

# Robotics Workshop

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**FACULDADE DE CIÊNCIAS**  
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# Today

- Robotics Concept and Context in nowadays society
- Fundamental Concepts of Systems Theory (Classic, Complex, Dynamic)
- Intelligent Robotics
- Automation and Internet of Things
- Practical concepts of Electricity and Circuits
- Introduction to practical Digital Electronics
- What will we be doing in Hackers at Porto?



# Objectives

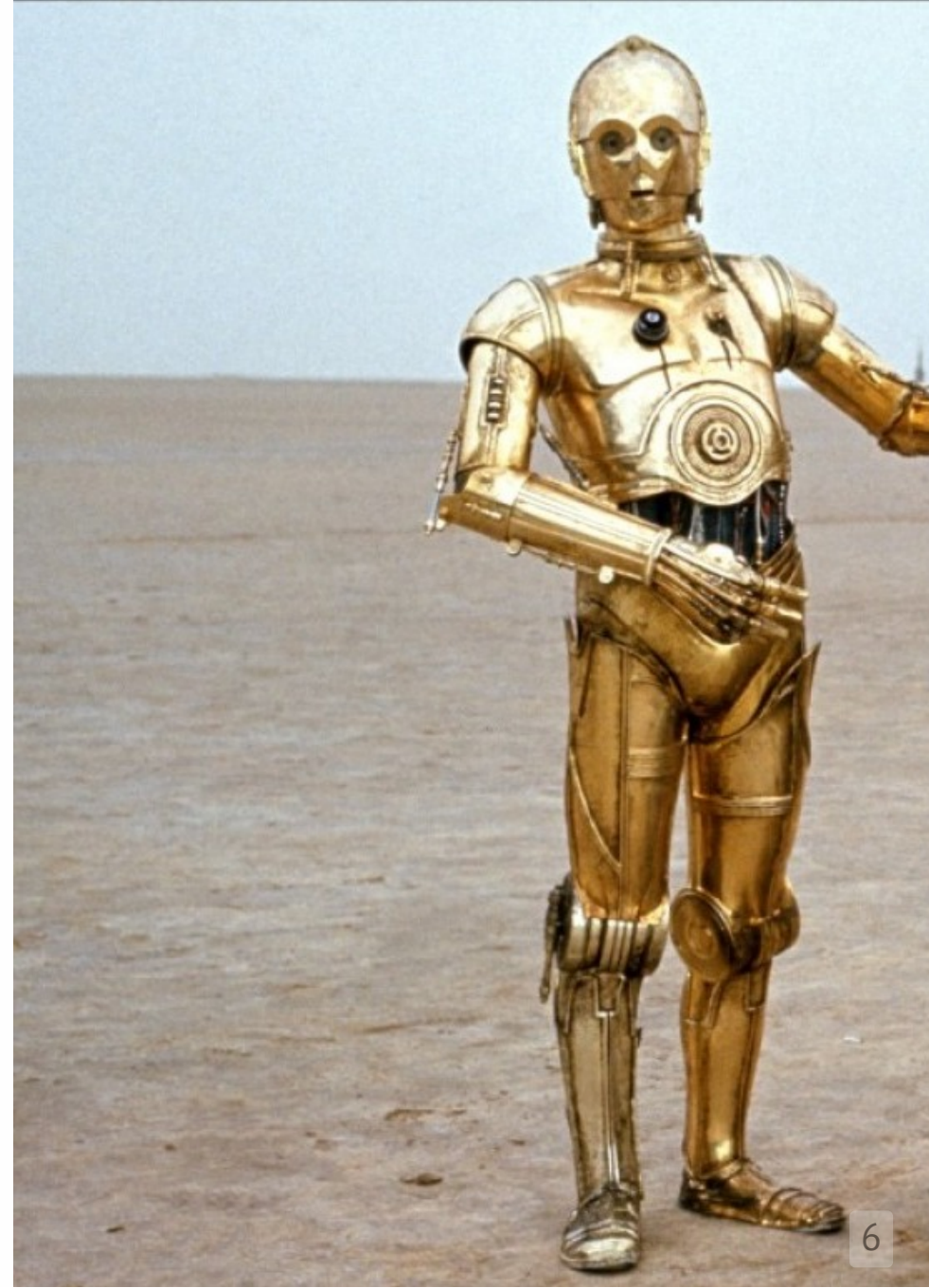
- Know how to automate situations by using **sensors** and **actuators**
  - These go hand in hand
- In this workshop you will:
  - Learn to **macgyver** about automation
  - Flesh out an "**automation toolkit**"
  - Learn the **fundamental concepts** of automation sciences



# Robot Definition and Types

Robot is derived from czech word "Robota"

- Meaning : "servant" and "forced work"
- First used by the czech writter Karel Capek (1920)





# Robot Definition and Types

These are available in the following types and shapes:

- Humanoids (are similar to human both in shape and locomotion method)
- Mobile (autonomous vehicles)
- Industrials (arms)
- Domestic (Washing machine, Vacuum cleaner)

# Robots vs Computers

- A robot is a machine capable of performing mechanical actions - automation
- A robot is capable of interacting with the environment: understand and modify the surroundings
- A computer can process data and produce information

Simulators

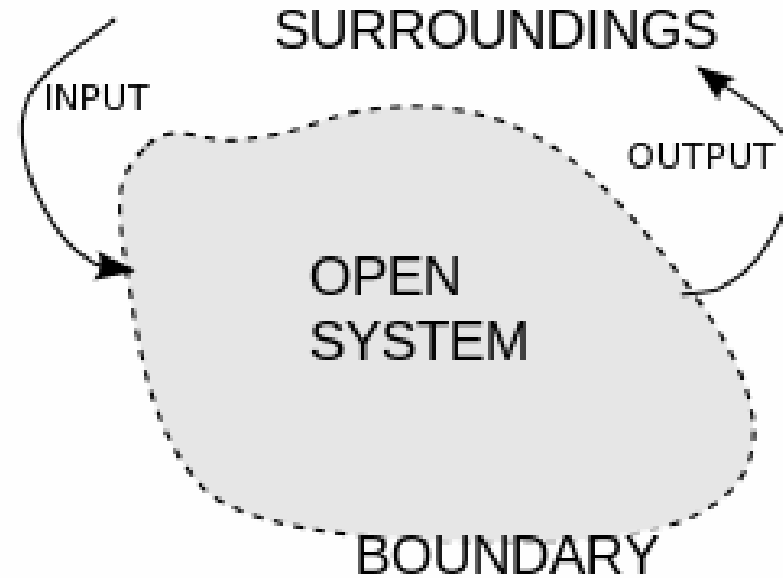


Hardware



# Systems

- A system is a set of entities that, due to its interactions, can be seen as a unified whole
- Complex systems are systems holding various interactions with the environment whose modelation is intrinsically difficult. Therefore, these systems present distinct properties that emerge from those relations





# Intelligence

- "Capacity of using knowledge to solve new problems and perceive how to tackle new situations"

## Artificial Intelligence

- "Science to build machines capable of doing things that would normally require human intelligence"





# Intelligent Robotics

Some complexity that a robot may encounter as a system:

- Environments: Dynamical, Inaccessible, Continuous, Non-deterministic!
- Sensorial fusion: Environment Perception
- Robot Control: Action
- Robot Architecture (Physics/Control)
- Unknown Environment Navigation
- Interaction with other robots/humans

# Internet of Things

- The Internet of Things is another complex system (in particular, a complex network)
- It consists on a network of electronic devices with connection capabilities allowing them to connect, interact and exchange data



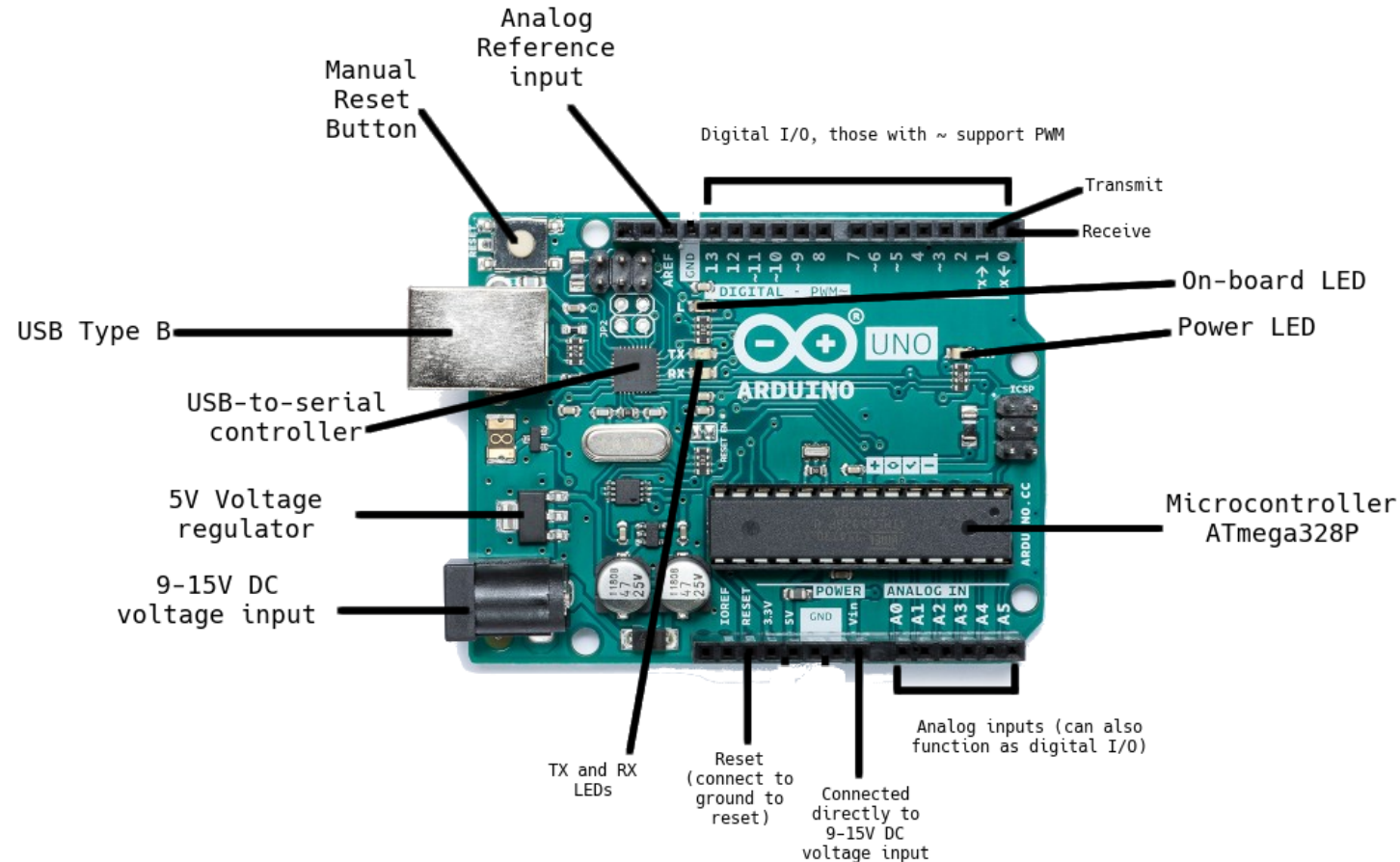


# Digital Electronics

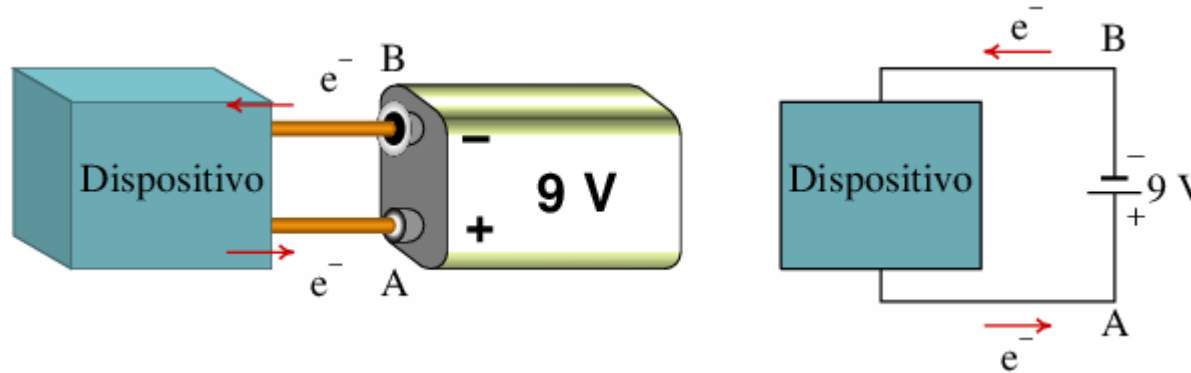
We will be using a development board named Arduino. These are programmable and can be reprogrammed as many times as we need. It features GPIO:

- Digital: Discrete and finite, described in two states: 1/0, ON/OFF
- Analogic: Continuous, may have a arbitrarily large number of values

# Components of an Arduino Board



# Circuits

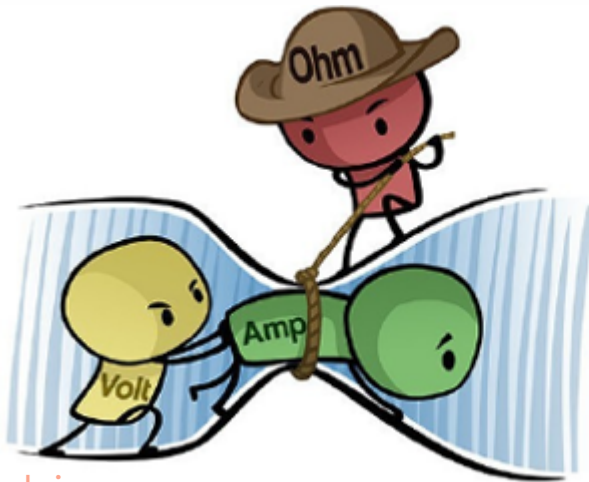


- It is important that we connect the battery in the right direction in the circuit
- Some components like LEDs are sensible to the way how they are connected (those are called polarized components)
- Others can be connected in any direction (e.g.: resistors)

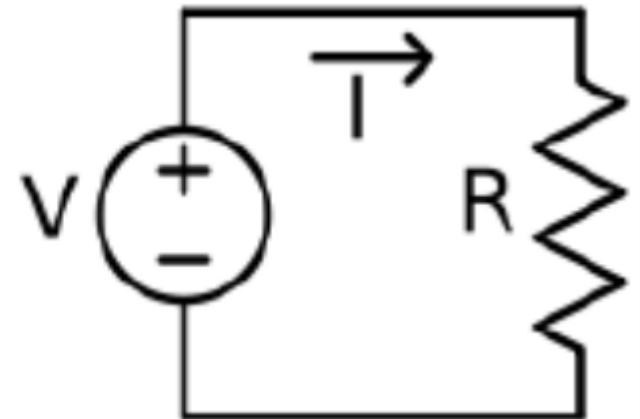
# Electricity: Ohm's Law

The electricity is a energy flow, either of electrons (more common) or protons, through a conductor material

- Voltage (V): it is a measure of the electric potential difference, given in Volts (V)
- Current (I): it is a measure of the flow of electric charge, given in Amperes (A)
- Resistance (R): it is a measure of the material opposition to the flow of electric current, given in Ohms ( $\Omega$ )



$$I = \frac{V}{R}$$



A person is working on a laptop. A breadboard circuit is connected to the laptop's keyboard area. The circuit includes a microcontroller, several LEDs, and various colored wires. The person is holding a small component, possibly a sensor or a connector, and is connecting it to the circuit. The text "Practical Activities" is overlaid on the image.

# Practical Activities



Blink a LED



# Why is the resistor needed?

$$V = IR = I\rho LA$$

When the resistance becomes very low and the voltage does not change, the current becomes very high. If  $R = 0$ , as is the case for an ideal short-circuit, there must be zero voltage across the circuit letting the current through.

$$\frac{\Delta R}{R_0} = \alpha \Delta T \quad \alpha = \text{temperature coefficient of resistance}$$

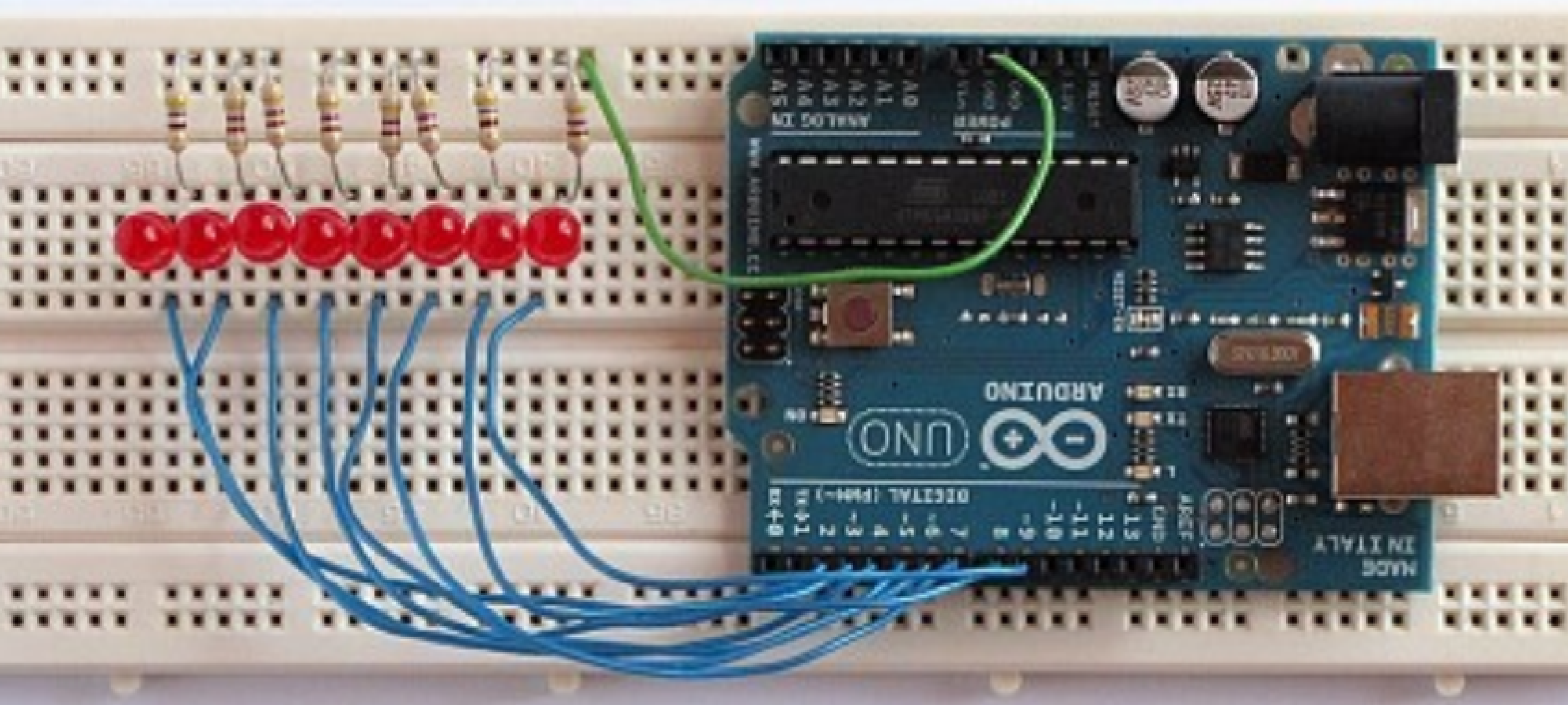
Since the electrical resistance of a conductor such as a copper wire is dependent upon collisional processes within the wire, the resistance could be expected to increase with temperature since there will be more collisions, and that is borne out by experiment. An intuitive approach to temperature dependence leads one to expect a fractional change in resistance which is

proportional to the temperature change.

$$P = IV = I^2 R = V^2 / R$$

The heavy current due to short-circuit causes excessive heating which may result in fire or explosion.

**tl;dr:** A resistor is needed because we could have a short circuit otherwise



## Knight Rider Display

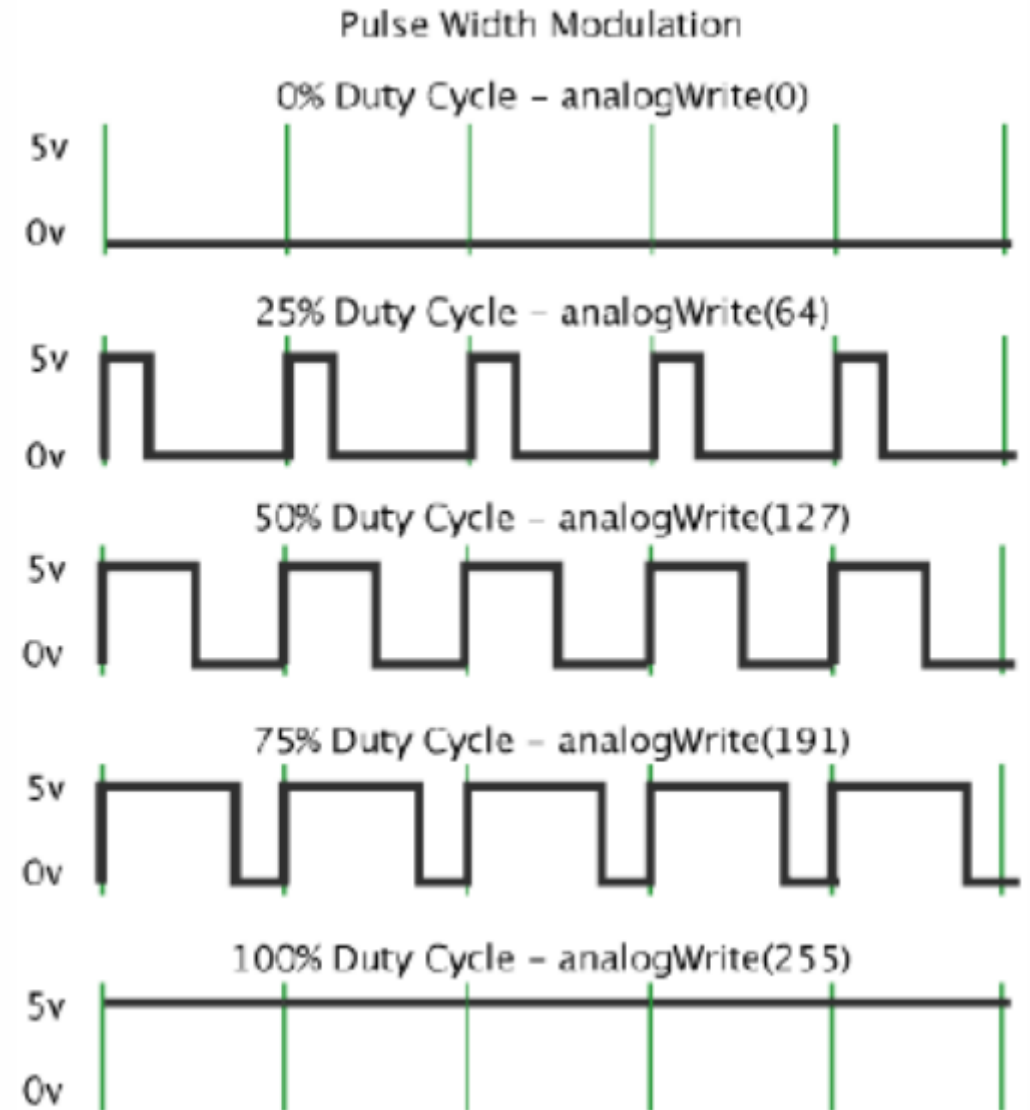


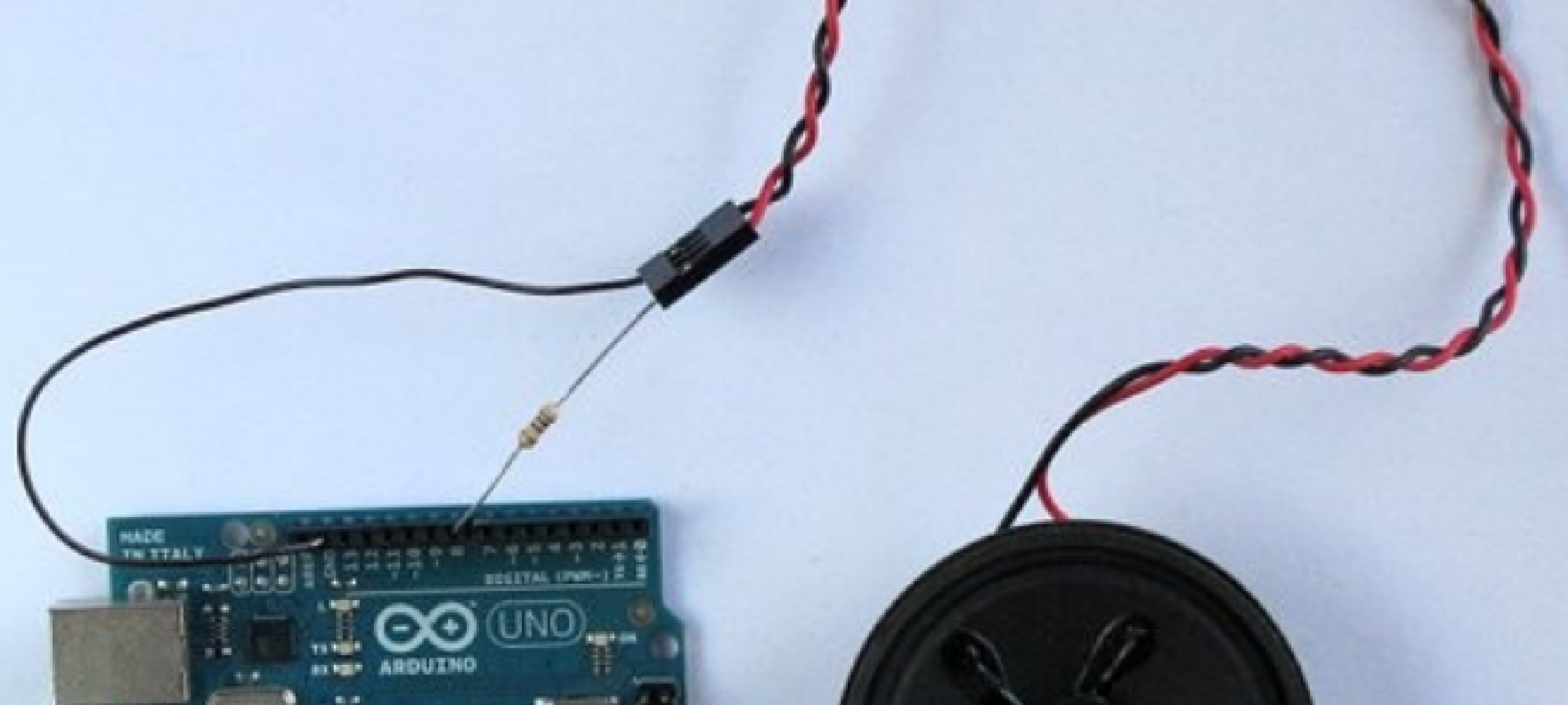


## Pulsating LED

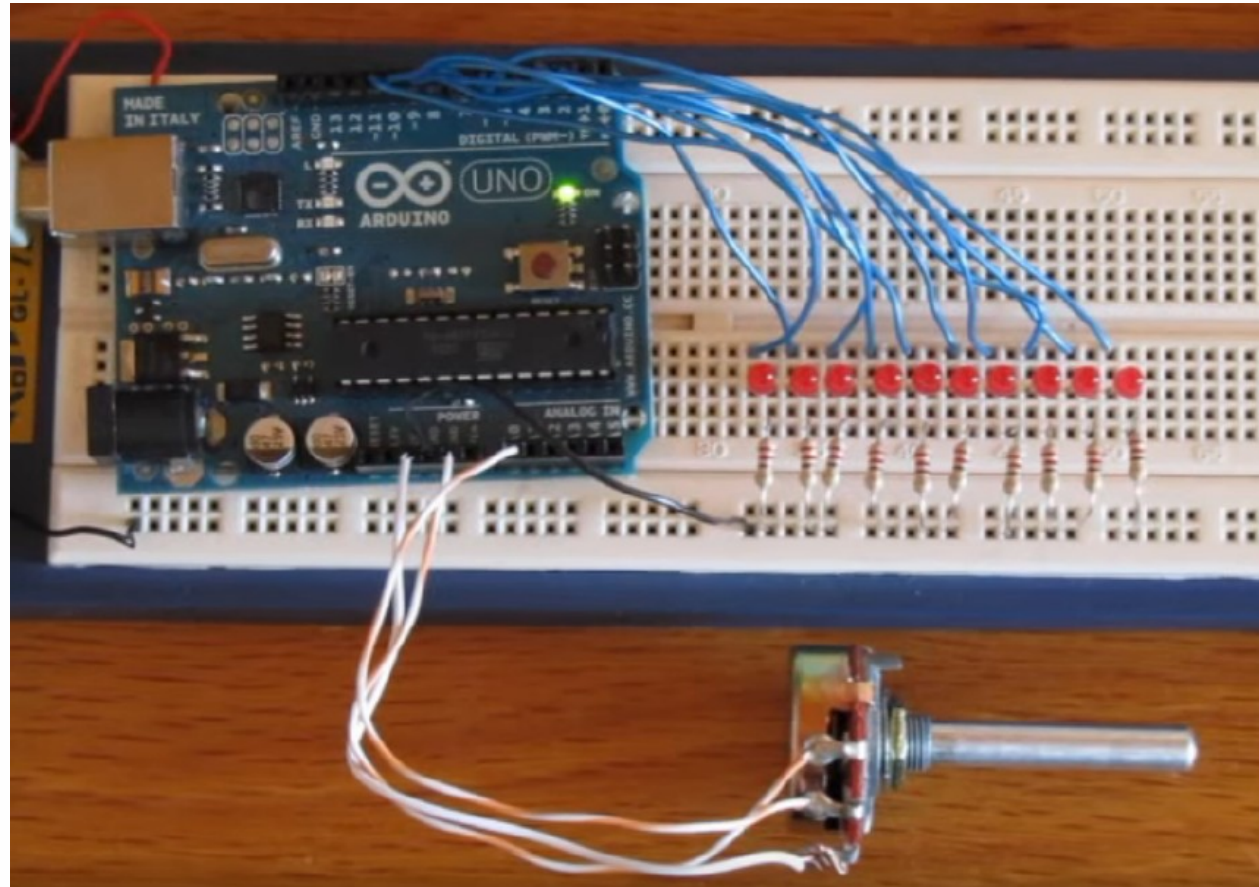
# What is PWM after all?

Pulse-width modulation (PWM) is a technique used to simulate an analogic output by means of a digital one, for that creating a squared wave that constantly alternates between on and off. The time in which the wave is 5V (ON) is named pulse width, which is changed to modify the analogic value





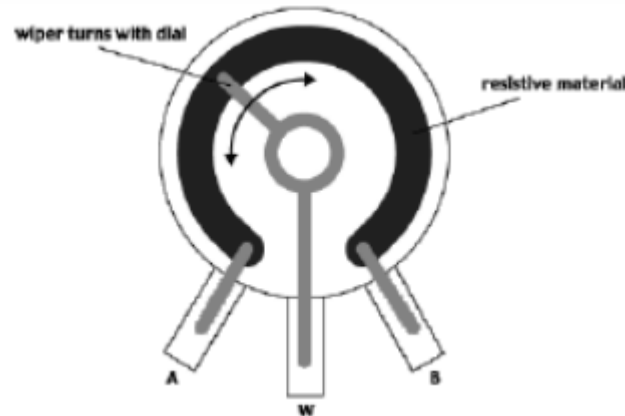
## Arduino Melody



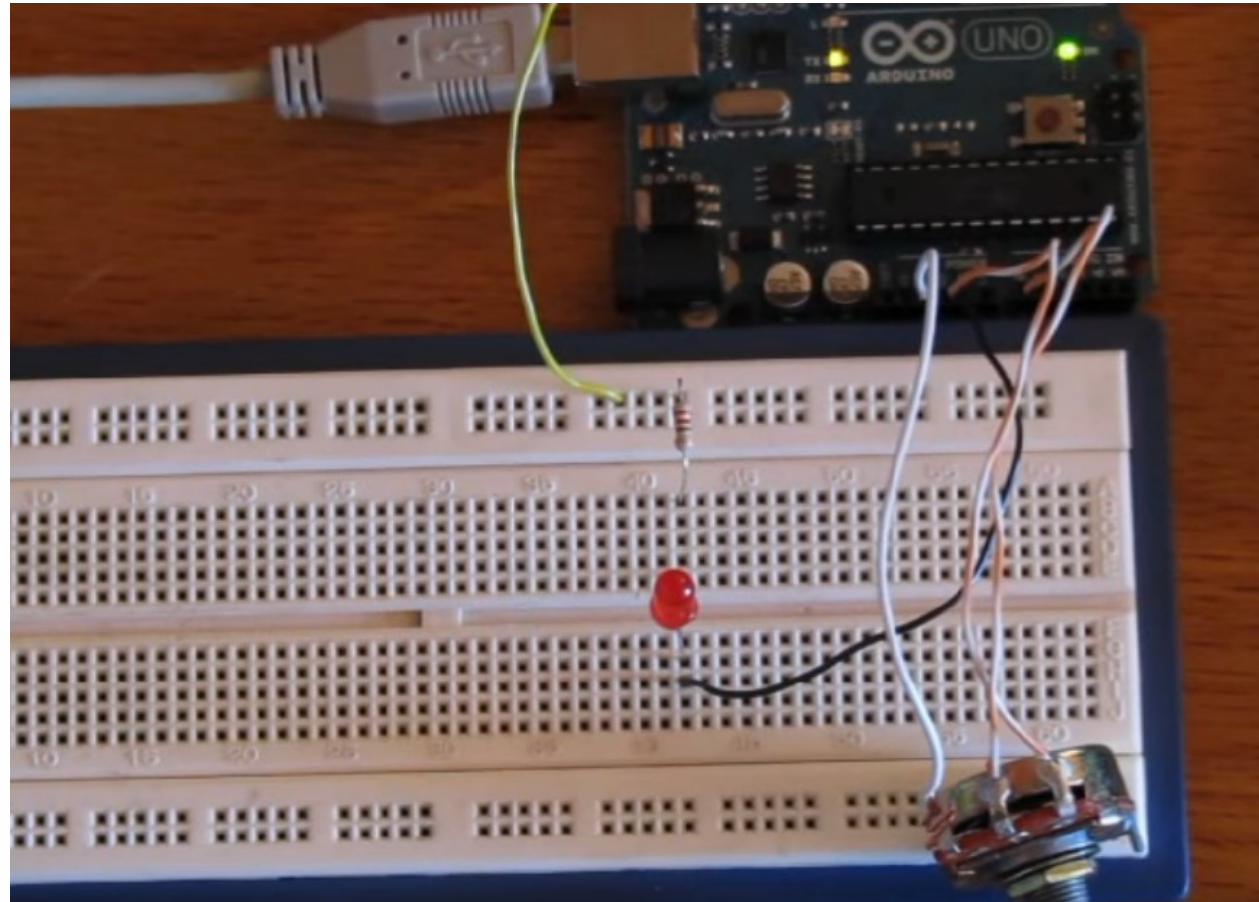
BarGraph

# What is a potentiometer?

- A potentiometer is a component of variable resistance that returns an analogic value. In our case, using an Arduino board, the range is comprehended between 0 and 1023
- Its resistance is controlled by rotating on its axis, as shown in the figure:

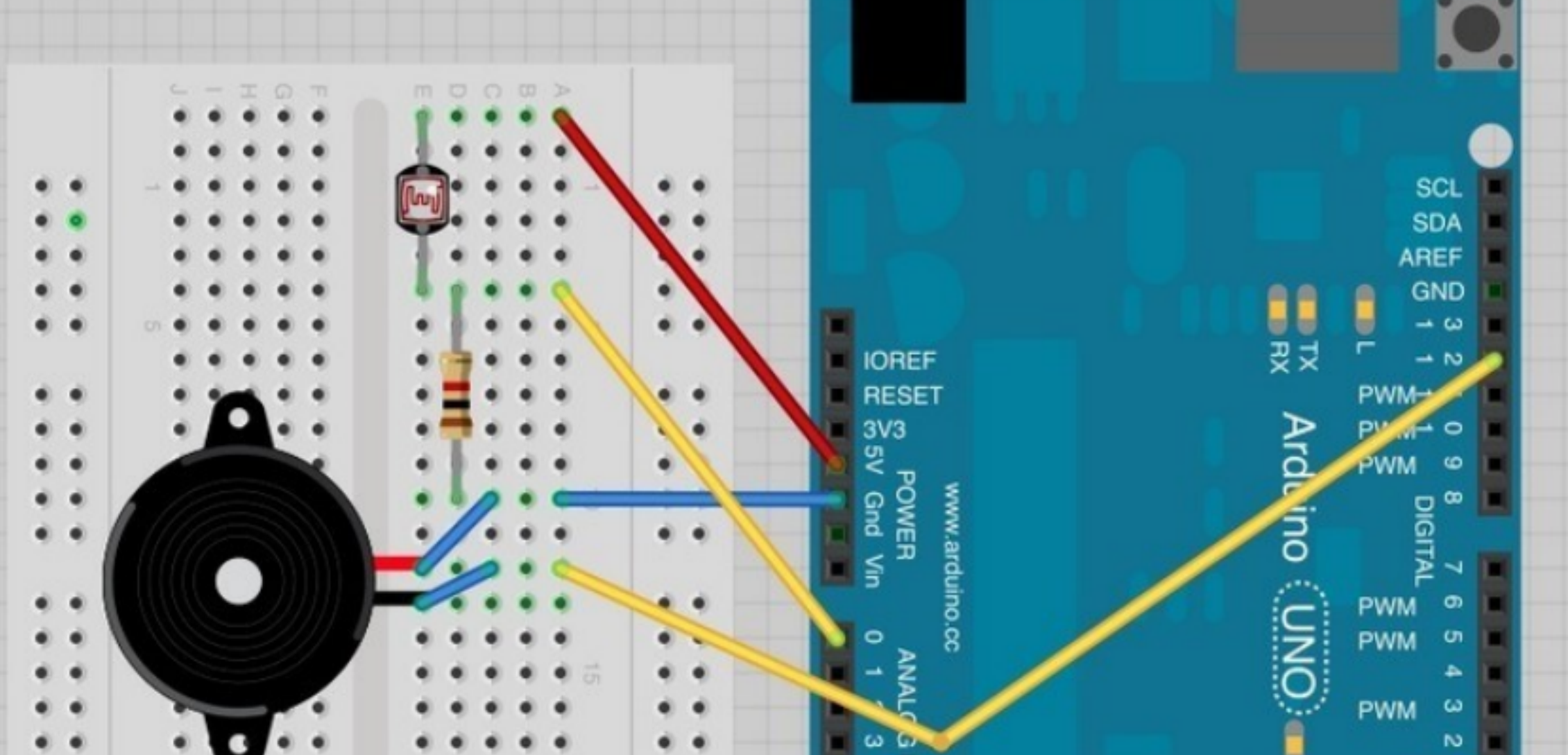


**NOTE:** The resistance value increases and decreases in a direction or another depending on how the pins are connected



Using a potentiometer to change a LED intensity

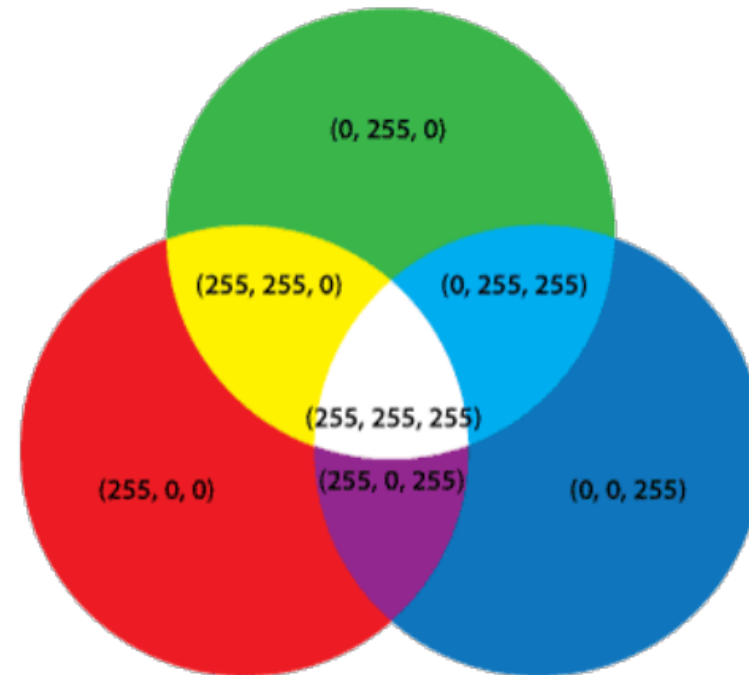
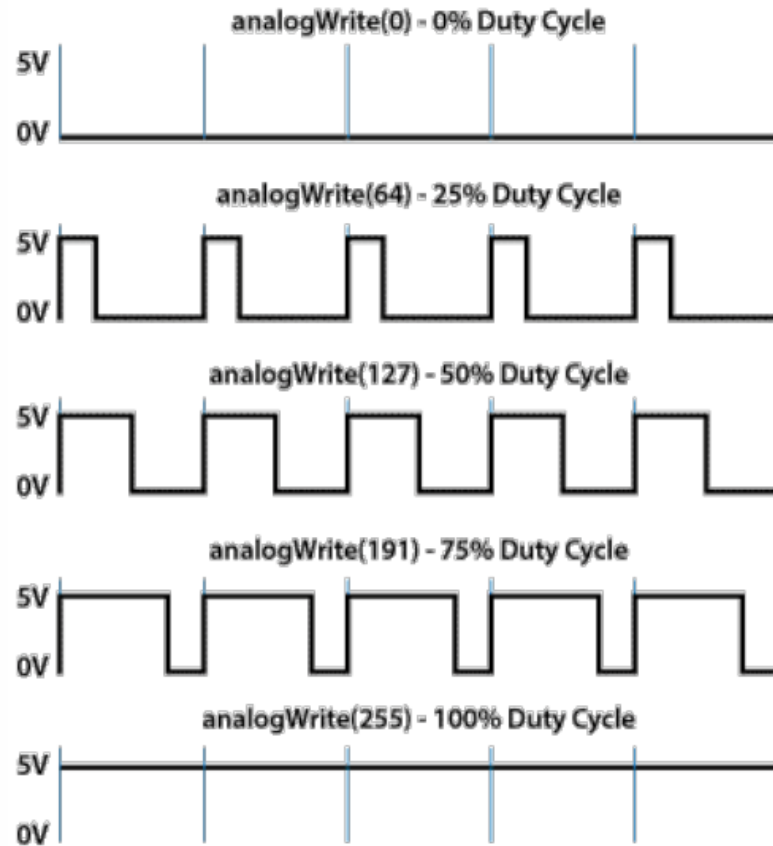




## Pseudo-Theremin

# RGB LED

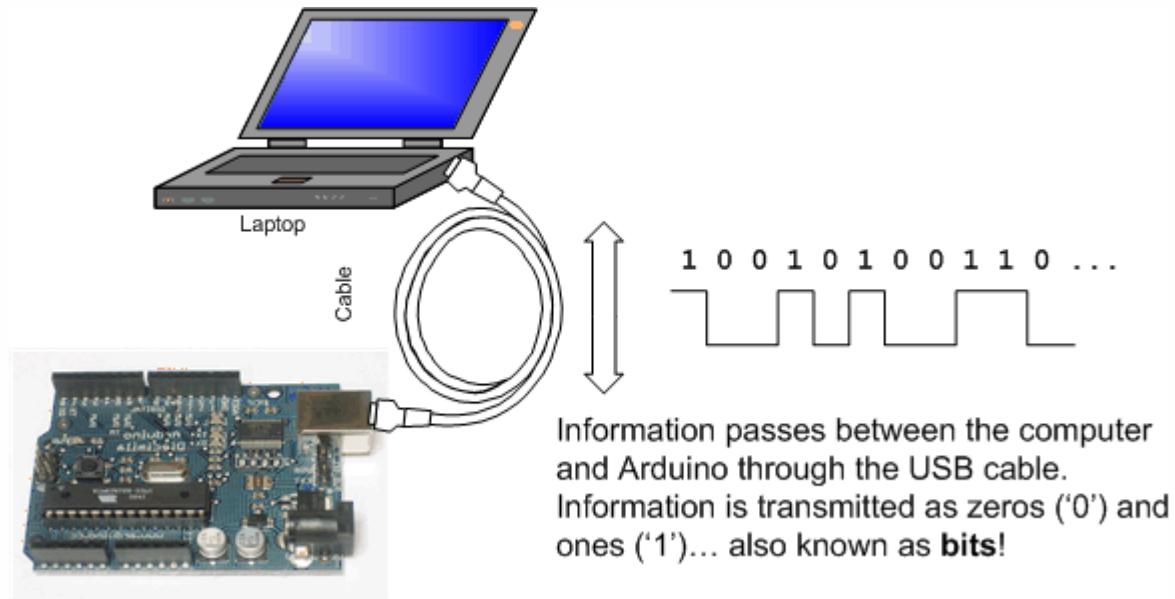
## PWM - Pulse Width Modulation





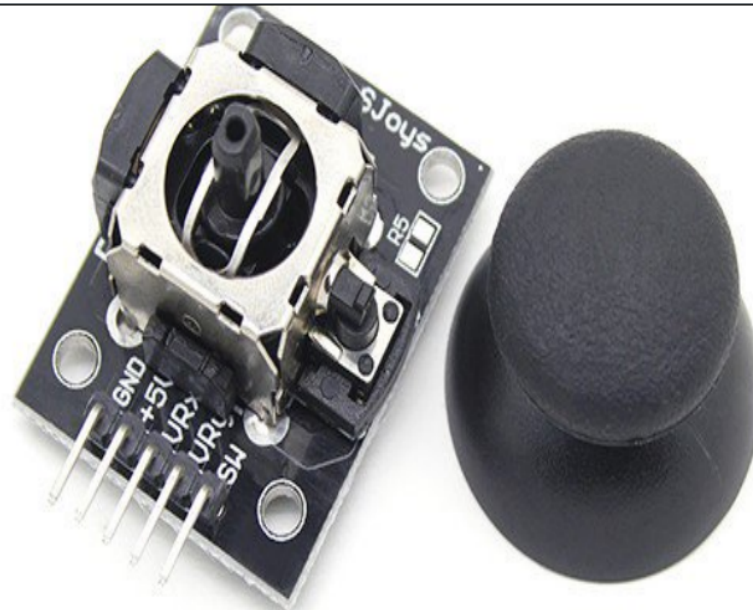
# Arduino Serial Port - "hello, world."

This allows not only to connect an Arduino to a computer but also, consequently, to the internet!

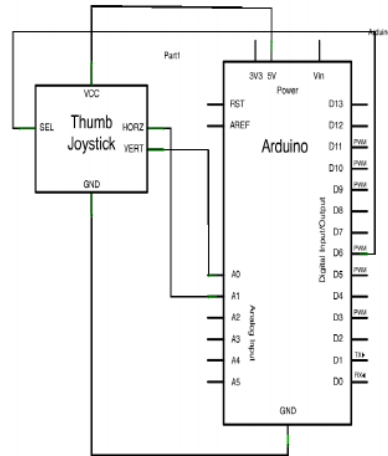
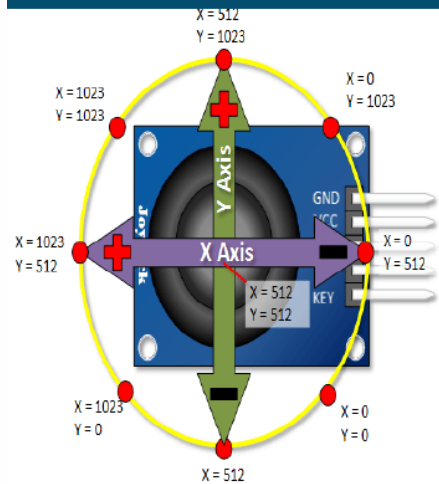


A person is working on a laptop. A breadboard circuit is connected to the laptop's keyboard area. The circuit includes a microcontroller, several LEDs, and various resistors. Wires connect the breadboard to the laptop's ports. The text "Some simple applications" is overlaid on the image.

# Some simple applications



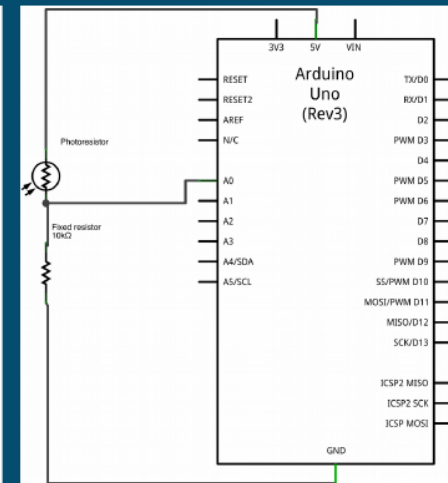
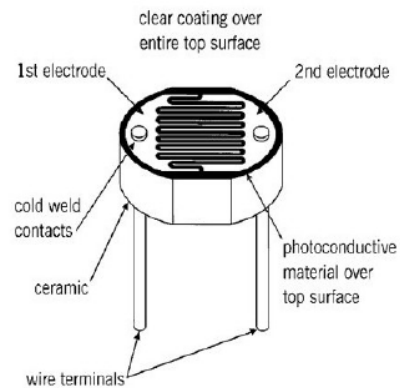
# PS2 JOYSTICK



<https://www.diogo.site/projects/basic-joystick-input-device>



# LIGHT GUN

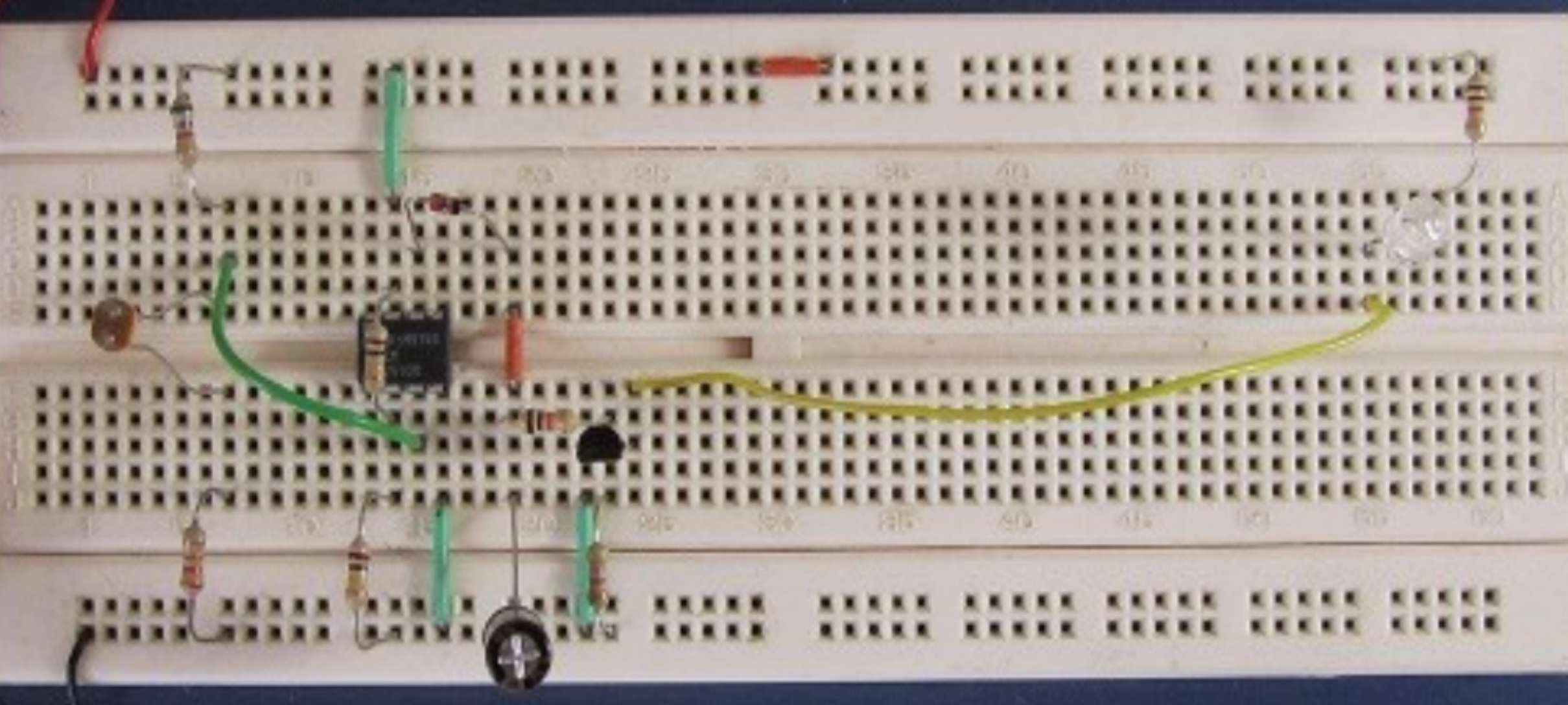


<https://www.diogo.site/projects/basic-joystick-input-device>



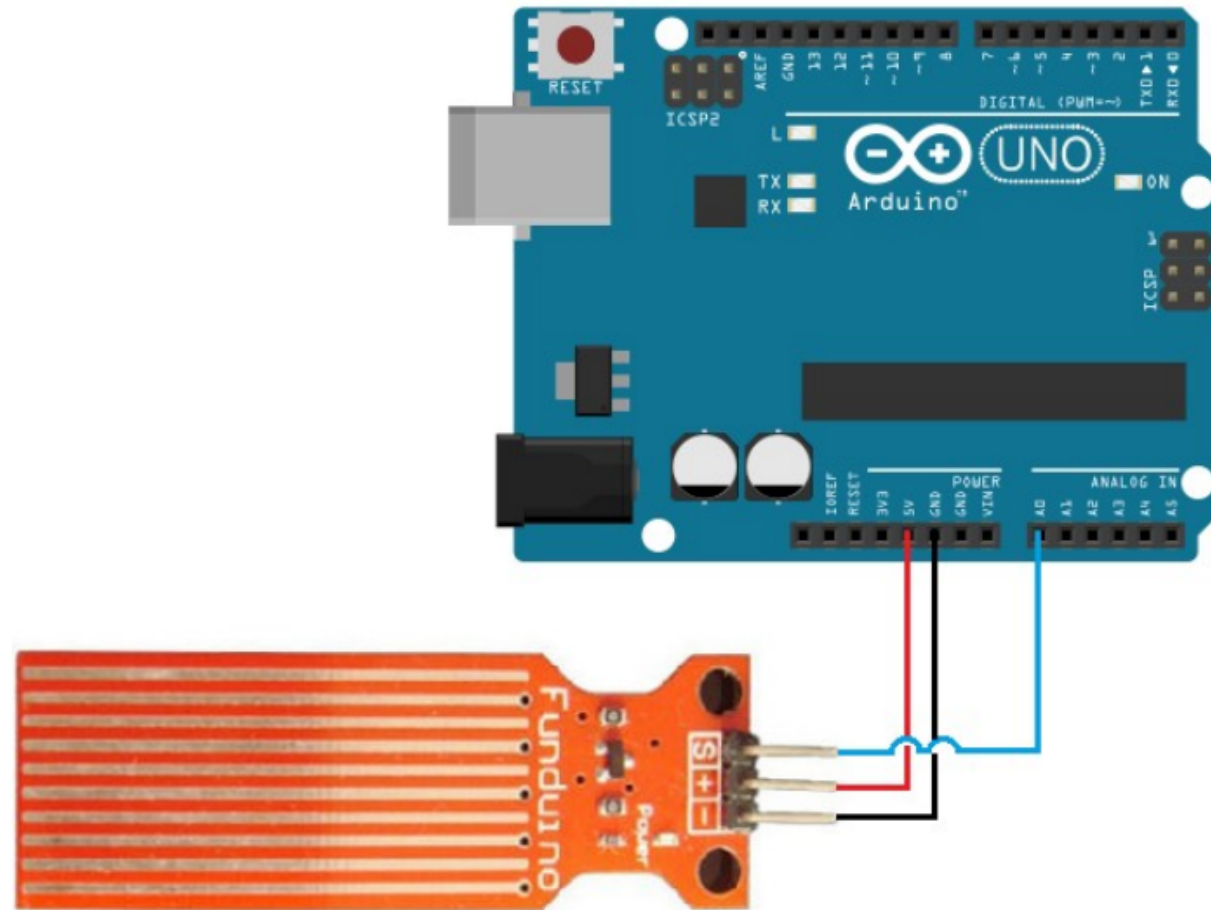
The good old Semaphore example





Presence Light (Analogic circuit for comparison with the seen so far)





## Water Leak Detector



## Fun with Binary

# Robotic Laws - Asimov

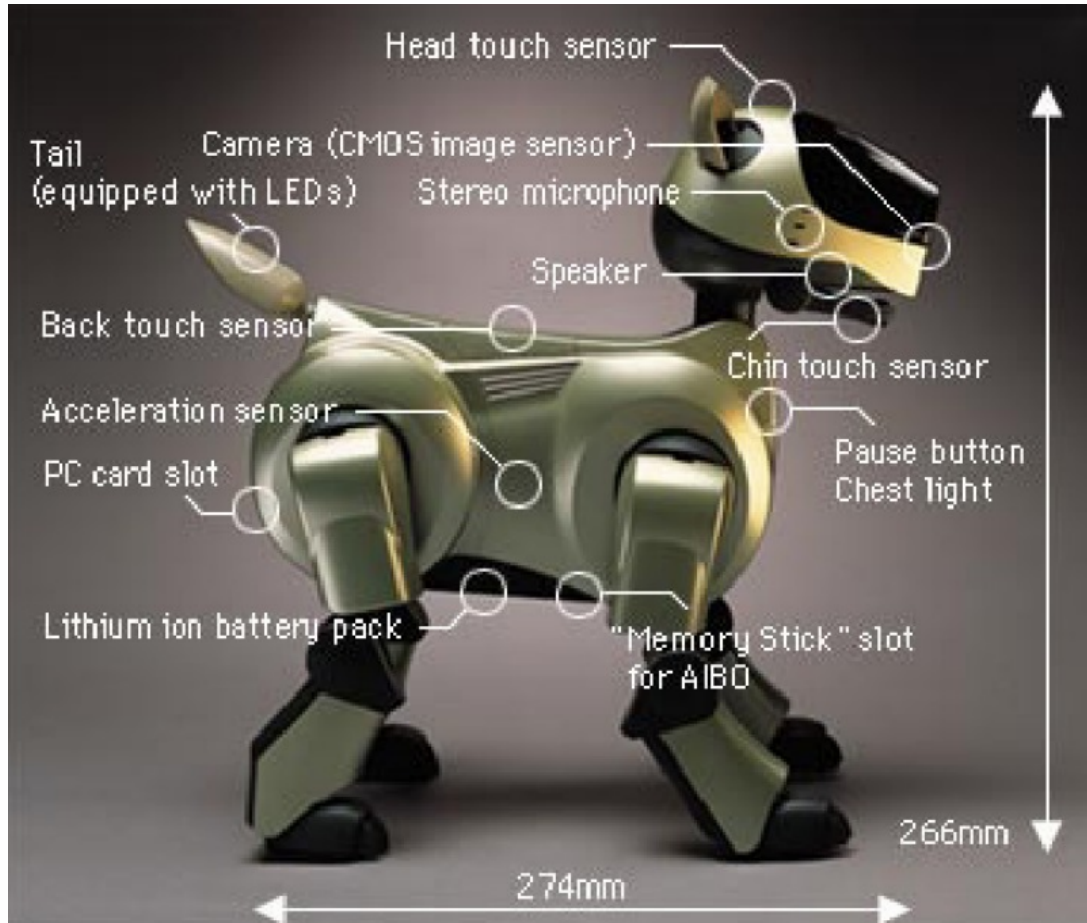
Much of science fiction literature considers the idea that robots might one day beat humans in intelligence level. Therefore the hypothesis of what could happen if these decide humans are dismissable arise.

To reduce this problem, Isaac Asimov propose the three robotic laws:

1. A robot shouldn't hurt a human, or, by innaction, let that happen
2. A robot should obey human orders, except if those break the first law
3. A robot should protect its existence as long as that doesn't break the first and second law



# AIBO as an interesting robotic platform example



- Video Camera
- Stereo Microphone
- Speaker
- Lights (LEDs)
- Lithium battery
- Wireless Communication
- Accelerometer, Touch, Proximity, Temperature e Vibration Sensors
- Actuators: 1-Mouth, 3-Head, 2-Tail, 1 2-Ears, 34-Legs





What is Boston Dynamics doing?

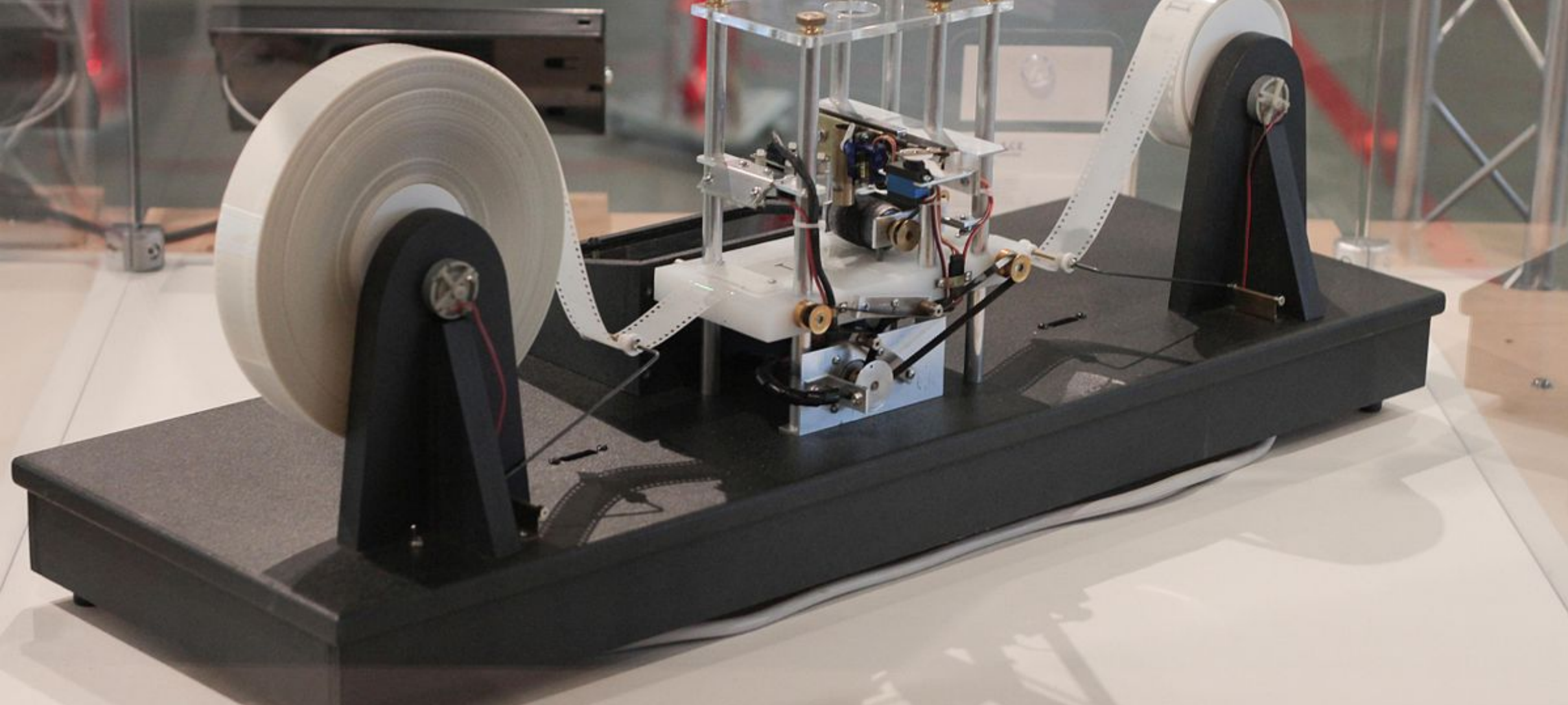
# Robotics Contests

- DARPA Grand-Challenge
- Intelligent Ground Vehicle Competition
- AAI Grand Challenges
- RoboCup
- First Lego-League
- RoboOlympics
- Manitoba Robot Games
- Robot Fights: BattleBots, RobotWars, Robot-Sumo



- In Portugal:
  - Festival Nacional de Robótica (incluindo condução autónoma)
  - Micro-Rato / Ciber-Rato
  - Robot-Bombeiro





## Gaming Turing Machine Simulator

# Final Remarks

We hope today was a lot of fun with us! A recording of this workshop will be shared in our youtube channel for future reference as usual.

If you are excited about this world, we will be weekly working on our Turing Machine at our current HaP Morning schedule, every **Wednesday at 11am!**

Happy hacking!