

# Inventing...



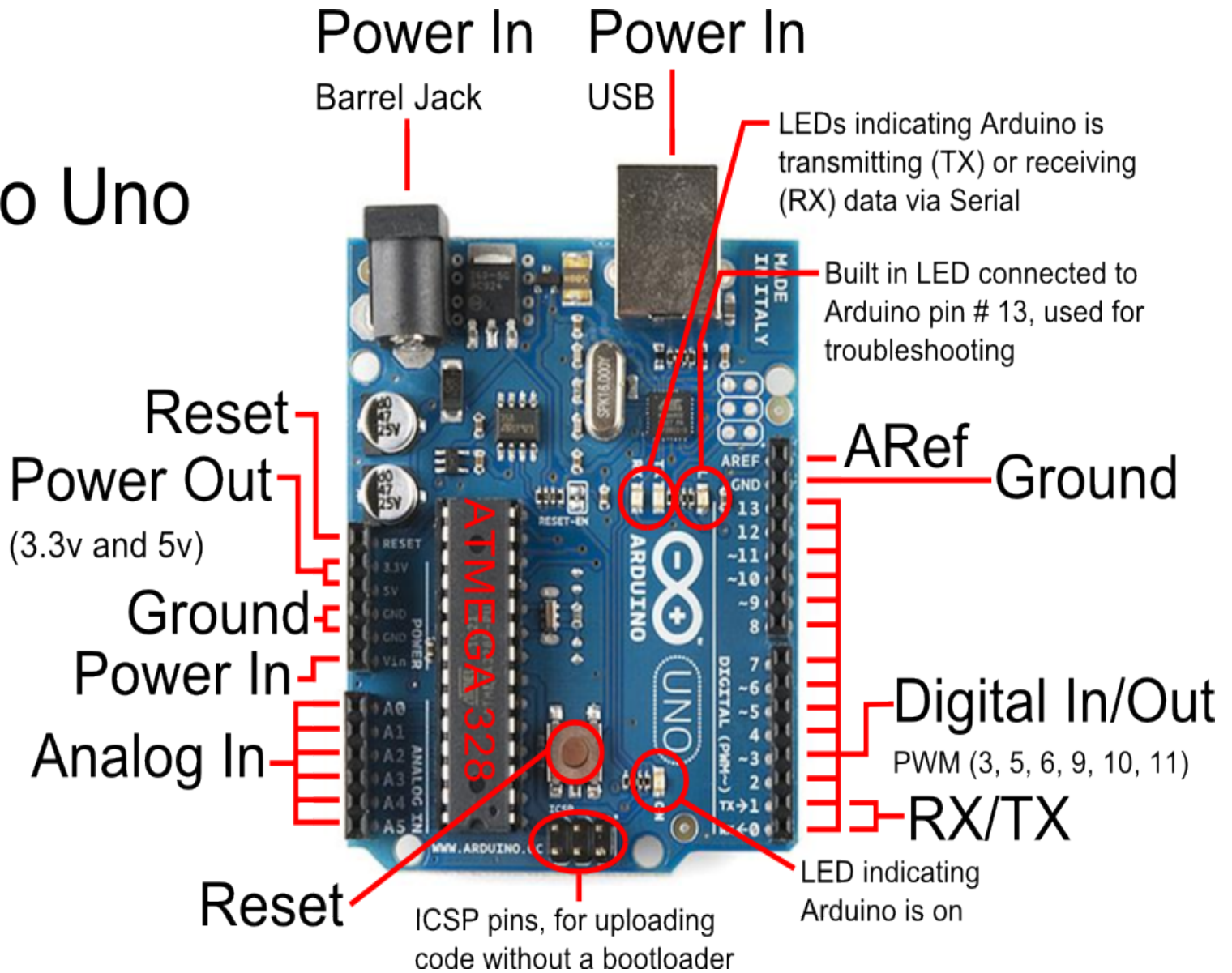
with Software and  
Electronics



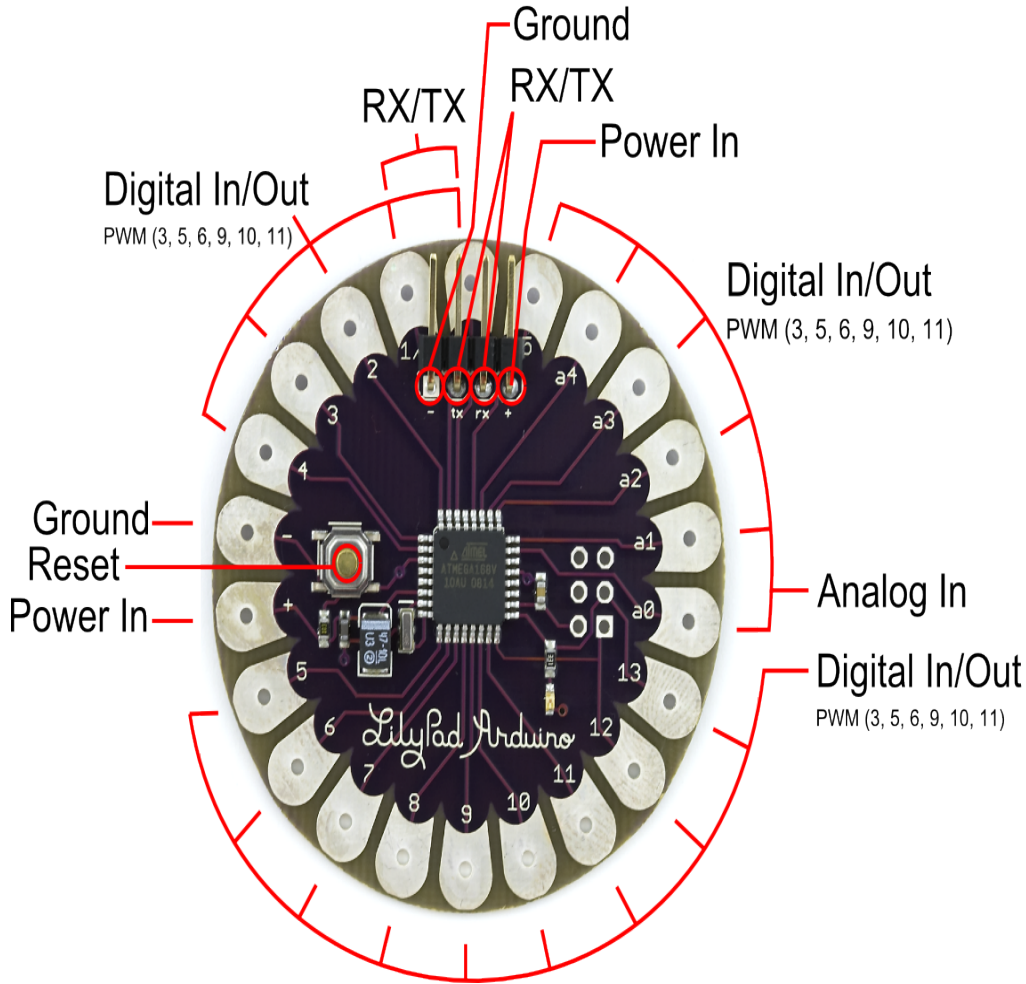
Making a light  
Blink...

- The Arduino Grand Tour

# Arduino Uno

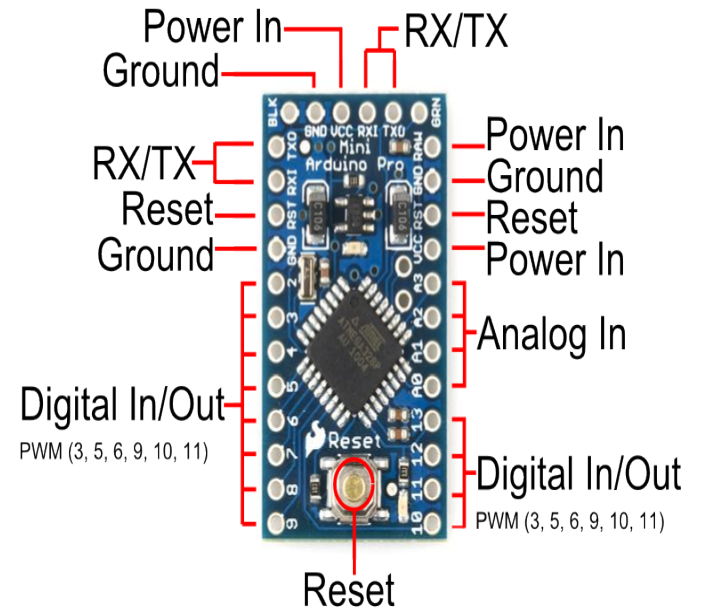


# Arduino Lilypad



Wearable! Sewable! Washable!

# Arduino Mini



Tiny!

- Circuit #1

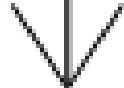
+

← *Swarms of excited electrons, ready to go find ground*



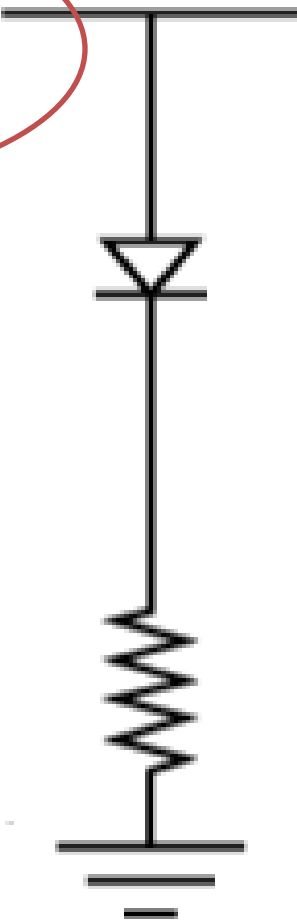
**Energy Source**  
Electricity starts here

Direction of current



**GND**

Electricity ends here

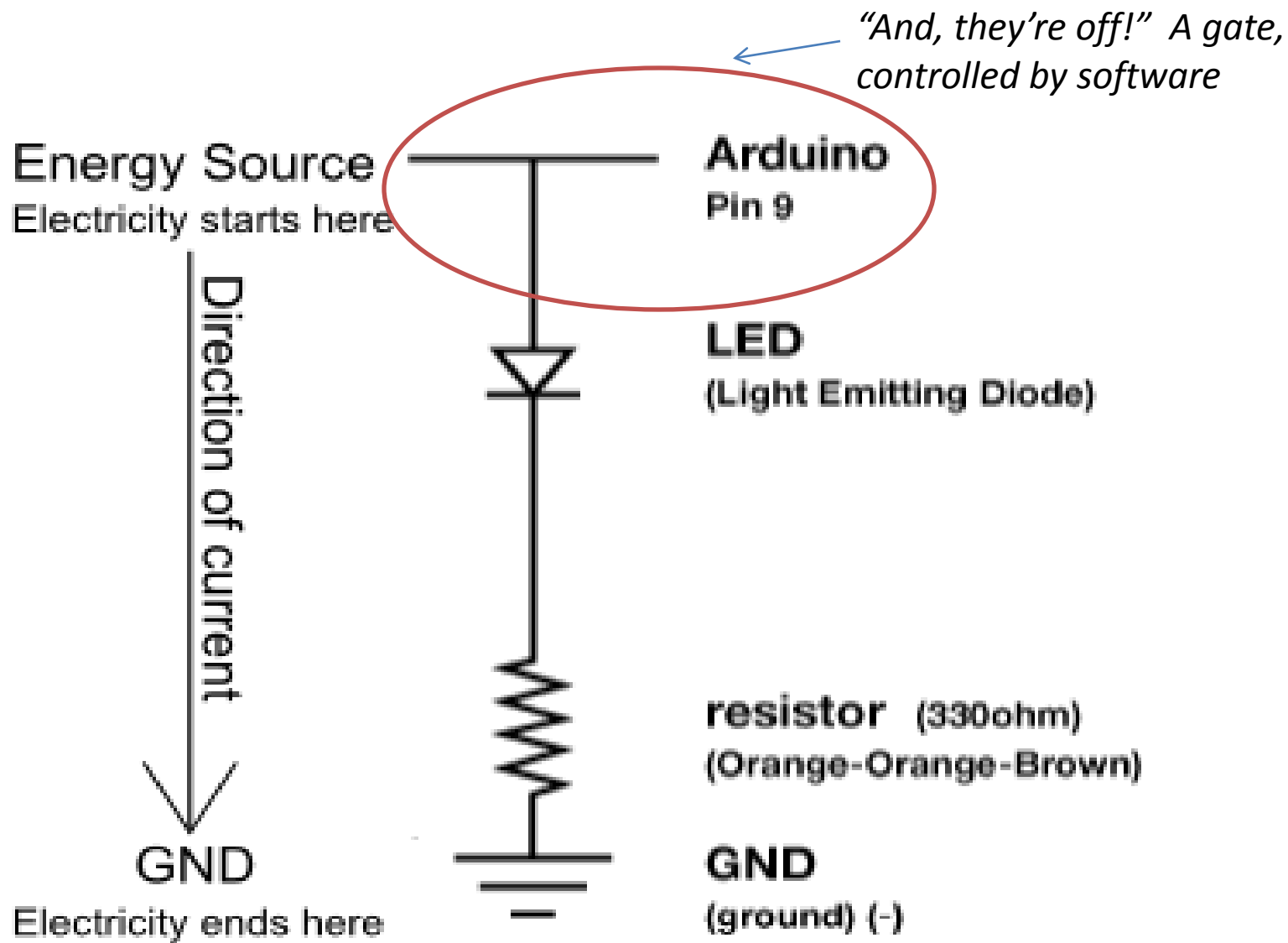


**Arduino**  
Pin 9

**LED**  
(Light Emitting Diode)

**resistor (330ohm)**  
(Orange-Orange-Brown)

**GND**  
(ground) (-)



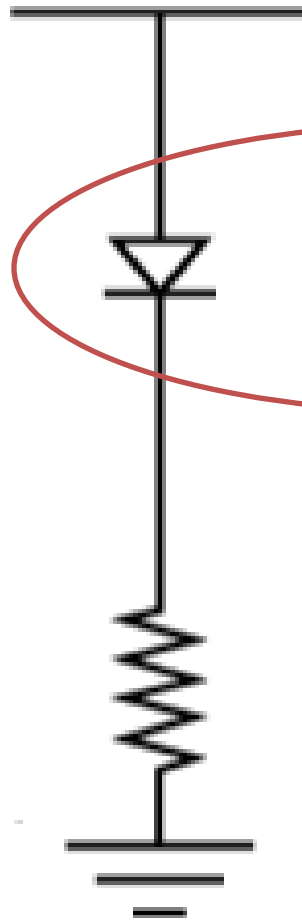


*A one-way-street (DIODE) which emits light (photons) when current passes through. The greater the current through the diode, the brighter the light.*

**Energy Source**  
Electricity starts here

Direction of current  
↓  
**GND**

Electricity ends here

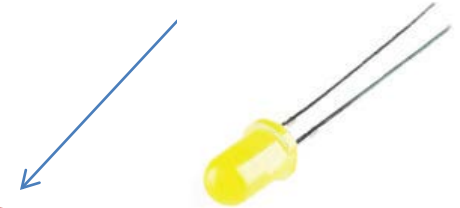


**Arduino**  
Pin 9

**LED**  
(Light Emitting Diode)

**resistor (330ohm)**  
(Orange-Orange-Brown)

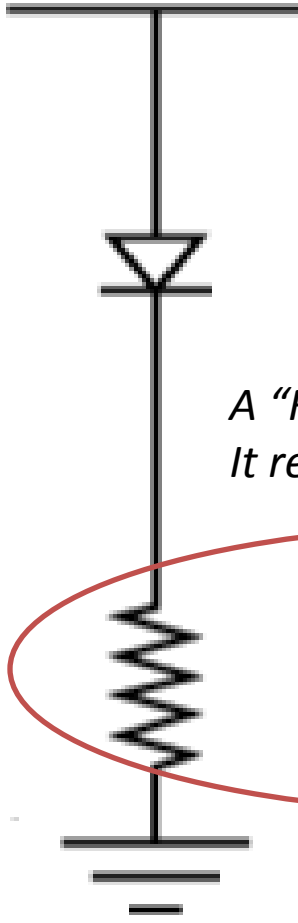
**GND**  
(ground) (-)



**Energy Source**  
Electricity starts here

Direction of current  
↓  
**GND**

Electricity ends here



**Arduino**  
Pin 9

**LED**  
(Light Emitting Diode)

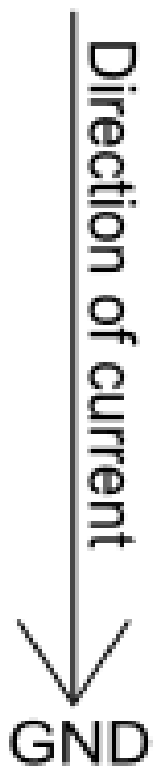
*A "RESISTOR" - that resists current, the more  
It resists, the dimmer the light from the LED*

**resistor (330ohm)**  
(Orange-Orange-Brown)

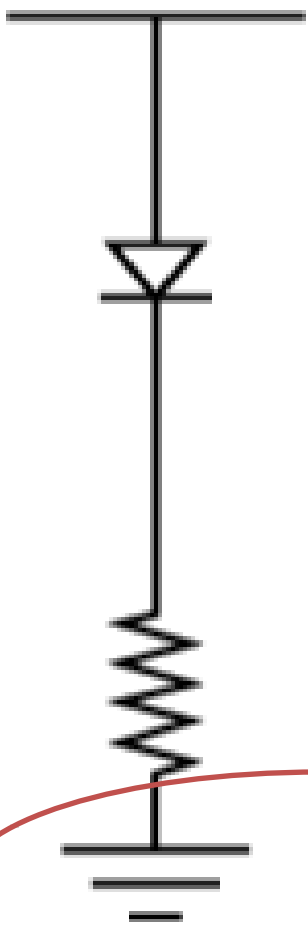
**GND**  
(ground) (-)



**Energy Source**  
Electricity starts here



Electricity ends here

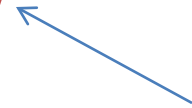


**Arduino**  
Pin 9

**LED**  
(Light Emitting Diode)

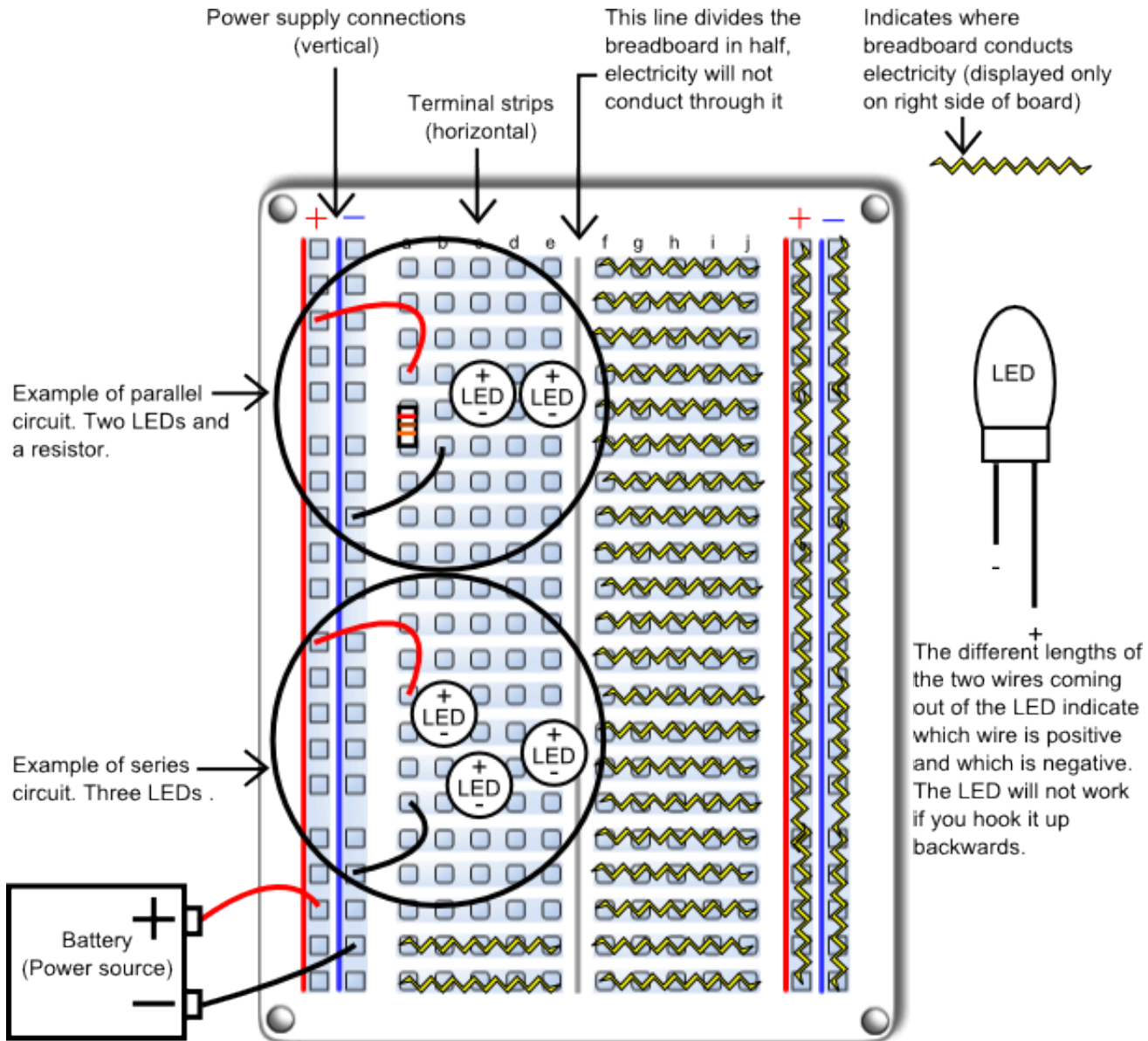
**resistor (330ohm)**  
(Orange-Orange-Brown)

**GND**  
(ground) (-)



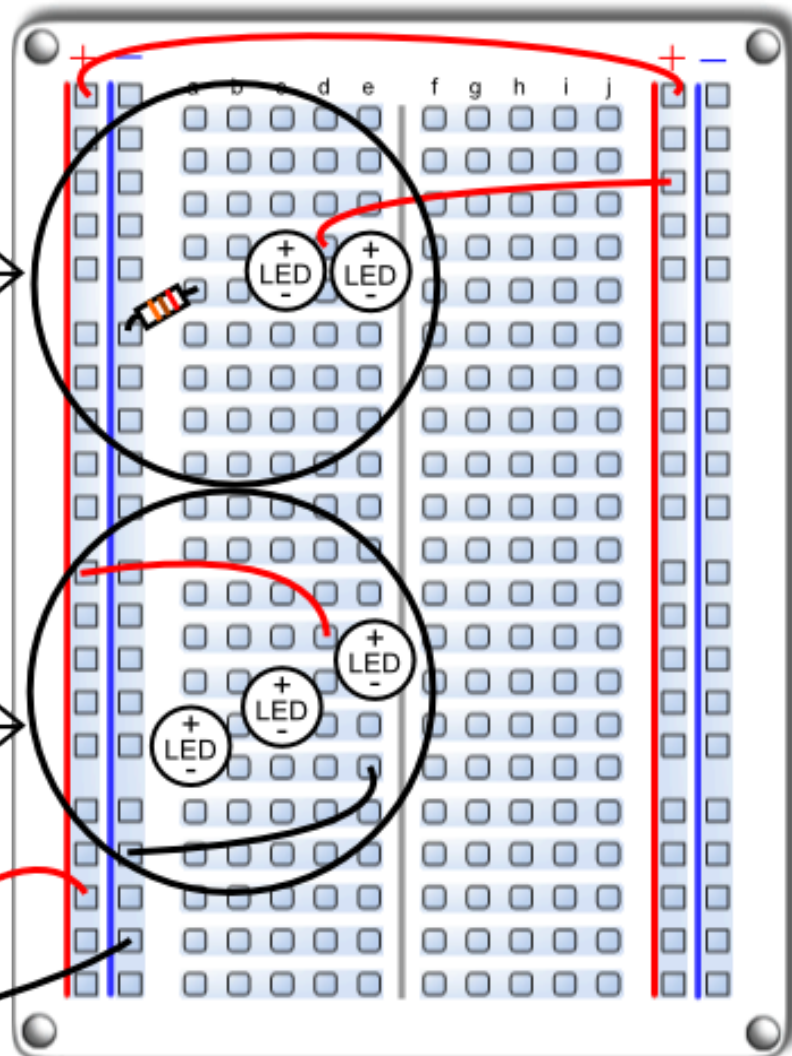
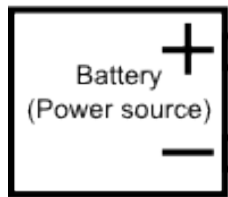
*"GROUND" – nirvana for electrons weary from Travel...*

- The Breadboard

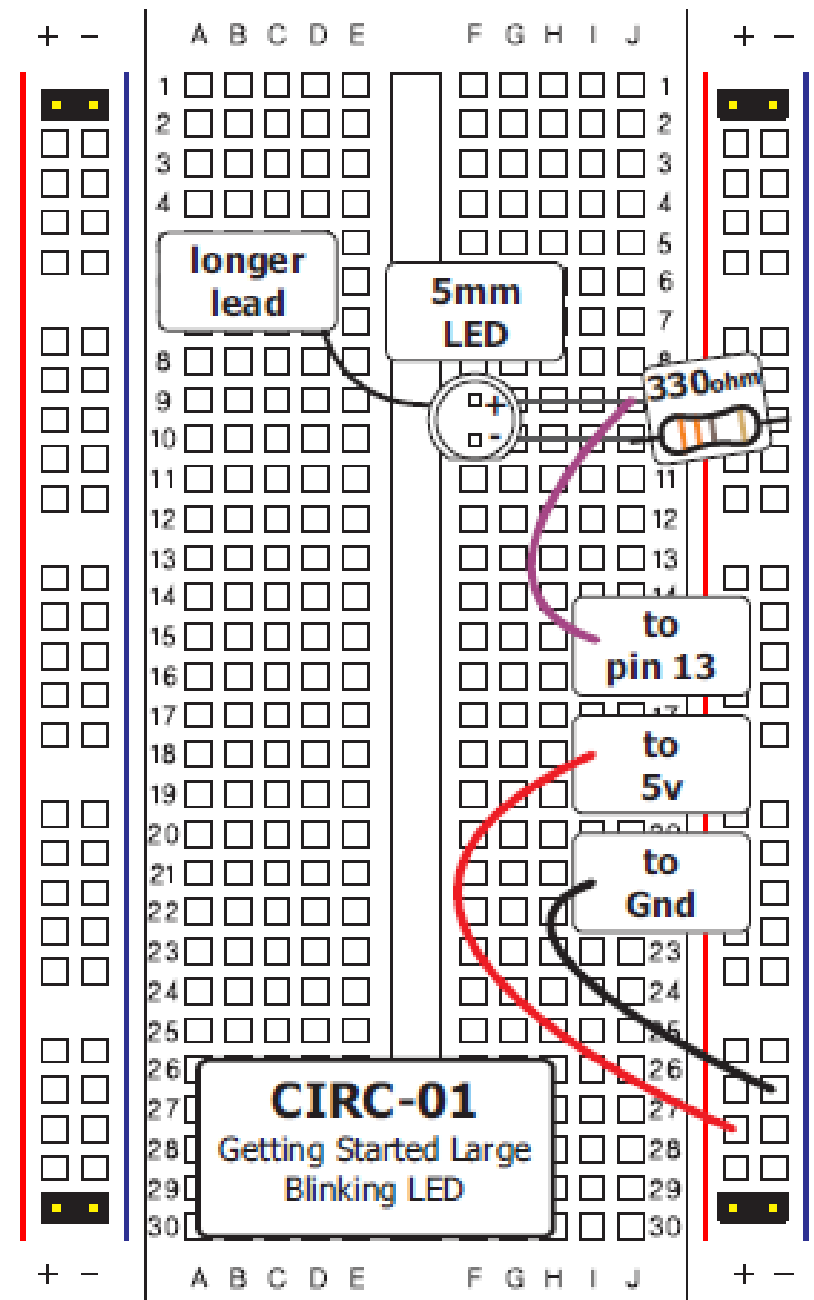


Example of parallel circuit. Two LEDs and a resistor.

Example of series circuit. Three LEDs .



< Breadboard Worksheet >





- The Sketch

## Code:

```
int ledPin = 3;

void setup() {
  pinMode(ledPin, OUTPUT);
}

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

- Tweaking

- Changing Pins
- Changing Blink Frequency
  - Multiple LEDs
  - Changing Brightness

- Analog vs. Digital
  - PWM

# Analog Signals

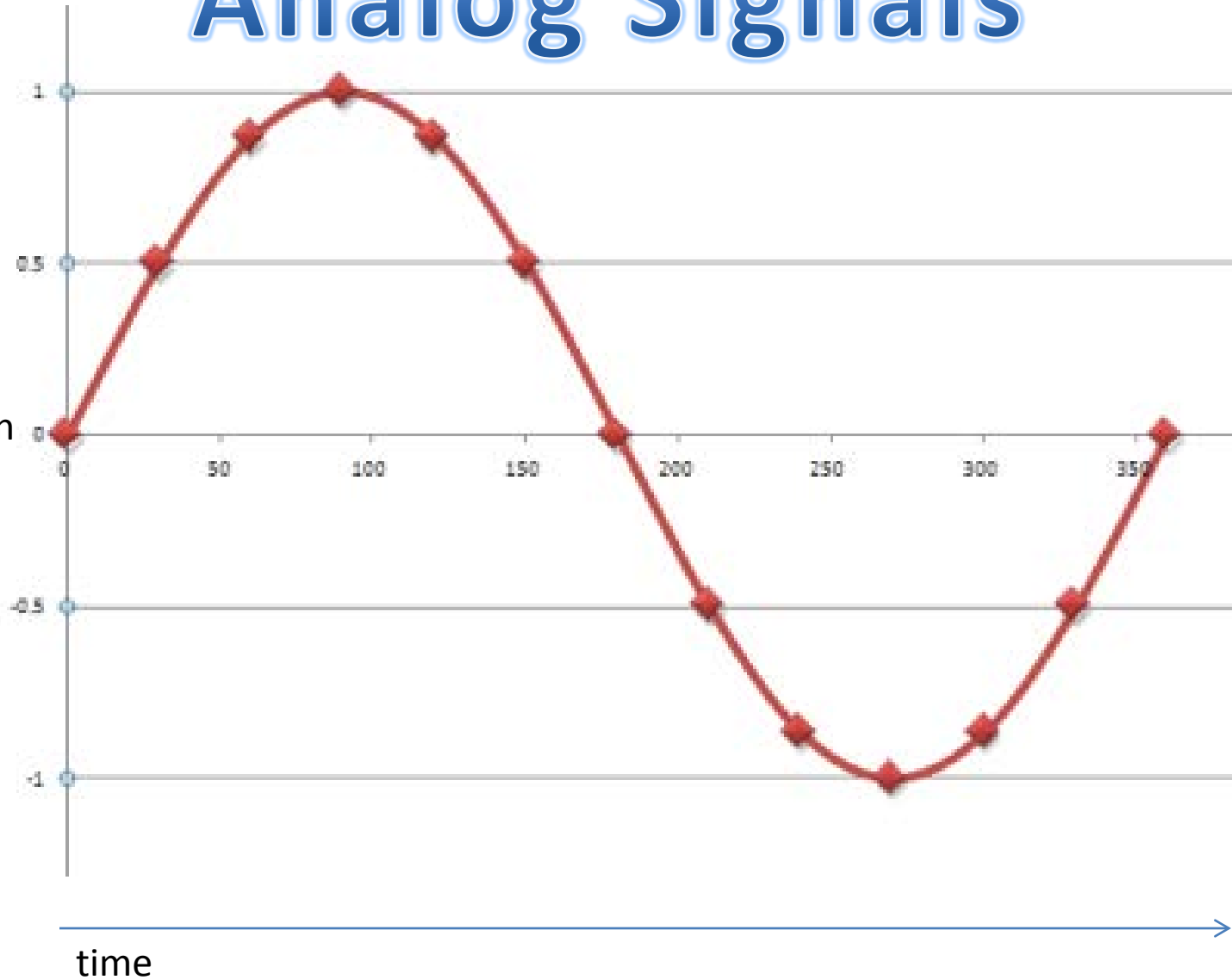
Max Volts  
("high")



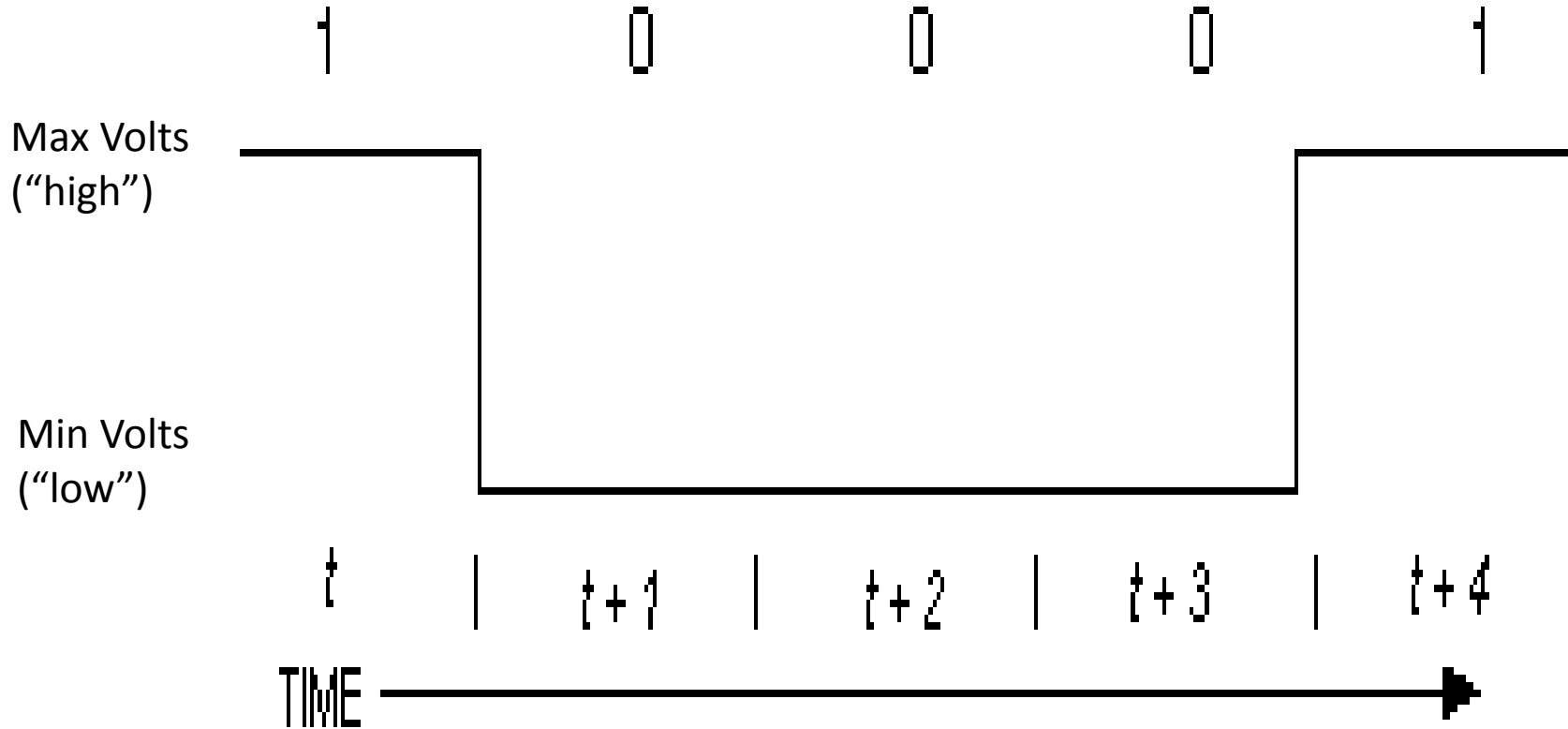
In-between



Min Volts  
("low")

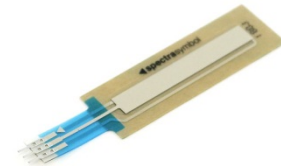
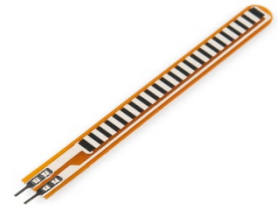
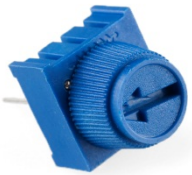


# Digital Signals



- *Analog Input Signals:*

*Thermometer  
Potentiometer  
Flex Sensor  
Photo-resistor  
Softpot*





- *Digital Input Signals:*



*Button*

Press  
me!

- *Digital Output Signals:*



*Relay*

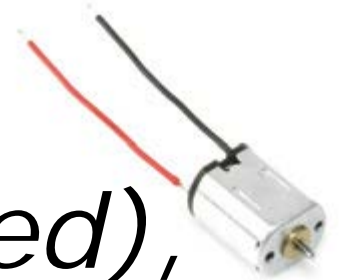
Turn  
me on!

*- Analog Output Signals:*



*LEDs: If we can vary the output voltage, we can vary the brightness!*

*Same for Motors (speed),  
Servos (angle),  
Buzzers (pitch)*



However....

- *Arduino accepts analog and digital inputs, **but can only output digital signals***

- *Huh?*

- *So do you mean we can't use  
some of this cool stuff in our  
kit?*

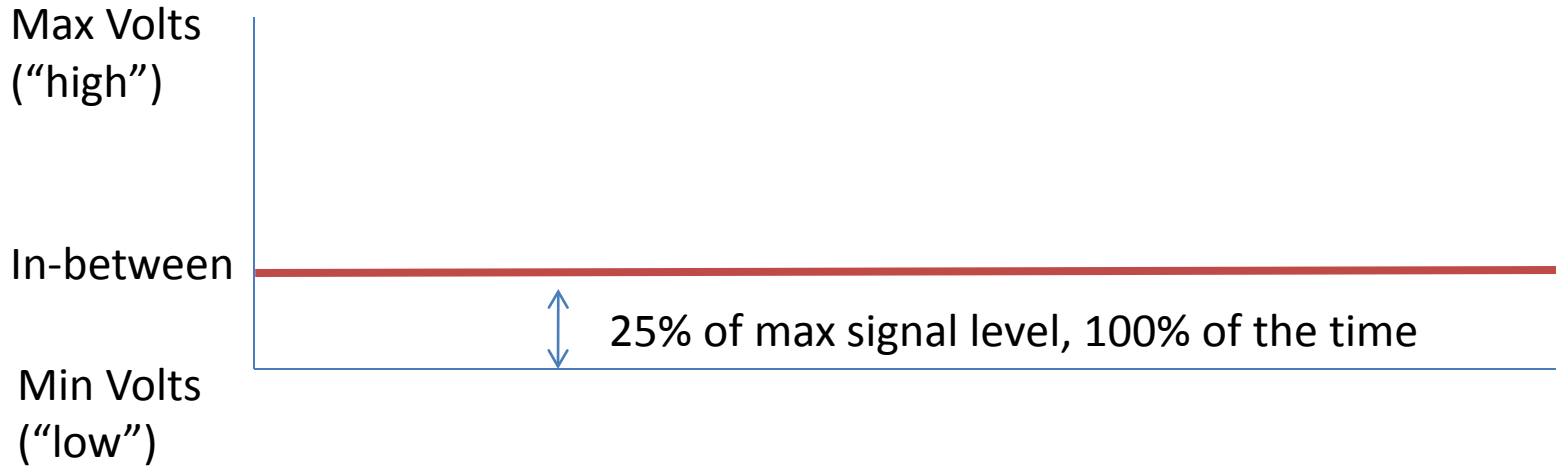
- *So how can we send vary the brightness of a LED if we can only output digital signals?*

- *Analog Outputs can be simulated with “**Pulse Width Modulation**”*

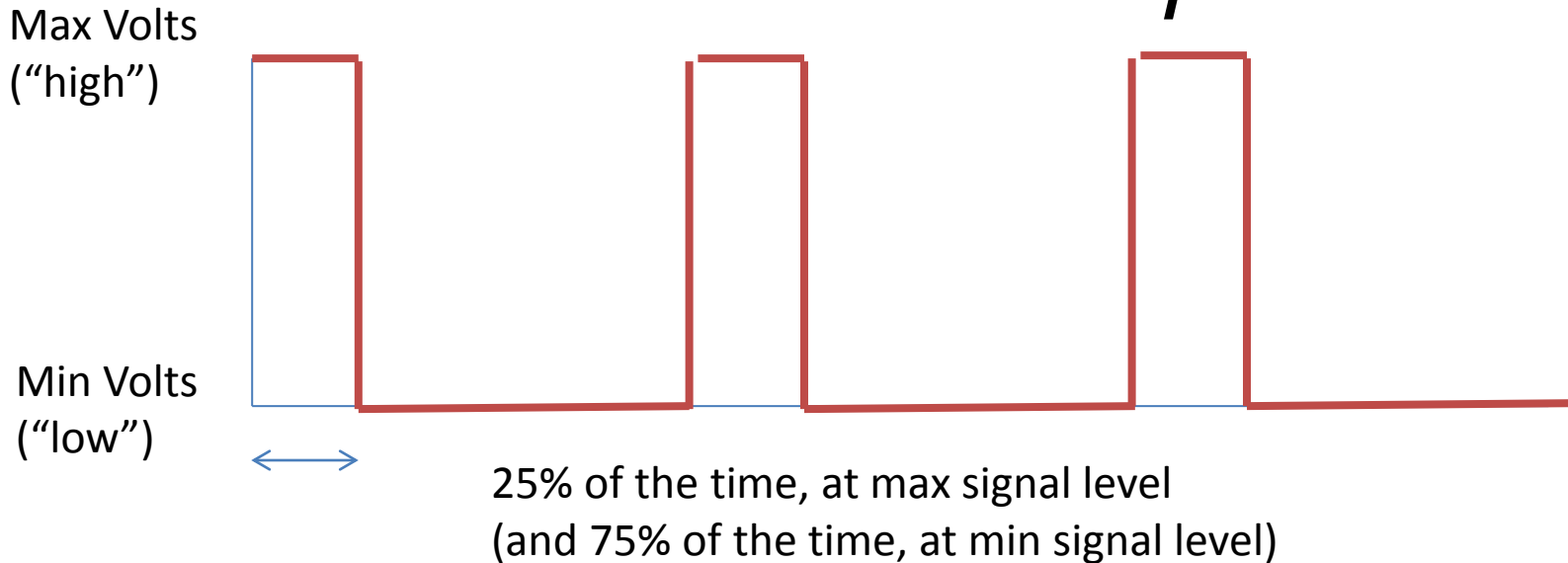
*(which varies the signal \*time\* rather than the signal \*level\*)*



- *So instead of:*



- *PWM will output:*



*But... but... but...*

*Wouldn't making a light blink  
just to make it dimmer be  
annoying...*

## *Surprising Fact:*

*- An LED that blinks fast enough will not appear to blink at all!*

## Things to remember about Analog:

- Analog Input uses the Analog In pins, Analog Output uses the PWM pins
- To receive an Analog signal use:  
*analogRead(pinNumber);*
- To send a PWM signal use:  
*analogWrite(pinNumber, value);*
- Analog Input values range from 0 to 1023 (1024 values because it uses 10 bits,  $2^{10}$ )
- PWM Output values range from 0 to 255 (256 values because it uses 8 bits,  $2^8$ )

## Things to remember about Digital:

- Digital Input/Output uses the Digital pins, but Analog In pins can be used as Digital
- To receive a Digital signal use:  
*digitalRead(pinNumber);*
- To send a Digital signal use:  
*digitalWrite(pinNumber, value);*
- Digital Input and Output are always either HIGH or LOW

## Control the brightness:

Change the LED to pin 9: (also change the wire)

[Because not all pins support PWM]

```
ledPin = 13; -> int ledPin = 9;
```

Replace the code inside the { }'s of loop() with this:

```
analogWrite(ledPin, new number);
```

```
// 0 = off, 255 = on, in between = different brightness
```

Then upload the sketch: (ctrl-u)