



# Start the journey to Internet of Things with Arduino

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[www.devoxx4kids.org/usa](http://www.devoxx4kids.org/usa)

[facebook.com/Devoxx4Kids](https://facebook.com/Devoxx4Kids)

@Devoxx4Kids





# Ground rules

- > Participate and enjoy; Share, work as a team.
- > Be Safe!
- > Getting attention: If your team needs help, make the red cup visible. Otherwise keep the green cup visible.
- > This is a work area! People are working. Please do not disturb them.
- > Use the kits carefully and re-assemble it back at the end of the workshop. Other teams will use them.
- > One parent can help the team, if needed.
- > Rest rooms are by the break room.



# New gadgets ....



## FLEX TRACKS:

的脚步 STEPS TAKEN

位置 DISTANCE TRAVELED

燃烧的卡路里 CALORIES BURNED

活跃分钟 ACTIVE MINUTES

睡眠小时 HOURS SLEPT

睡眠质量 QUALITY OF SLEEP

Powered by Fitbit's leading-edge accelerometer, Flex bases calculations like calories burned on your personal profile — reflecting your stats, not any average Joe's.



[www.devoxx4kids.org/usa](http://www.devoxx4kids.org/usa)

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# New gadgets ....

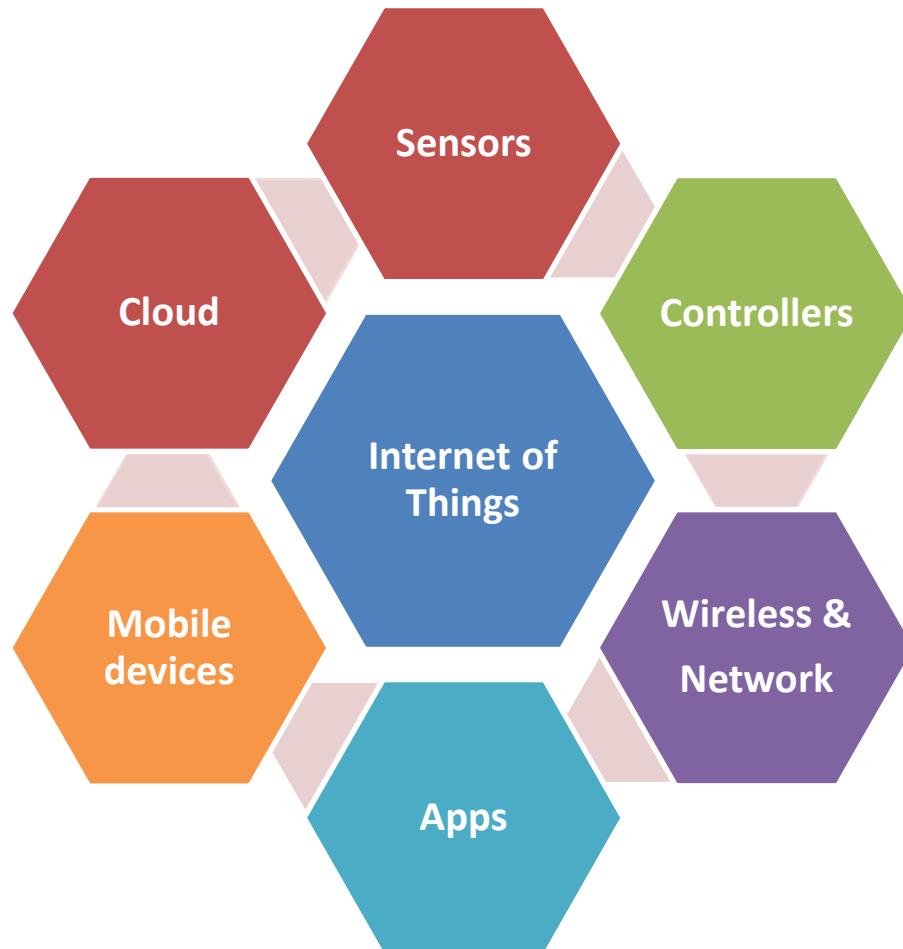




Have you seen this  
one ....



# Joining hands ...





# What are we going to do today?

- > Use electricity to sense and change the world around us.
- > Connect sensors and actuators to controller (Arduino) and make "Things"
- > Write instructions for Arduino to provide "behavior" to "Things"
- > Communicate with "Things" over network



I am Arduino!



Sono Arduino!

나는 아두 이노입니다

मैं अर्दुनओ हूँ

我的Arduino!

Ik ben Arduino!

Je suis Arduino

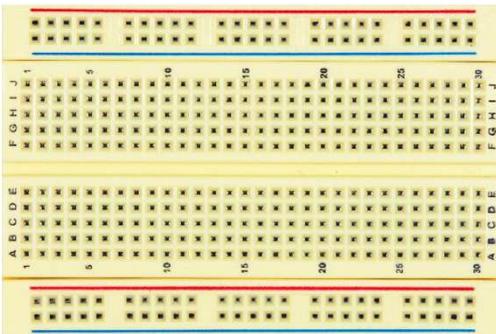


# Activity #1

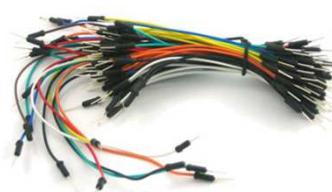
- > Build a light with a switch you push to turn it on (Just like the one for door-bell)
- > Try with the Latch (an On-Off switch, just like one for light)



# What do you need?



Breadboard



Wires  
1 Red  
1 Black



Battery Holder



2 AA Batteries



Push to On  
Switch

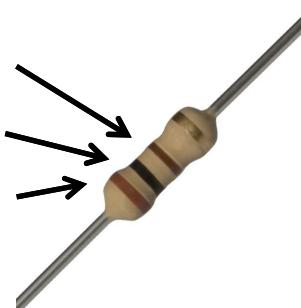


Latch

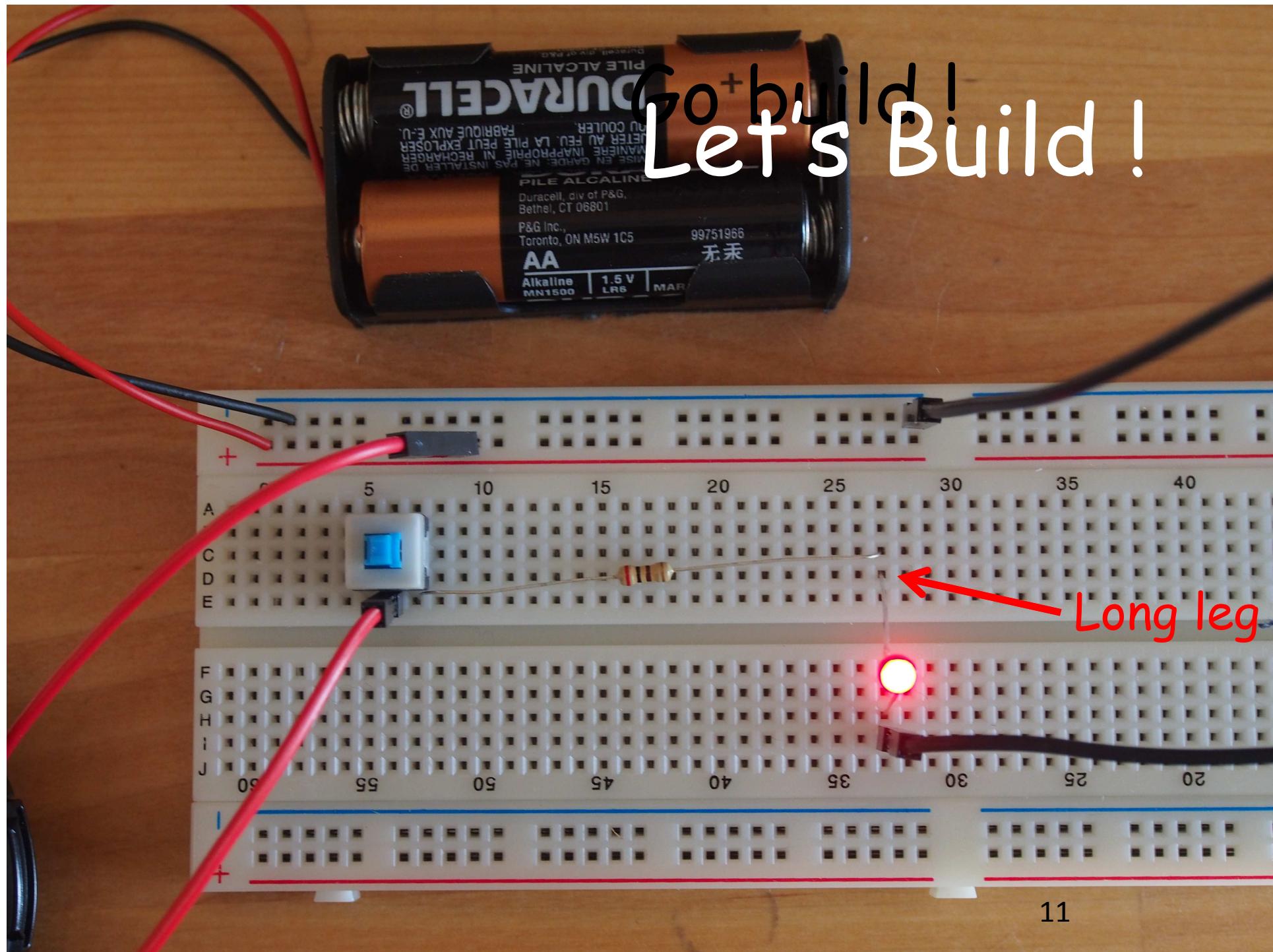


Red L-E-D

Brown Ring  
Black Ring  
Brown Ring



Resistor (100 ohms)



# Did it work?



Did you try with the  
other type of switch?

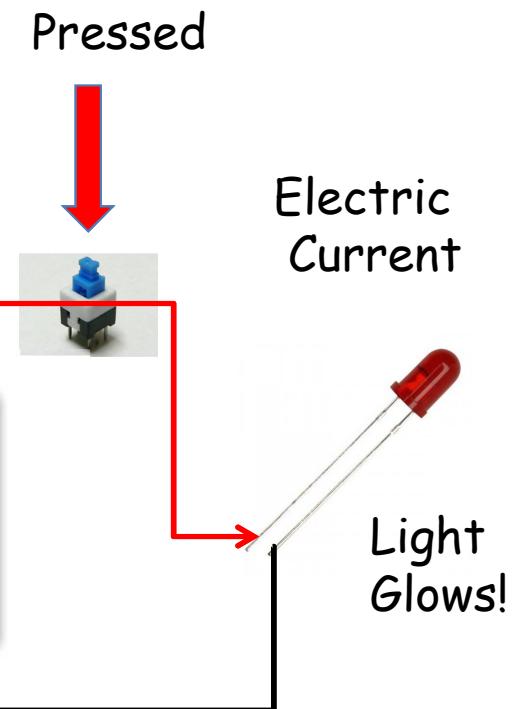
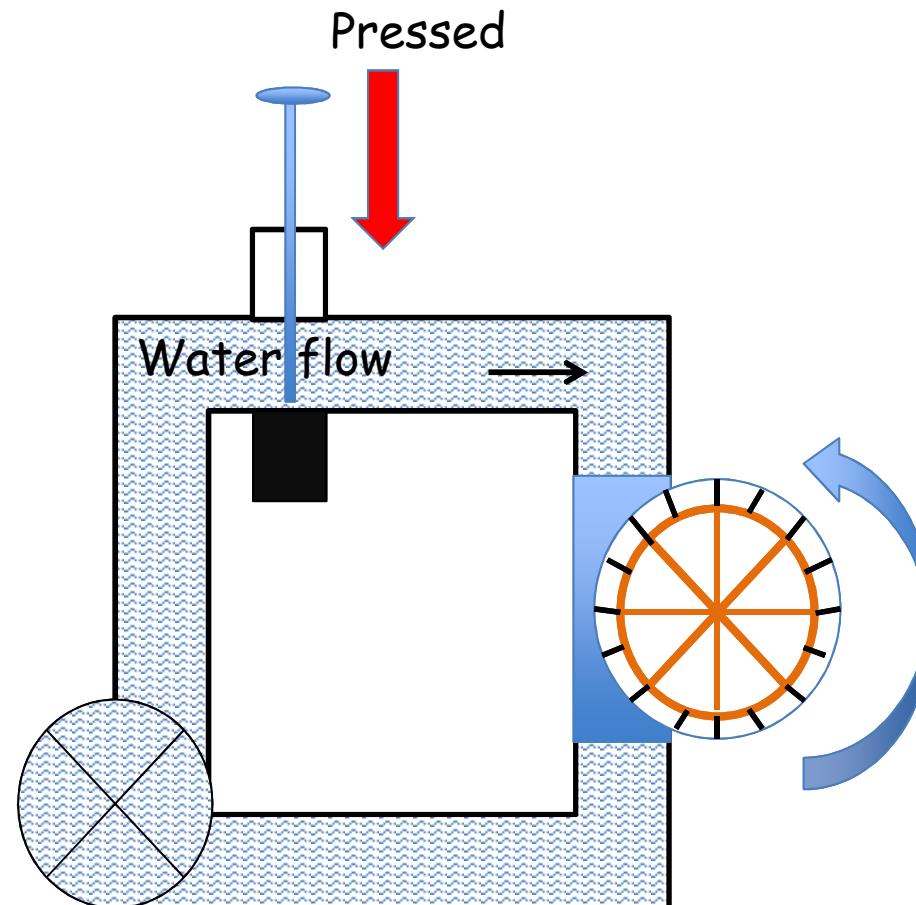
- > What is the difference?



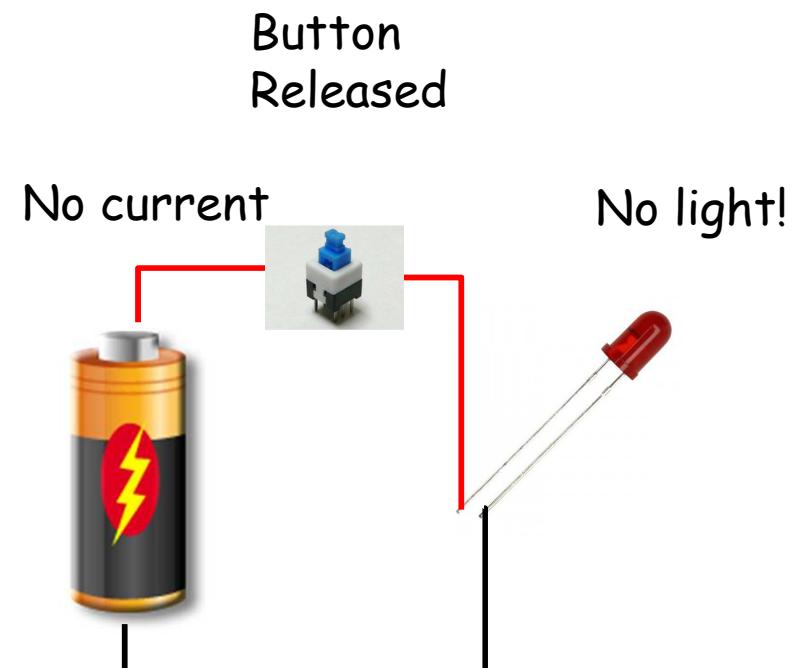
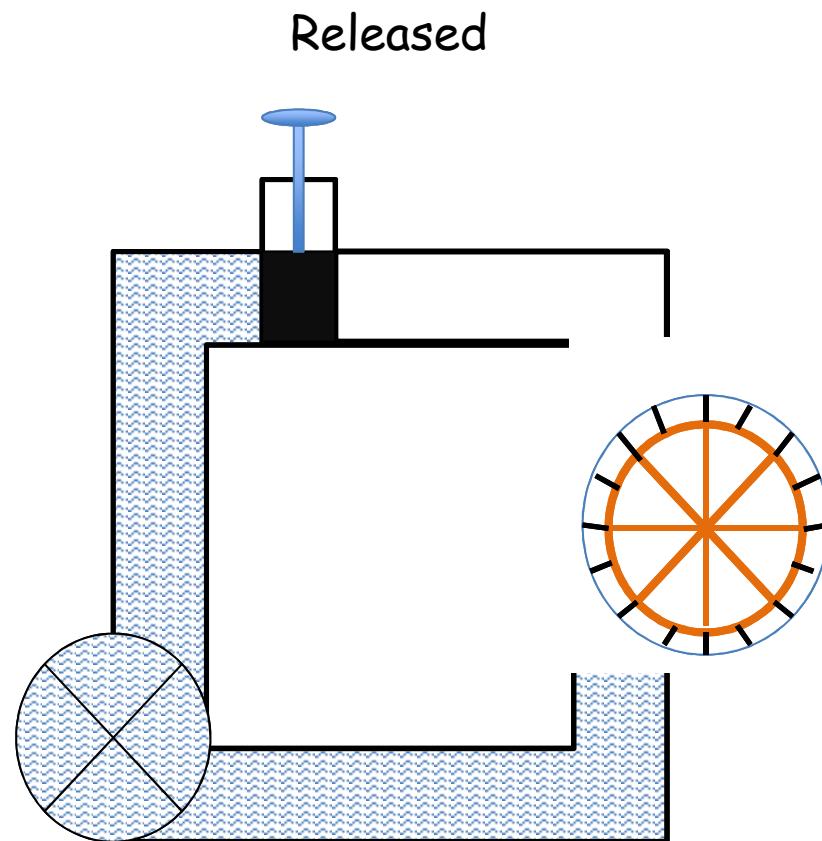
# Electricity

- > Atom and sub-atomic particles
  - Electrons (negatively or -ve charged)
  - Protons (positively or +ve charged )
- > Electric charge
- > Electric force
- > Electricity
- > Animations to check out:  
<http://scratch.mit.edu/users/Devoxx4Kids-USA/>

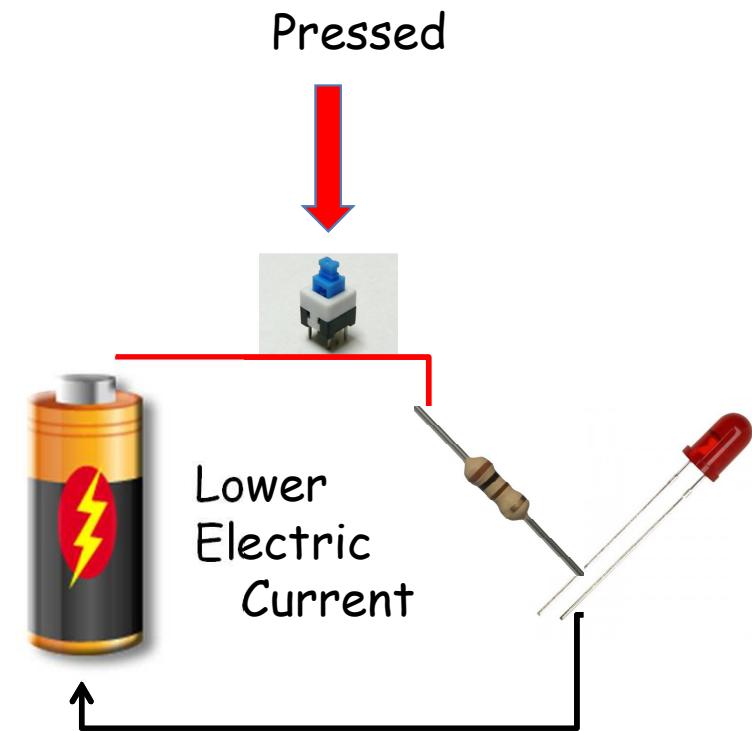
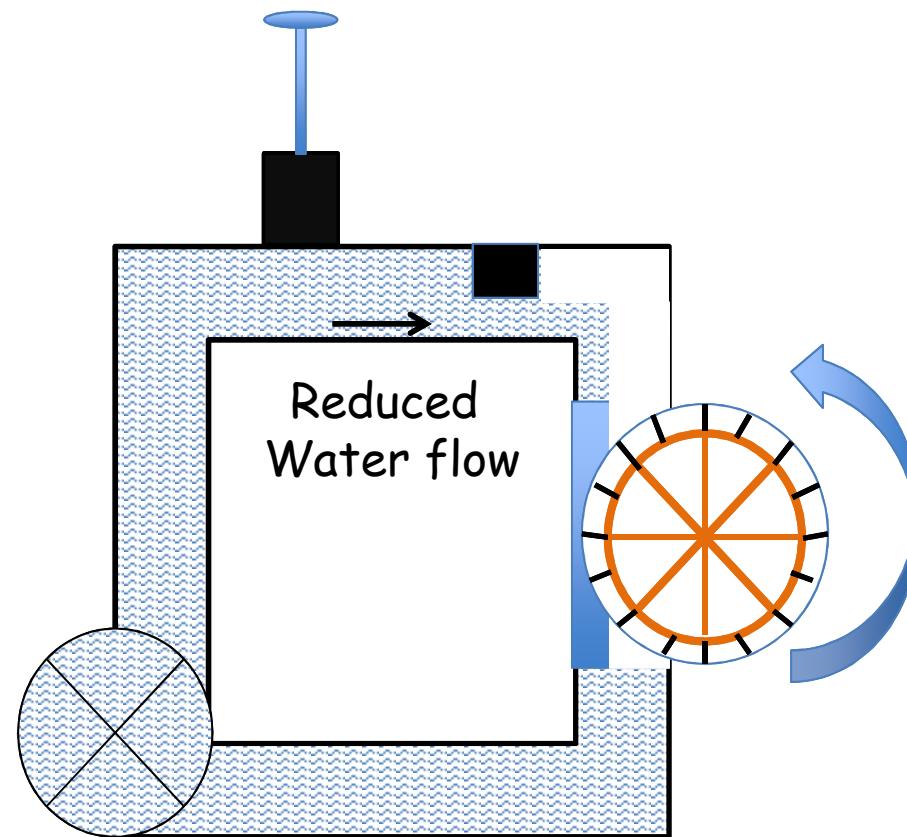
# How does it work?



# What does switch do?



# Why do we need the resistor?





# Electric push (Voltage)

- > Voltage is the push for the charge to flow
- > Voltage is measured in Volts
- > Volts is shown as 'V' in diagrams



# Electric Current

- > Current is the flow of electric charge
  - > Current is measured in Ampere
  - > Ampere is shown as Amp or A in diagrams
  - > Smaller unit of current is milli Ampere (or mA).
  - > 1000 milli Ampere = 1 Ampere
- [www.devoxx4kids.org/usa](http://www.devoxx4kids.org/usa)



# Resistance

- > Resistance is the opposition to the passage of electric current
- > Resistance is measured in Ohms.
- > Resistance is shown as Ohms or  $\Omega$  in diagrams. Larger resistances are shown as "Kilo" or "Mega"

# Let us meet the components ....

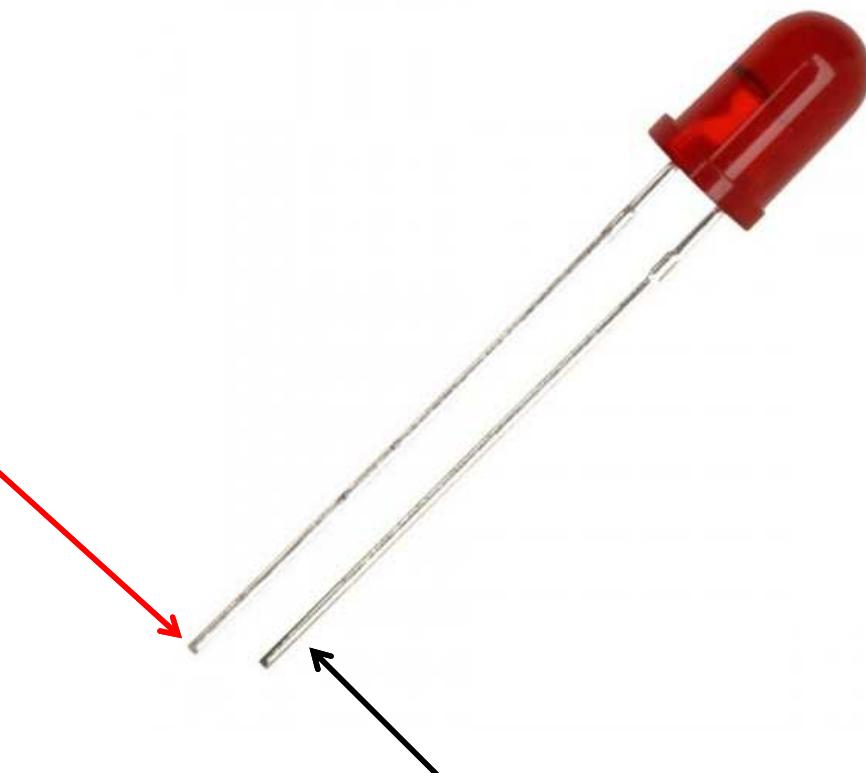
# I am battery

- > I push the electrons or "electric charge" in the circuit
- > Each battery provides a push for electrons to flow.
- > The push is also called Voltage and is measured in Volts.
- > Each AA Battery provides 1.5 Volts of push.
- > Two batteries pushing after one another create a push of 3.0 volts



# I am L-E-D

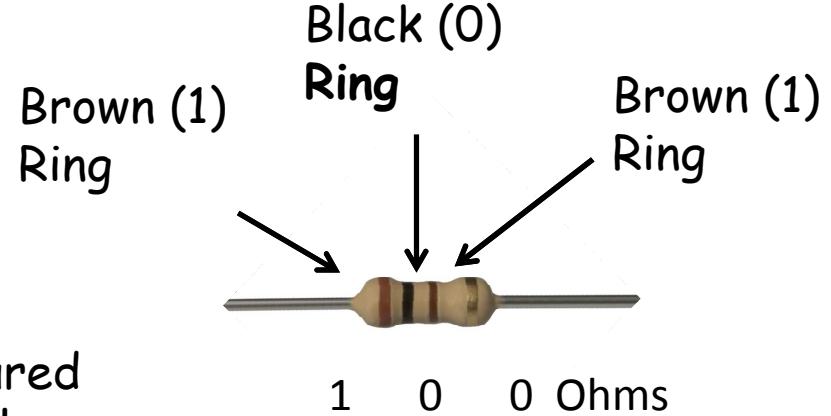
- > An LED is a very small light, often colored (white / red / yellow / green)
- > Each LED has two legs ... a short and a long
- > Long is the PLUS (+) (positive pole)
- > It glows when current flows
- > It can handle only small amount of current



> Short ... MINUS (-) (Negative pole)

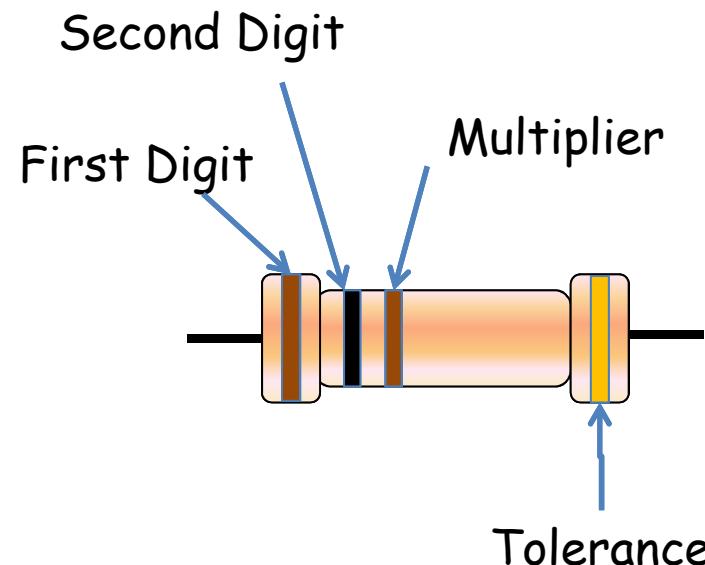
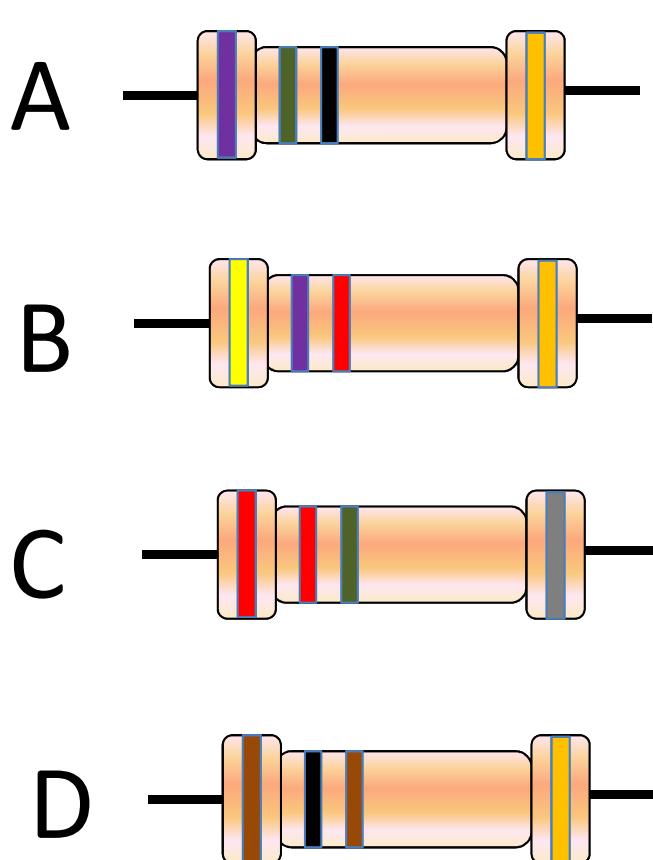
# I am resistor

- › I offer resistance to the flow of current
- › The amount of resistance I offer is fixed.
- › The amount of resistance I offer is measured in Ohms. Sometimes people prefer to use Kilo and Mega Ohms to keep the numbers small and easily readable
- › The amount of resistance I offer is identified by the colors of the rings on me.



Resistor (100 ohms)

# How much is my resistance?

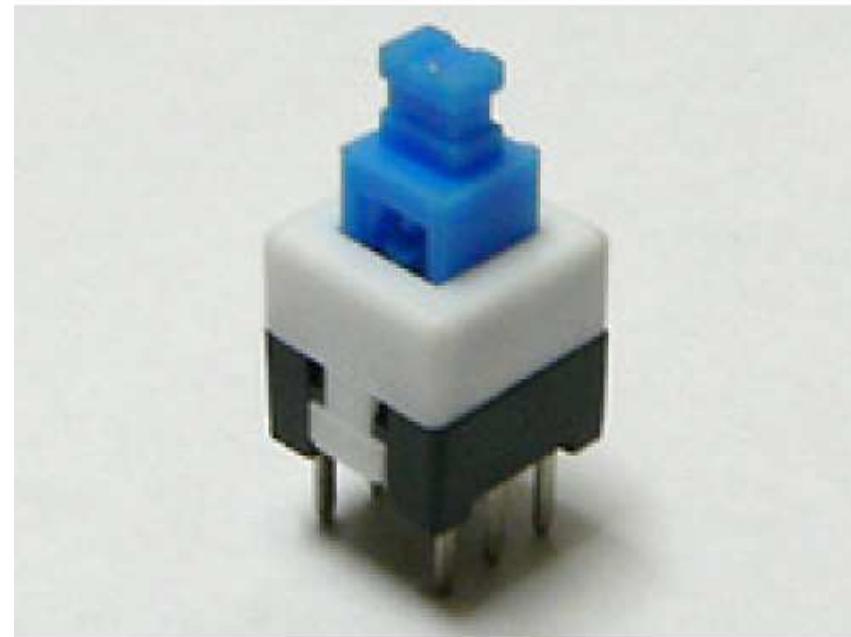


Color	Value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Color	Tolerance
Silver	10%
Gold	5%

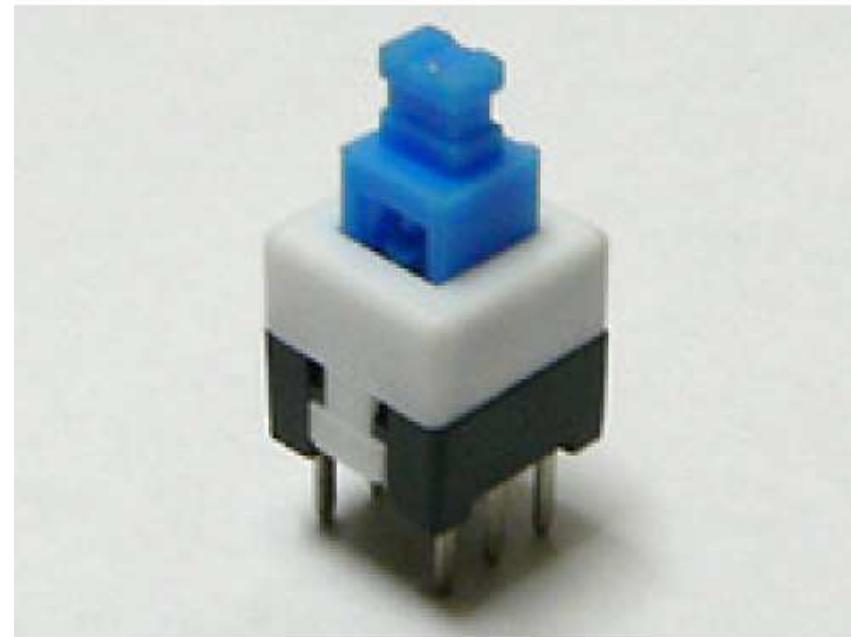
# I am “Push for On” switch

- > I let current pass when you press me.
- > I do not let any current to flow when I am left alone.



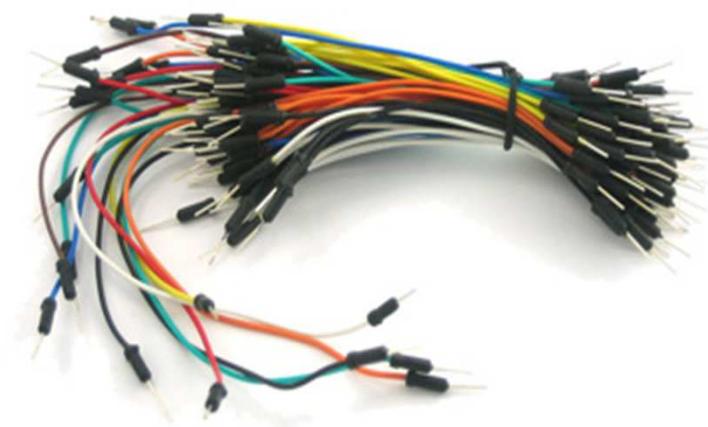
# I am Push Button Latch

- > Press me to close the circuit ("On")
- > Press again to open the circuit ("Off")



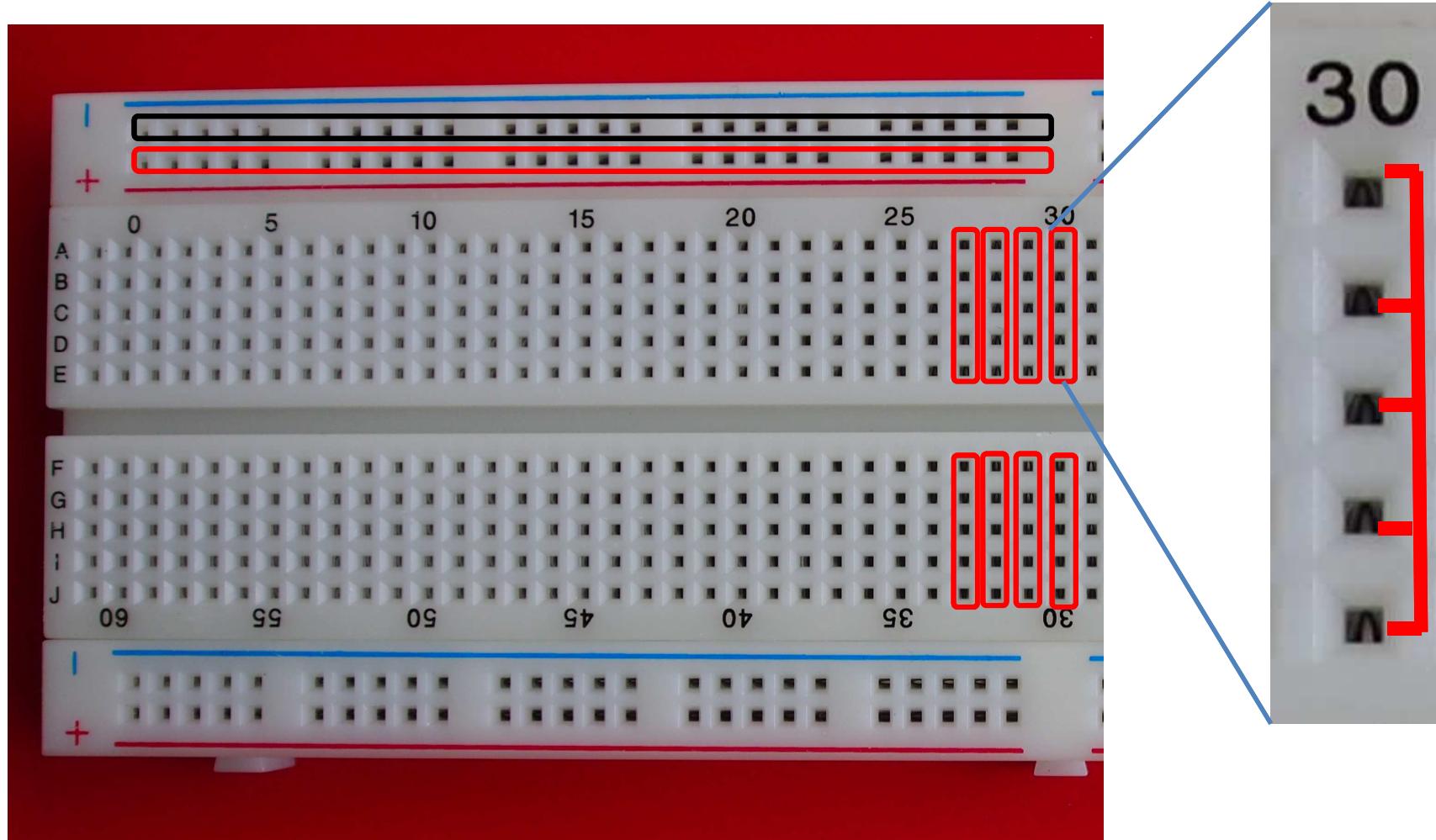
# I am wire

- > I am the pipe thru which electrons flow from one component to another.
- > I do not change the flow/ offer resistance.
- > Whatever voltage is one end, it gets transferred to the other end.
- > Color of the insulation does not change what I do!
- > Color can help identifying what signal I have, if you follow convention. For example, red color is usually the +ve voltage while black is Ground.

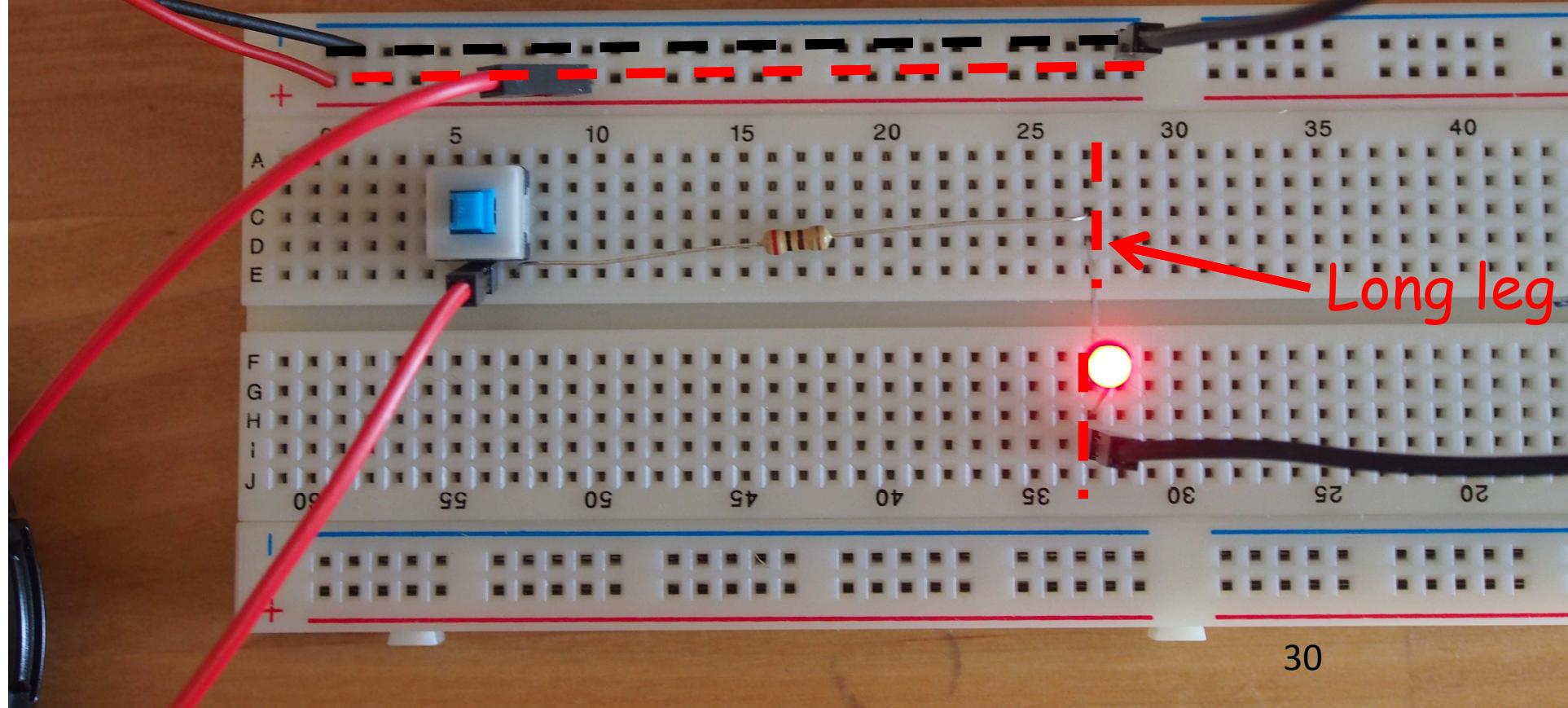




# I am Breadboard

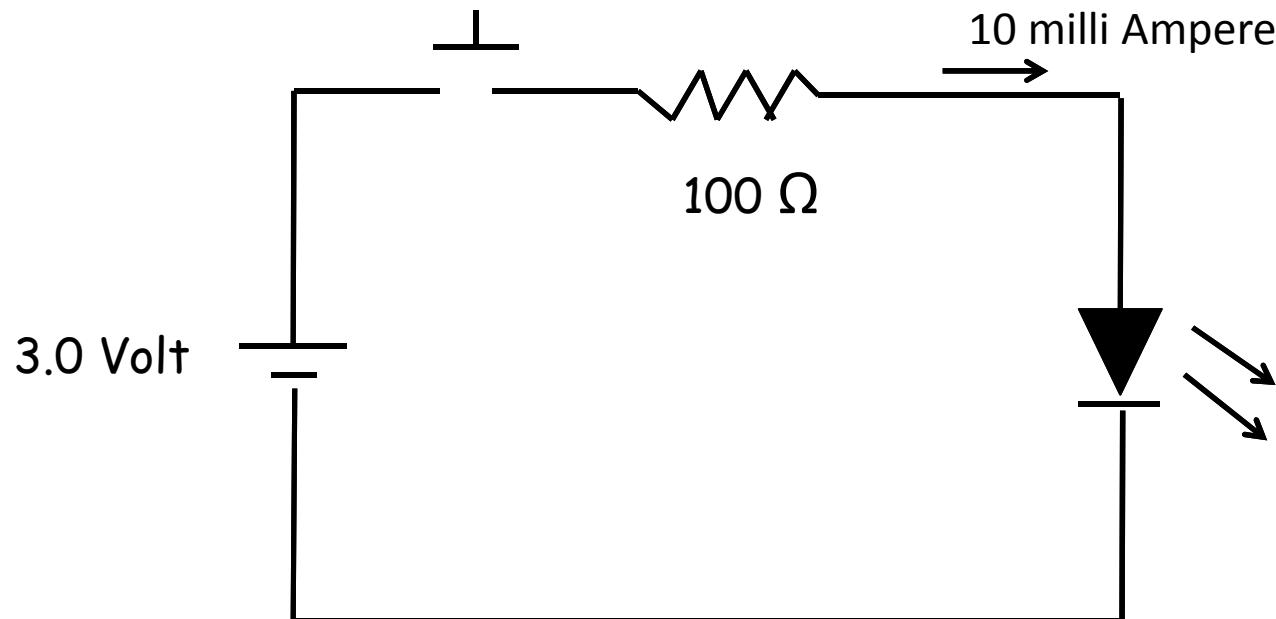


# Under the breadboard hood



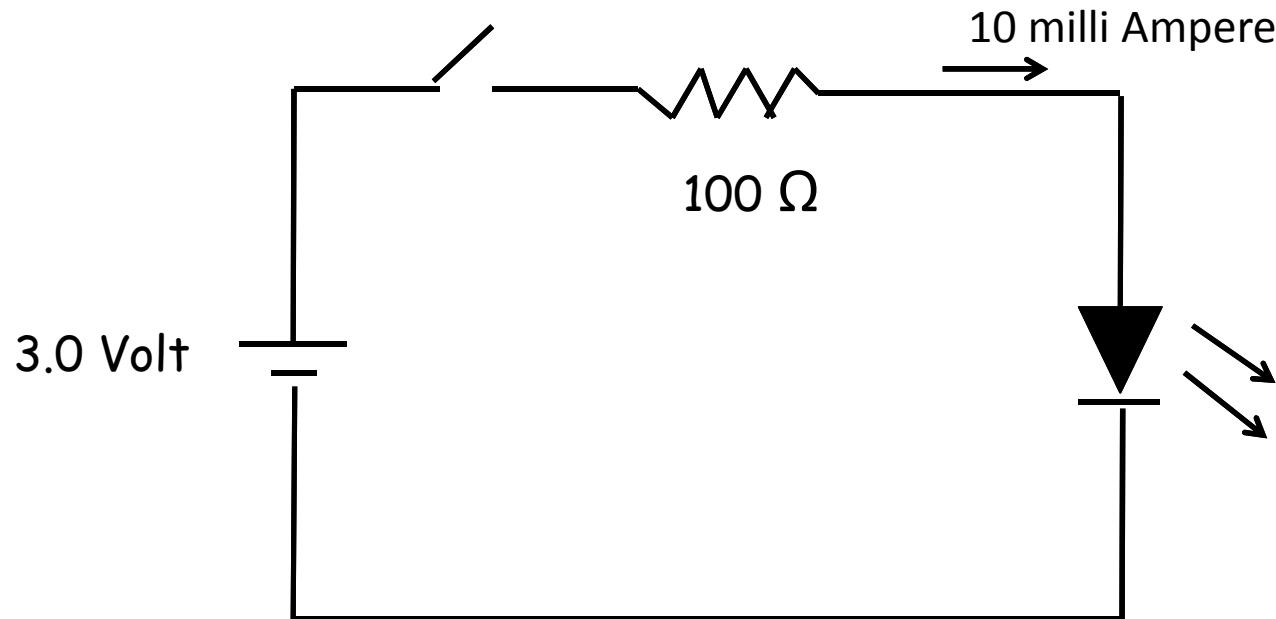
30

# The circuit diagram



... in the language of the engineers !

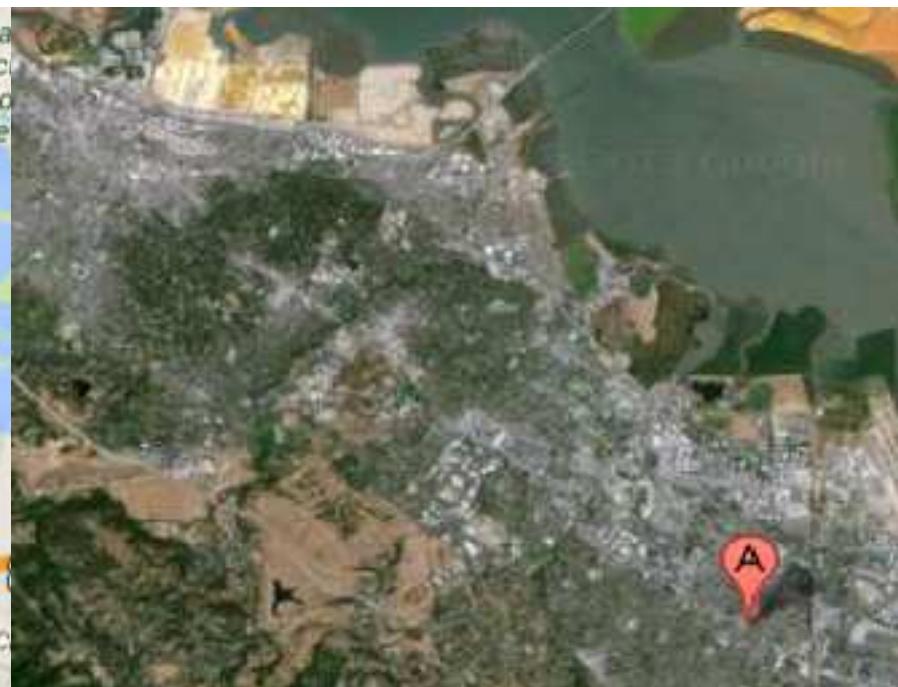
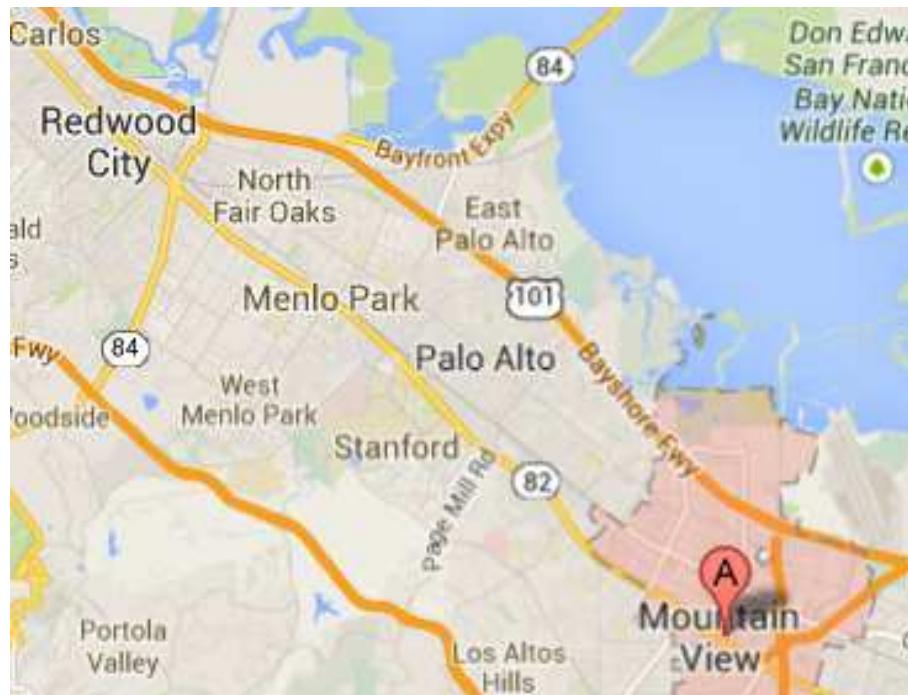
# The circuit diagram



... in the language of the engineers !



Which picture will you use to help a friend drive from Redwood City to Mountain View?



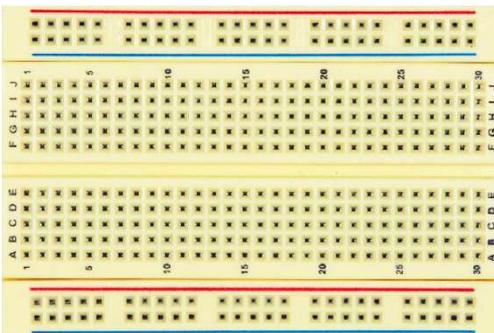


# Activity #2

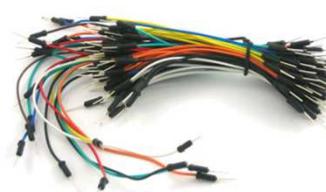
- > Build a light with a Dimmer



# What do you need?



Breadboard



Wires  
1 Red  
1 Black



Battery Holder



2 AA Batteries

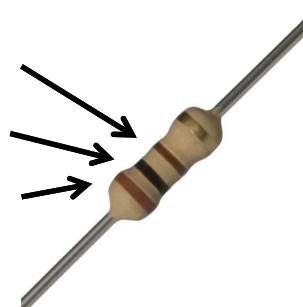


10 Kilo Ohm variable resistor  
Aka Potentiometer



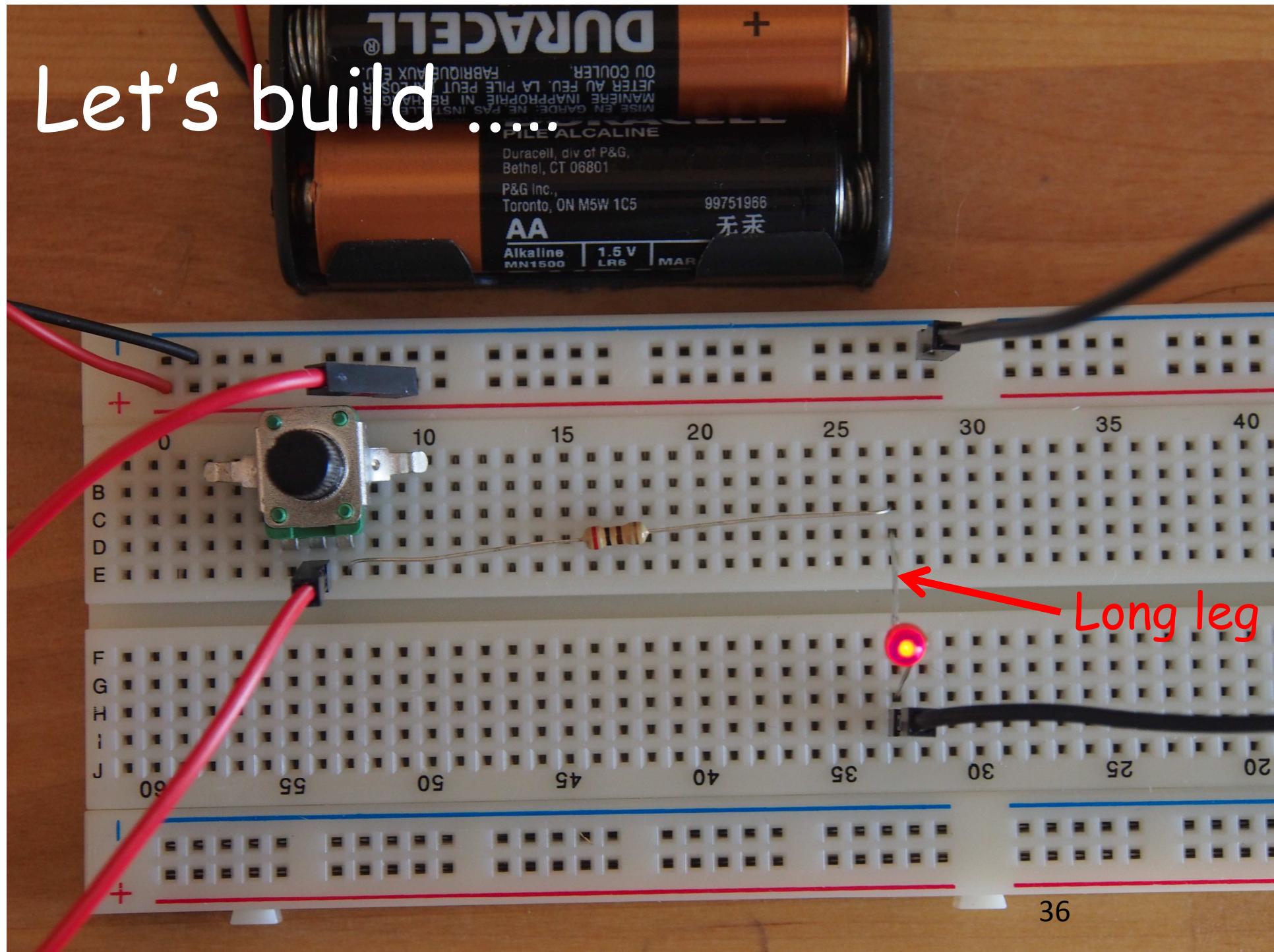
Red L-E-D

Brown Ring  
Black Ring  
Brown Ring



Resistor (100 ohms)

# Let's build ...



# Did it work?

# Let us meet the components ....

# I am the variable resistor

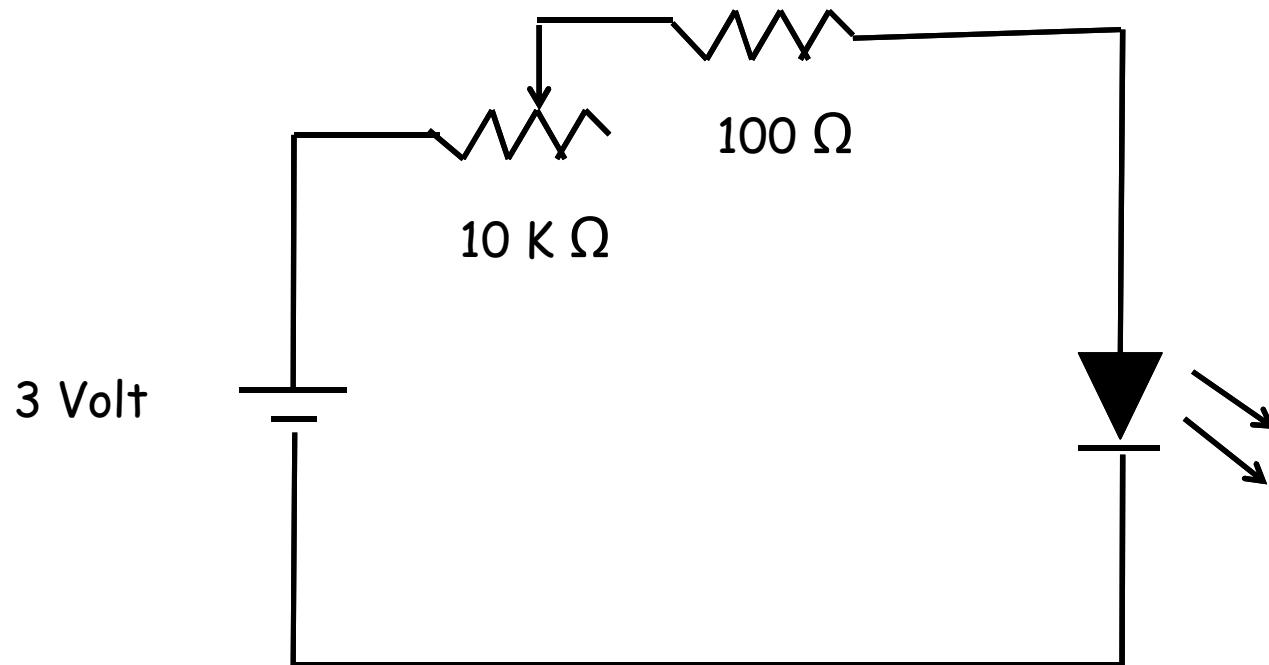
- > Resistance between the middle terminal and either of the two end terminal depends upon where the knob is turned.
- > The amount of resistance is somewhere in between fixed resistance and zero.



> I offer fixed resistance between the two end terminals.

→ I have three terminals

# The circuit diagram



... in the language of the engineers !



# How does it work?

[www.devoxx4kids.org/usa](http://www.devoxx4kids.org/usa)

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# Ohm's Law

- > If we increase the resistance in the circuit, less current will flow thru it.
- > Provided we do not change the voltage (push).



# Ohm's Law

- > If we increase the push(voltage) applied to the circuit, more current will flow thru the circuit
- > Provided we do not change the resistance

# Ohm's Law

- > Voltage drop across a component is the amount of current flowing through it and multiplied by the resistance offered by it.
- >  $V = I * R$



# What do we use Ohm's law for?

> LED manufacturer says: "This LED may be damaged if current above 10 milli Amps flows thru it. The voltage across the red LED will be 2 volts when it is glowing."



# Please remove the batteries

> Why?



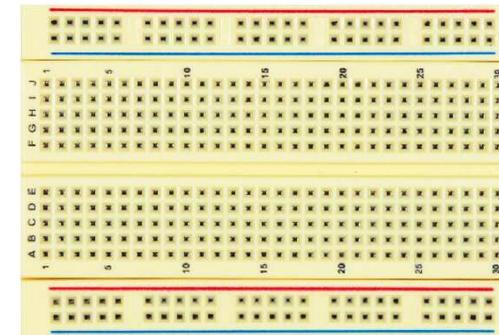
# Activity #3

- > Blinking LED using Arduino



# What do you need?

Arduino



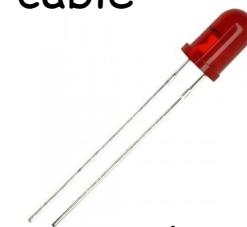
Breadboard



Wires  
1 Red  
1 Black

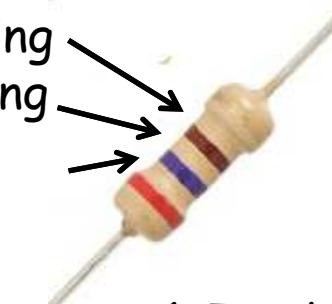


USB cable



Red L-E-D

Brown Ring  
Violet Ring  
Red Ring

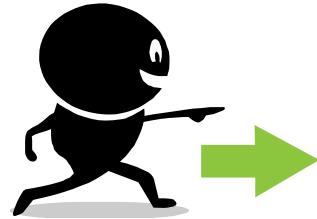


Resistor (270 ohms)



# How does it work?

## Instructions



Input ports



Sensing



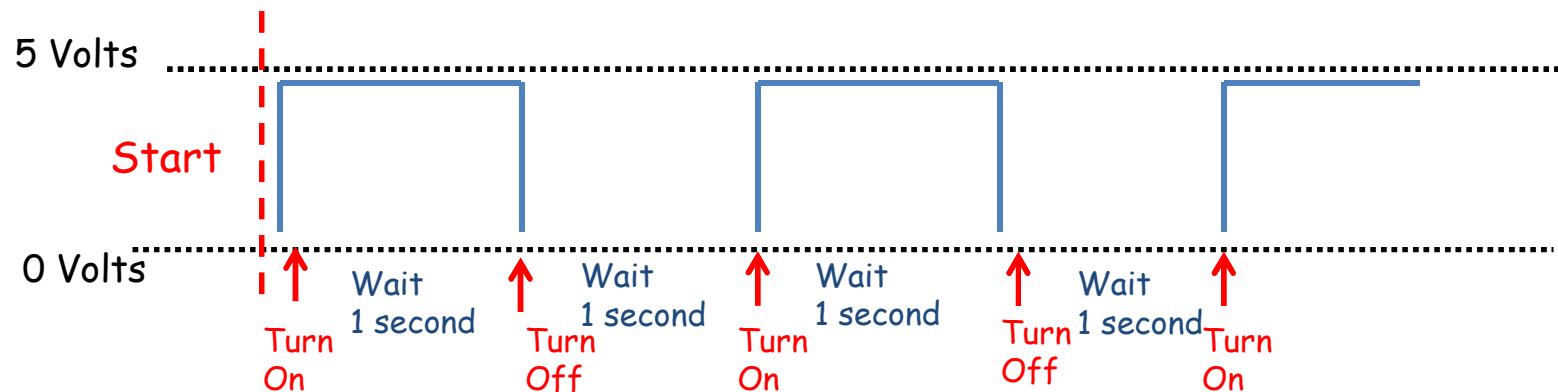
Output ports



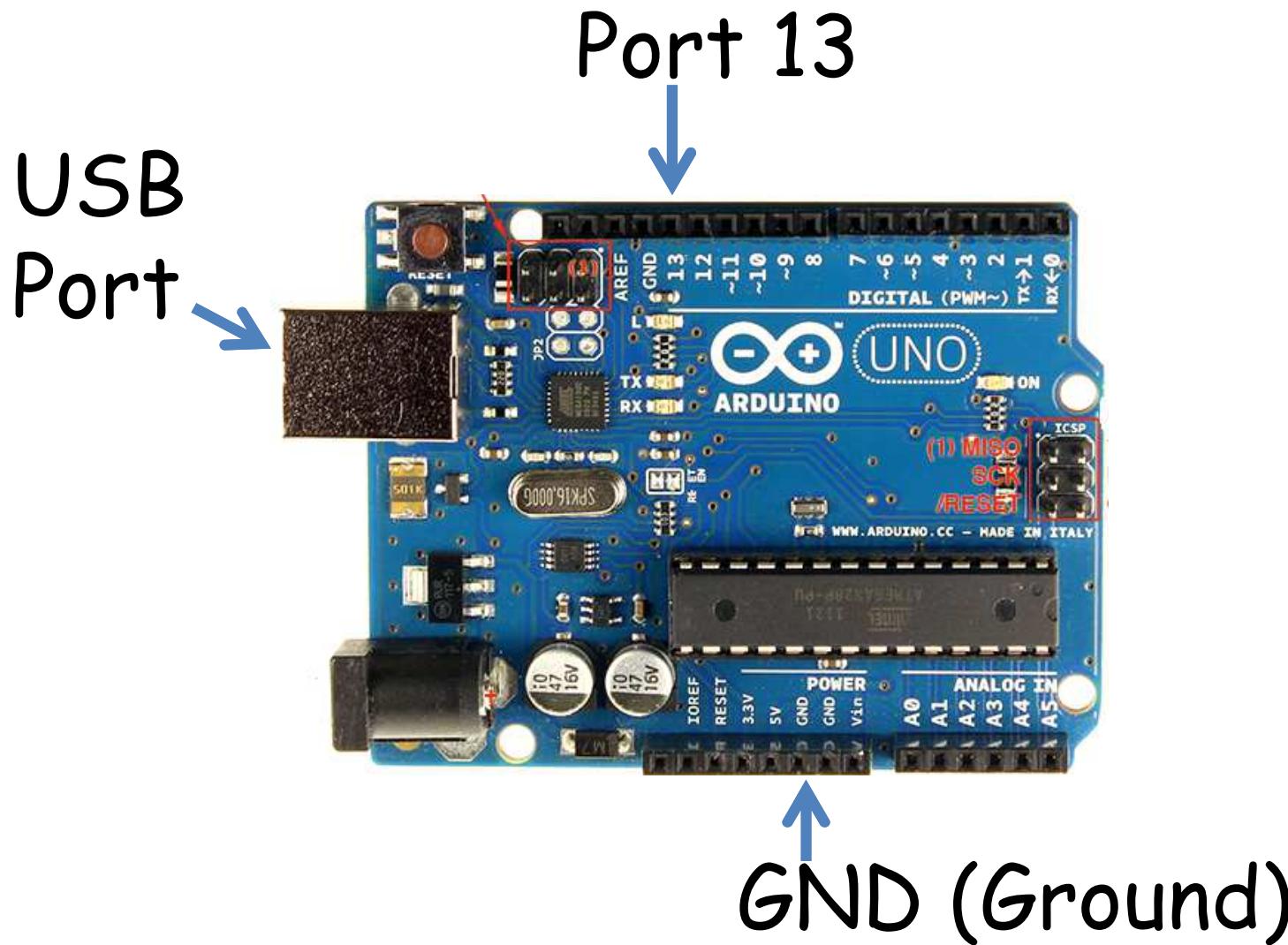
Controlling

# Digital Output Port

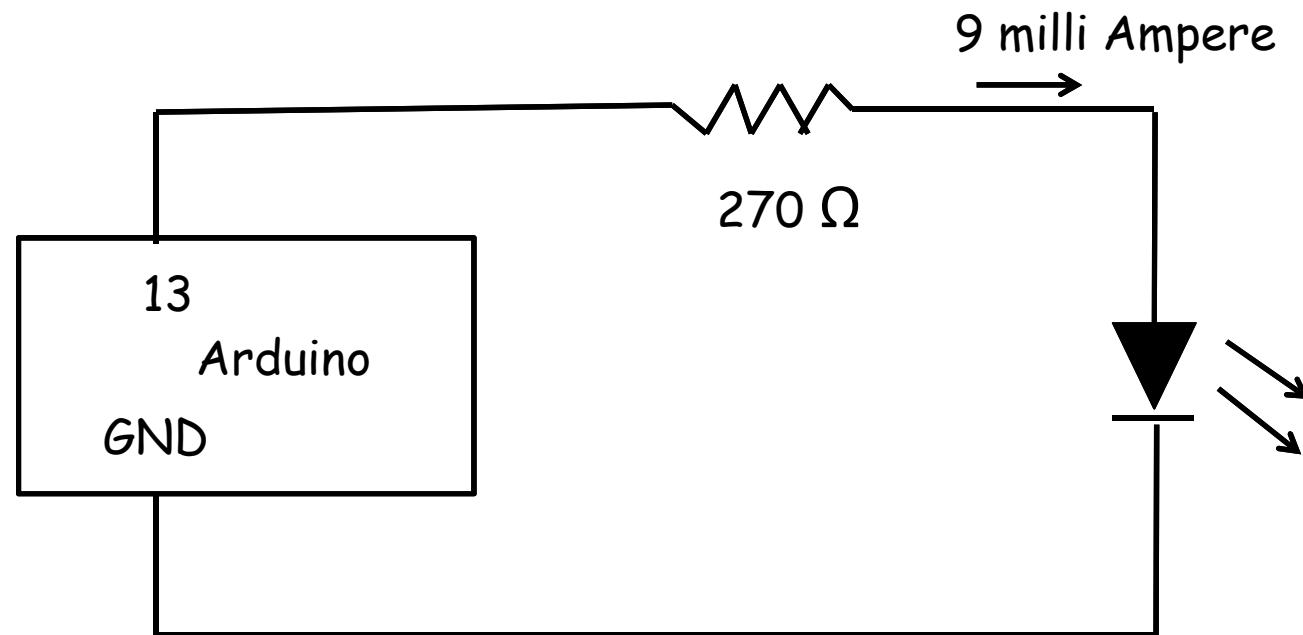
- > Device (our LED circuit) is connected to the port
- > Arduino generates signal on the port
- > The device receives the signal and acts
- > Example: Signal on the port is set to 5 Volts to "Power-On" the LED



# Let's meet the components ....



# The circuit diagram



... in the language of the engineers !

# Let's build!

Connect - ve of Board To GND on Arduino

Connect USB cable

Connect +ve of Board to Port 13 on Arduino

Long leg



# Time to write a "Sketch"



Did you download and install the software successfully? If not ...

- > Go <http://arduino.cc/en/Main/Software>
- > Download the software appropriate for your computer
  - Windows 7
  - Windows 8
  - Mac
  - Linux
- > Install the software on your computer
- > 64 bit Windows – manually install Driver using Device Manager.

# Install the driver (Windows only)

- > Open Windows explorer and navigate to "Computer" and right click on it.
- > Select "Properties"
- > Click on "Device Manager"
- > Look under Ports (COM & LPT). Mostly likely you will find the Arduino as COM3 or COM4.
- > Right click and choose to "Update Driver Software"
- > Select "Browse my computer for software driver"
- > Select the appropriate driver from the "drivers" directory of the Arduino software you had downloaded. (e.g. ....arduino\arduino-1.0.5\drivers )



# Is Arduino connected the computer?

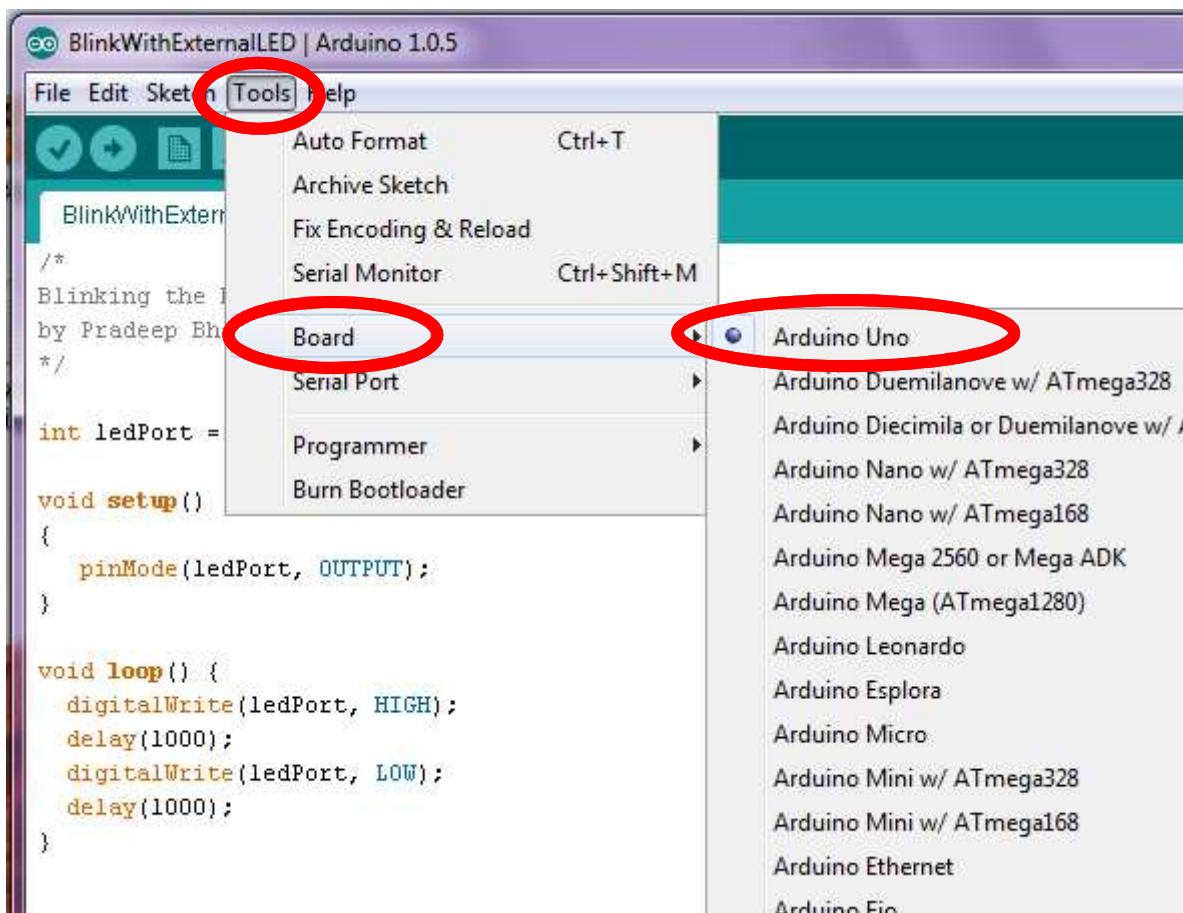
- > Time to get them talking ....



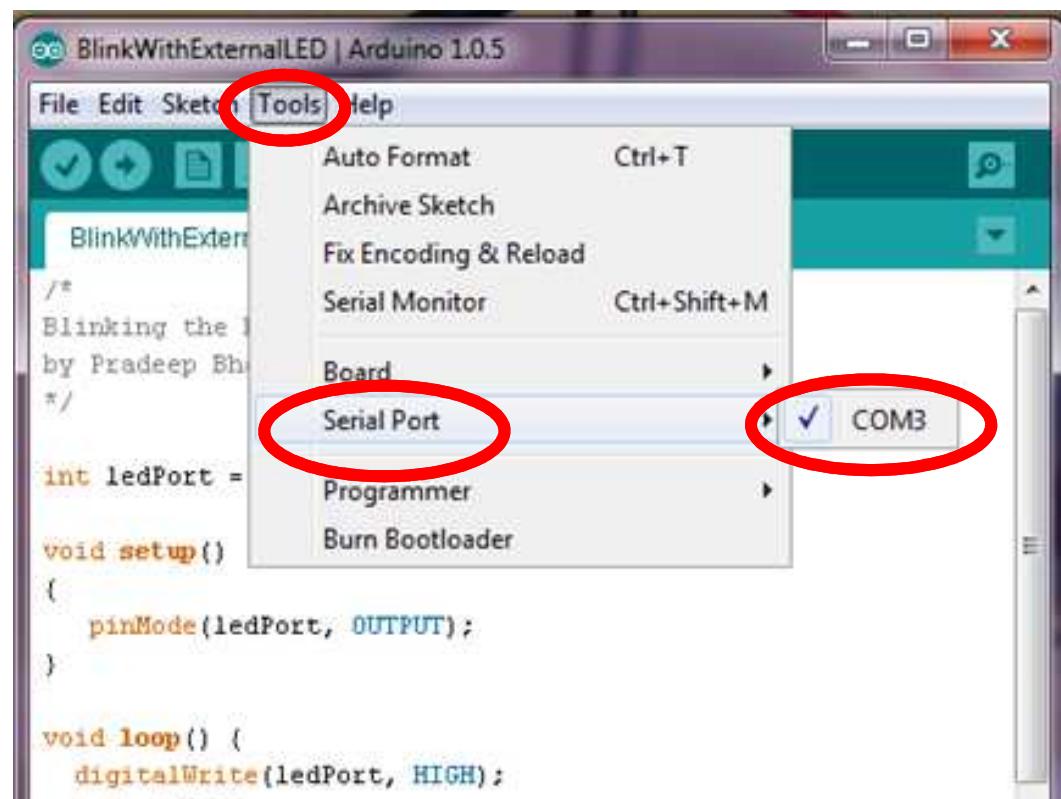
# Outline of the Sketch: Please Arduino ....

1. Use Port 13 for output
2. Set Port 13 voltage = 5 Volts (Glow the LED)
3. Wait for 1 second
4. Set Port 13 voltage = 0 Volt (Switch-off LED)
5. Wait for 1 second
6. Keep repeating the Steps 2 to 4 forever

# Select Board "Arduino Uno"

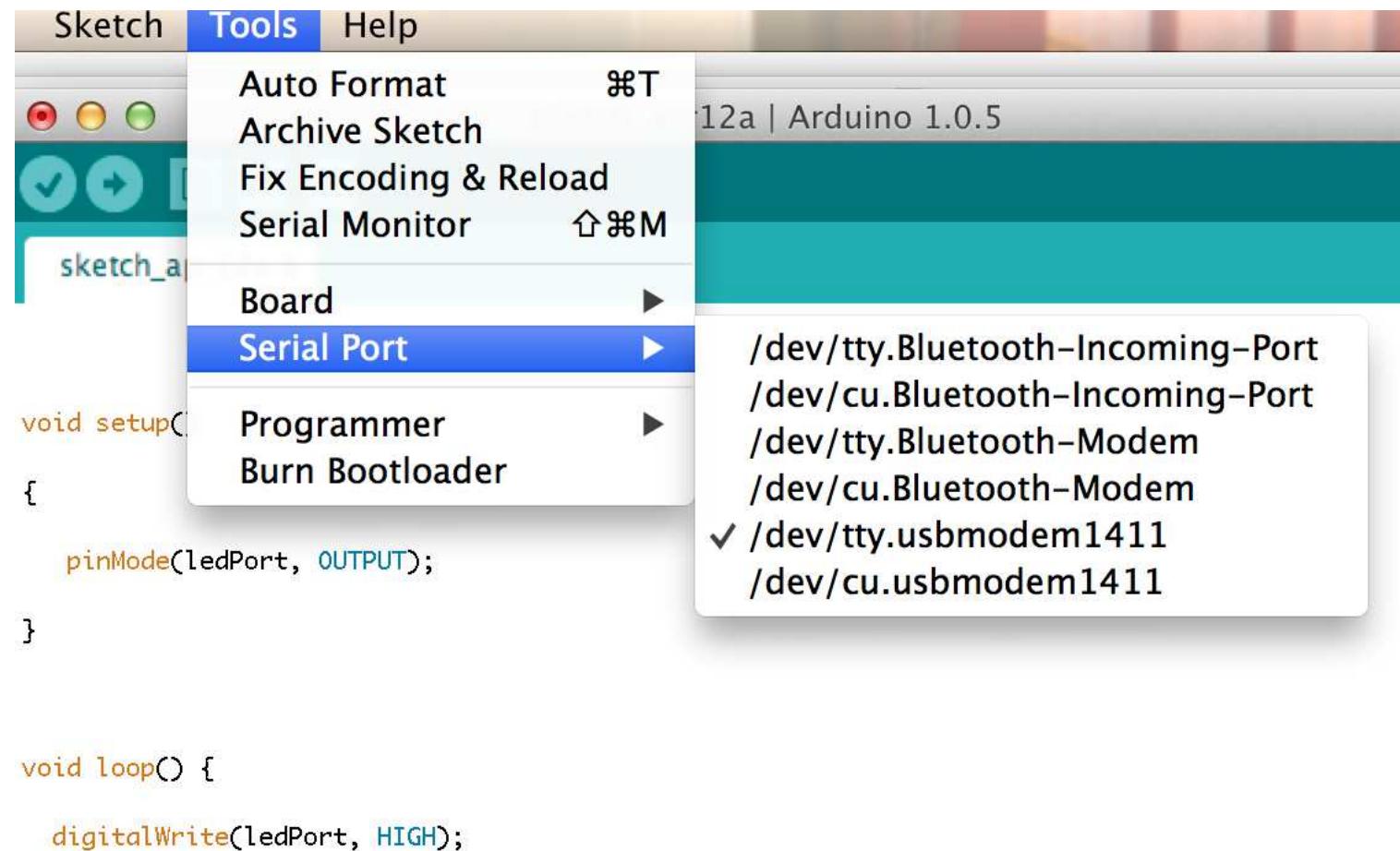


# Select the Communication Port (Windows)





# Select the Communication Port (Mac)



# Write the Sketch

```

BlinkWithExternalLED | Arduino 1.0.5
File Edit Sketch Tools Help
BlinkWithExternalLED $ 
/*
Blinking the External LED
by Pradeep Bhatte
*/
int ledPort = 13 ;
void setup()
{
    pinMode(ledPort, OUTPUT);
}
void loop() {
    digitalWrite(ledPort, HIGH);
    delay(1000);
    digitalWrite(ledPort, LOW);
    delay(1000);
}

```

Done uploading.  
Binary sketch size: 1,084 bytes (of a 32,256 byte maximum)  
Arduino Uno on COM4

Click on Upload to send  
the instructions from  
the computer to Arduino

Verify instructions were  
Uploaded!!  
And there were no errors



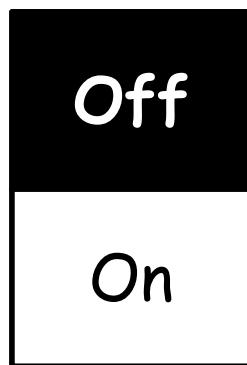
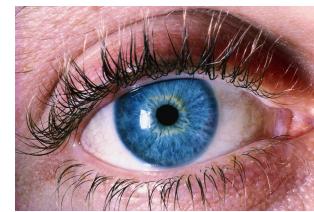
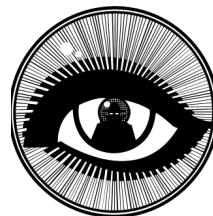
# Sketch

```
int ledPort = 13 ;  
  
void setup()  
{  
    pinMode(ledPort, OUTPUT);  
}  
  
void loop() {  
    digitalWrite(ledPort, HIGH);  
    delay(1000);  
    digitalWrite(ledPort, LOW);  
    delay(1000);  
}
```

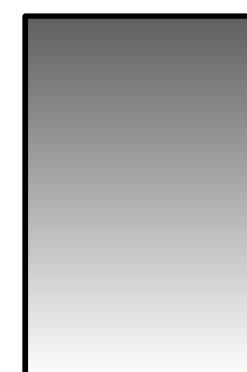
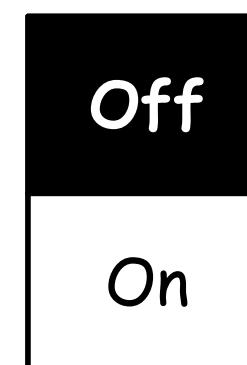
# Did it work?

# Talking to the world

Input Port



Output Port

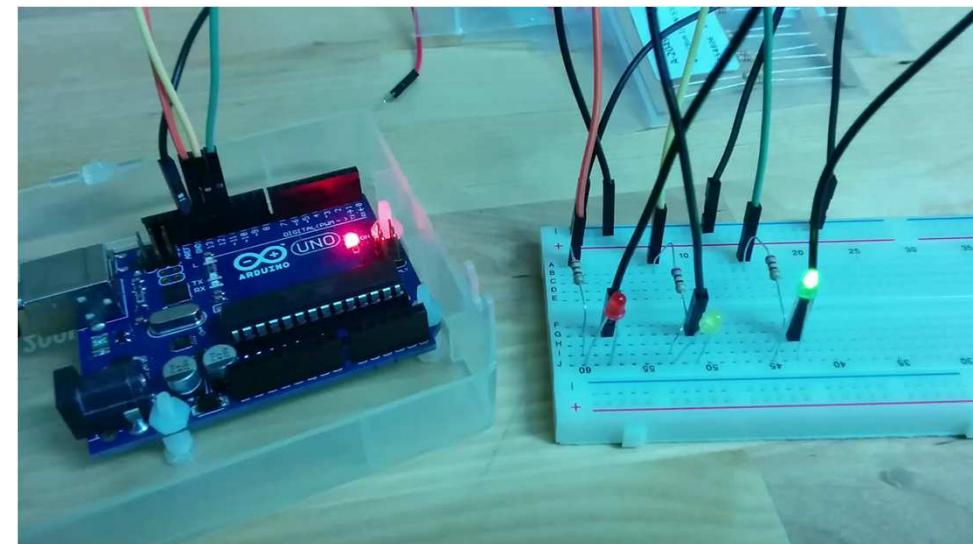


# Digital Input Port

- > Signal on the port is measured as either 0 or 1. It can only be one of the two values.
- > Example
  - If voltage on the port is 5 V, it is On (Binary 1)
  - If voltage on the port is 0 V, it is off (Binary 0)

# Activity #4

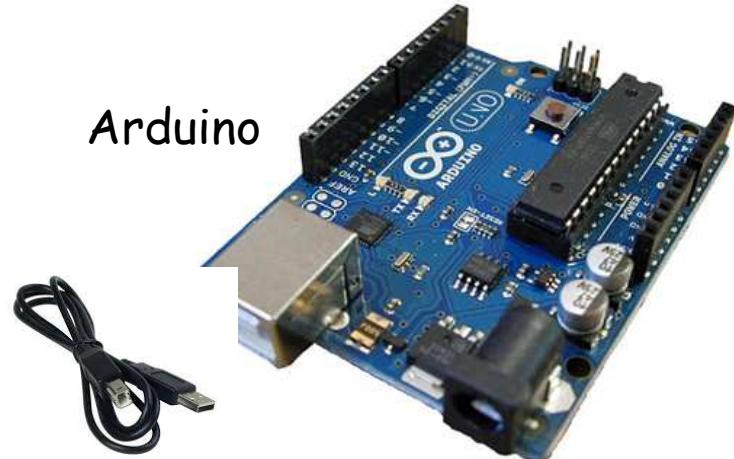
- > Arrange three LEDs (Red, Yellow and Green) in a row and make them glow like a traffic light
- > 10 seconds Green
- > 2 seconds Yellow
- > 10 seconds Red





# What do you need?

Arduino



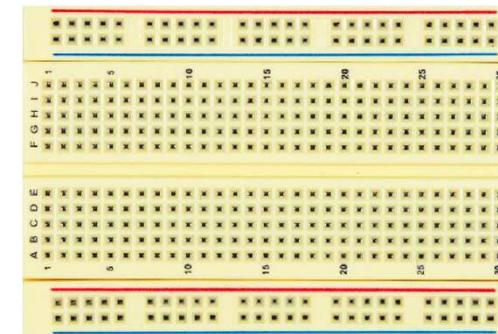
USB cable



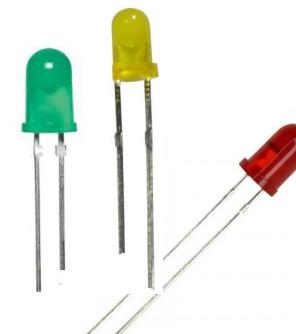
Wires  
1 Red  
1 Black



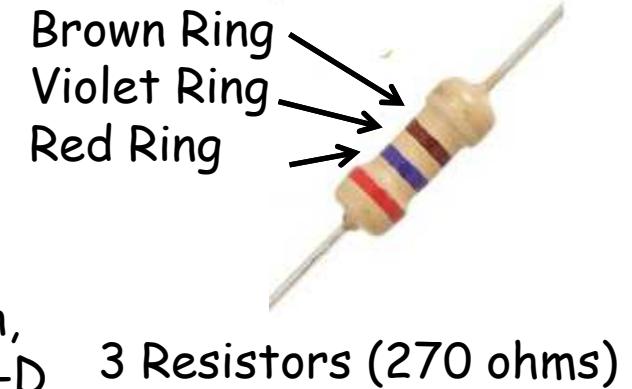
Laptop



Breadboard

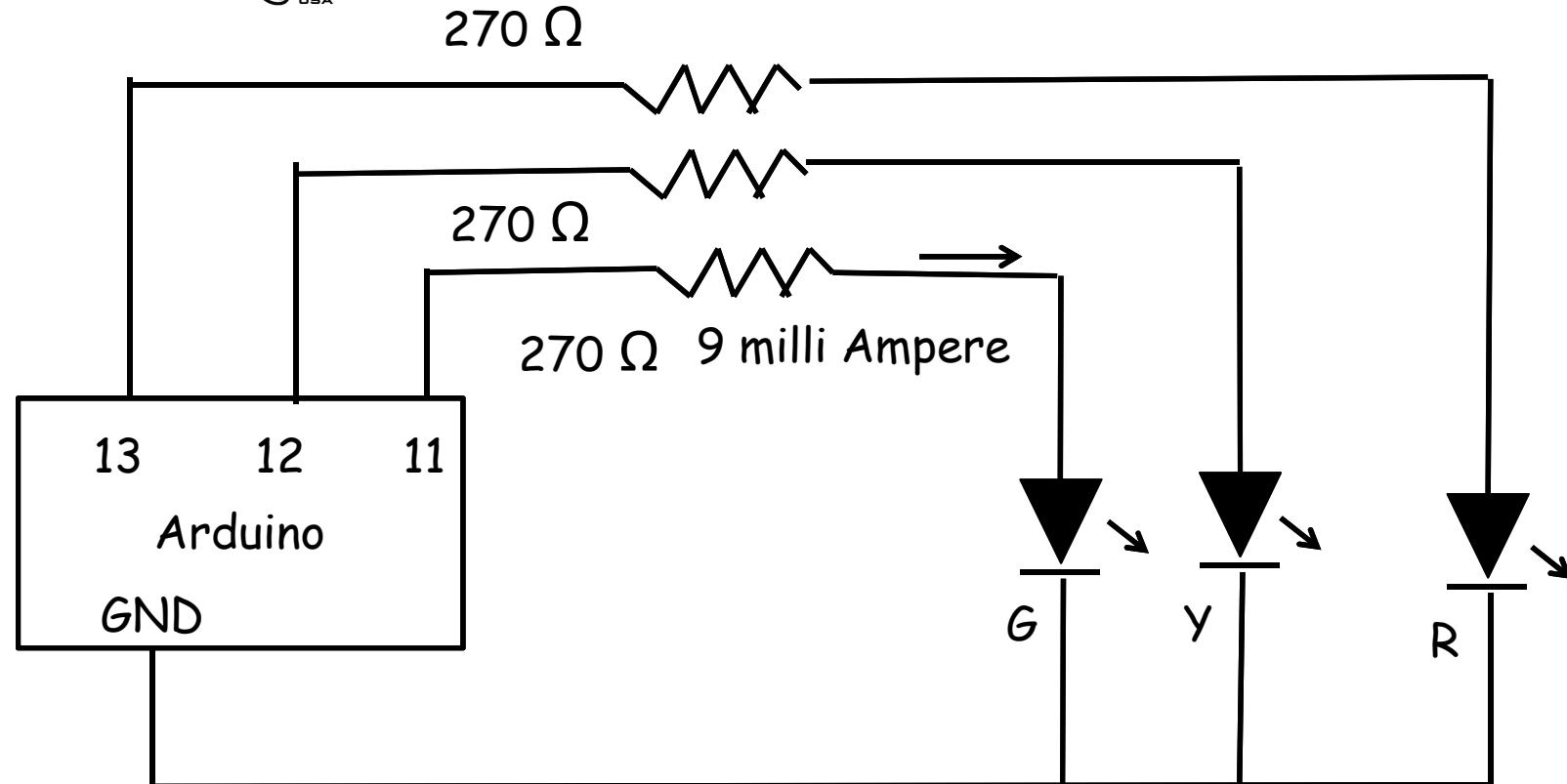


Red, Green,  
Yellow L-E-D



Brown Ring  
Violet Ring  
Red Ring  
3 Resistors (270 ohms)

# The circuit diagram



... in the language of the engineers !

# Let's build!

Connect - ve of Board To GND on Arduino

Connect  
Port 13 to Red  
Port 12 to Yellow  
Port 11 to Green

Connect -ve leg  
of all LEDs to -  
ve of the Board

Long leg

# Let's build!

Connect - ve of  
Board To GND  
on Arduino



Connect  
Port 13 to Red LED's  
resistor  
Port 12 to Yellow LED's  
Resistor  
Port 11 to Green LEDs  
resistor

Connect USB cable



# Sketch

```
/*  
Traffic Light  
by Pradeep Bhatia  
*/  
  
int redLEDPort = 13 ;  
int yellowLEDPort = 12 ;  
int greenLEDPort = 11 ;  
  
void setup()  
{  
    pinMode(redLEDPort, OUTPUT);  
    pinMode(yellowLEDPort, OUTPUT);  
    pinMode(greenLEDPort, OUTPUT);  
}  
  
void loop() {  
    digitalWrite(greenLEDPort, HIGH);  
    delay(10000);  
    digitalWrite(greenLEDPort, LOW);  
    digitalWrite(yellowLEDPort, HIGH);  
    delay(2000);  
    digitalWrite(yellowLEDPort, LOW);  
    digitalWrite(redLEDPort, HIGH);  
    delay(10000);  
    digitalWrite(redLEDPort, LOW);  
    delay(1000);  
}
```

WW Done Saving

Click on Upload to send the instructions from the computer to Arduino

Verify instructions were Uploaded!!  
And there were no errors



```
int redLEDPort = 13 ;
int yellowLEDPort = 12 ;
int greenLEDPort = 11 ;
void setup()
{
    pinMode(redLEDPort, OUTPUT);
    pinMode(yellowLEDPort, OUTPUT);
    pinMode(greenLEDPort, OUTPUT);
}
void loop() {
    digitalWrite(greenLEDPort, HIGH);
    delay(10000);
    digitalWrite(greenLEDPort, LOW);
    digitalWrite(yellowLEDPort, HIGH);
    delay(2000);
    digitalWrite(yellowLEDPort, LOW);
    digitalWrite(redLEDPort, HIGH);
    delay(10000);
    digitalWrite(redLEDPort, LOW);
    delay(1000);
}
```

# Did it work?



# Activity #5

## Automatic Eco Light

- > LED does not glow when the surrounding has fair amount of light.
- > LED glows when it gets dark
- > The glow intensity increases as it gets darker

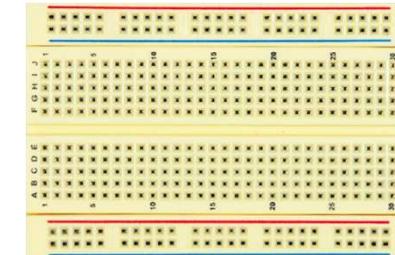


Keep the circuit you  
build for next  
activity!

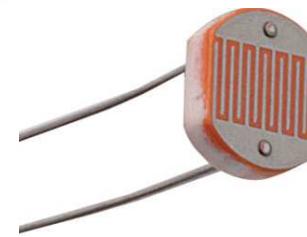


# What do you need?

Arduino



Breadboard



Light  
Dependent  
resistor (LDR)



Laptop

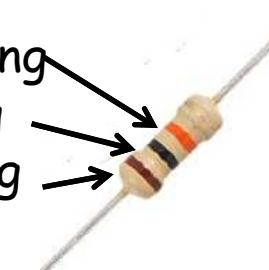
[www.devoxx4kids.org/usa](http://www.devoxx4kids.org/usa)

Orange Ring  
Black Ring  
Brown Ring

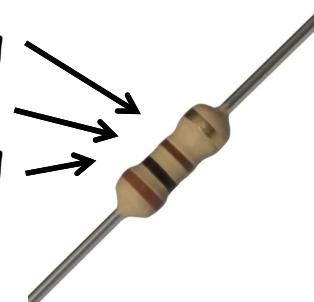


White LED

Resistor (10 Kilo ohms)



Brown Ring  
Black Ring  
Brown Ring

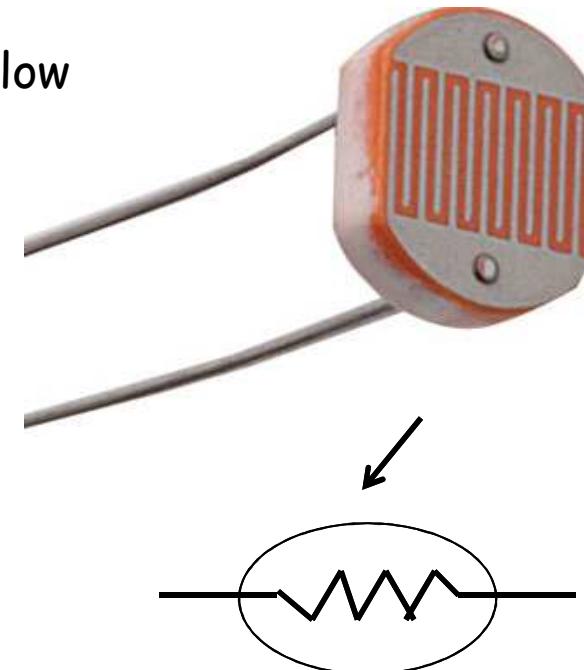


Resistor (100 ohms)

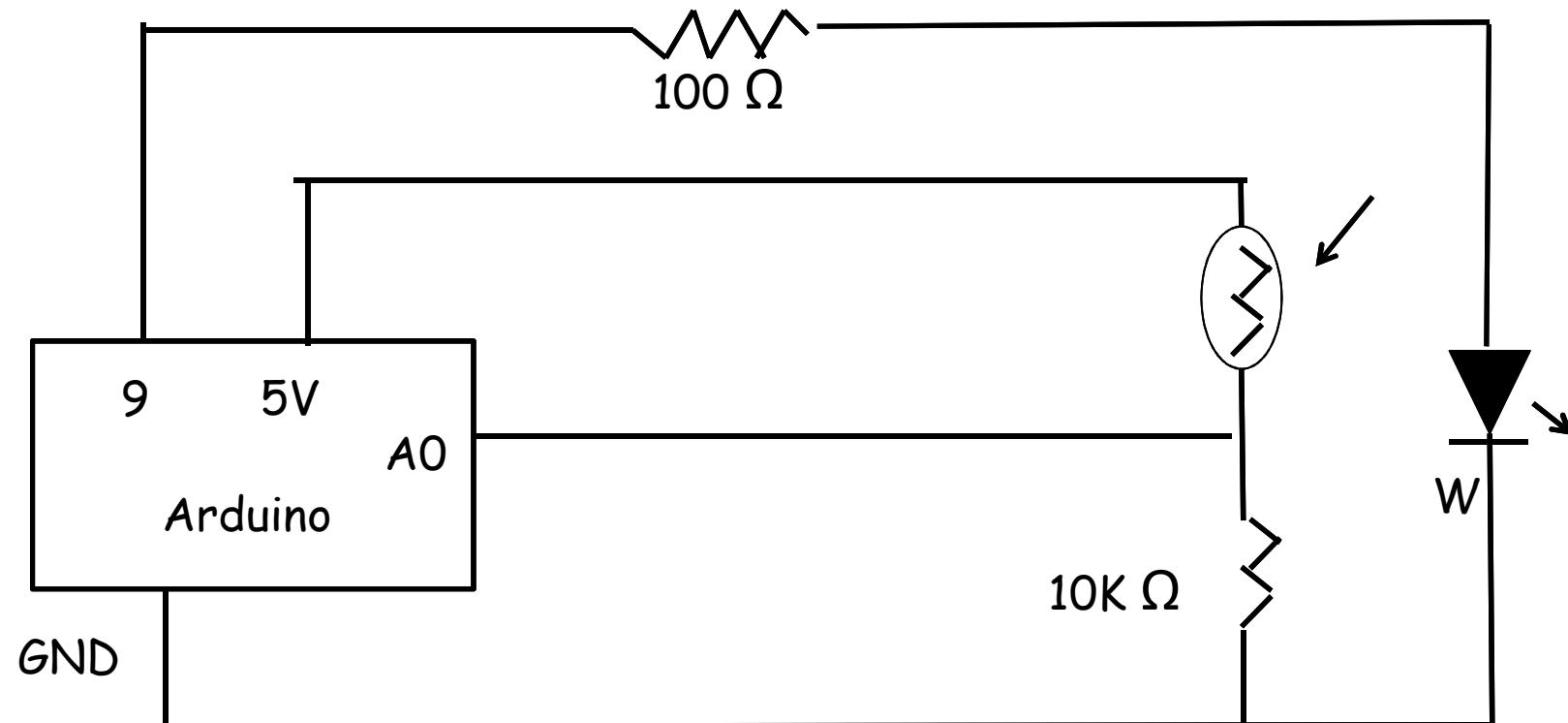


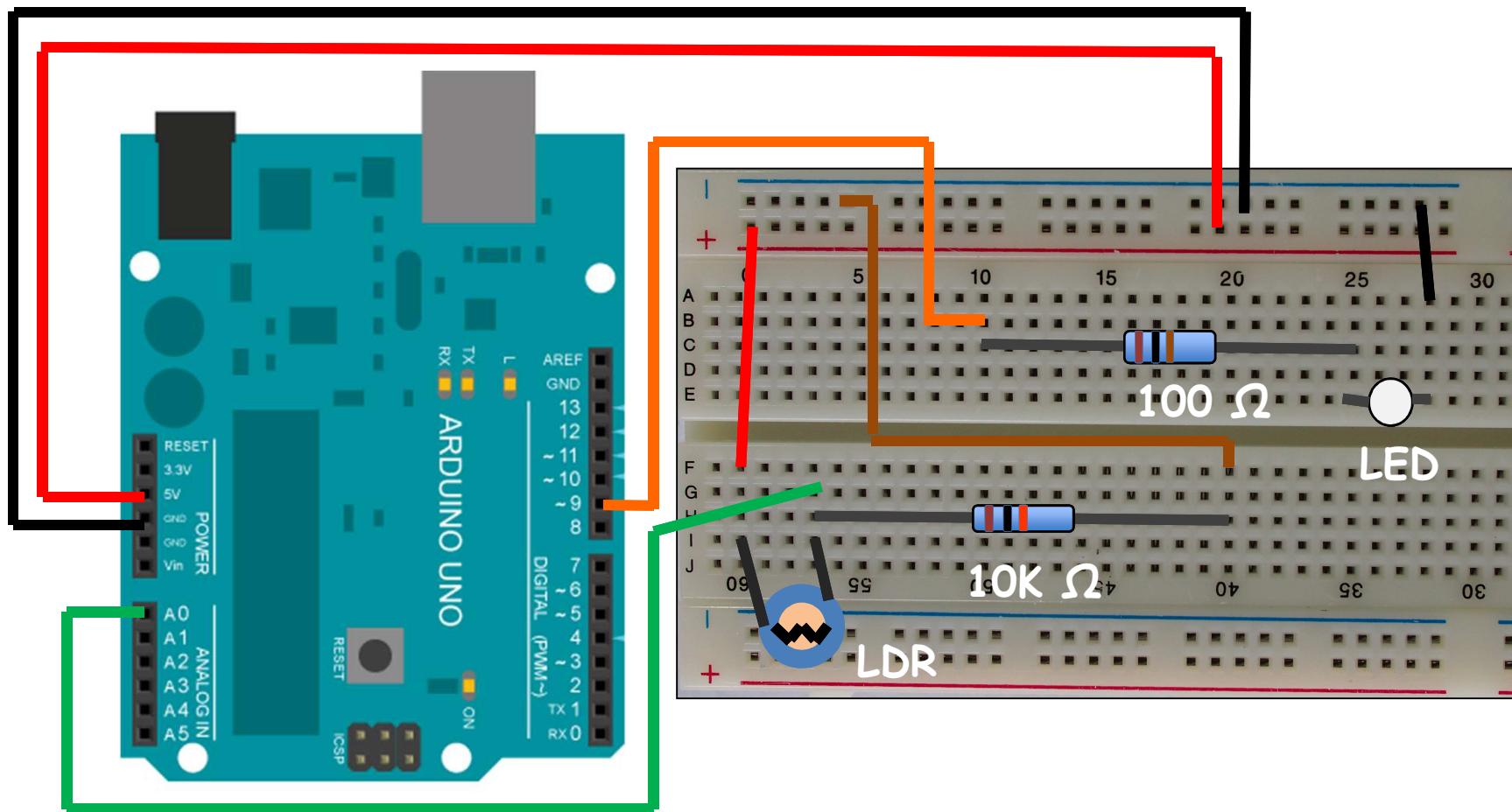
# I am Light Dependent Resistor ....

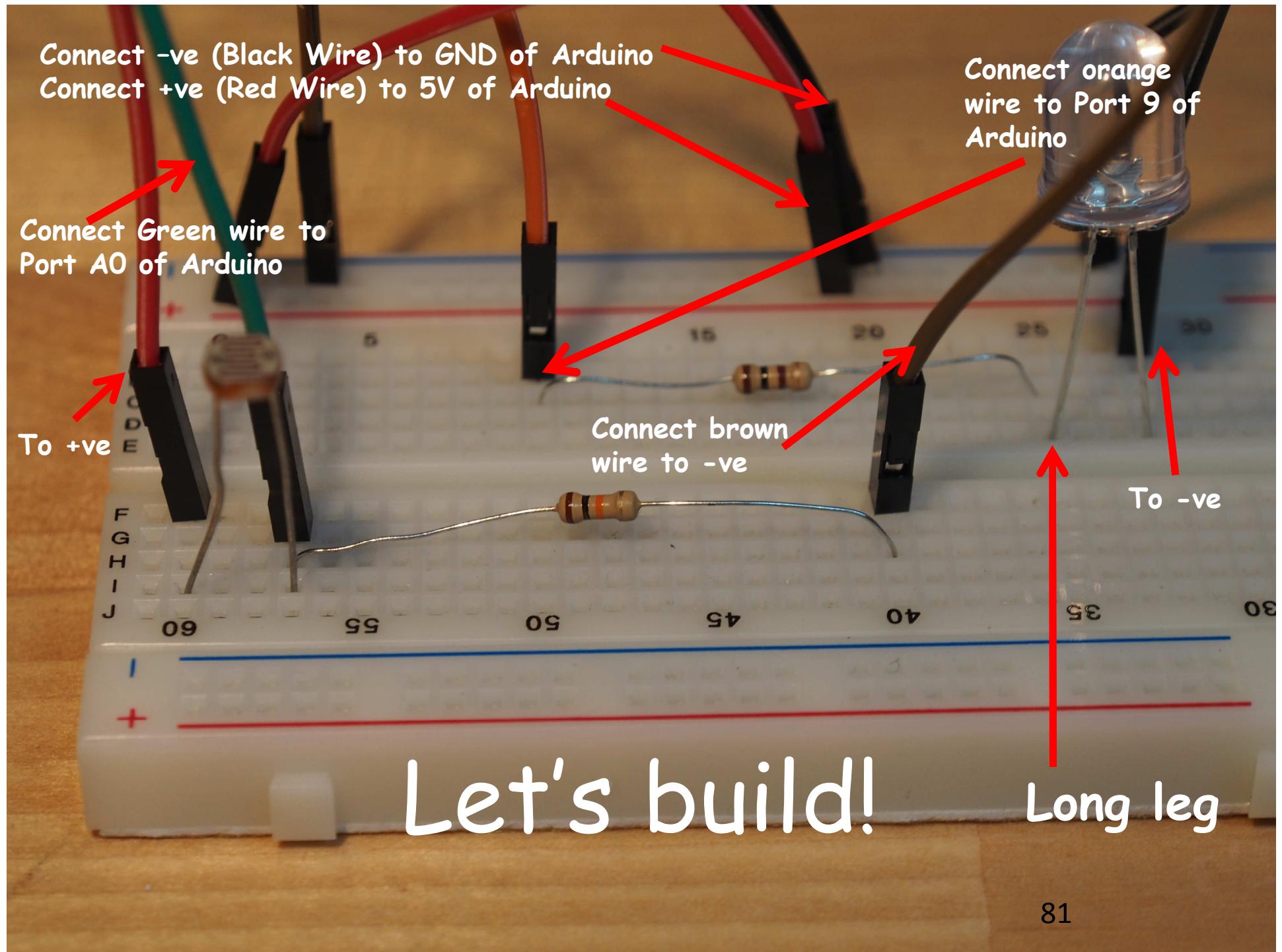
- › You can call me LDR
- › When there is light, my resistance is low
  - › More current flows thru me
- › When it is dark my resistance is high
  - › Less current flows thru me

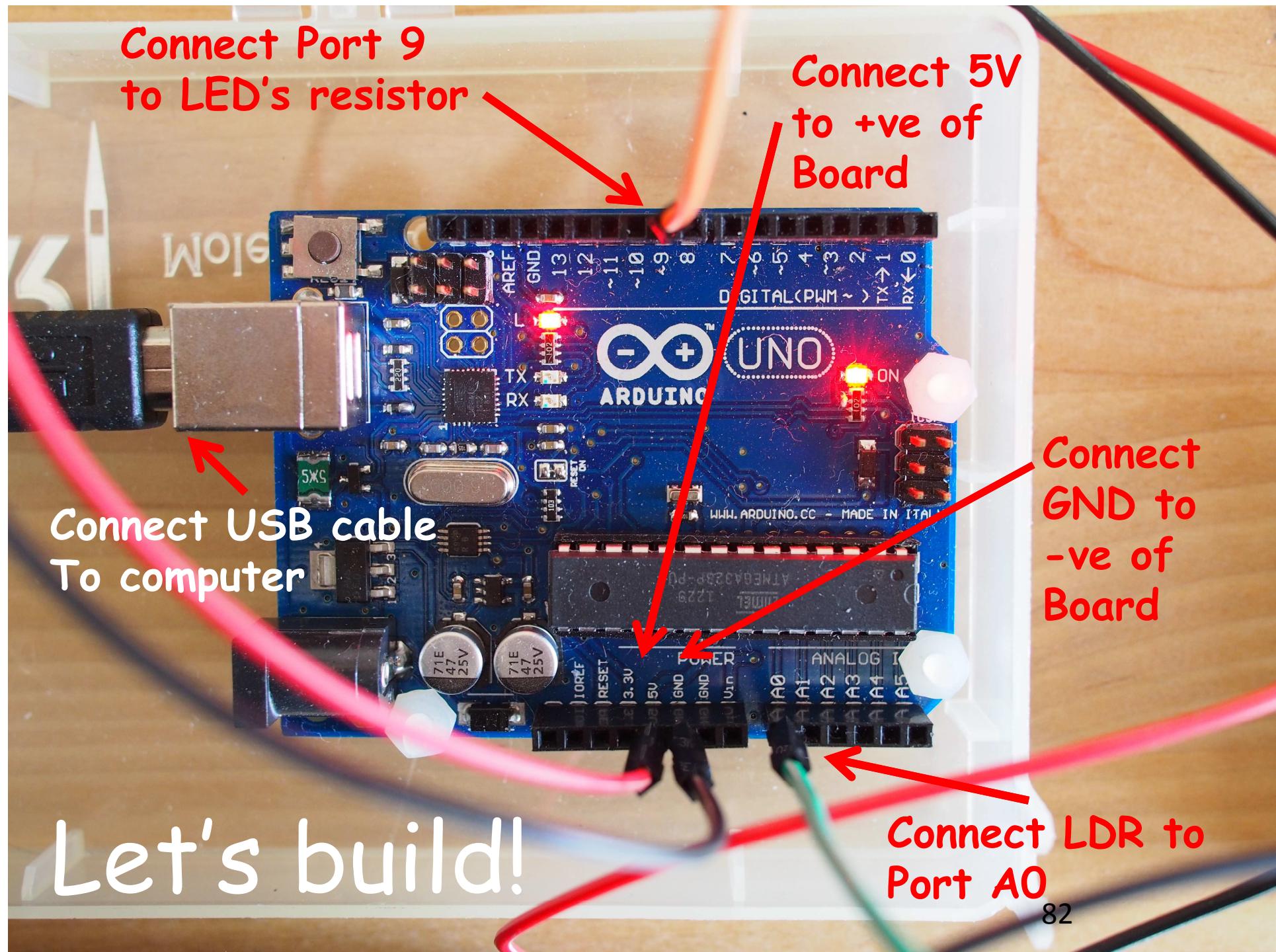


# Circuit Diagram











# Sketch - Part 1

```
const int LED_PORT = 9;  
const int LIGHT_SENSOR_PORT = 0;  
const int INTERVAL = 1000; // we will check brightness 1000 millisecond or 1  
second  
  
int sensedValue; // value sensed on the Analog input port  
float voltage; // a number between 0 and 5 Volts  
float light; // a number between 0 and 1, 0 means very dark, 1 means bright  
float darkness; // a number between 0 and 1, 1 means it is very dark)  
float needLight;  
int setLEDT0; // value to output on the analog port for LED
```



# Sketch - Part 2

```
void setup() {  
    pinMode(LED_PORT, OUTPUT);  
    pinMode(LIGHT_SENSOR_PORT, INPUT);  
    Serial.begin(9600) ;  
    for (int i = 0; i<=255 ; i++ ) {  
        analogWrite (LED_PORT,i);  
        Serial.println(i);  
        delay (100);  
    }  
    analogWrite (LED_PORT, 0);  
    delay (100);  
}
```



```
void loop() {  
    sensedValue = analogRead(LIGHT_SENSOR_PORT) ;  
  
    // read the input on analog port  
    // Convert the analog reading (which goes from 0-1023) to a voltage (0-5V):  
    // Voltage will only go from 0.4 to 2.5 approximately only  
    voltage = sensedValue * 0.0049 ;  
    light = sensedValue / 1023.0 ;  
    darkness = 1 - light ;  
  
    if ( darkness > 0.5 ) needLight = ( darkness - 0.5 ) / ( 1 - 0.5 );  
    else needLight = 0 ;  
    setLEDTo = 255 * needLight ;  
    analogWrite (LED_PORT, setLEDTo);  
    Serial.print("Sensor Value = ");  Serial.print(sensedValue);  
    Serial.print(" Voltage =");  Serial.print(voltage);  
    Serial.print(" Light =");  Serial.print(light);  
    Serial.print(" Darkness =");  Serial.print(darkness);  
    Serial.print(" need light =");  Serial.print(needLight);  
    Serial.print(" Set LED port to =");  Serial.println(setLEDTo);  
    delay (INTERVAL);
```



Keep the circuit you  
build for next  
activity!

# Analog Input Port

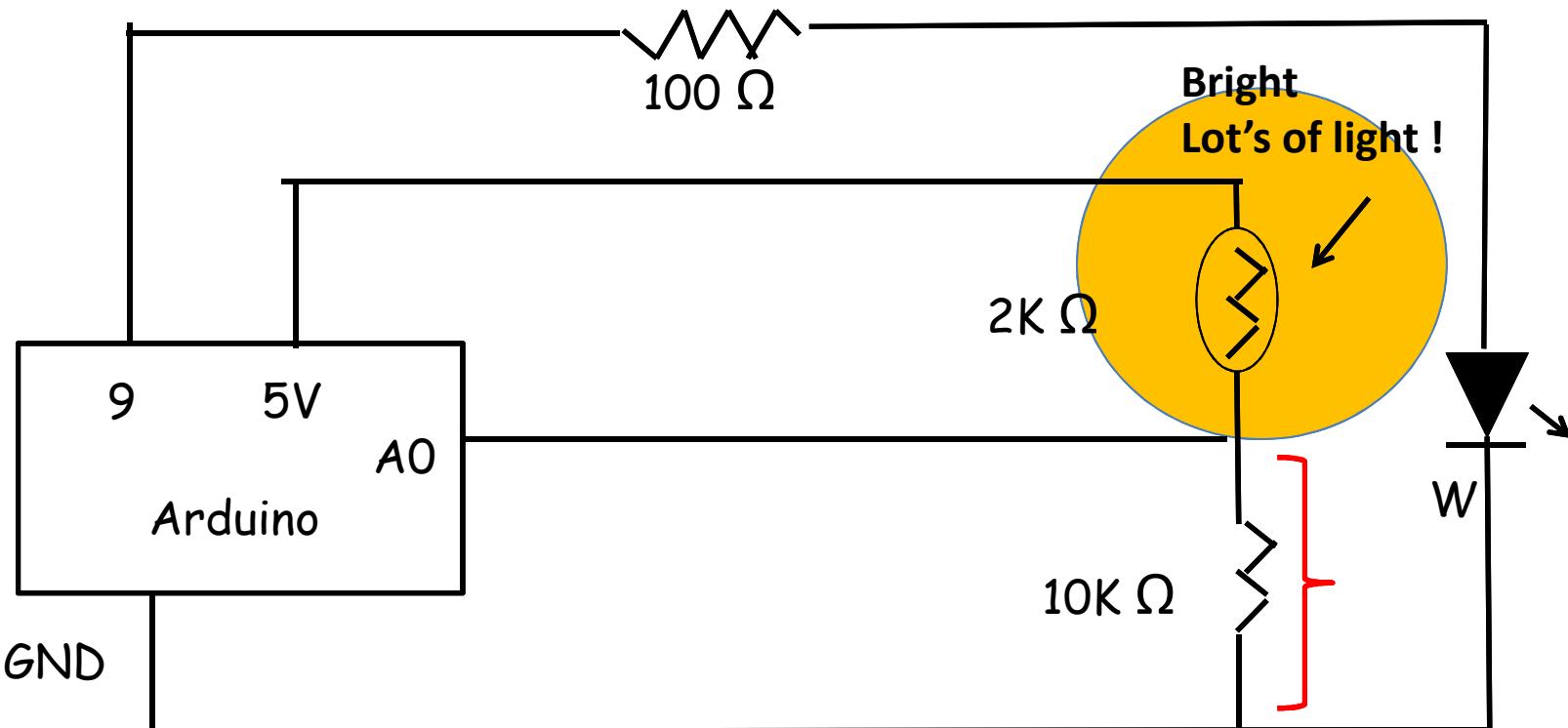
- > Signal on the port is measured as a number between 0 and 1023
- > Example
  - If voltage on the port is 5 V, value of the input is measured as 1023
  - If voltage on the port is 2.5 V, value of the input is measured as 612
  - If voltage on the port is 0 V, value of the input is measured as 0



# Analog Output Port

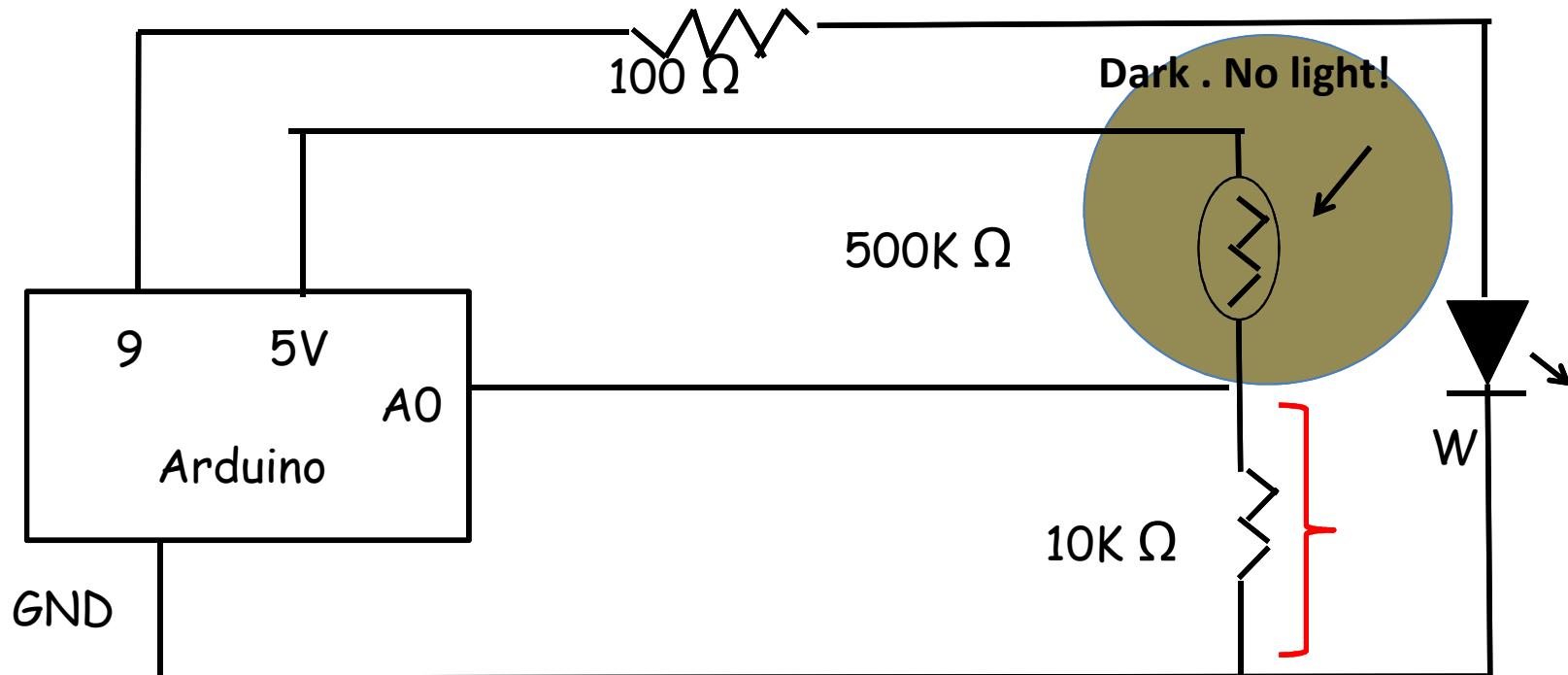
- > Signal of value between 0 and 255 can be sent out. 0 means 0 Volts. 255 means 5 Volts.
- > Example
  - If 255 is written to the output port, signal on the pin goes to 5 Volts.
  - If 123 is written to the output port, signal on the pin goes to 2.5 Volts.
  - If 0 is written to the output port, signal on the pin goes to 0 Volts.

# How does it work?



- LDR offers resistance of about 2500 ohms
- Voltage across 10 Kilo  $\Omega$  Resistor is about 4 volts
- Current flowing 0.4 milli Amps
- Arduino senses a value of about 800 on the Analog input port A0

# How does it work?



- LDR offers resistance of about 500,000 ohms
- Voltage across 10,000 ohm resistor drops to about 0.01 volts
- Current flowing drops to about 0.001 milliAmps
- Arduino senses a value of about 2 on the Analog input port A0

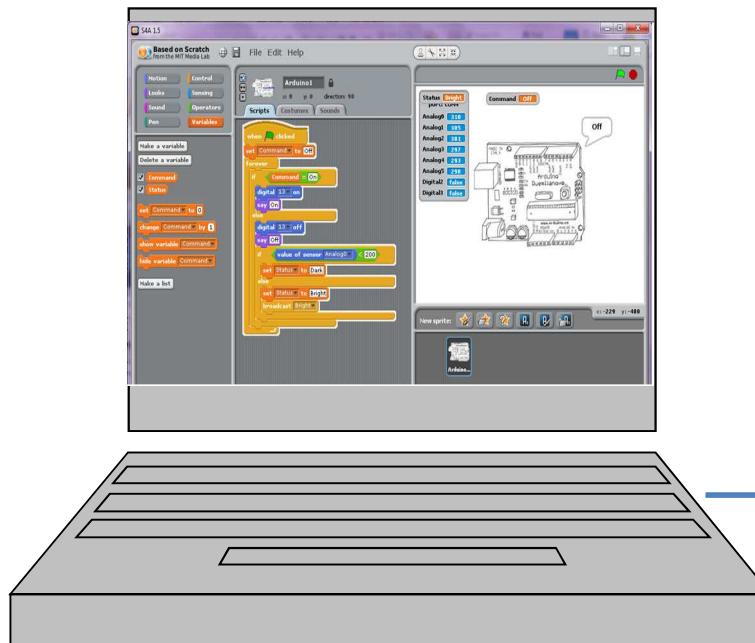


# Activity #6 Remote controlled light

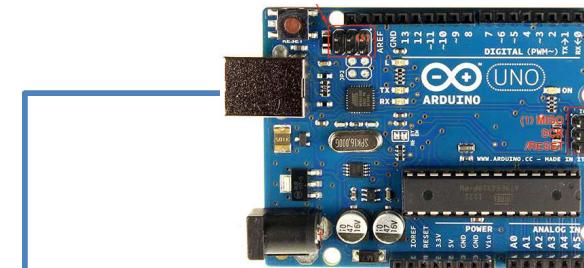
- > Re-use the light sensor and LED circuit we built earlier
- > Instead of Arduino automatically switching on or off the LED, this time we will control it over the network.
- > We will check the lighting situation around our sensor from another computer
- > Turn On or Turn Off the LED by sending command from another computer.



# What are we going to build?



Scratch Program

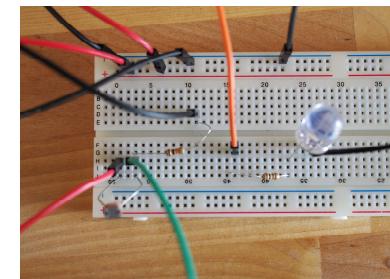


S4AFirmware program

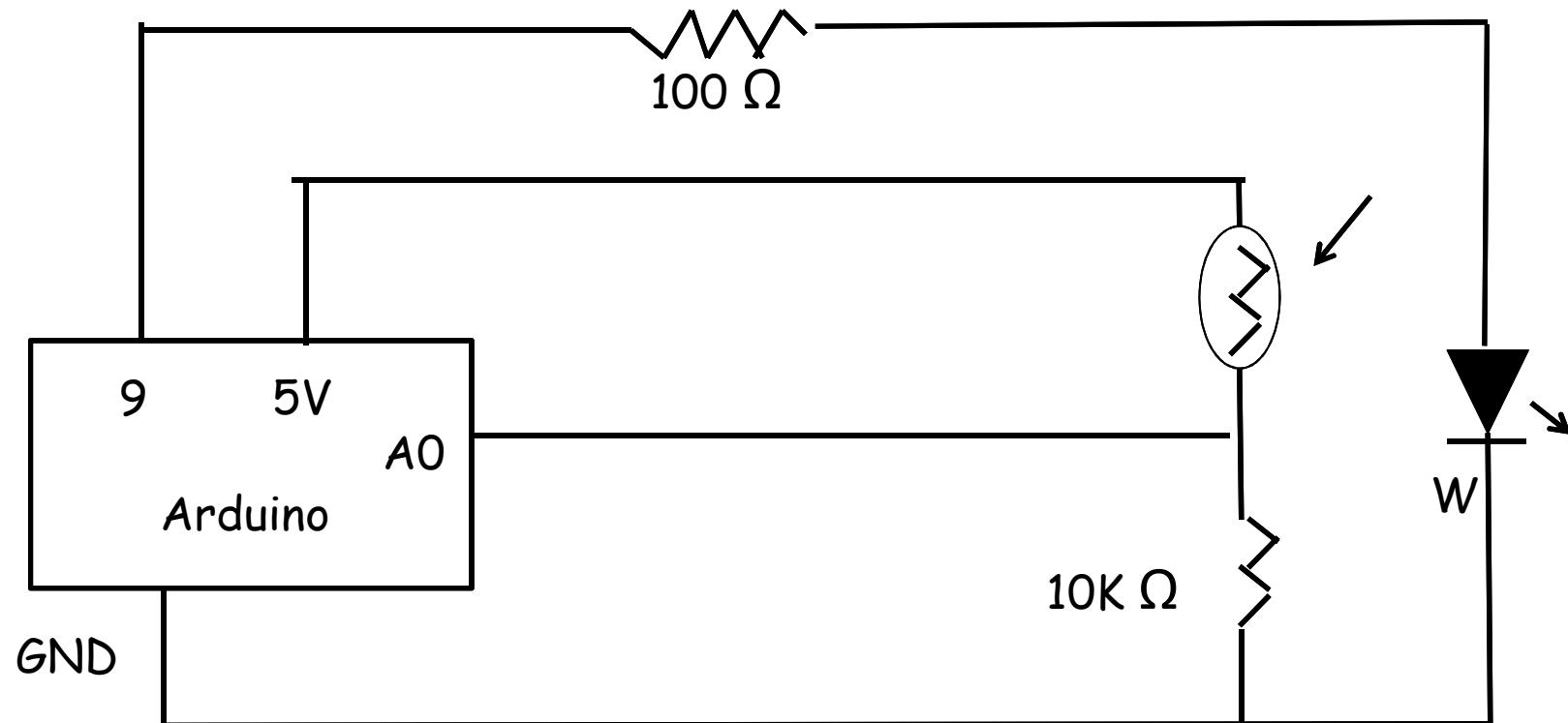
```
File Edit Sketch Tools Help
S4AFirmware15 | Arduino 1.0.5
// NEW IN VERSION 1.5:
// Changed pin 8 from standard servo to normal.

// NEW IN VERSION 1.4:
// Changed Serial.print() for Serial.write() in

// NEW IN VERSION 1.3:
// Now it works on GNU/Linux. Also tested with:
// timer2 set to 20ms, fixing a glitch that mad
// readSerialport() function optimized.
// pulse() modified so that it receives pulse w
// updateServoMotors changes its name as a glob
```



# Circuit Diagram





Did you download and install the Scratch4Arduino? If not ...

- > Go <http://s4a.cat/>
- > Download the software appropriate for your computer
  - Windows
  - Mac
  - Linux
- > Install Scratch4Arduino



# Installing S4A on Mac

- > S4A installation on Mac needs work around:
  - Security permissions need to be changed to "Anywhere" in order to open the app.
  - [https://groups.google.com/forum/#topic/s4a-community/5e\\_ge7XKehw](https://groups.google.com/forum/#topic/s4a-community/5e_ge7XKehw)



# Load the S4A Firmware sketch to the Arduino

- > Locate the file S4AFirmware15.ino
- > Run Arduino software
- > Open the sketch S4AFirmware15.ino
- > Connect Arduino and upload the sketch to Arduino board using Arduino software
- > Make sure it loaded successfully!
- > Exit the Arduino software once done!

# Load the S4A Firmware sketch to the Arduino

A screenshot of the Arduino IDE interface. The title bar says "S4AFirmware15 | Arduino 1.0.5". The menu bar includes File, Edit, Sketch, Tools, and Help. Below the menu is a toolbar with icons for file operations. The main area shows the code for "S4AFirmware15". The code is a multi-line comment block. It starts with "/\* NEW IN VERSION 1.5:" and ends with "\*/". Inside this block, there are two lines: "// Changed pin 8 from standard servo to normal" and "/\* NEW IN VERSION 1.4:" followed by another line. The code continues with "/\* NEW IN VERSION 1.3:" and several more lines of comments about improvements to the timer and serial port functions.

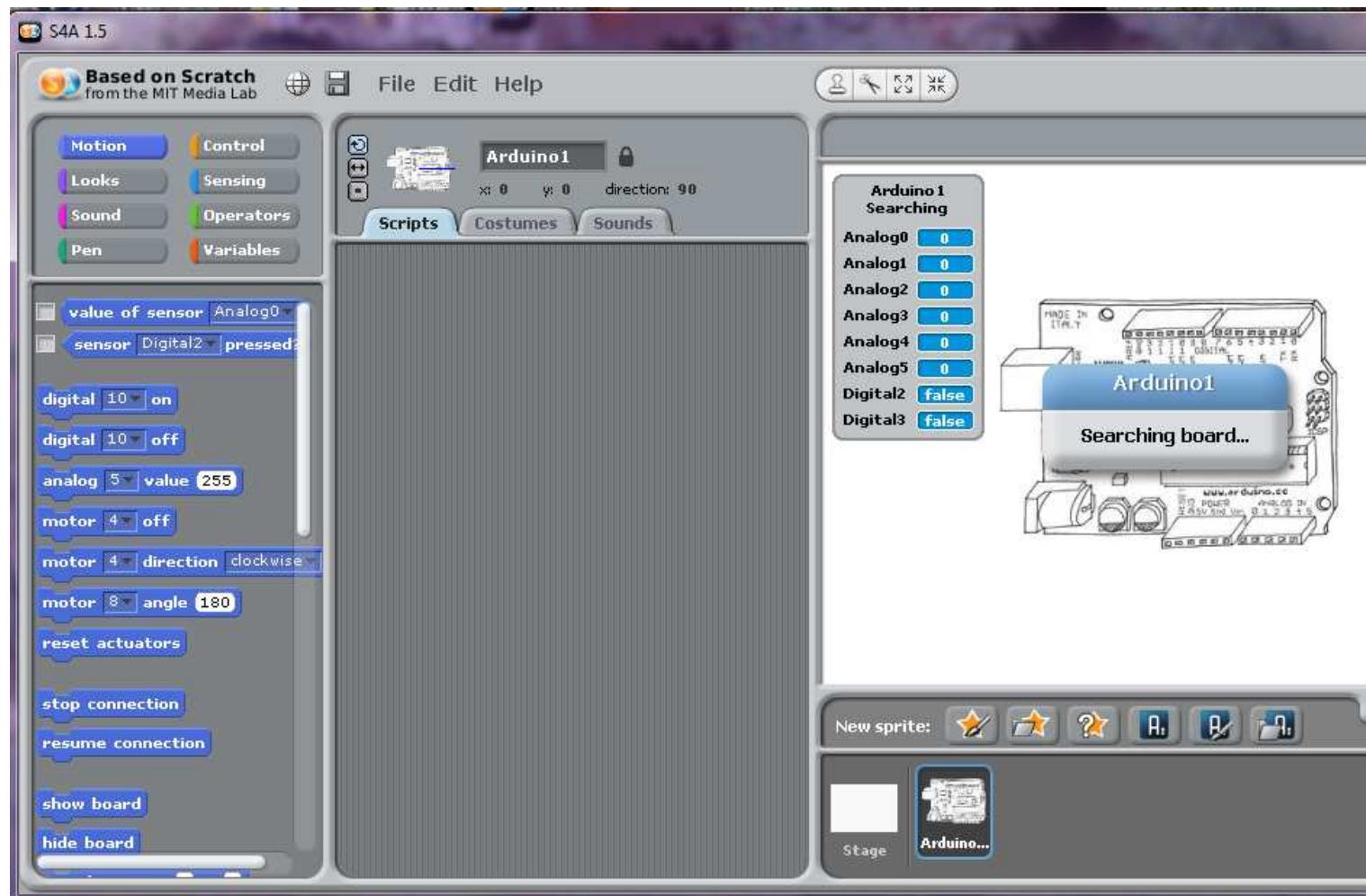
```
// NEW IN VERSION 1.5:  
// Changed pin 8 from standard servo to normal  
  
/* NEW IN VERSION 1.4:  
// Changed Serial.print() for Serial.write() in  
  
/* NEW IN VERSION 1.3:  
// Now it works on GNU/Linux. Also tested with!  
// timer2 set to 20ms, fixing a glitch that mad  
// readSerialport() function optimized.  
// pulse() modified so that it receives pulse w  
// updateServoMotors changes its name as a glob
```



Connect to wireless  
network  
"devoxx4kids"

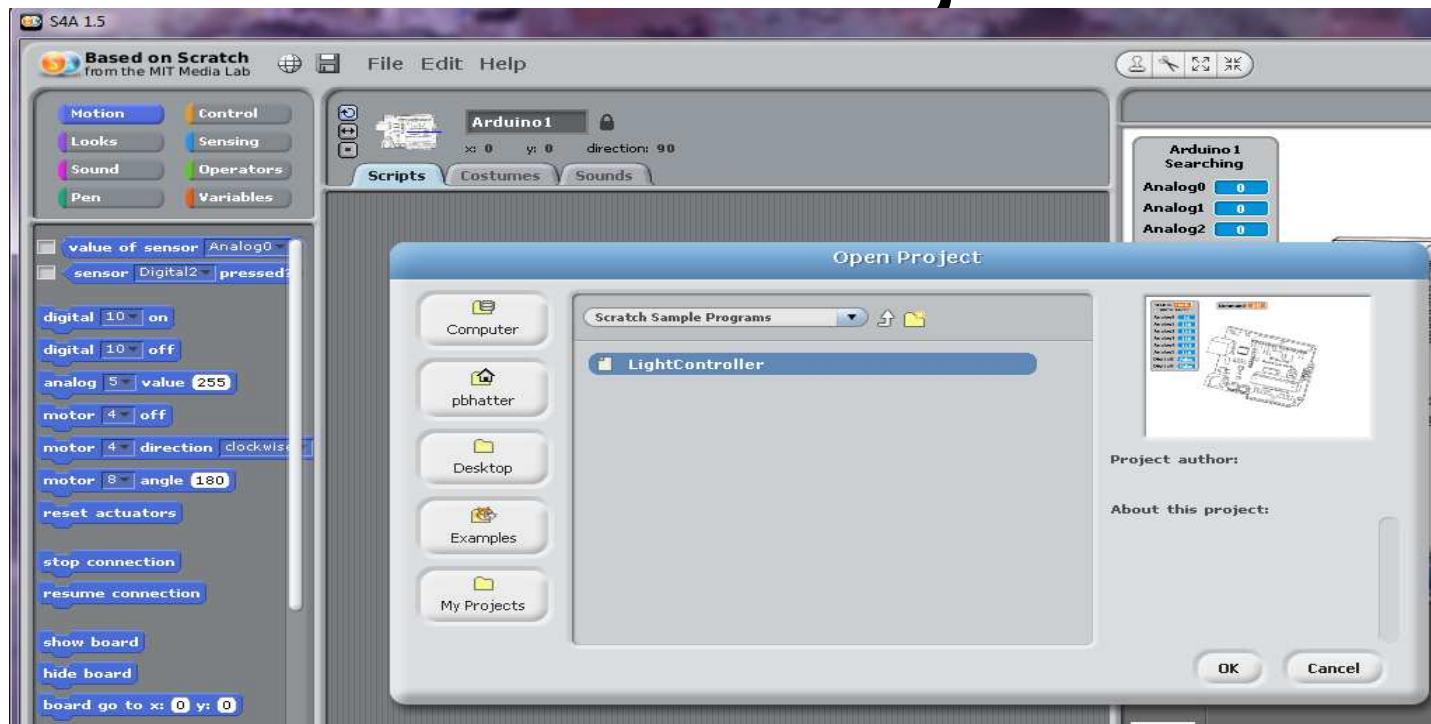


# Run Scratch 4 Arduino

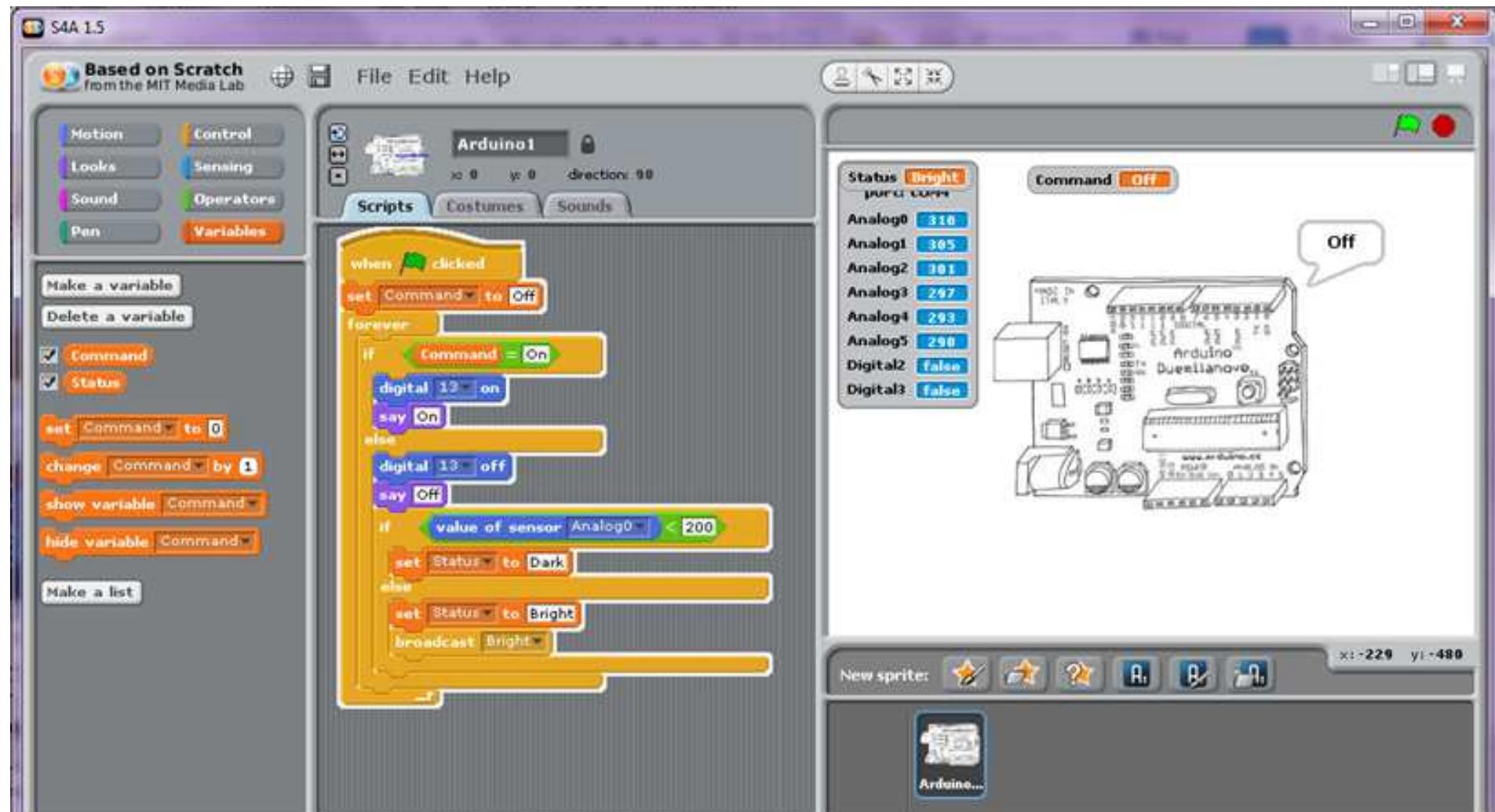




# Open the project LightController



- > Navigate to Menu : File > Open
- > Find, select and open the file LightController





# "LightController" project

- > Arduino is connected to the computer.
- > The message "Searching for board" should go away
- > Did you see the message "Remote Sensor Connections Enabled"?
- > Are the variables showing running numbers?



# Have you used Scratch?

**Animate It**

Make a simple animation.



**Animate It**

GET READY

Click for duplicate (stamper) tool.

Click the sprite to duplicate the costume.

Use the paint tools to make the new costume look different.

TRY THIS CODE

```
when green flag clicked
  forever
    switch costume to [penguin1 v]
    wait (0.5) secs
    switch costume to [penguin2 v]
    wait (0.5) secs
```

DO IT!





# What is Scratch?

- > Scratch is a programming environment where you can create your own interactive stories, games, and animations
- > You can use it on internet or you can download and run it on your computer
- > We will download and run on the computer
- > Info and downloads at:  
<http://scratch.mit.edu/>

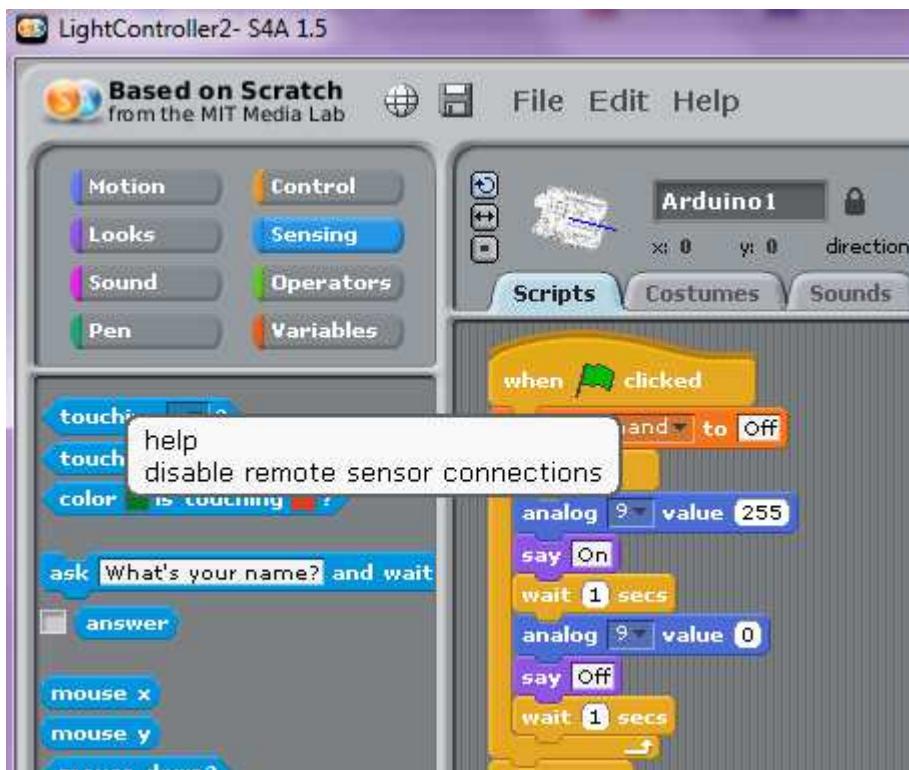


# What is Scratch for Arduino?

- > S4A is a Scratch modification that allows for simple programming of the Arduino.
- > It provides new blocks for managing sensors and actuators connected to Arduino.



# Enable remote sensor connection



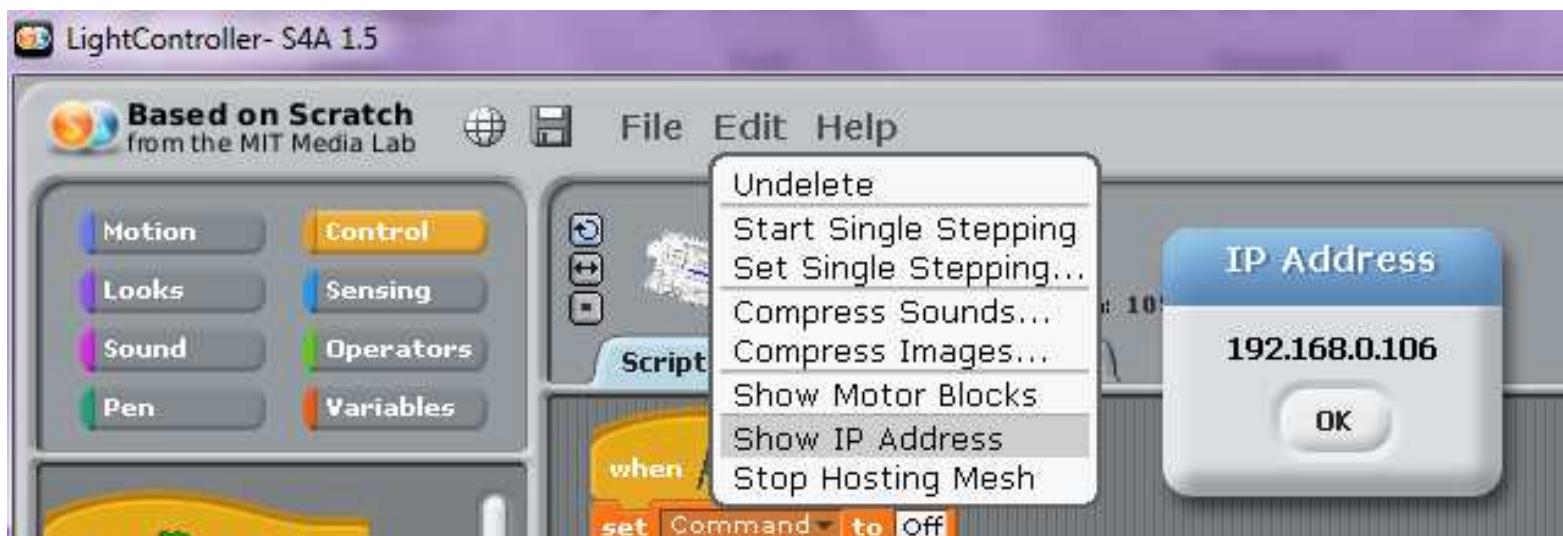
- > Click on "Sensing" Block Palette
- > Right click on one of the blocks, "help" menu will open.
- > Click on enable remote sensor connections.



- > Click on the green flag to start the program
- > Did the LED Blink 5 times?

```
when green flag clicked
set Command to Off
repeat (5)
    analog 9 value 255
    say On
    wait (1) secs
    analog 9 value 0
    say Off
    wait (1) secs
end
forever
if (Command = On) then
    analog 9 value 255
    say On
else
    analog 9 value 0
    say Off
end
if (value of sensor [Analog0] < 200) then
    set Status to Dark
else
    set Status to Bright
broadcast Bright
```

# Note the IP address of your computer



- › Click on menu "Edit" > "Show IP Address"
- › Note down the IP Address displayed



# Command to check light around sensor

> [http://192.168.0.106:42001/?send\\_vars](http://192.168.0.106:42001/?send_vars)

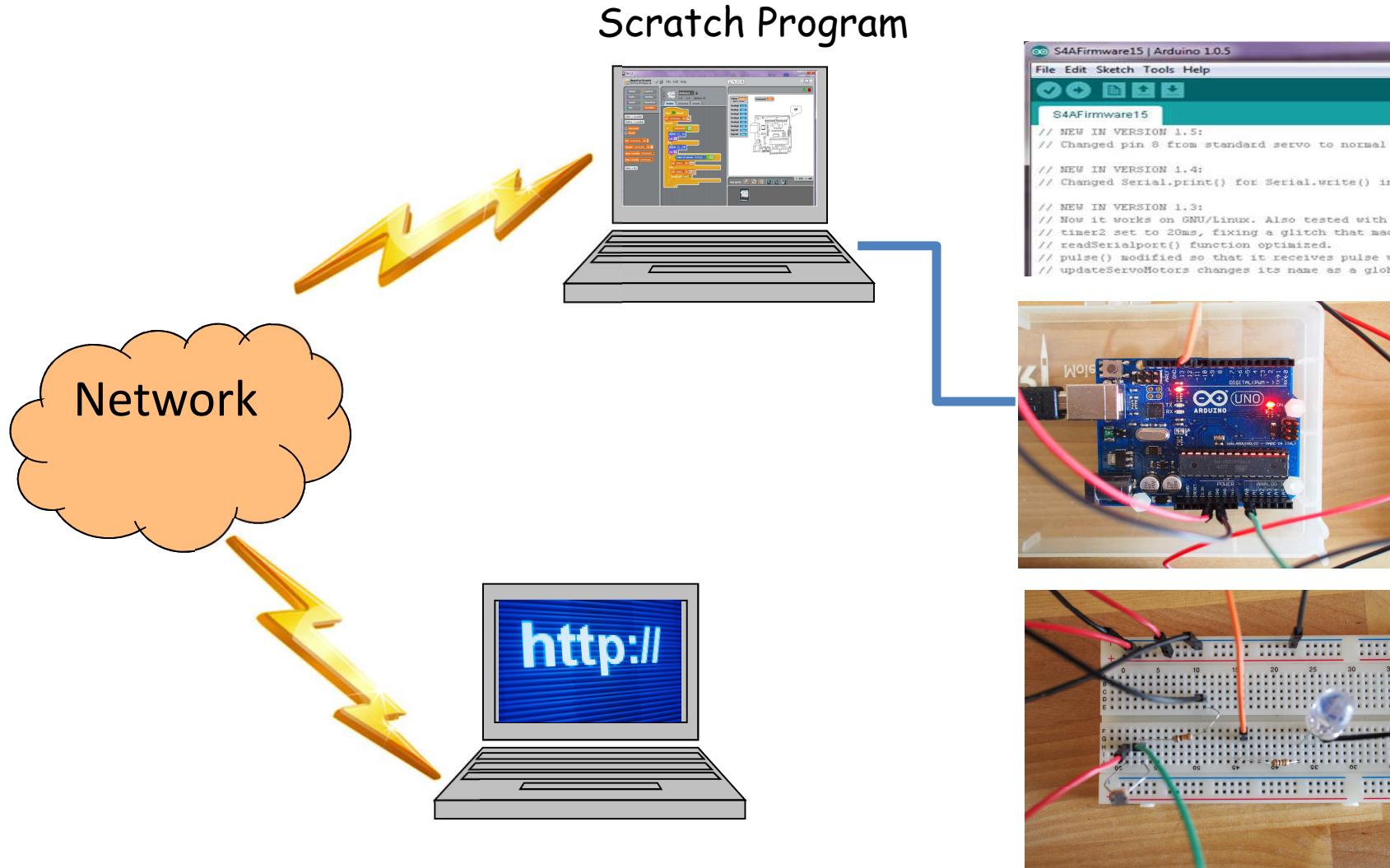


# Commands to turn on or off the LED

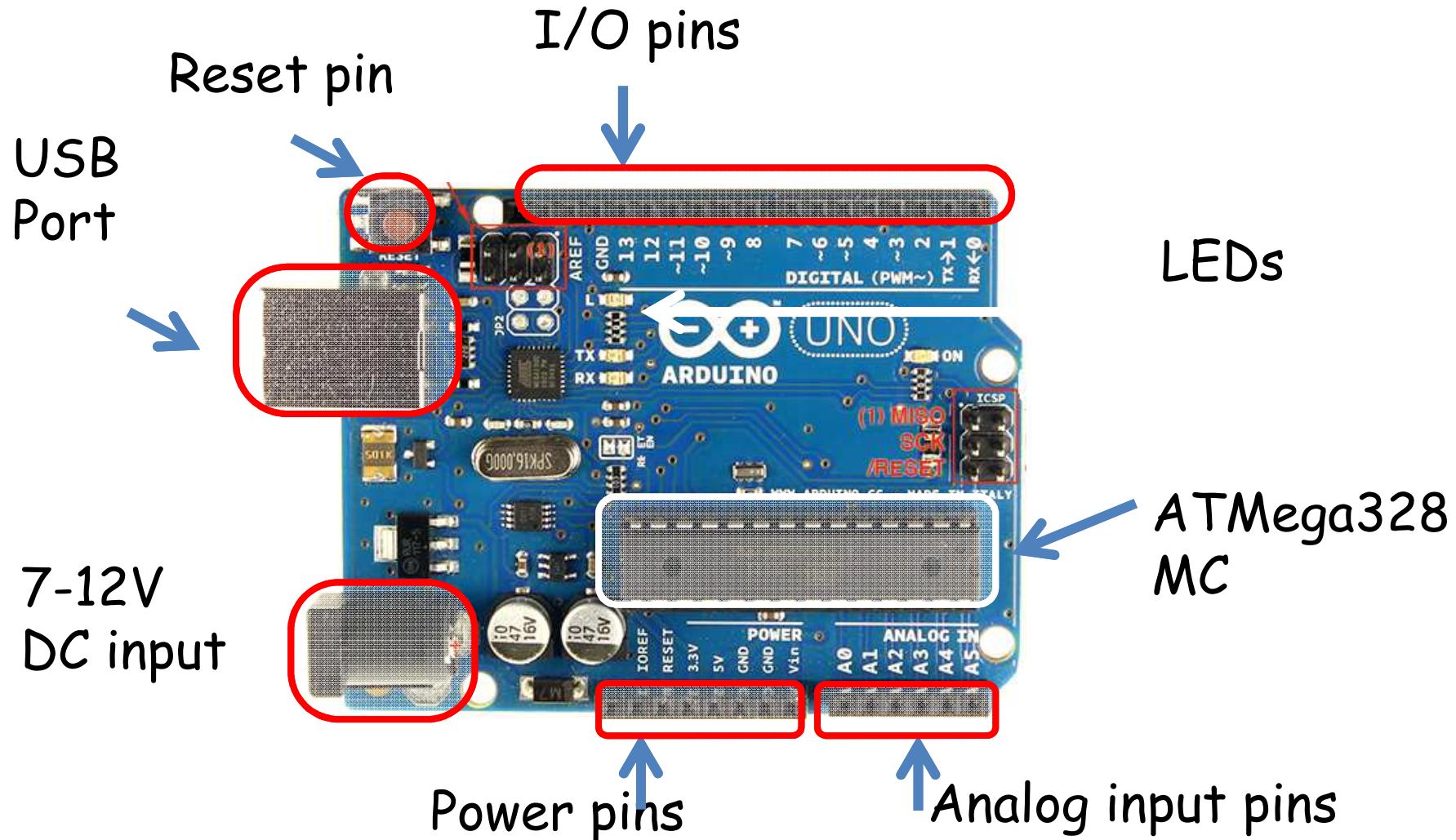
- > <http://192.168.0.106:42001/vars-update=Command=On>
  
- > <http://192.168.0.106:42001/vars-update=Command=Off>



# How does it work?



# Let's meet the Arduino again





# Books

- > Exploring Arduino by Jeremy Blum
- > Programming Arduino Getting Started with Sketches
- > Programming Arduino Next Steps by Simon Monk
- > Arduino Cookbook by Michael Margolis

# Useful websites

- > Arduino reference [www.arduino.cc/en/Reference/HomePage](http://www.arduino.cc/en/Reference/HomePage)
- > Arduino forum [www.arduino.cc/forum](http://www.arduino.cc/forum)
- > Ideas for projects <http://www.instructables.com/>
- > Ideas for projects <http://makezine.com/>
- > <http://www.allaboutcircuits.com/>
- > <http://www.wikipedia.org/>