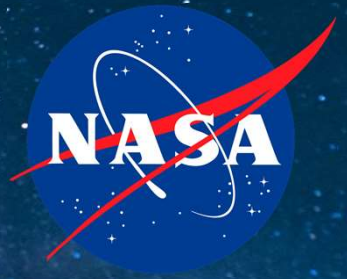
# *HiBall Balloon Payload Workshop*

Arduino Introduction






Partner

# Arduino Driving Lessons

A. Arduino IDE
B. Arduino Overview
C. Arduino Communication
D. Blink an Led, Change the World

# *Download Arduino IDE:*

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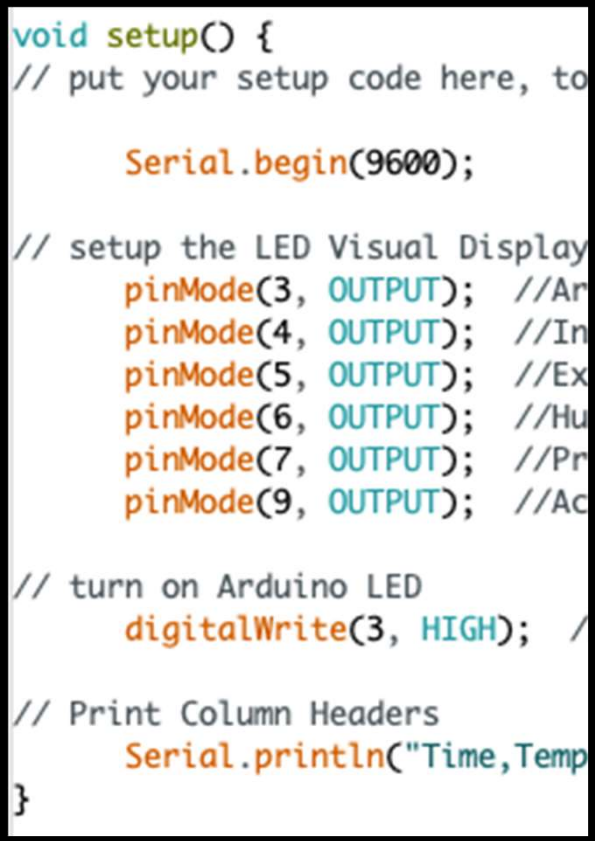
- **What's an IDE?**

- Integrated Development Environment
  - Word processor for source code
  - All development tools in one place
    - Syntax Highlighting
    - Autocomplete
    - Analyzers
    - Debugging
  - Reconfigurable to each developers style



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

      Serial.begin(9600);

// setup the LED Visual Display
      pinMode(3, OUTPUT);  //Ar
      pinMode(4, OUTPUT);  //In
      pinMode(5, OUTPUT);  //Ex
      pinMode(6, OUTPUT);  //Hu
      pinMode(7, OUTPUT);  //Pr
      pinMode(9, OUTPUT);  //Ac

// turn on Arduino LED
      digitalWrite(3, HIGH);  /

// Print Column Headers
      Serial.println("Time,Temp
}
```

# *Download Arduino IDE:*

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

      Serial.begin(9600);

// setup the LED Visual Display
      pinMode(3, OUTPUT);  //Arduino on
      pinMode(4, OUTPUT);  //Internal Temp
      pinMode(5, OUTPUT);  //External Temp
      pinMode(6, OUTPUT);  //Humidity
      pinMode(7, OUTPUT);  //Pressure
      pinMode(9, OUTPUT);  //Accels

// turn on Arduino LED
      digitalWrite(3, HIGH);  // Leave on while

// Print Column Headers
      Serial.println("Time,Temp1F,Temp2F,RH,Pres
}
```

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

      Serial.begin(9600);

// setup the LED Visual Display
      pinMode(3, OUTPUT);  //Arduino on
      pinMode(4, OUTPUT);  //Internal Temp
      pinMode(5, OUTPUT);  //External Temp
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      pinMode(7, OUTPUT);  //Pressure
      pinMode(9, OUTPUT);  //Accels

// turn on Arduino LED
      digitalWrite(3, HIGH);  // Leave on whi

// Print Column Headers
      Serial.println("Time,Temp1F,Temp2F,RH,P
}
```

# *Download Arduino IDE:*

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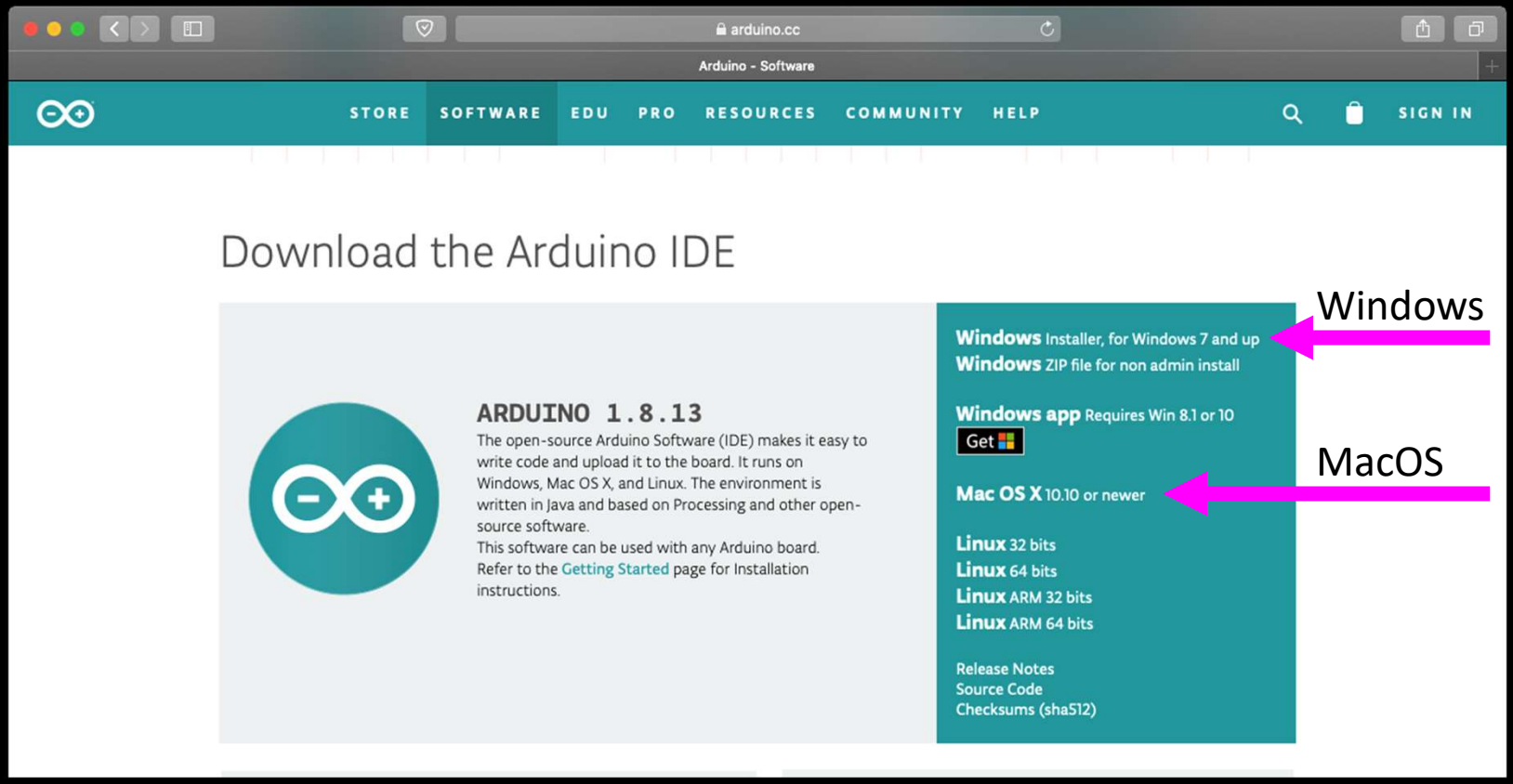
https://www.arduino.cc/en/Main/Software



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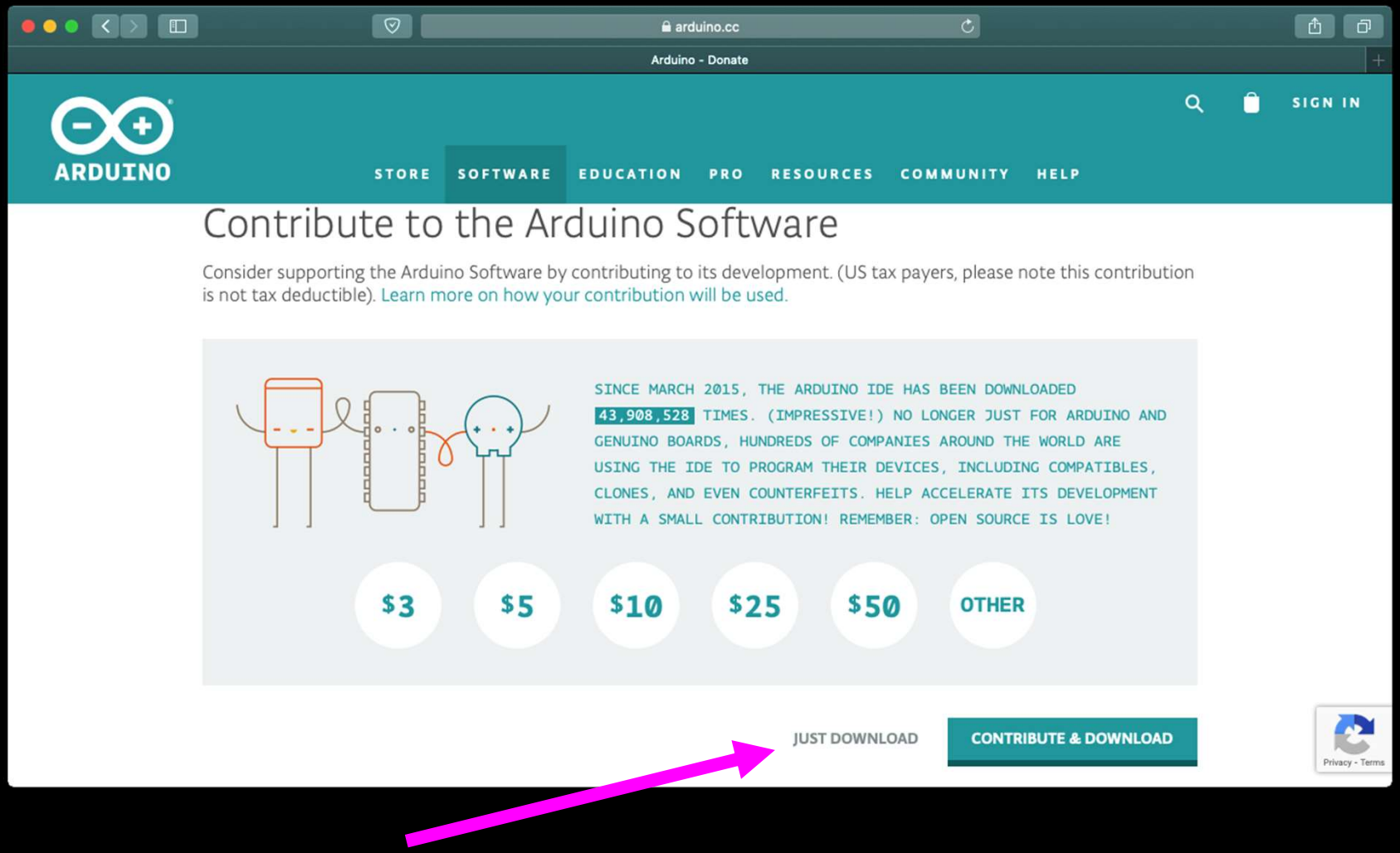

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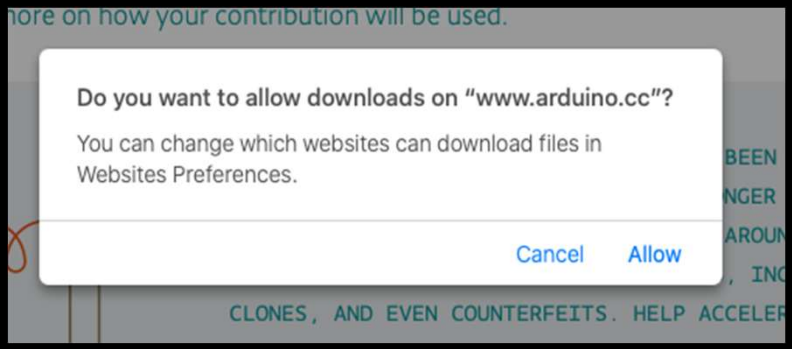
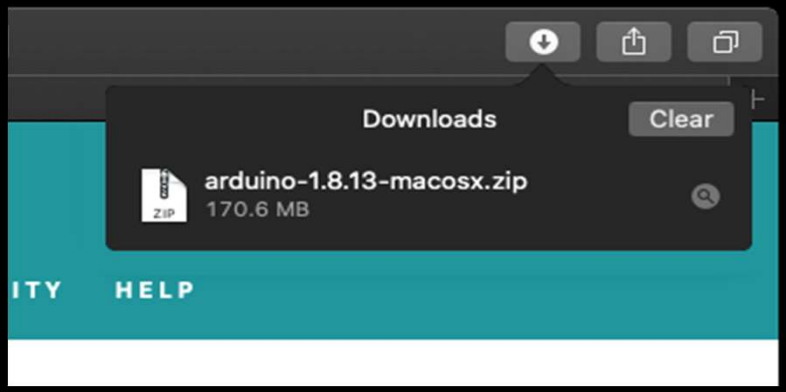
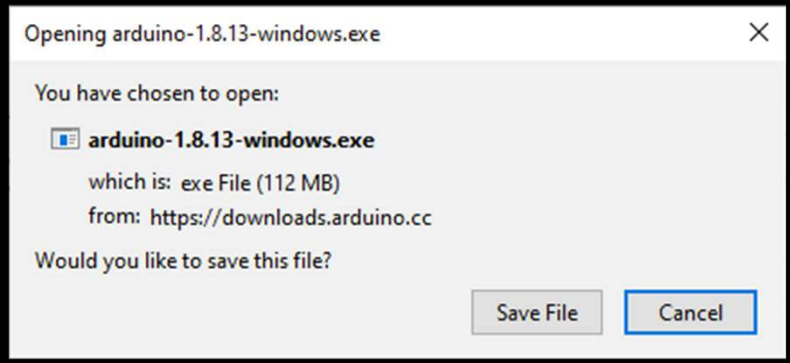
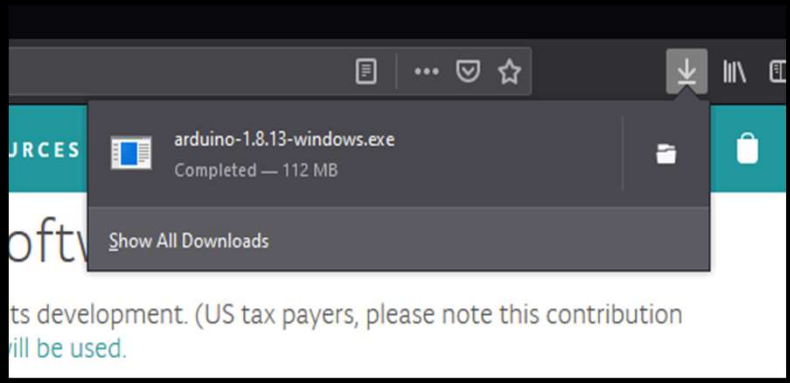
## MacOS




## Windows



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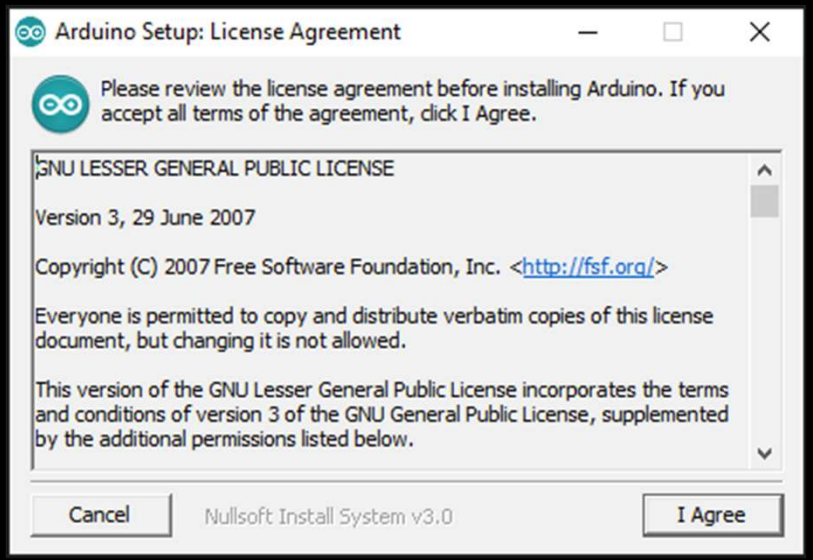
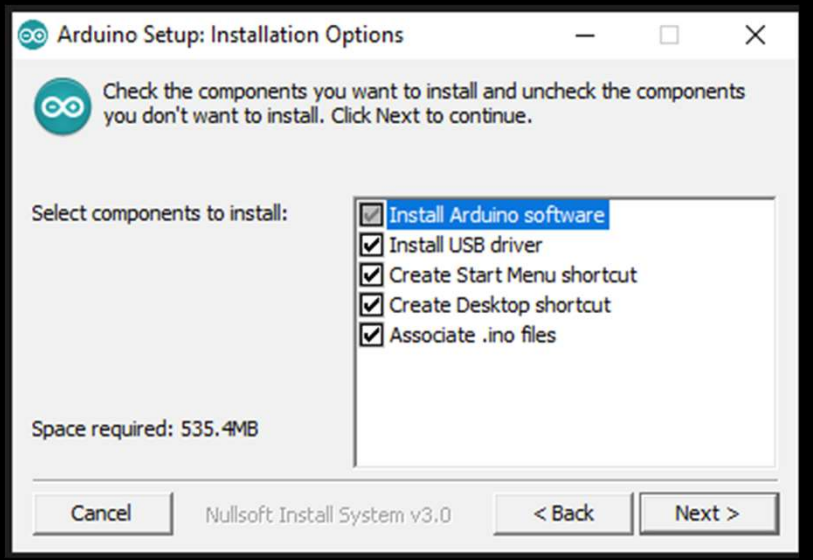
## Windows Installation



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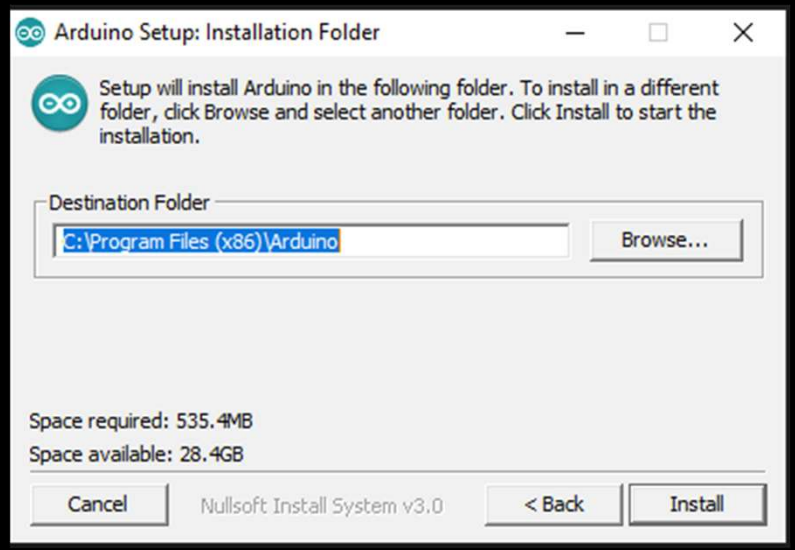
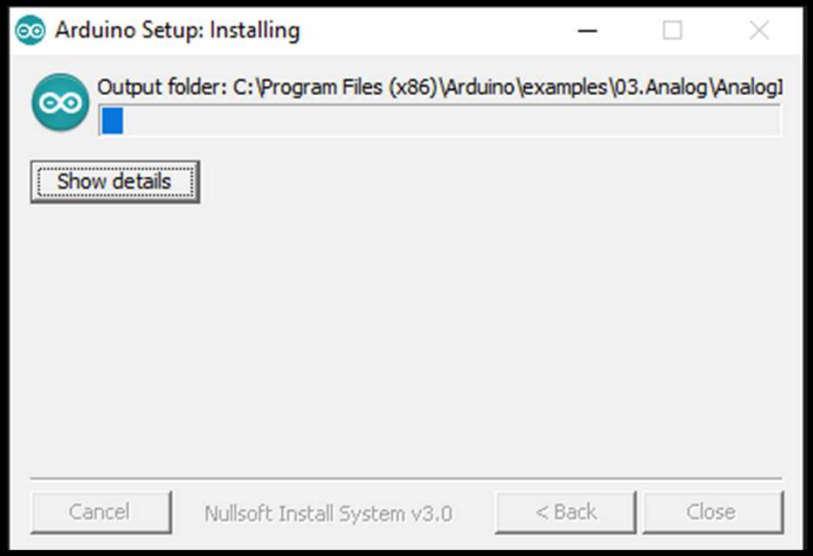
## Windows Installation *(Cont.)*



# *Download Arduino IDE:*

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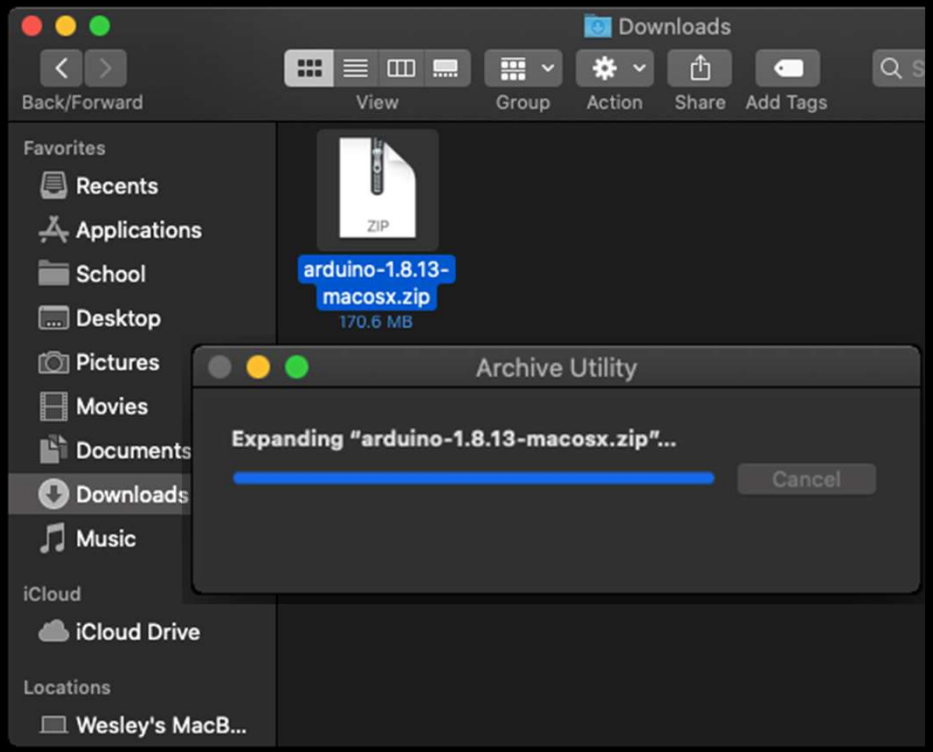
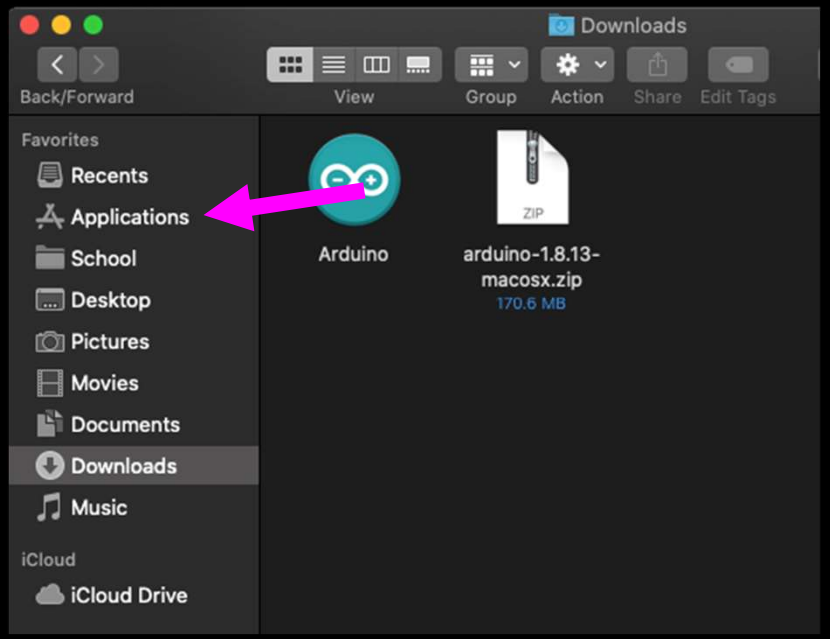
## Mac Installation



# *Download Arduino IDE:*

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# Arduino Driving Lessons

A. Download Arduino IDE
B. Arduino Overview
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# *Arduino Overview:*

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- **General Purpose computer**
  - Usually has a human in the loop
  - Can be reconfigured to do any number of tasks (excel, email, music)

- **Embedded Systems**
- Human input not required all the time
  - Takes specific inputs and computes outputs for a very specific application
  - Meets real-time goals
    - Heart monitor
    - Automatic braking systems (ABS)

# *Arduino Overview:*

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- **Arduino is an embedded system**
- **Board supports an open source environment, lots of assistance available online**
- **Extremely modular**
- **Types of Arduinos: Uno, Due, Mega…**
- **Each version has different capabilities**
- **Lots of analog and digital I/O**

# *Arduino Overview:*

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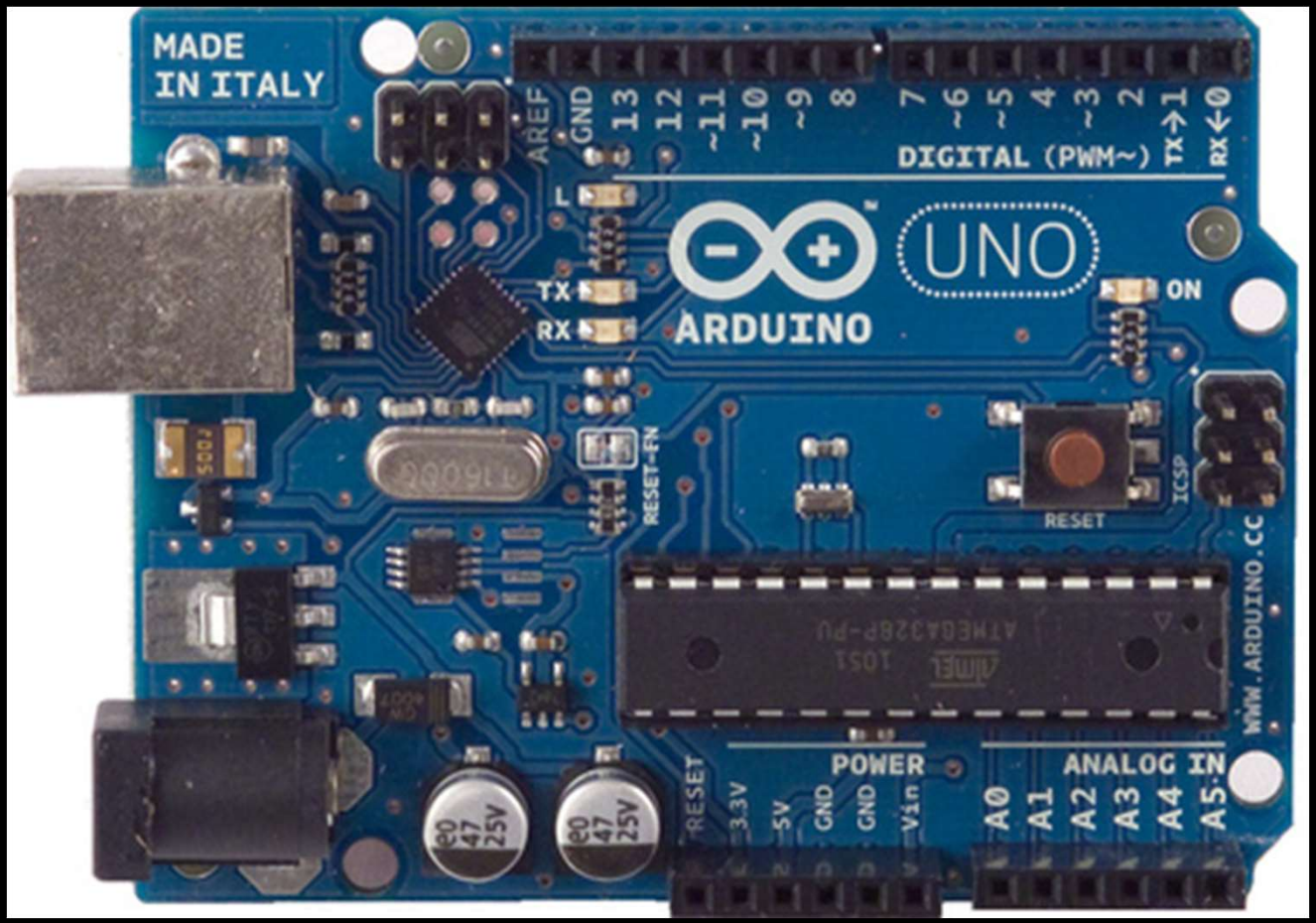
## Arduino Uno Rev 3



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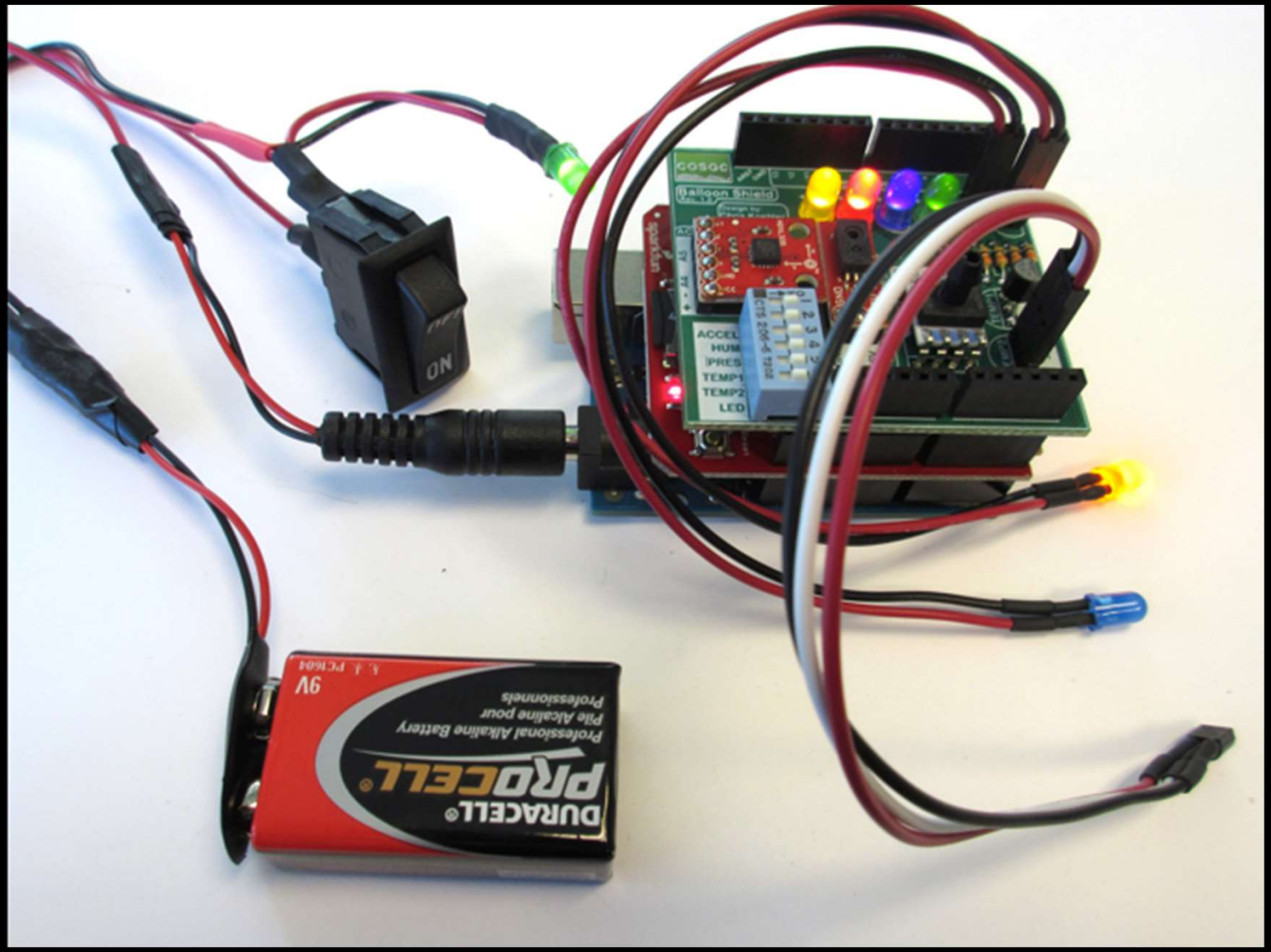

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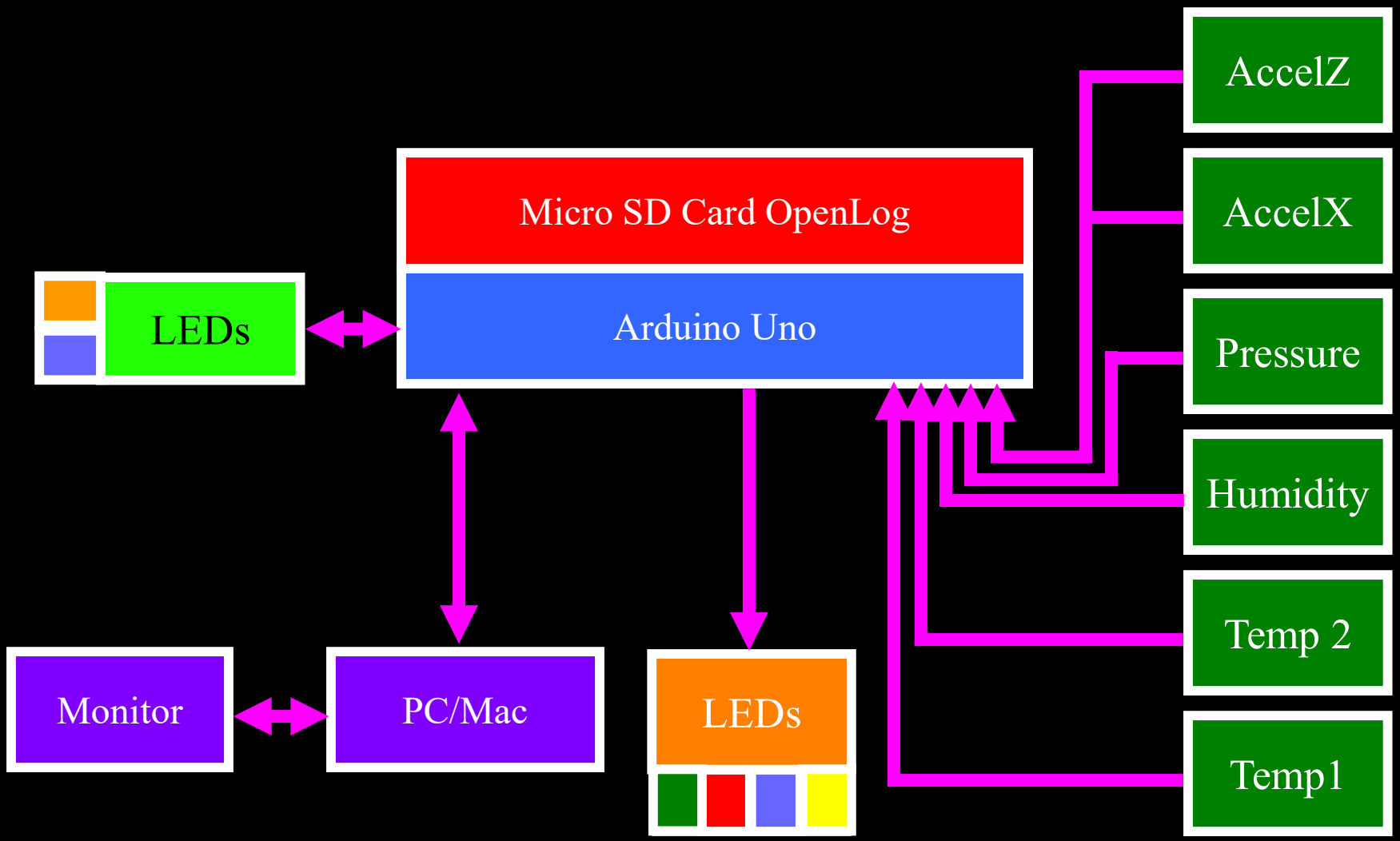

# *Arduino Overview:*

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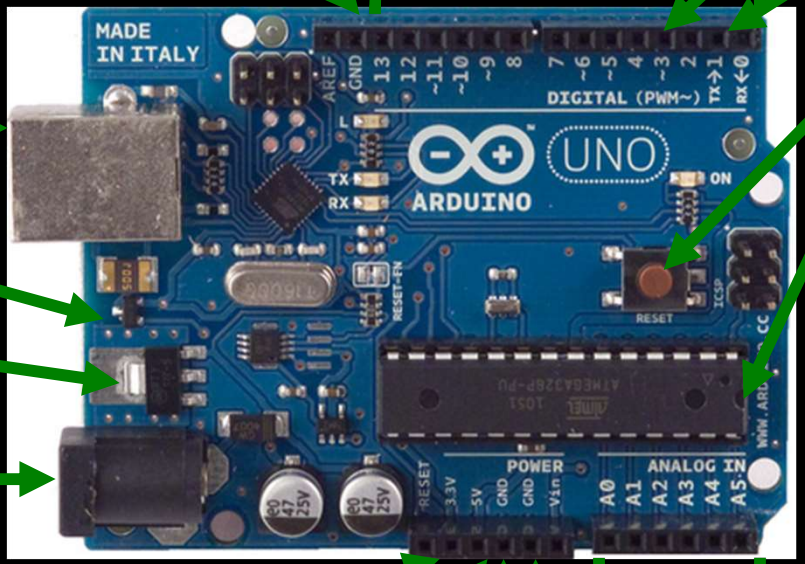
## What's under the hood?




External Interrupts

14 Digital Input/Outputs

GND

Serial I/O

Reset

USB

3.3 V Regulator

5.0 V Regulator

9V DC Power In

ATmega328
- 10 Bit ADC
- 16 MHz
- 32 KB Flash
- I2C, Serial & SPI
- 40 to +85C

3.3 V

5.0 V

GND

6 Analog Inputs

# *Arduino Overview:*

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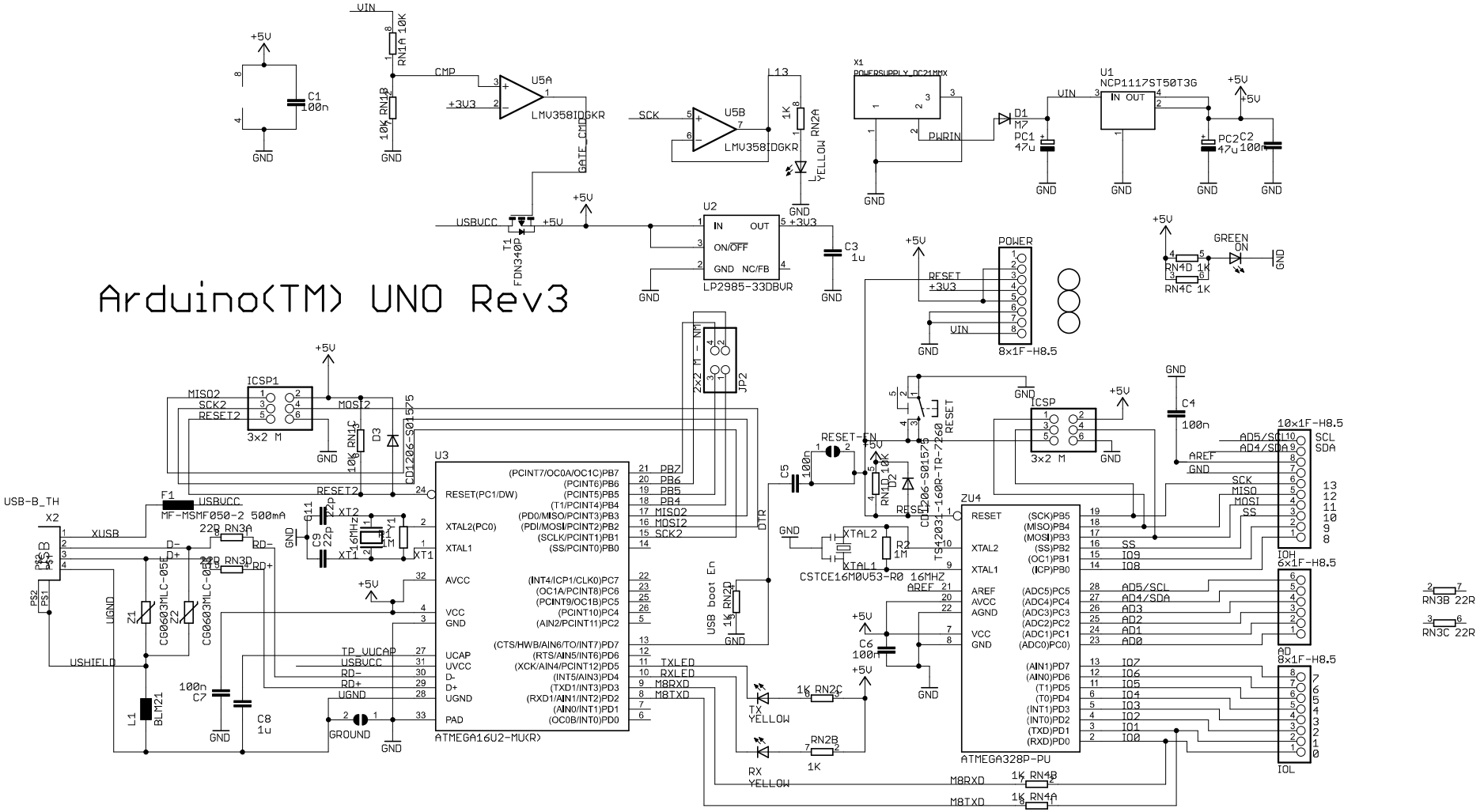

# *Arduino Overview:*

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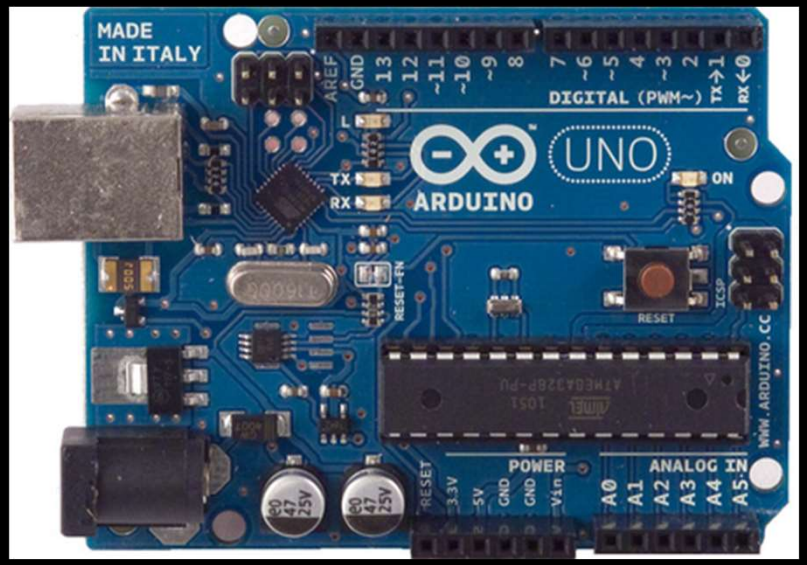
- **So what does all that mean?**



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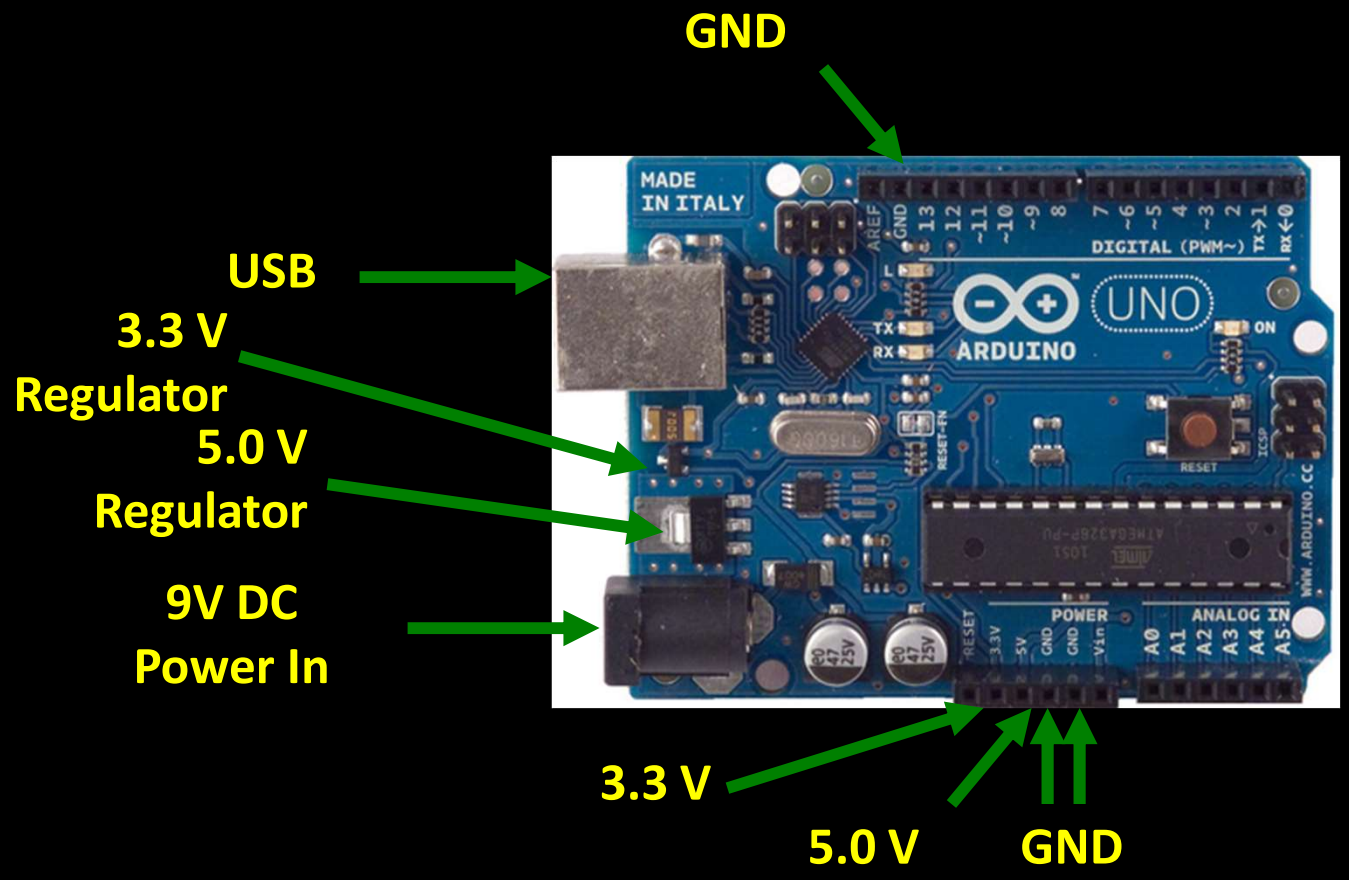
## The Easy Stuff…



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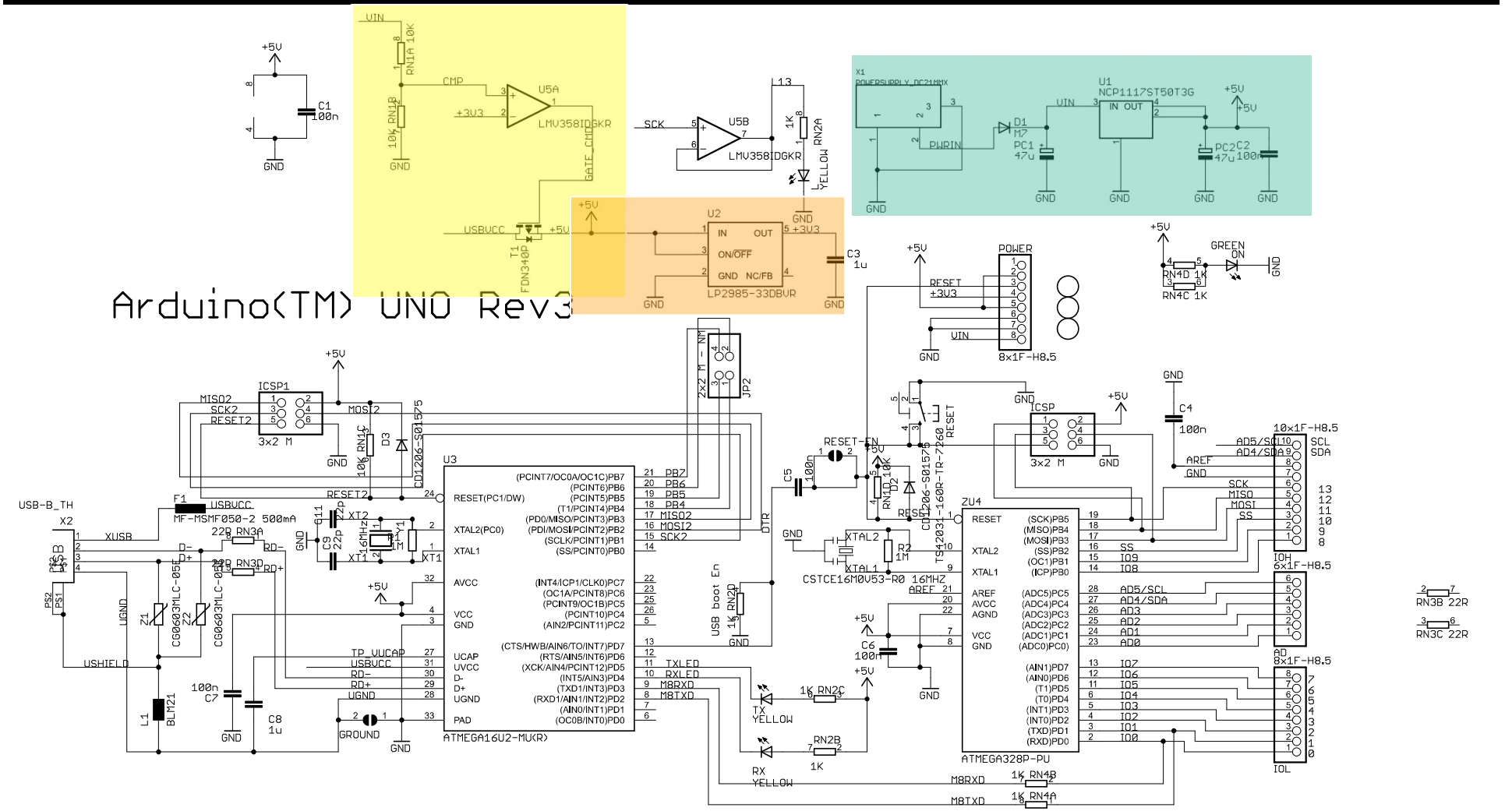

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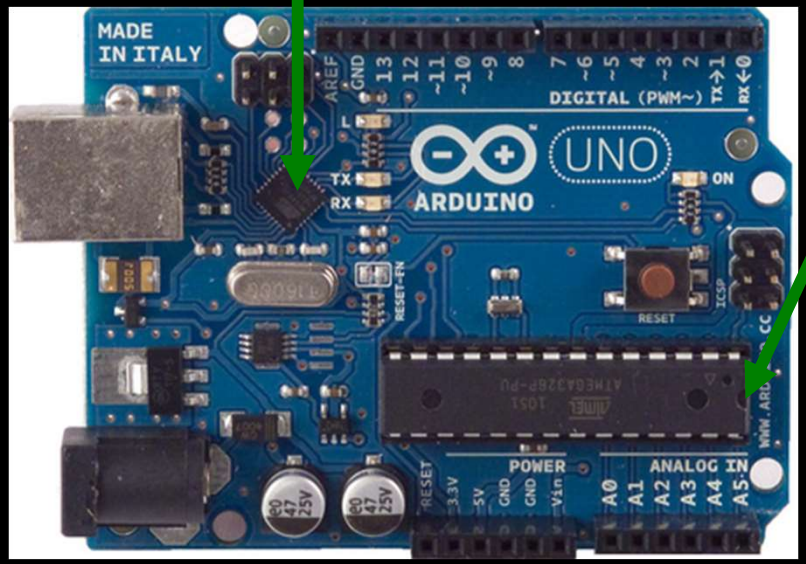
## The Chips…

**ATmega16U**
- **Handles the USB interface to the computer**
- **We don't program this one**




**ATmega328**
- **10 Bit ADC**
- **16 MHz**
- **32 KB Flash**
- **I2C & SPI**
- **40 to +85C**

# *Arduino Overview:*

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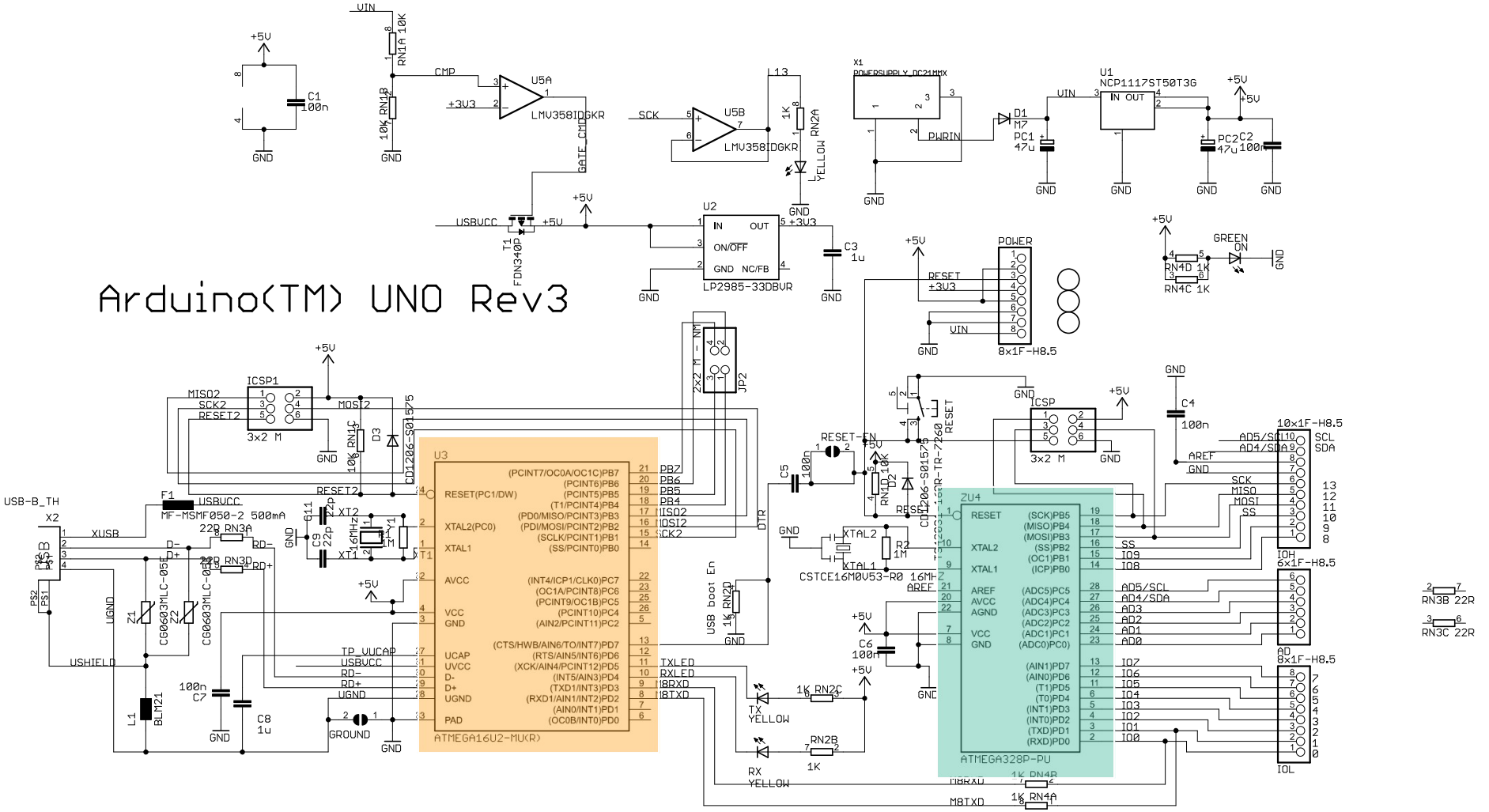

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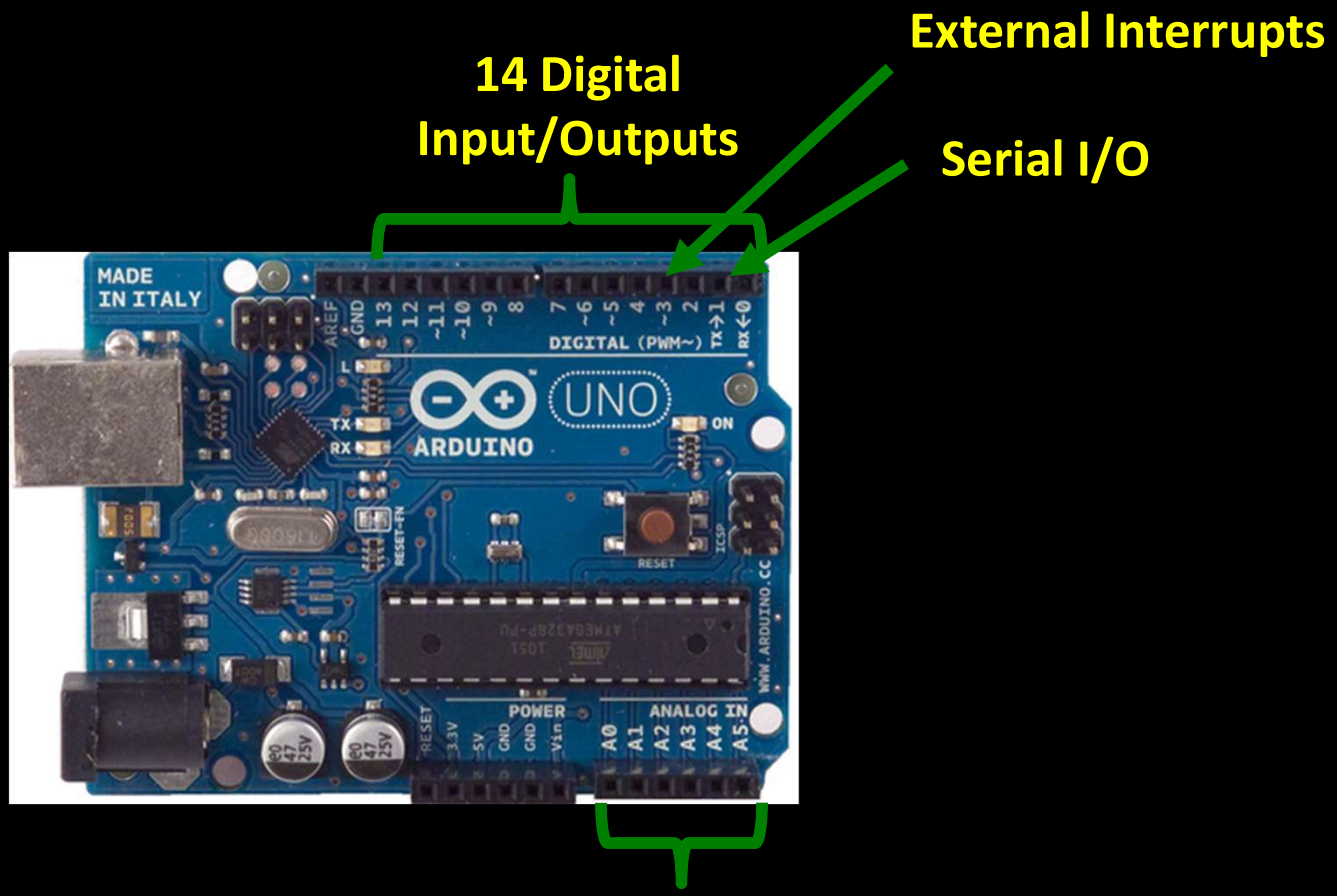
## Other…



# *Arduino Overview:*

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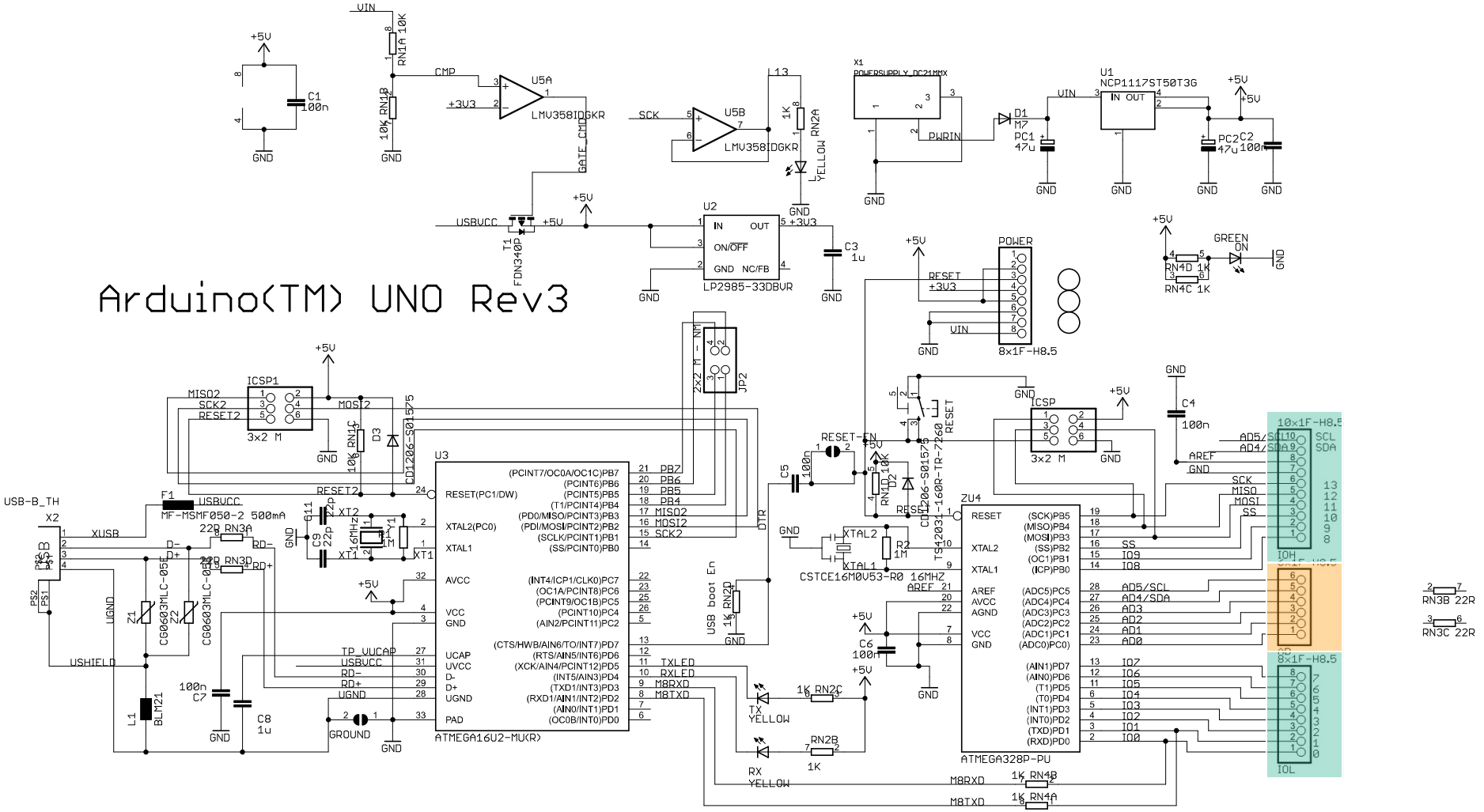

# *Arduino Overview:*

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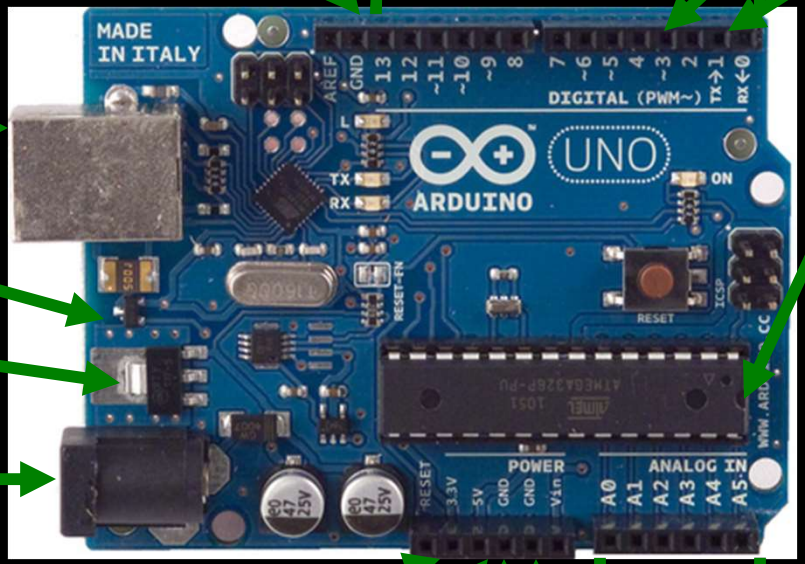


GND

14 Digital Input/Outputs

External Interrupts

Serial I/O

USB

3.3 V Regulator

5 V Regulator

9V DC Power In

ATmega328
- 10 Bit ADC
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3.3 V

5.0 V

GND

6 Analog Inputs

# *Arduino Overview:*

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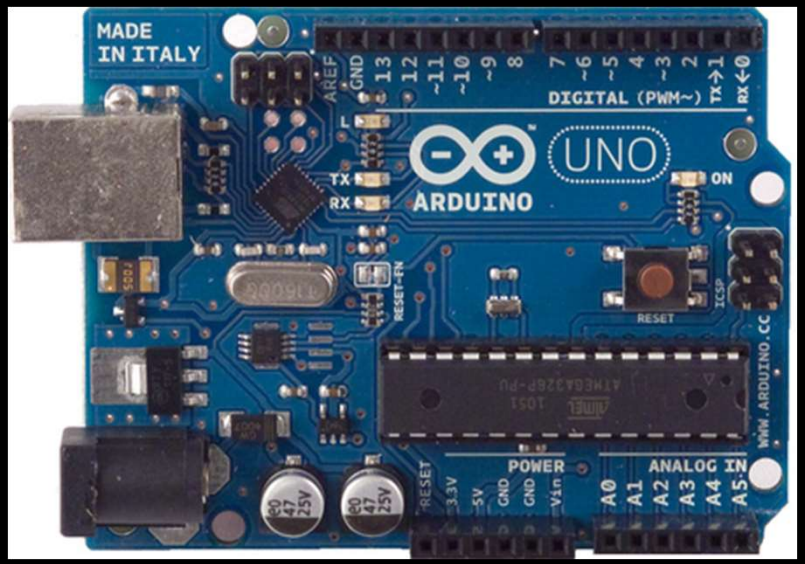
- **Let's take it for a drive…**



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Arduino Uno

# *Arduino Overview:*

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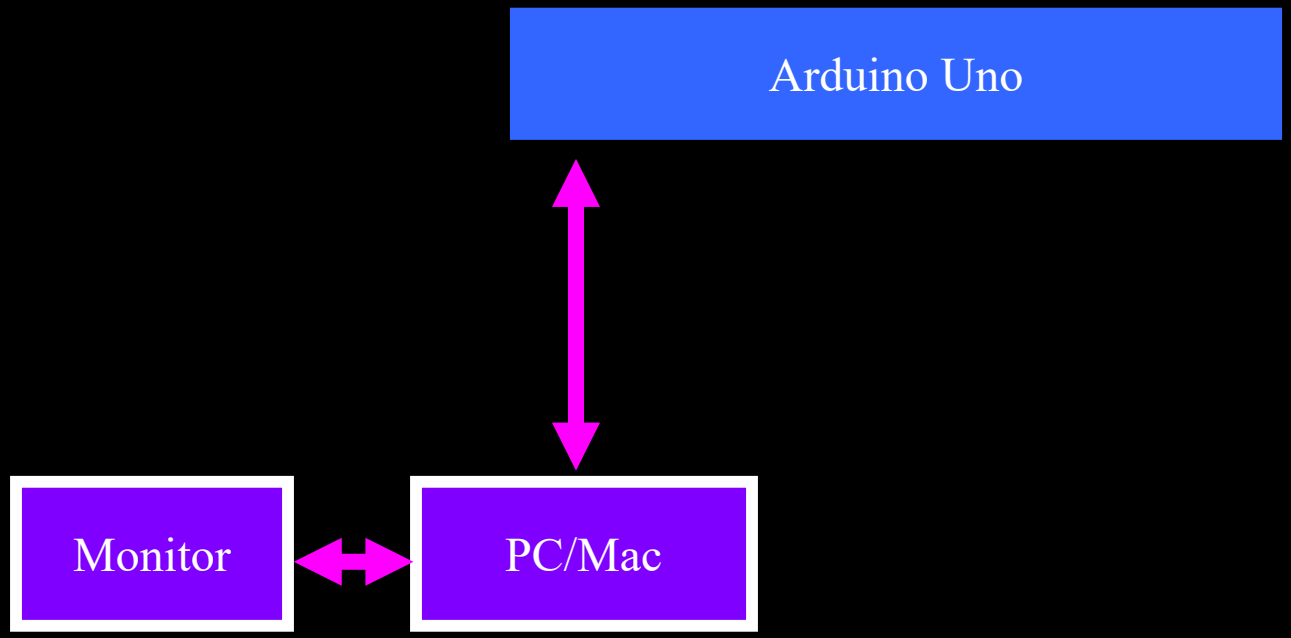

# *Arduino Overview:*

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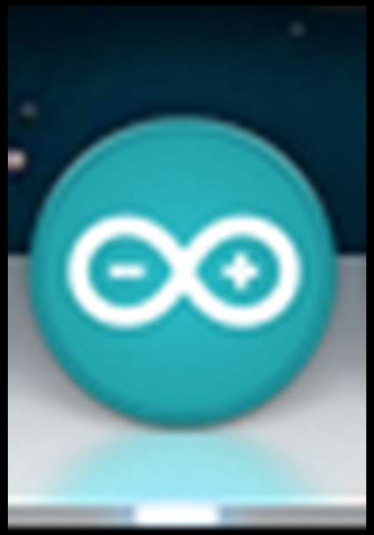
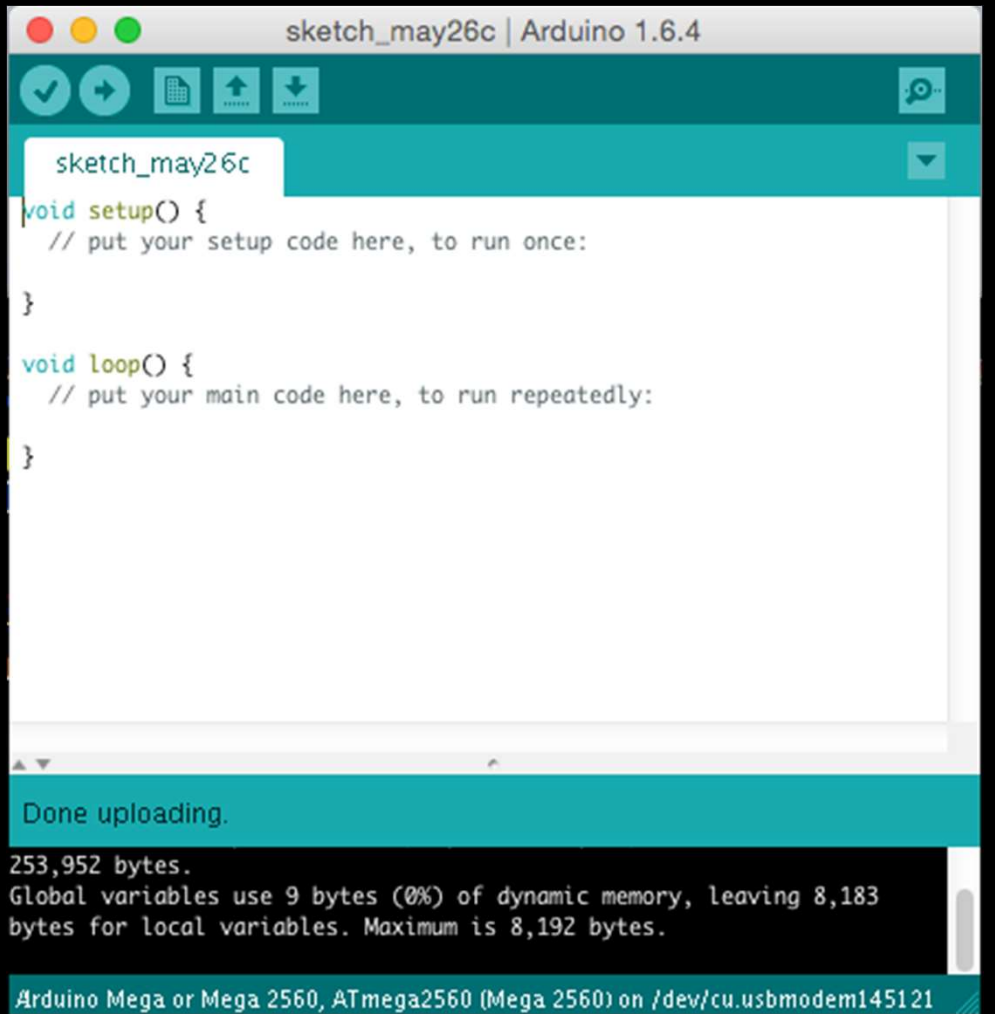
- **Launch the Arduino Software**
- **A new Sketch opens**





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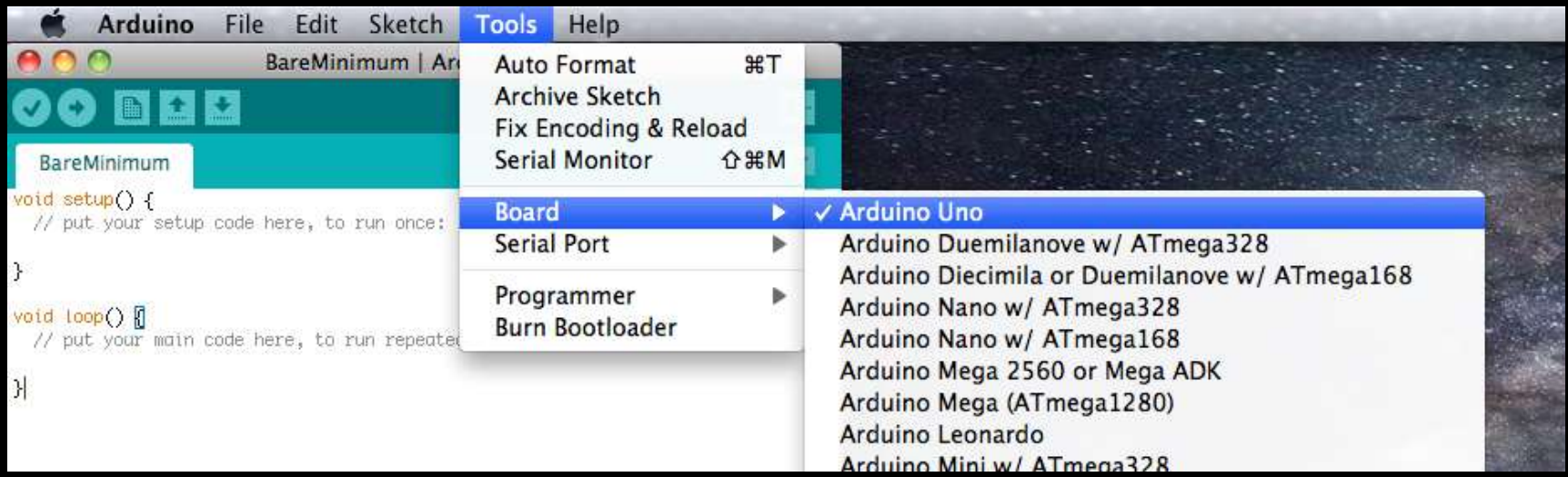
**Select the right board =**

**Tools > Board > Arduino Uno**



# *Arduino Overview:*

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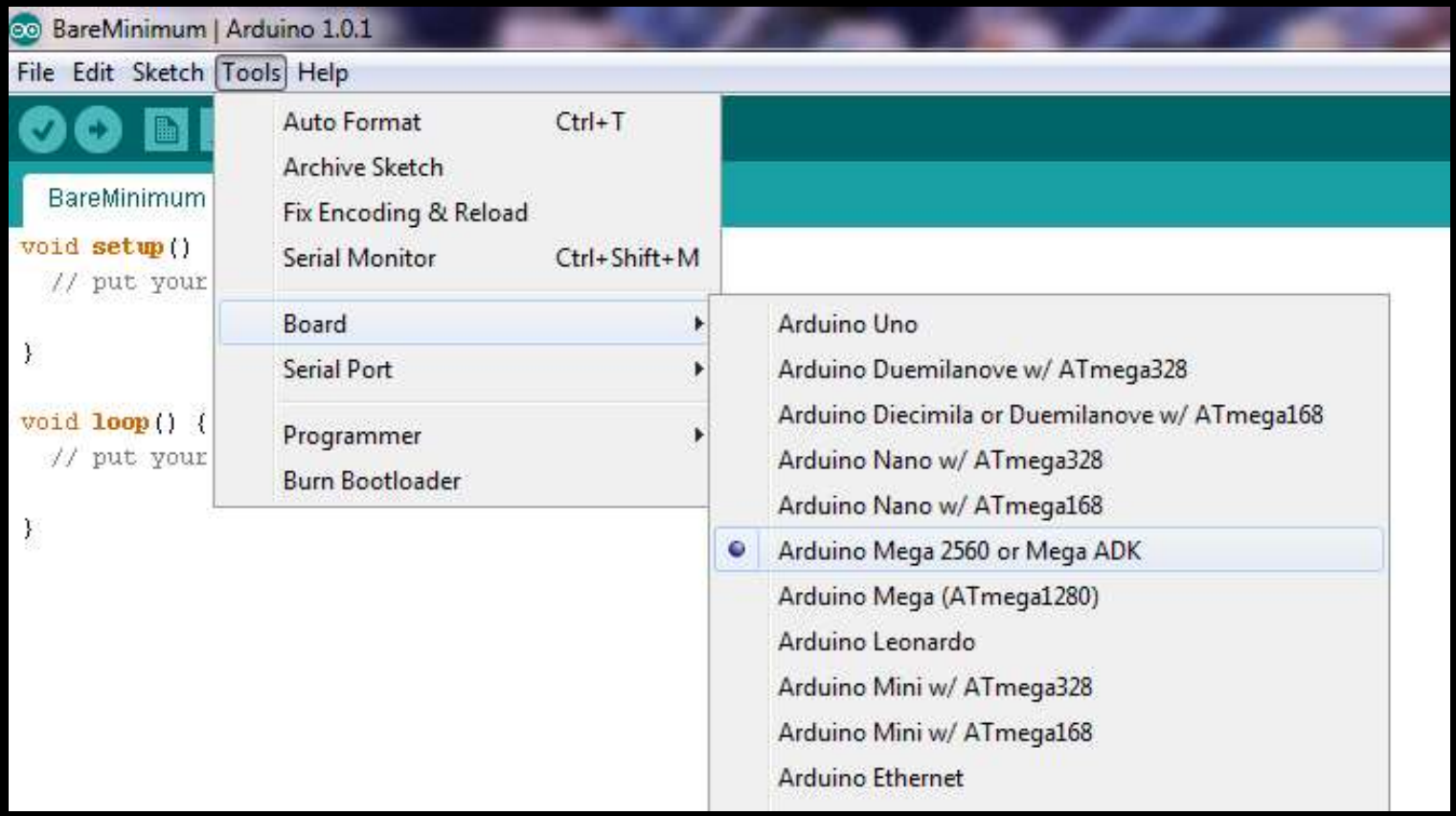

# *Arduino Overview*

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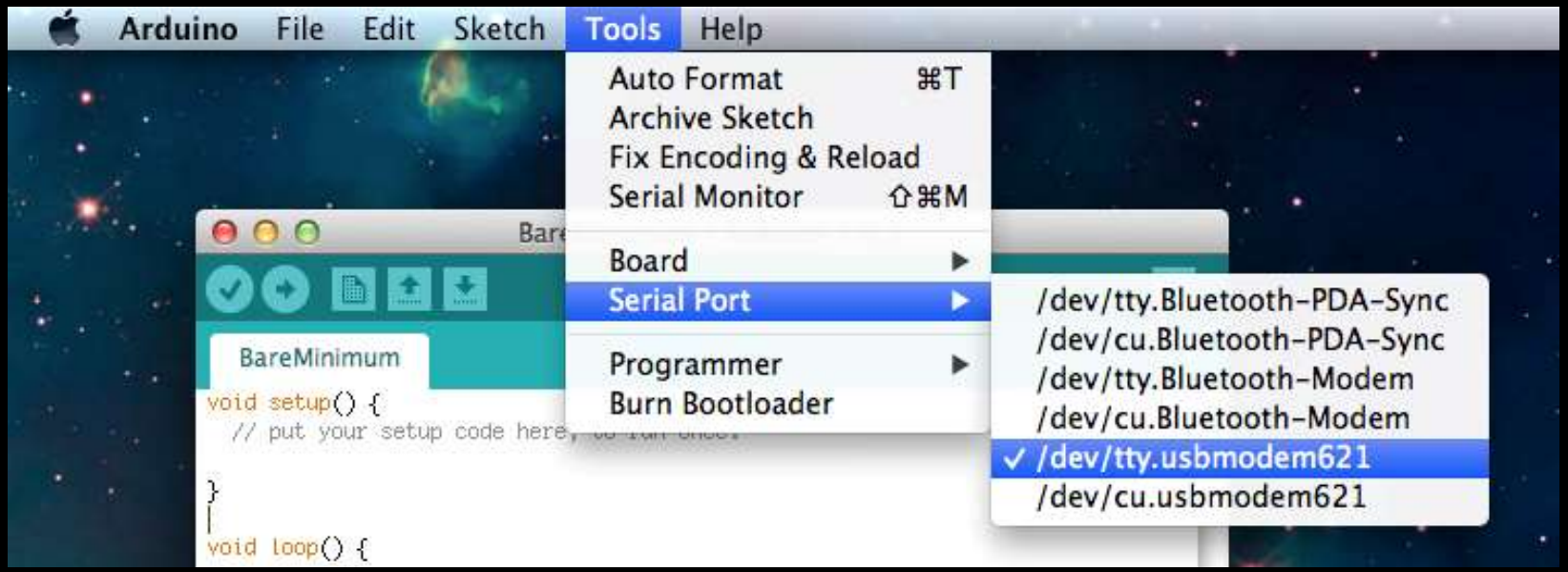
- **Select a serial port**

- For Mac use **Tools > Serial Port > /dev/tty.usbmodemxxx**

- **Note: the 'xxx' and 'xx' above can be any number – it does not matter which number you choose as long as one is selected**



# *Arduino Overview:*

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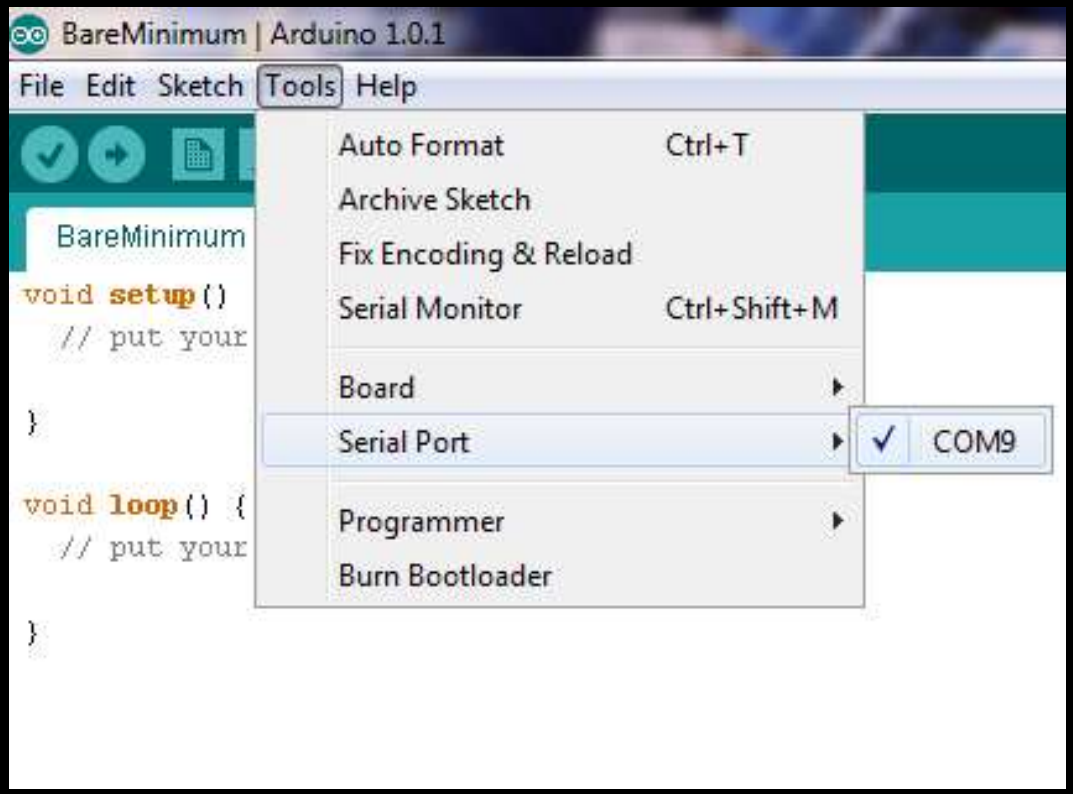
- **Select a serial port**

- For PC use **Tools > Serial Port > COMxx**

**Note: the 'xxx' and 'xx' above can be any number – it does not matter which number you choose as long as one is selected**



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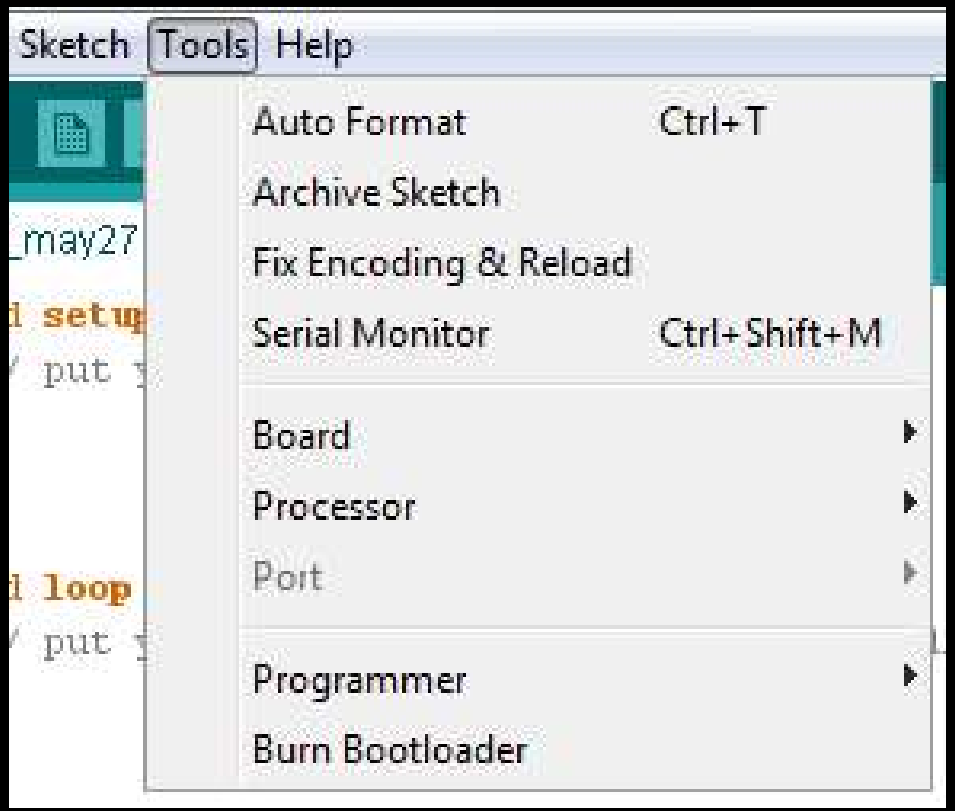
**Port is big source of frustration for Windows users**
**- The dreaded "grayed out" port**




**When it happens…**

- **Unplug Arduino from laptop**
- **Close Arduino software**
- **Plug Arduino back into laptop**
- **Restart Arduino software**

# *Arduino Overview:*

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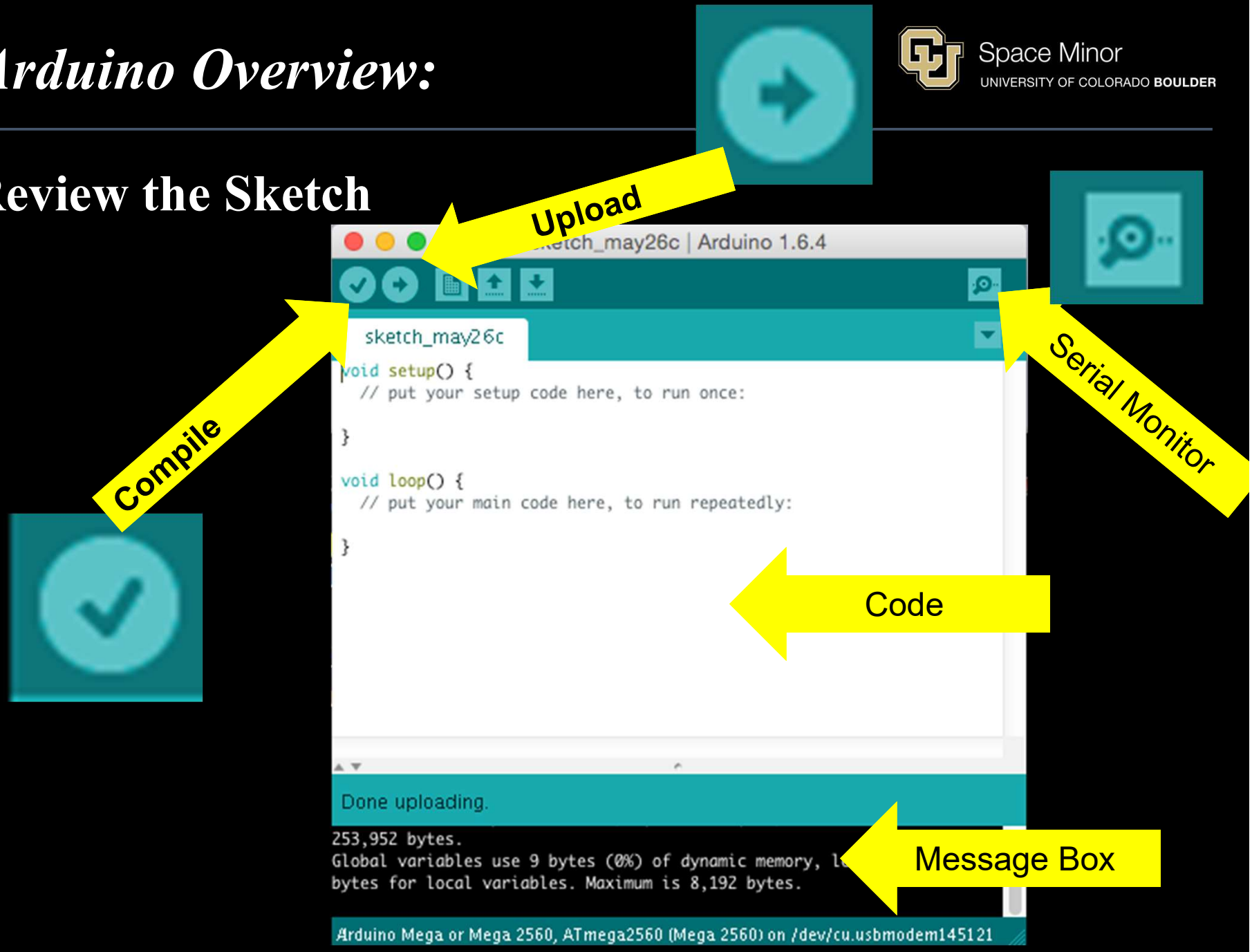
## Review the Sketch



# *Arduino Overview:*

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**There are three main sections of code in an Arduino sketch:**

- **Definitions**
- **Void Setup**
- **Void Loop**

# *Arduino Overview:*

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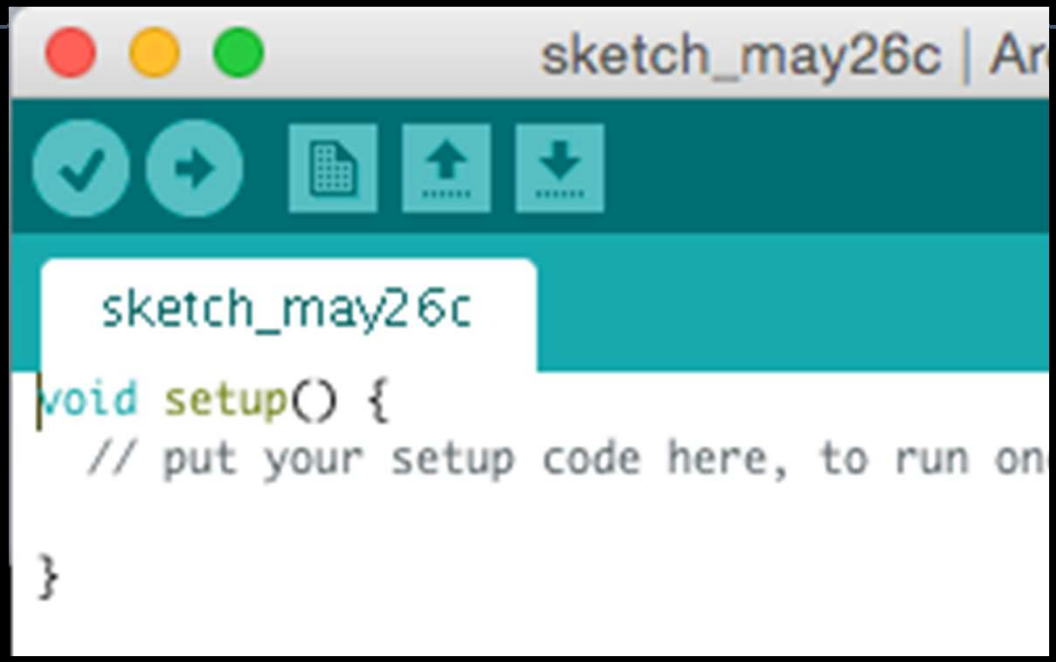
**Definitions**




- **Definitions are declared prior to void setup and can include pin definitions, libraries to include in the sketch, functions, and global variables**
- **Most programs declare something, but this is not required. Examples later on…**

# *Arduino Overview:*

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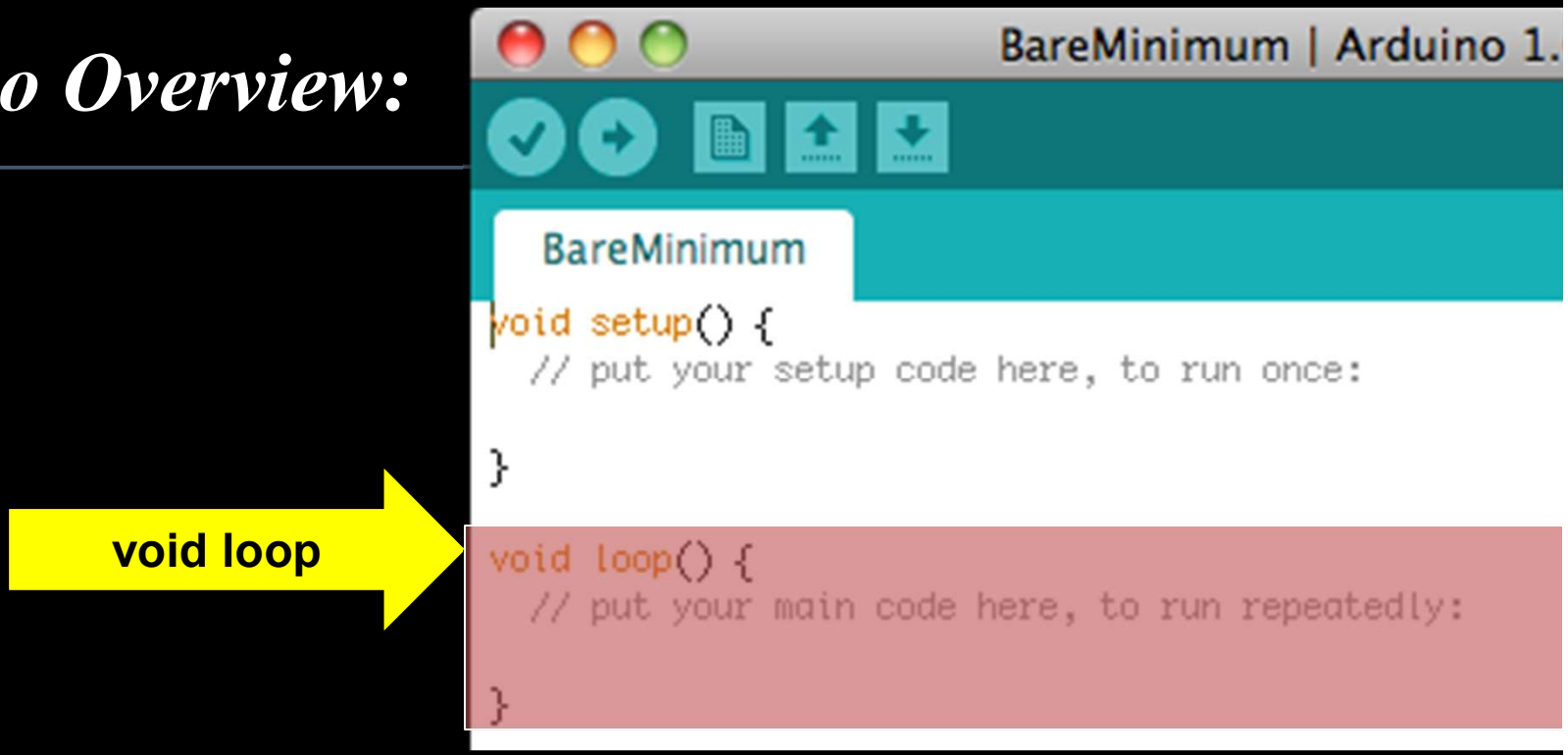
- **void setup is the first code block in the sketch**
- **It is run only once**
- **Used for setup of pin modes, communication initialization, and any code we only want to run one time**

# *Arduino Overview:*




- **void loop is the second code block in the Arduino sketch and it continuously repeats itself**
- **For code that needs to repeat such as sampling a sensor every couple of seconds**
- **Where the primary tasks of the code are carried out**

# *Arduino Overview:*

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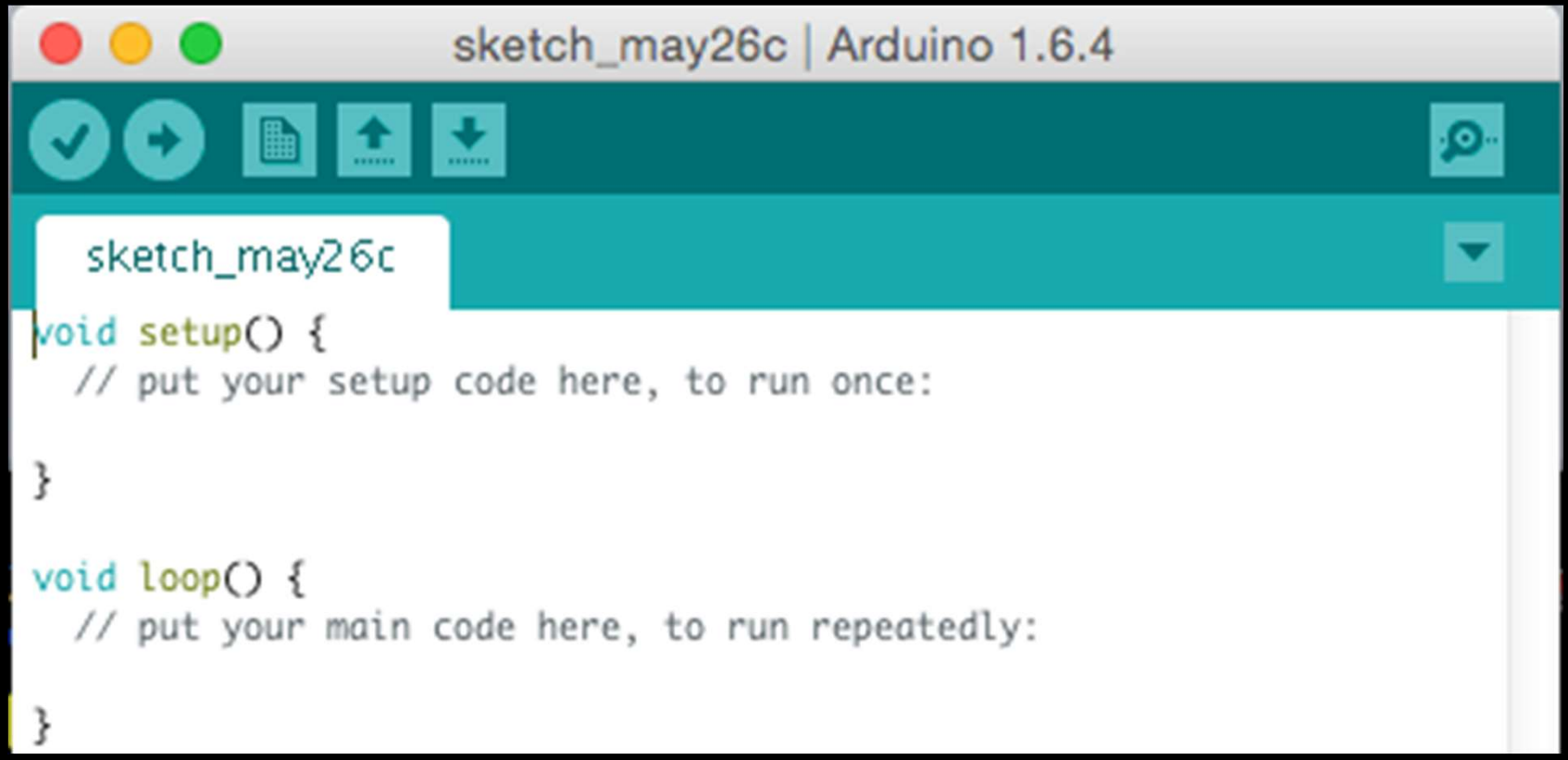


- **Even though this Sketch is not doing anything, it has all the necessary ingredients to be compiled and uploaded**

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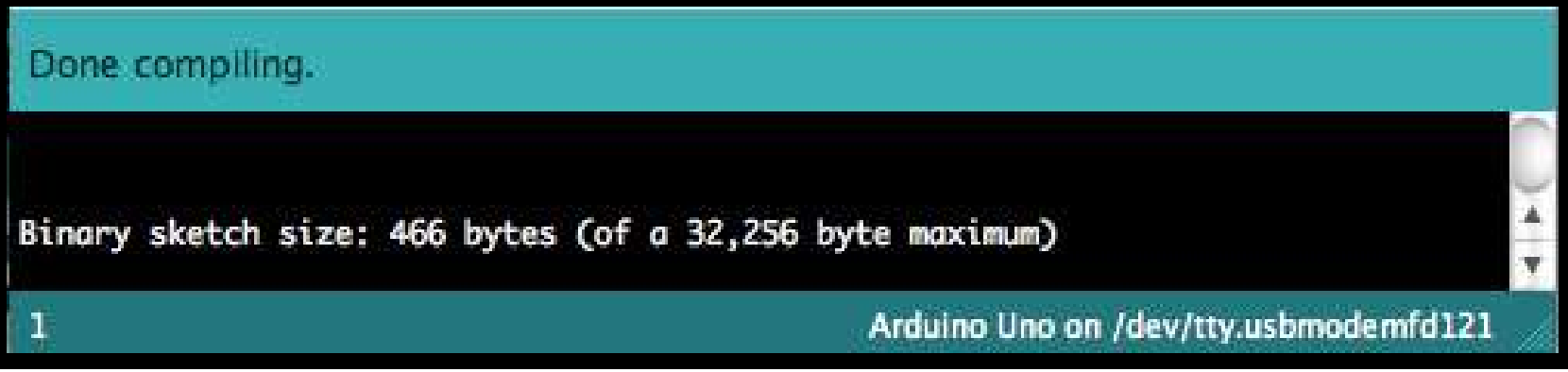
## 1. Compile code and check for messages

#1


**Should see this at the bottom…**



# *Arduino Overview:*

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- **What is Compiling?**
  - **It checks your code for syntax errors and returns error messages**
  - **Converts human-readable code into machine language (zeroes and ones)**
  - **When you tell the Arduino to upload, it first compiles then uploads (programs) your code (communicating with laptop and Arduino)**

# Arduino Driving Lessons

A. Download Arduino IDE
B. Arduino Overview
C. Arduino Communication
D. Blink an Led, Change the World

# *Arduino Overview:*

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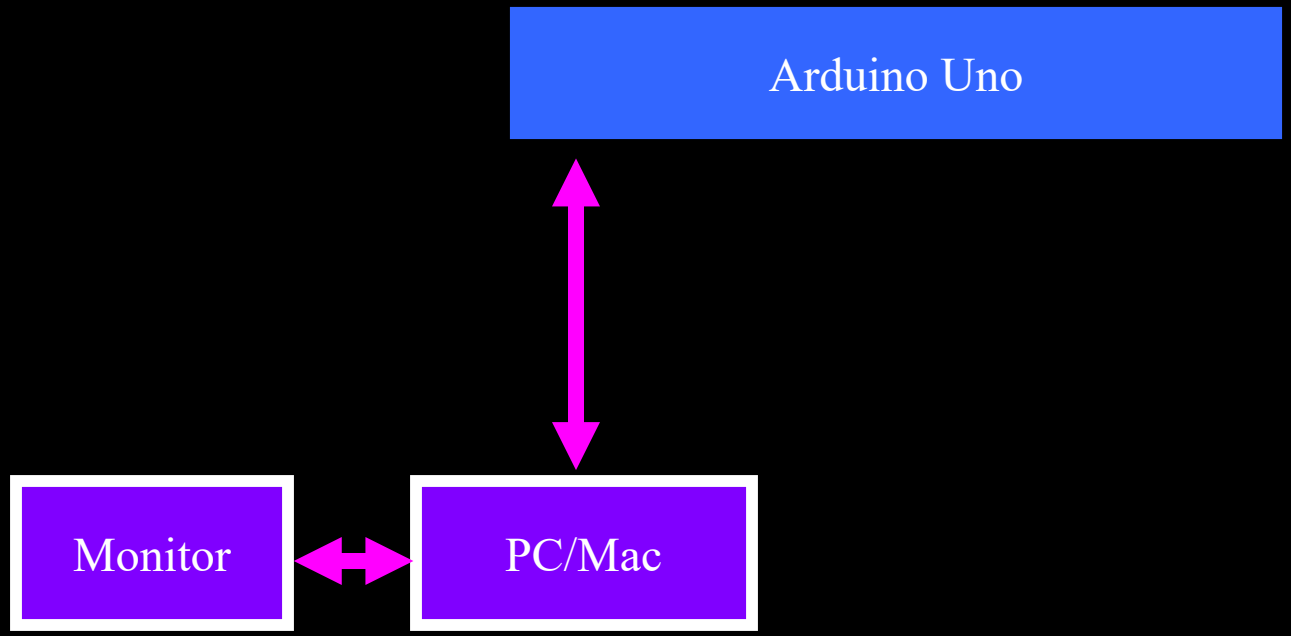

# *Arduino Communication:*

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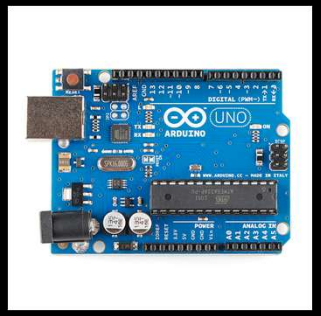
**Arduino uses serial communication to communicate with your laptop.**

**Serial communication is a widely used interface* for transmitting (Tx) and receiving (Rx) binary data and requires a few easy functions to get it started with Arduino.**

* UART (common set of communication rules)

# *Arduino Communication:*

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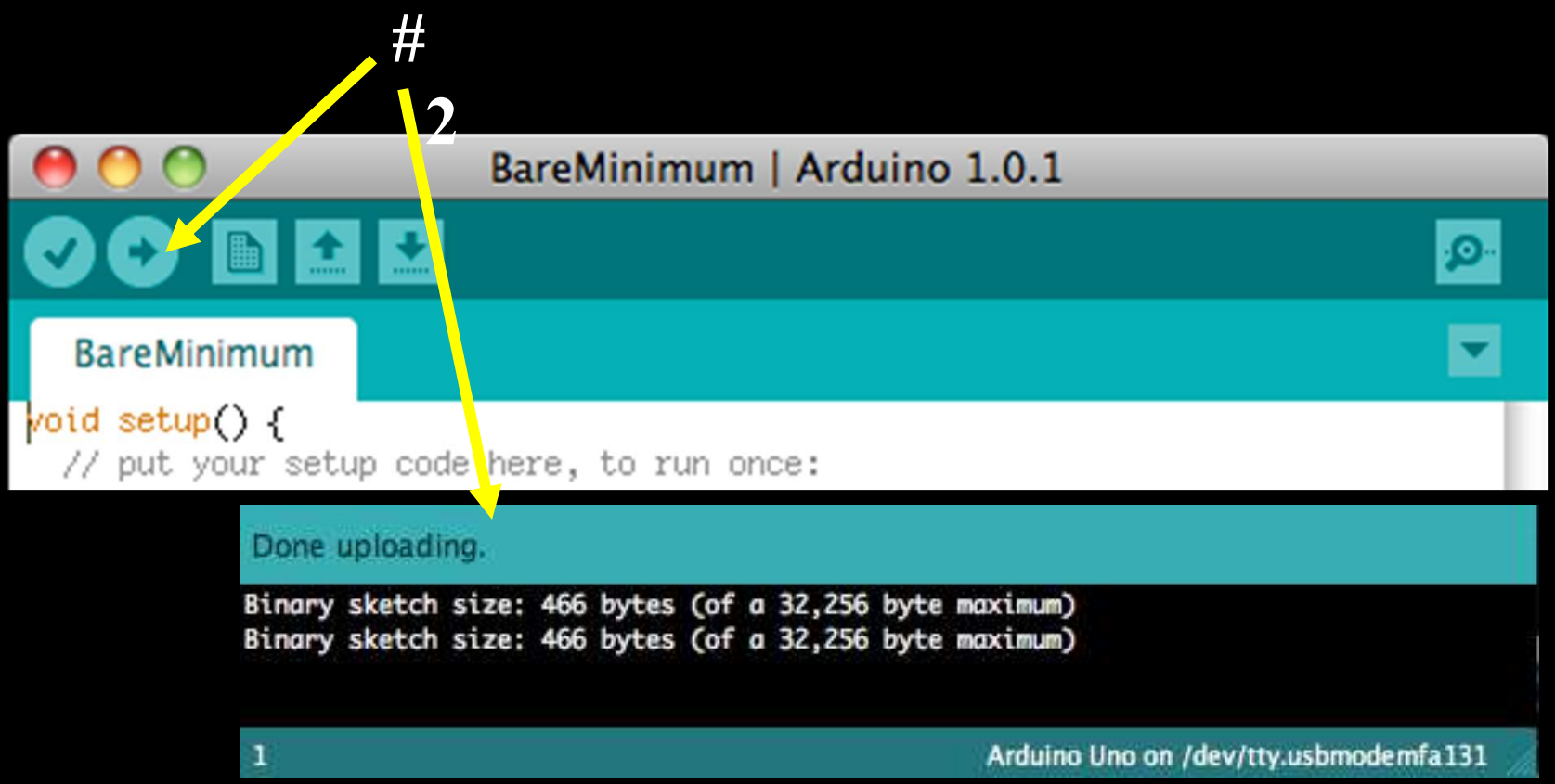
## 2. Upload code to Arduino

***If successfully uploaded, you will know that your PC/MAC can communicate with your Arduino***



# *Arduino Communication:*

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## What is code?

# *Arduino Communication:*

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**What is code?**

- **It is a language to talk with your computer**

- **Programming languages are like foreign languages**

- **We say "Hello," Arduino says**

```
Serial.begin(9600);
Serial.print("Hello");
```

- **Arduino language is based on C/C++**

# *Code Checklist:*

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| ✓ | Code Structure | Example | Location |
|---|---|---|---|
| | `void setup(){ }` | `void setup(){ //setup code here }` | |
| | `void loop() { }` | `void loop() { //loop code here }` | |
| | `Serial.begin(baud rate);` | `Serial.begin(9600);` | Setup |
| | `Serial.print( );` | `Serial.print("hello world");` | Loop |
| | `Serial.println( );` | `Serial.println("hello world");` | Loop |
| | `Serial.print("\t");` | `Serial.print("\t Tabs are fun");` | Loop |
| | `Serial.print(value to print);` | `Serial.print(sensorValue);` | Loop |
| | `Serial.print(value to print, # of digits);` | `Serial.print(sensorValue, 2);` | Loop |
| | `//` | `// This is a comment` | Anywhere |
| | `/* */` | `/* blah blah`<br>`a comment block`<br>`blah blah */` | Anywhere |
| | `int integer_name = initial_value;` | `int led = 13;` | Definitions |
| | `float decimal_number_name;` | `float sensorValue;` | Definitions |
| | `pinMode(pin, mode);` | `pinMode(13, OUTPUT);` | Setup |
| | `digitalWrite(pin, value);` | `digitalWrite(13, HIGH)` | Loop |
| | `delay(time in millesec);` | `delay(1000);` | Loop |
| | `analogRead(pin);` | `analogRead(A0);` | Loop |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# *Arduino Communication:*

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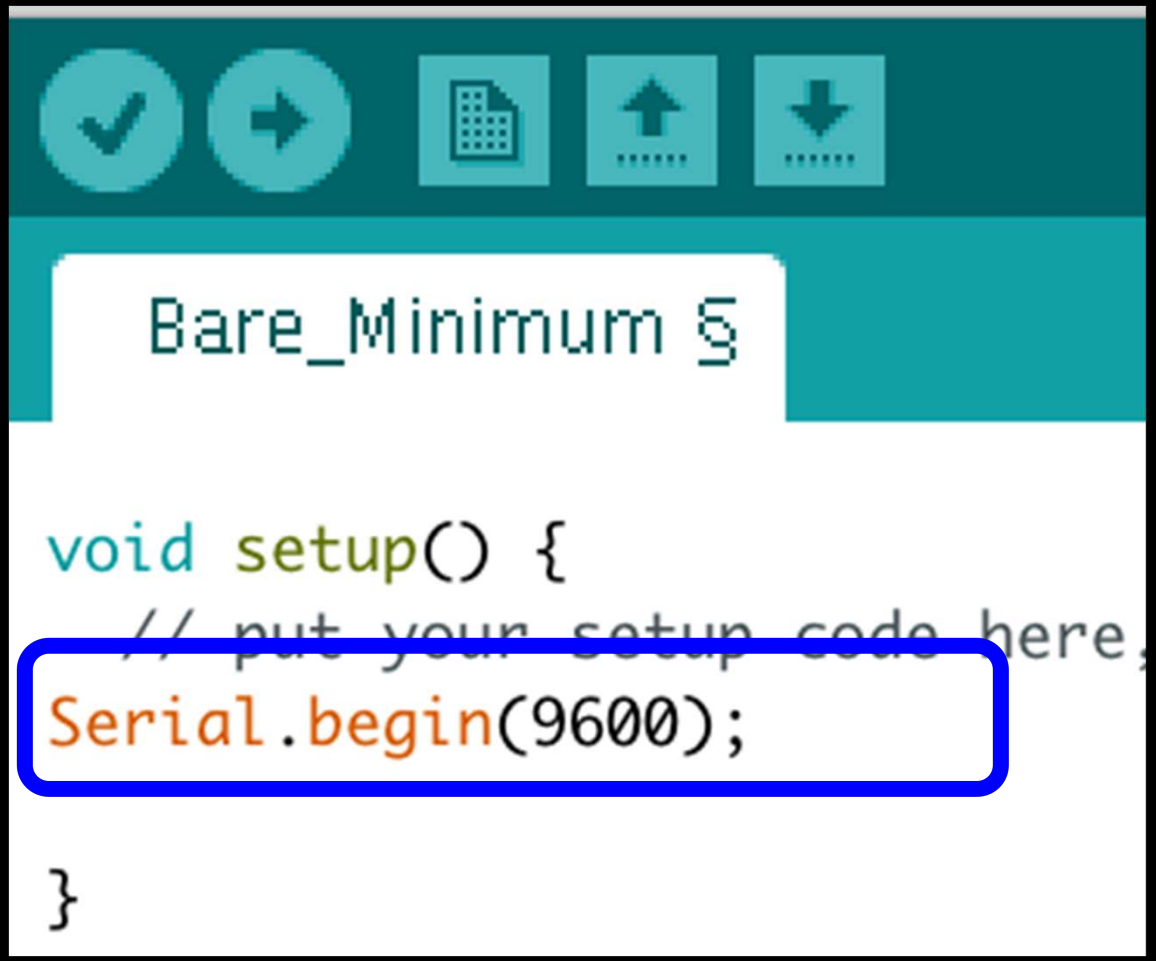
- **Modify the sketch to add the following to the void setup( )**



# *Arduino Communication:*

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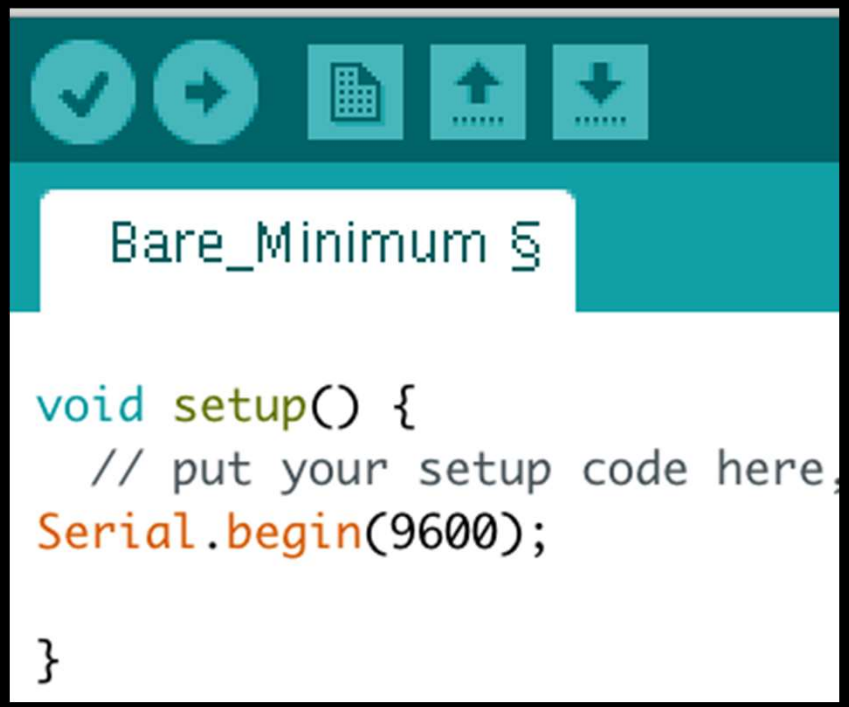
**Serial.begin( )**

- **Serial.begin( ) needs us to specify a communication rate (baud rate)**
- **We use 9600 bits per second, so put 9600 in the parentheses**
- **Serial.begin( ) is in setup because this rate needs to be set only once**



# *Arduino Communication:*

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**Modify your sketch to include the following:**

```
void loop() {
  // put your main code here, to run repeatedly:
Serial.println("hello");
}
```

- **Serial.print( ) will just print to the monitor**

- **Serial.println( ) will print to the monitor and then go to the next line (essentially pushes 'return')**

# *Arduino Communication:*

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1. **Compile code and check for messages**

2. **Upload code to Arduino (will check communication with Arduino too)**

# *Arduino Communication:*

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- **To open the serial monitor, click here**

# *Arduino Communication:*

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- **You should see this on your serial monitor**

# *Arduino Communication:*

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**- Congratulations!**

**- You have now successfully programmed your Arduino – You are a computer programmer**

# *A Brief History Break:*

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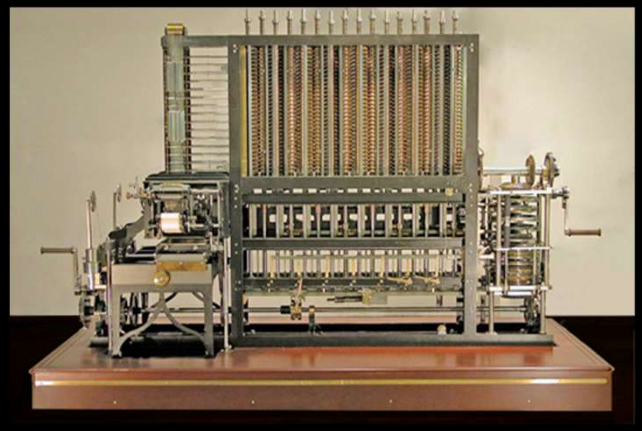
**Ada Lovelace – Mathematician**

**First computer programmer in 1842**

**"Analytical Engine"**

**Saw that it was more than number crunching, but was a tool capable of great problem solving**

**Published most elaborate and complete programs**



# *Arduino Preferences:*

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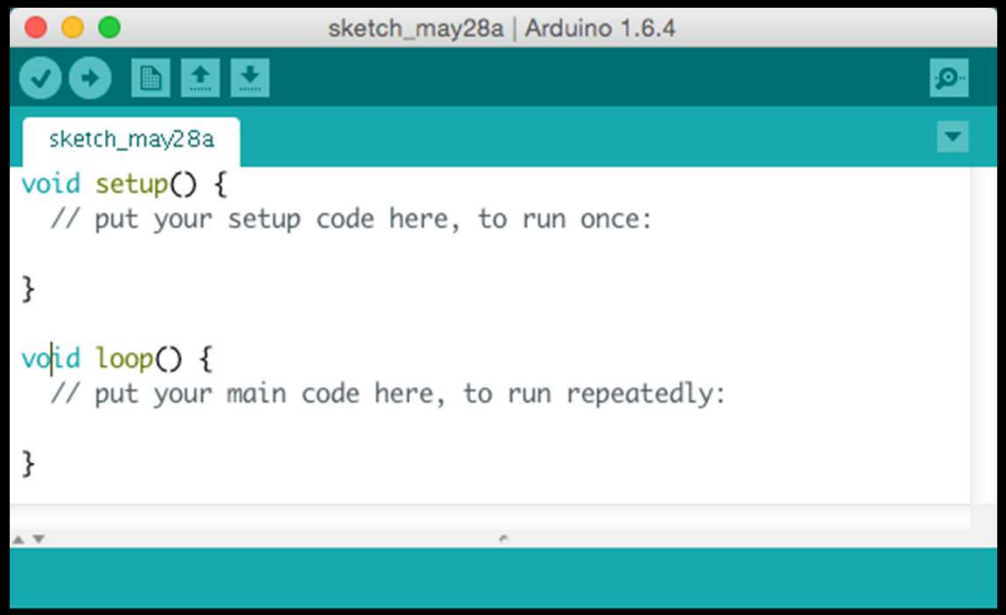
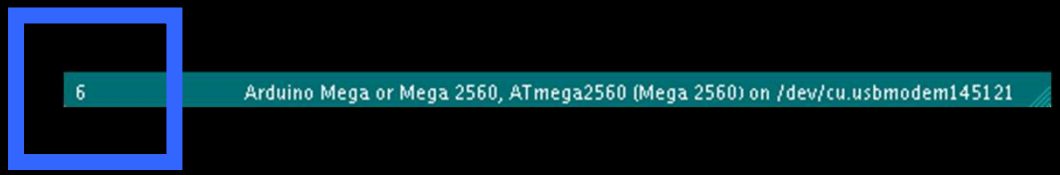
## Other features about Arduino IDE




Line Number of cursor in code

# *Arduino Preferences:*

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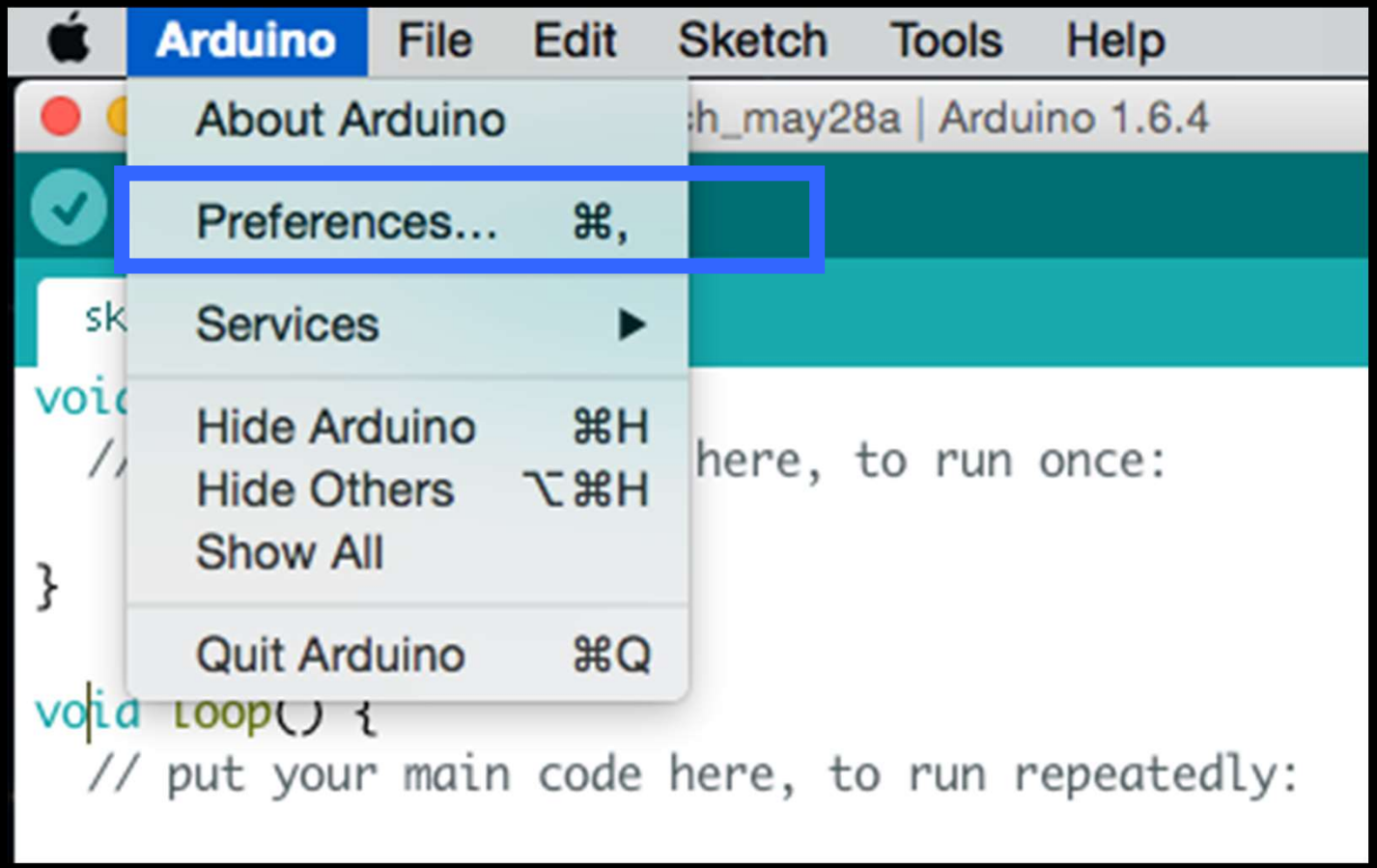
## Other features about Arduino IDE



# *Arduino Preferences:*

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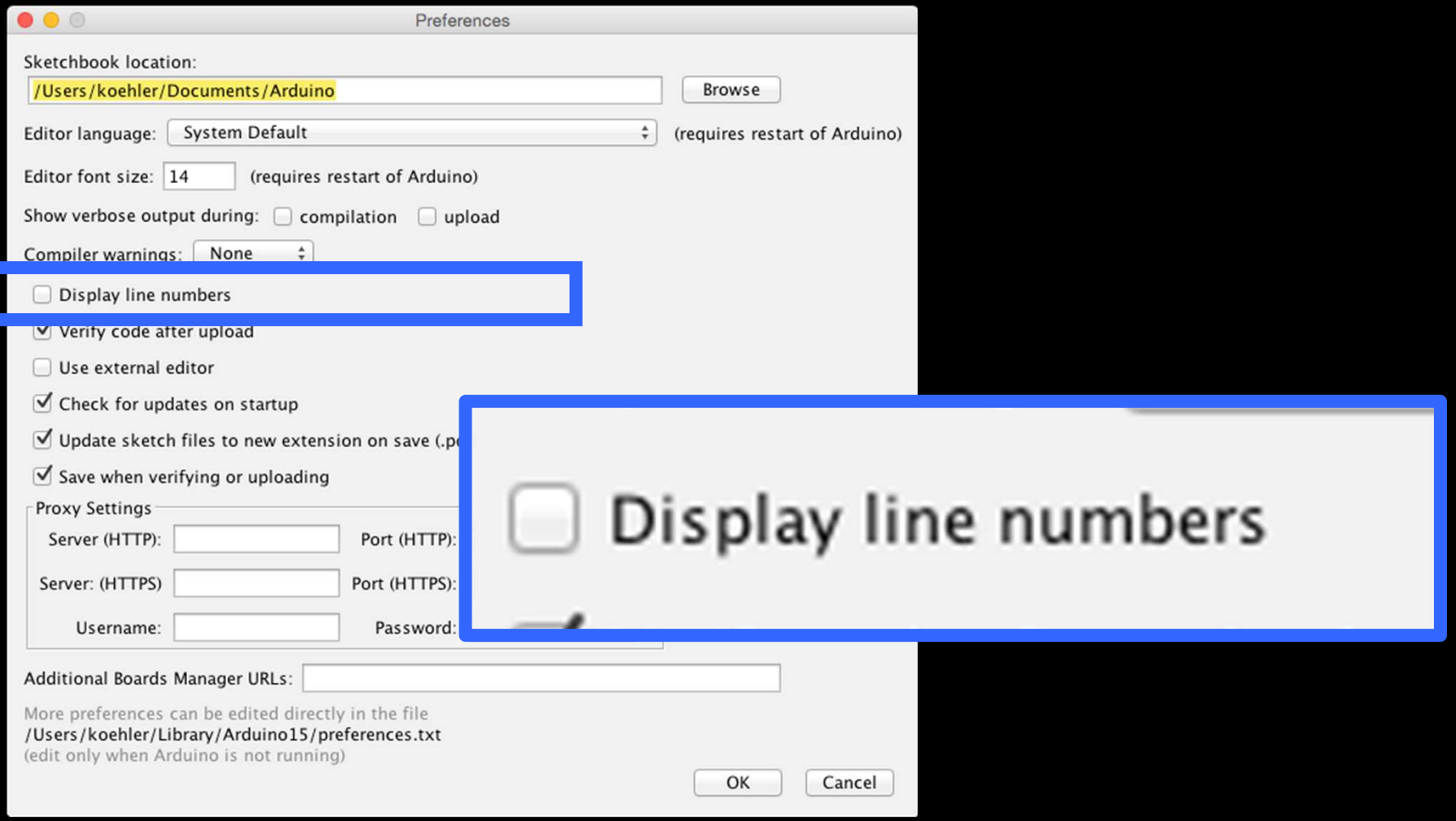
## Other features about Arduino IDE



# *Arduino Preferences:*

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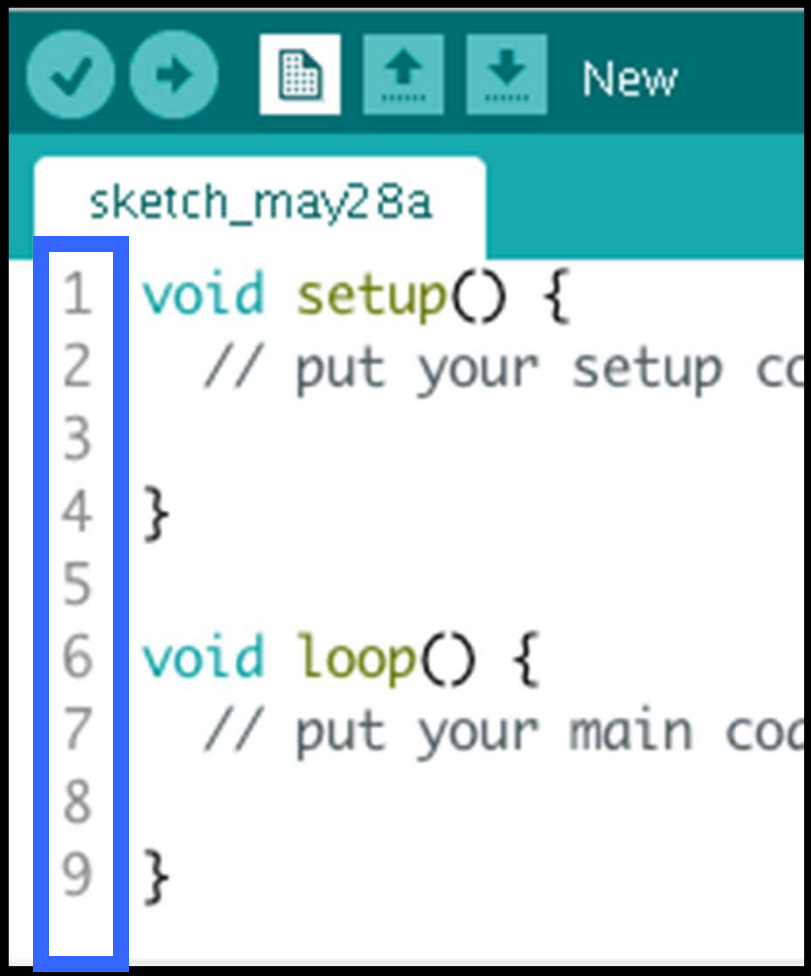
## Other features about Arduino IDE



# *Arduino Preferences:*

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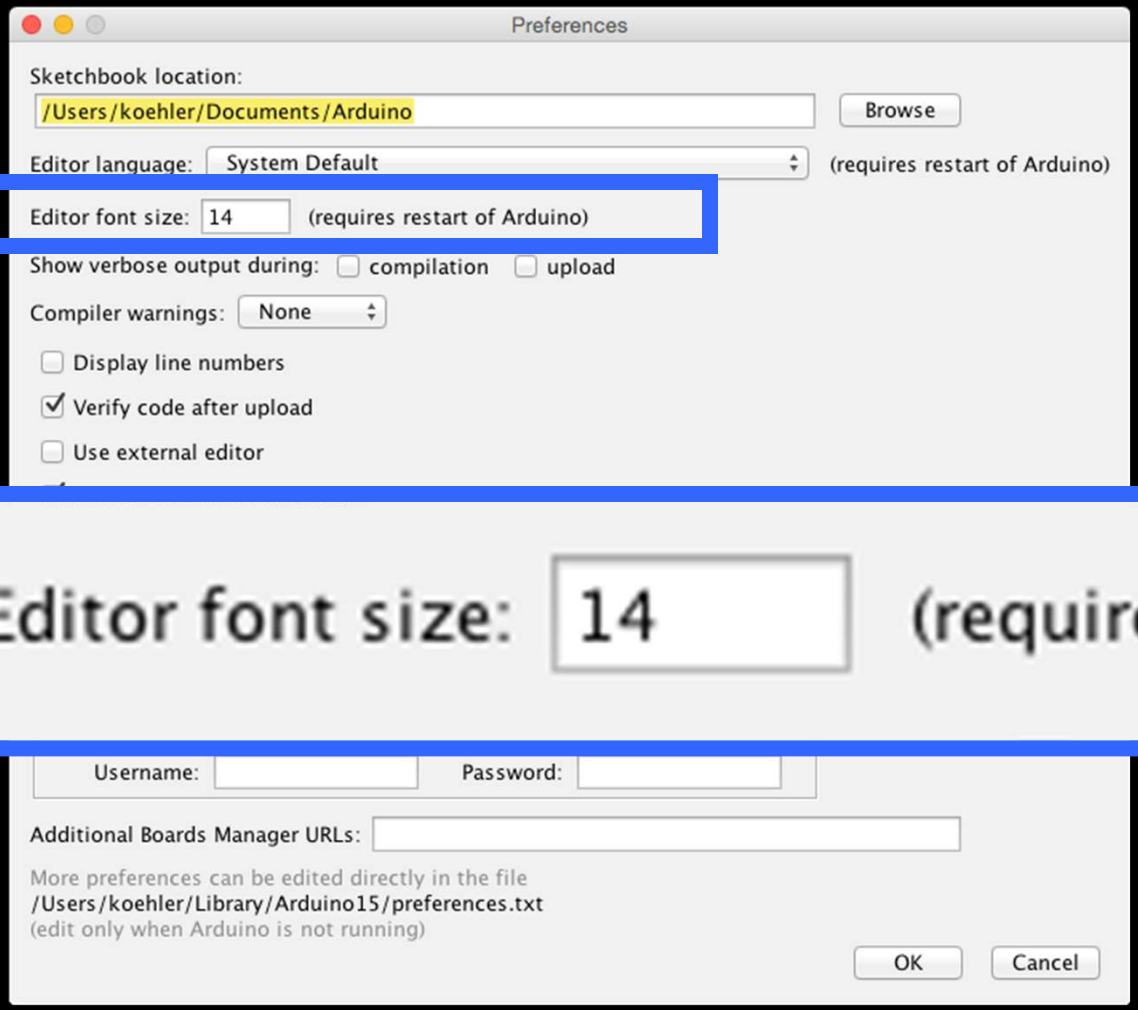
## Other features about Arduino IDE



# *Arduino Communication:*

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## Commenting

- Arduino ignores comments but humans read them
- Words become light gray if they commented out
- Put // in front of a line to comment out whole line
- To comment out an entire section, put /* at the beginning and */ at the end

```
//you can type anything you want here!
this is NOT a comment!! //uh oh!
/*
I can type whatever I want here.
Notice how it's gray?
*/
```

# *Arduino Communication:*

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**Commenting – MOST IMPORTANT THING!!**

**It makes your code readable, provides context, helps draft out what you want to next.**

- **Click to the top of the sketch hit enter to create a new line above void setup( )**

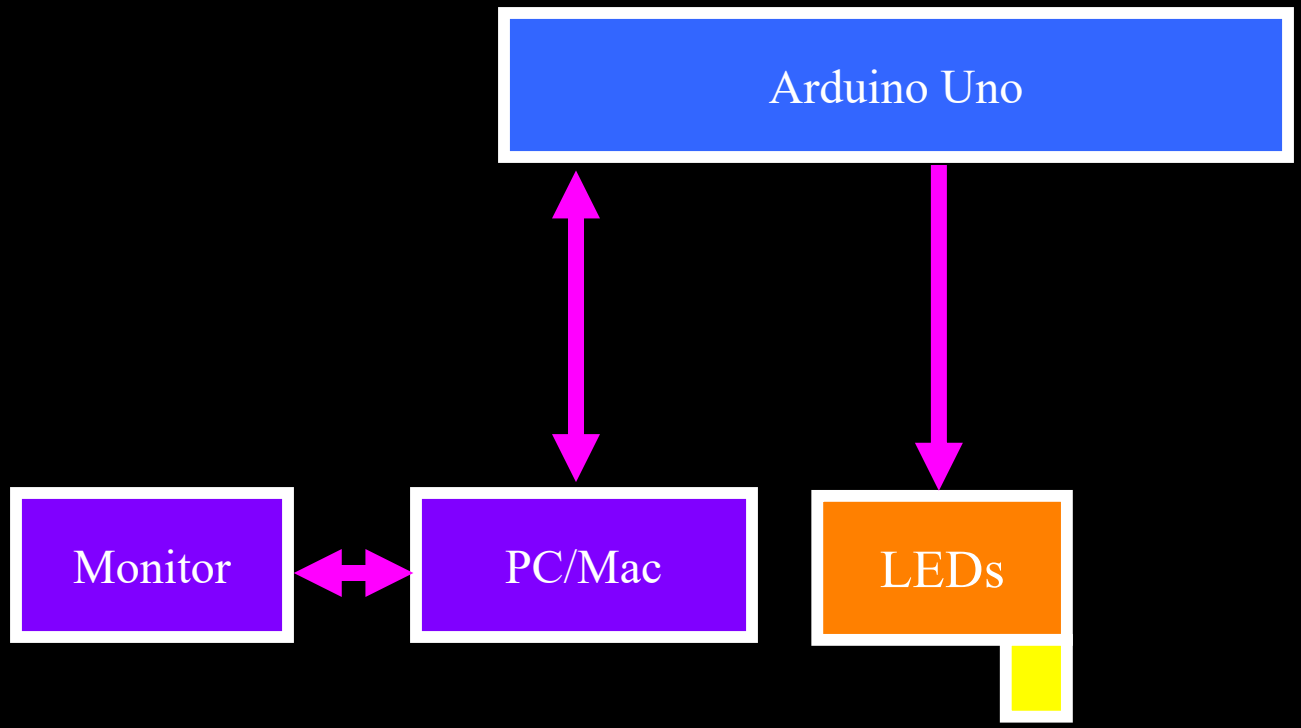
- **Try out your own comment. Insert your name at the top of the sketch. Try both methods.**

# Arduino Driving Lessons

A. Download Arduino IDE
B. Arduino Overview
C. Arduino Communication
D. Blink an Led, Change the World

# *Blink an LED:*





# *Blink an LED:*

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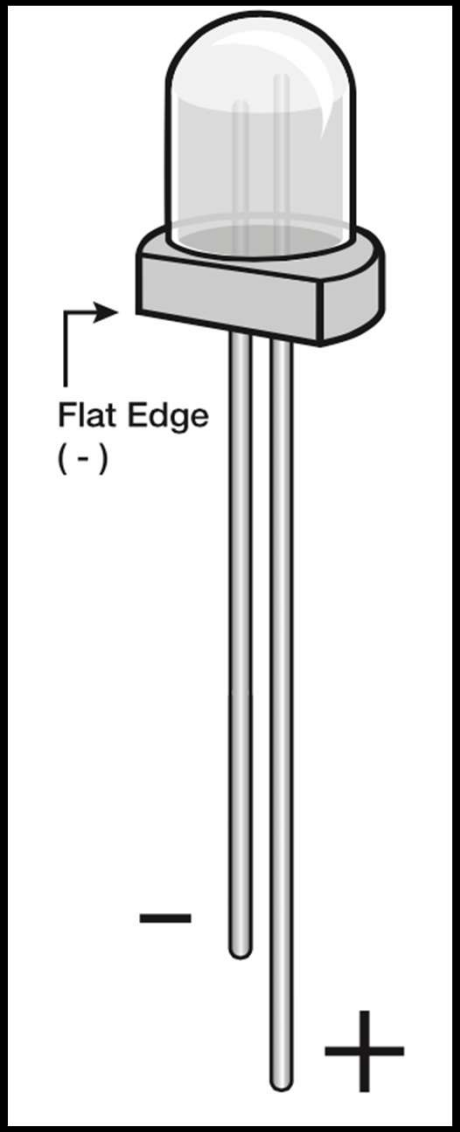
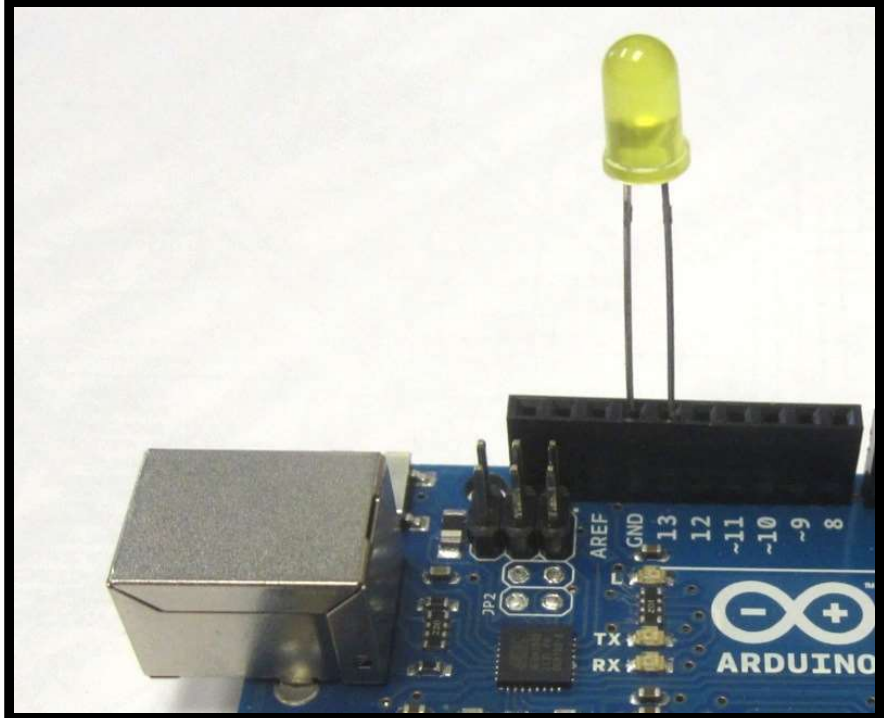



**- Connect an LED (+ lead) to pin 13 and (- lead) to GND**

**- Negative lead is usually the shorter lead**




# *Blink an LED:*

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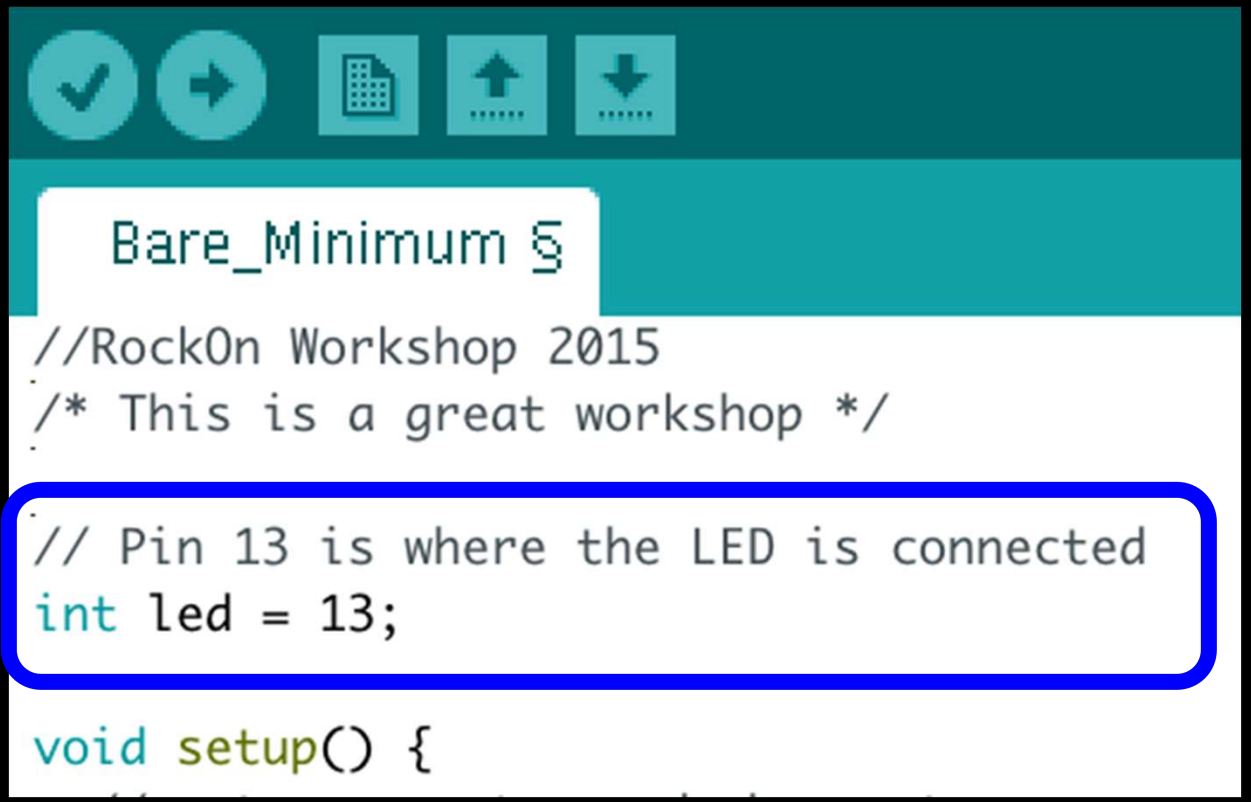
- **Add the following to the definitions area of your sketch - *above void setup( )***

- **Add some comments too**



## *Blink an LED:*

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- Note that "int" turned blue → we are defining a data type
- Arduino knows variable "led" represents an integer
- Anytime "led" is used in the code, Arduino sees 13
  - Ex. 12 + led = 25
- There are many more data types

```
// Pin 13 is where
int led = 13;
```

# *Blink an LED:*



**- Add the following to the your sketch in void setup( )**

```
void setup() {
  // put your setup code here, to run once:
  // initialize the digital pin as an output
  pinMode(led, OUTPUT);
  Serial.begin(9600);
}
```

# *Blink an LED:*

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- **pinMode(pin#, mode)**
  - **“pin#” refers to a specific pin on the Arduino you are wanting to use (in our case pin 13 aka “led”)**
  - **“mode” is either INPUT or OUTPUT**
    - **OUTPUT sets up the pin so it can give outputs**
    - **INPUT sets up the pin so it can receive inputs**

# *Blink an LED:*

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- Add the following to your sketch in void loop( )

```
void loop() {
  // put your main code here,
  Serial.println("hello");
  digitalWrite(led, HIGH);
  delay(1000);
  digitalWrite(led, LOW);
  delay(1000);
}
```

- void loop ( ) …
- Runs once void setup is finished
- Loops through the code within forever

# *Blink an LED:*

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**digitalWrite(pin#, value)**

- "**pin#**" is whichever pin you are writing to
- "**value**" can be either HIGH or LOW

- **HIGH** means the pin is at 5V – "on"
- **LOW** means the pin is at 0V – "off"

```
  Serial.println("Hello");
  digitalWrite(led, HIGH);
  delay(1000);
  digitalWrite(led, LOW);
  delay(1000);
}
```

# *Blink an LED:*

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**delay(time)**

- **Arduino will wait a specific amount of time (in milliseconds) before going to the next line of code**

```
  Serial.println("Hello");
  digitalWrite(led, HIGH);
  delay(1000);
  digitalWrite(led, LOW);
  delay(1000);
}
```

# *Blink an LED:*

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1. **Compile code and check for messages**

2. **Upload code to Arduino**

# *Blink an LED:*

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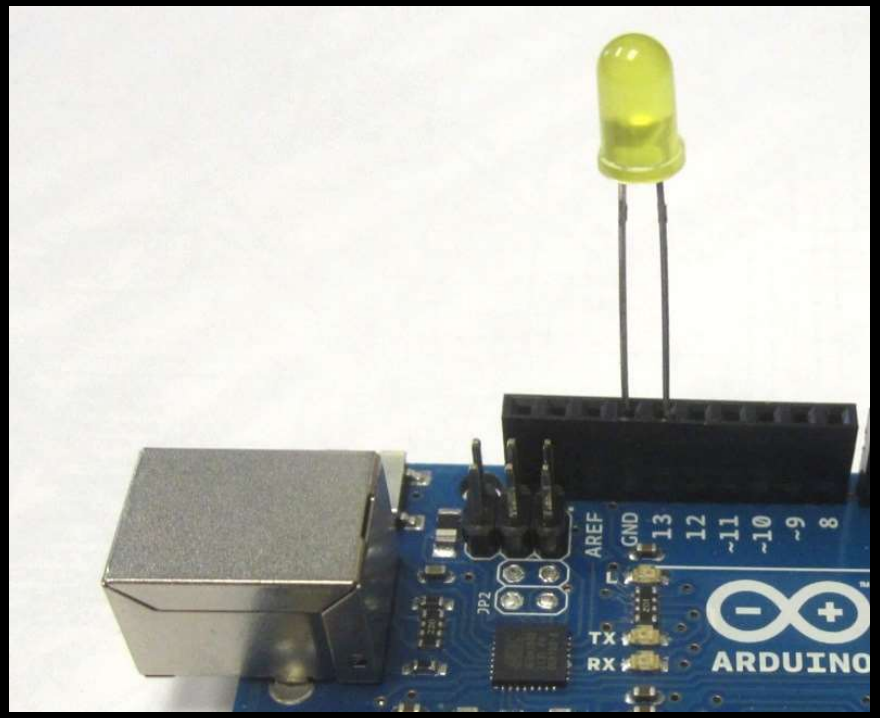
- **Does LED blink?**

- **Change the delay in the sketch and try again**

- **Do you see a change?**



# *Blink an LED:*

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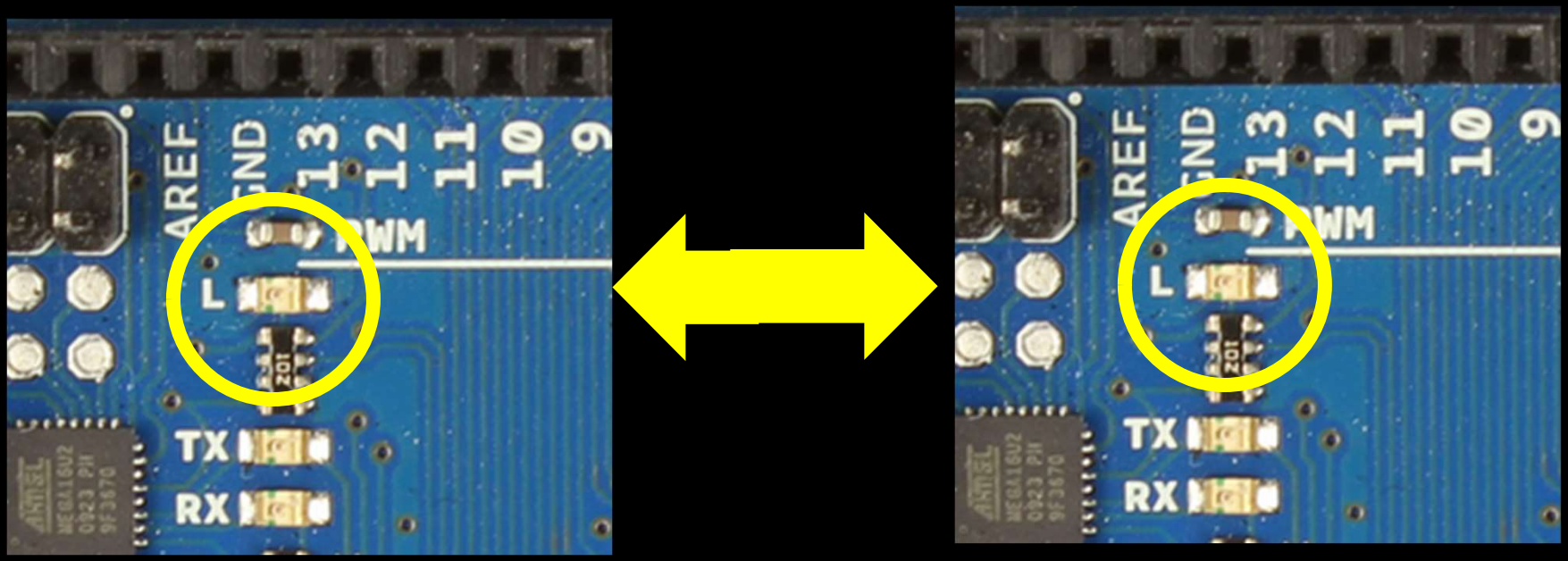
- **Remove the LED from PIN 13 and GND**
- **Another LED on the board should start blinking**
- **The "L" on the Uno stands for LED**
- **Do you see this?**



# *Blink an LED:*

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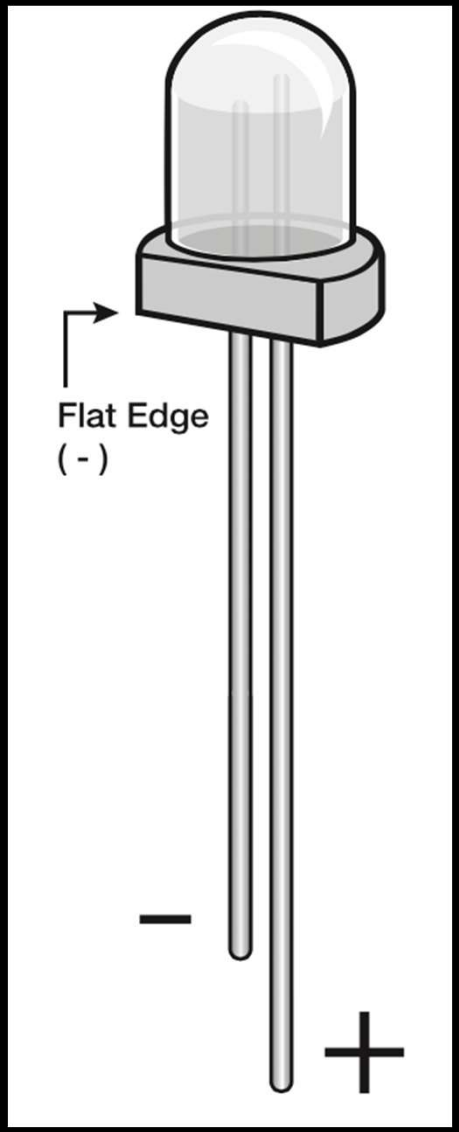
- **Say you wanted to blink an LED on Pin 9, what would you change in the code?**

- **int led = 9;**



## *Blink an LED:*

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- **Could you connect LED directly to Pin 9 and GND like for Pin 13?**

- **No (OK for a few seconds) but why?**

- **LED requires some current limiting (resistor)**

# *Blink an LED:*

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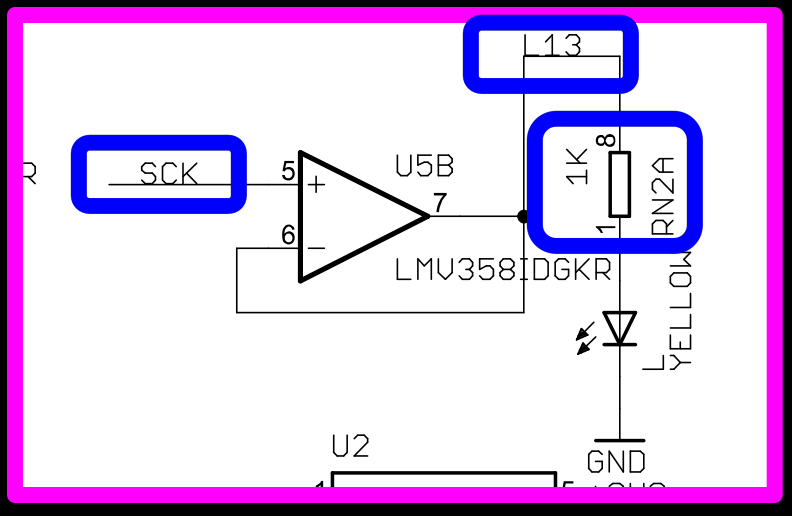
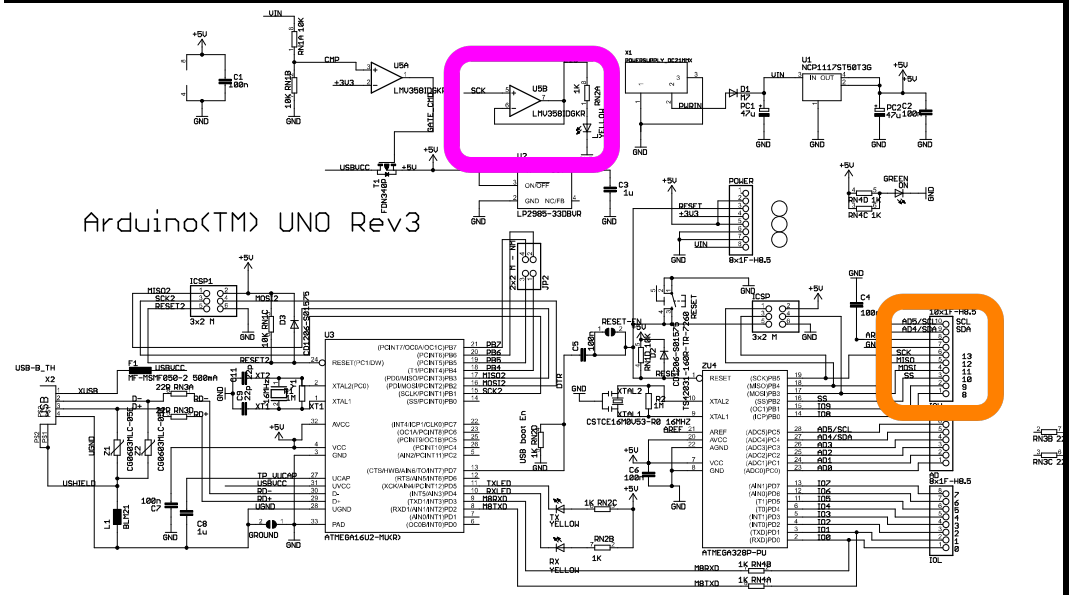
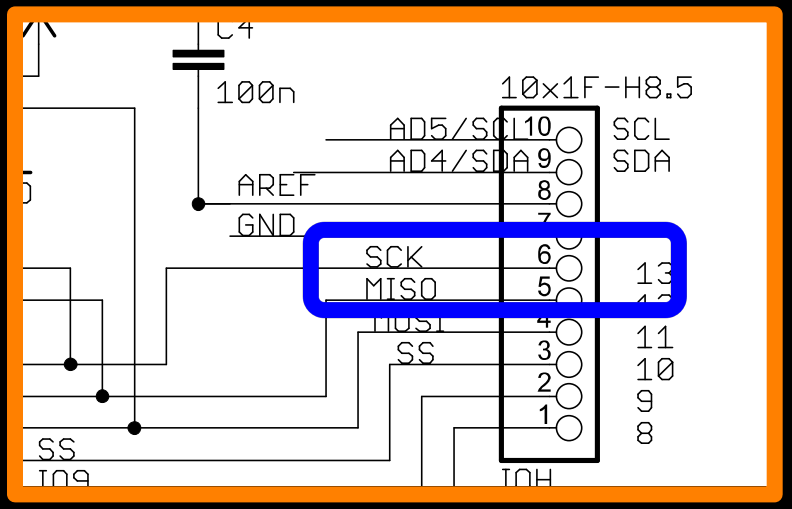



- **Let's look at Pin 13 on the schematic**
- **Follow the line and find a built in 1K resistor**



# *Blink an LED:*

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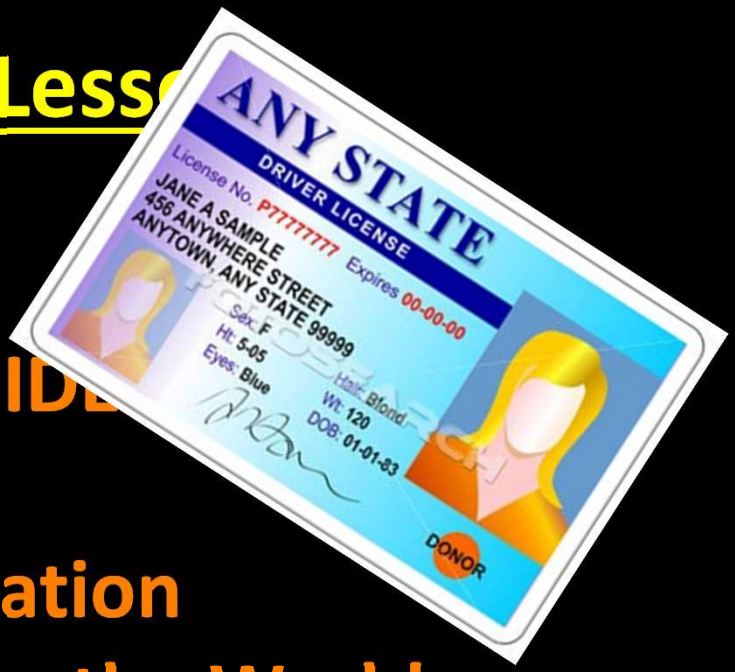
- **If you can Blink an LED, you can change the world**

- **Why?**

***PLEASE SAVE YOUR SKETCH FILE***

# Arduino Driving Less

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