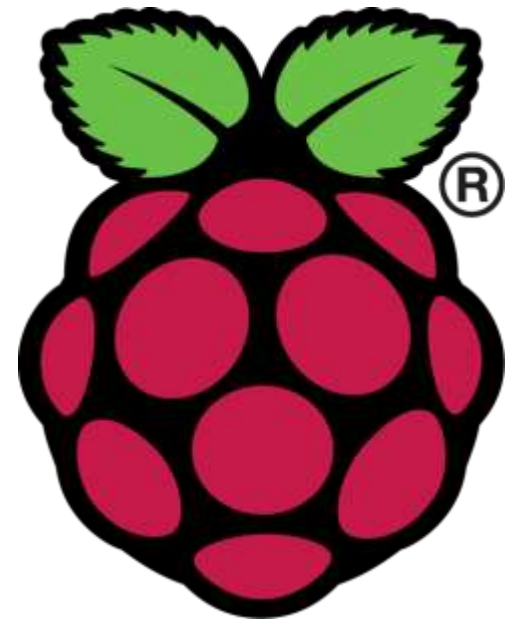


Arduino and Raspberry-pi for daily life in the lab

Build your own behavioural assay



Aim: To give you an idea of what is possible with microcontrollers and how we can use them to solve our problems in science

1. What is an Arduino?
2. What can it do ?
3. How to use it?
4. Example of use
5. What is a Raspberry Pi ?
6. In what does it differ from an Arduino ?
7. What can it do ?
8. How to use it ?

What is an Arduino ?

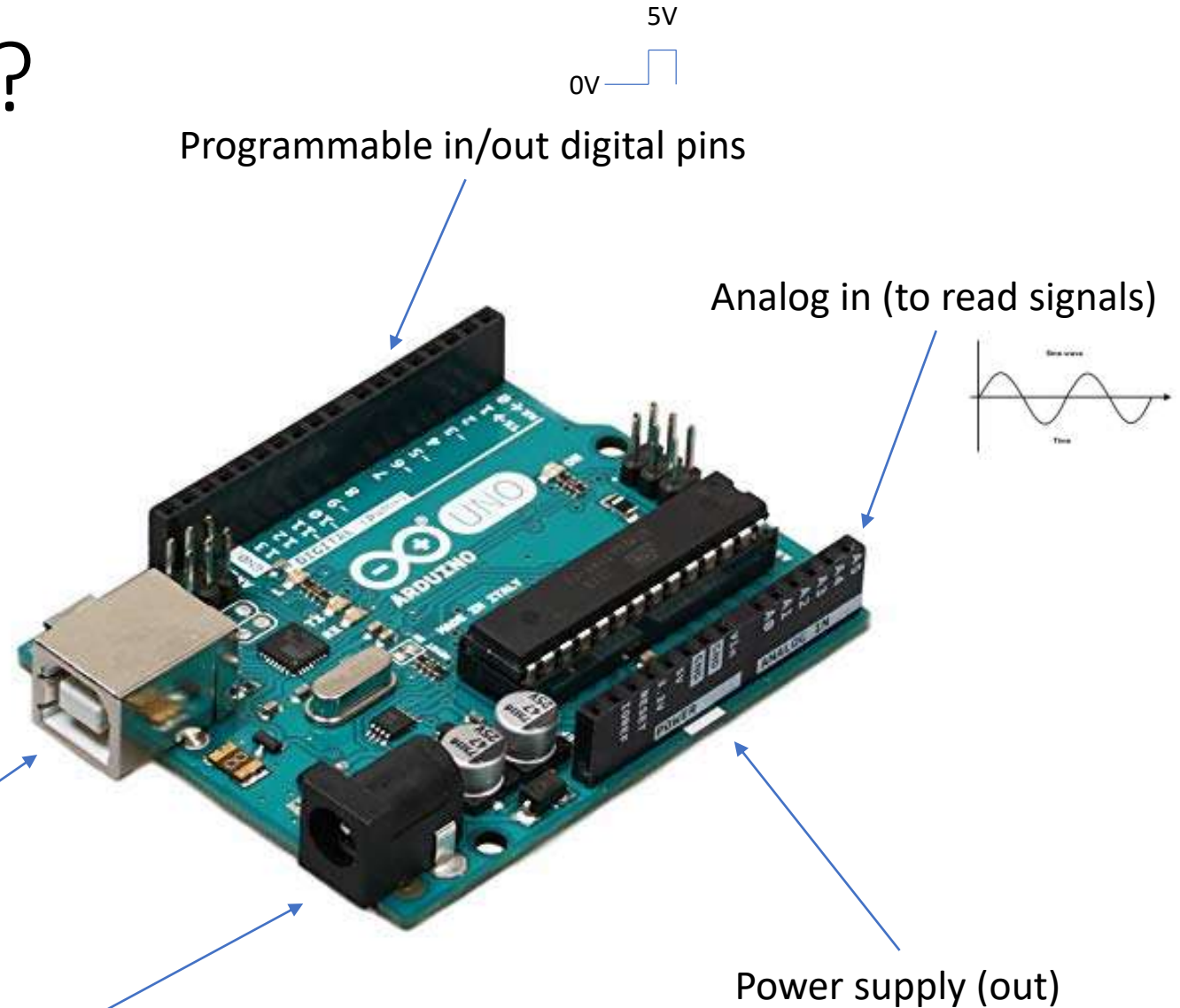
It's an easily programmable and cheap microcontroller



USB Connection to computer

- Programming the board
- Serial communication

Power supply (if used alone)



What can it do ?



Digital input

By receiving TTL
Or serial from other
systems



Electrophysiology recording system

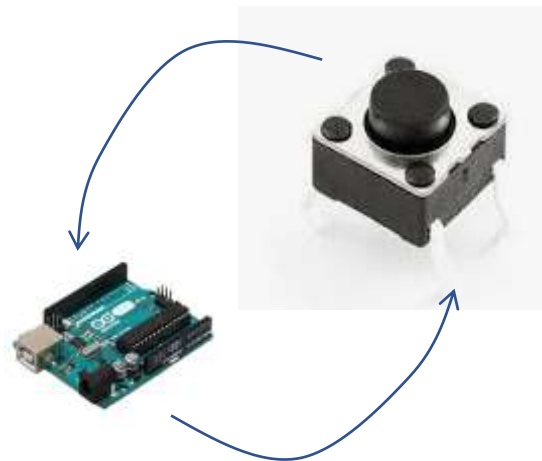


TTL : Transistor-transistor logic
Two states: High or Low



To itself through detectors

Button



Hall sensor (magnetic)



Tilt switch



Analog input

Manual potentiometer



Sound



Touch



light



Humidity/temperature



3 axis accelerometer



Digital output

By sending TTL
Or serial

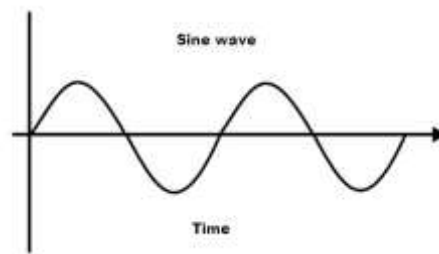
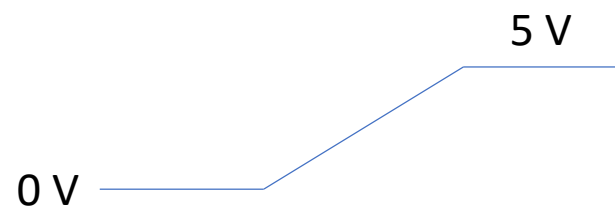
0V  3.3 or 5V



Controlling servo-motor



Analog output



Code is divided in 3 parts:

How to use it



ARDUINO 1.8.10

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. Refer to the [Getting Started](#) page for Installation instructions.

- ARDUINO IDE is a light and easy to use software to write code directly in the Arduino boards
- The language, similarly to R, is based on C and thus is quite comparable

```
const int led = 2;

void setup() {
  // put your setup code here, to run once:
  pinMode(led, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000);             // wait for a second
  digitalWrite(led, LOW);  // turn the LED off by making the voltage LOW
  delay(1000);
}
```

Variable assignment

Code setup

Continuous loop

Example of quick project (problem):

Are you slightly annoyed
when someone is exceeding
the 20 minutes allowed for
a progress report ?



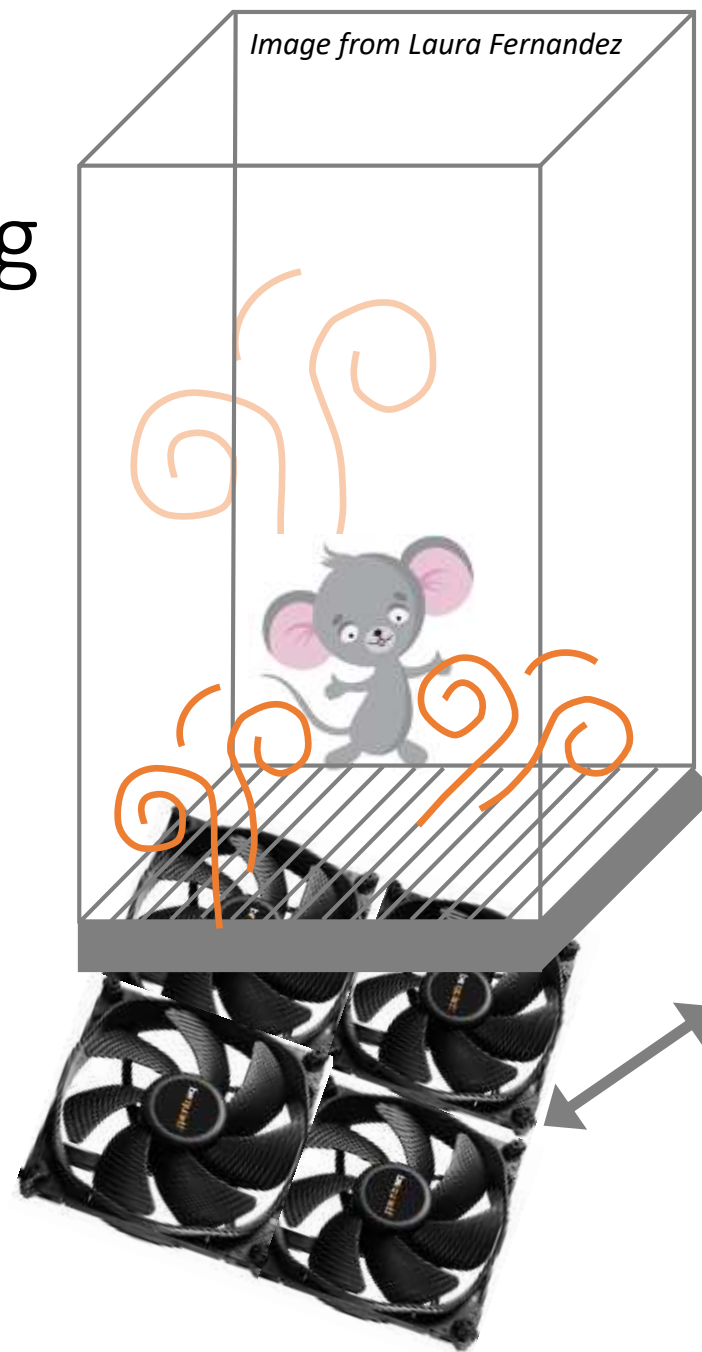
Arduino is the solution



Example of use



Somatosensory fear conditioning



Problem : We want to assess somatosensory memory

Solution : wind as the CS

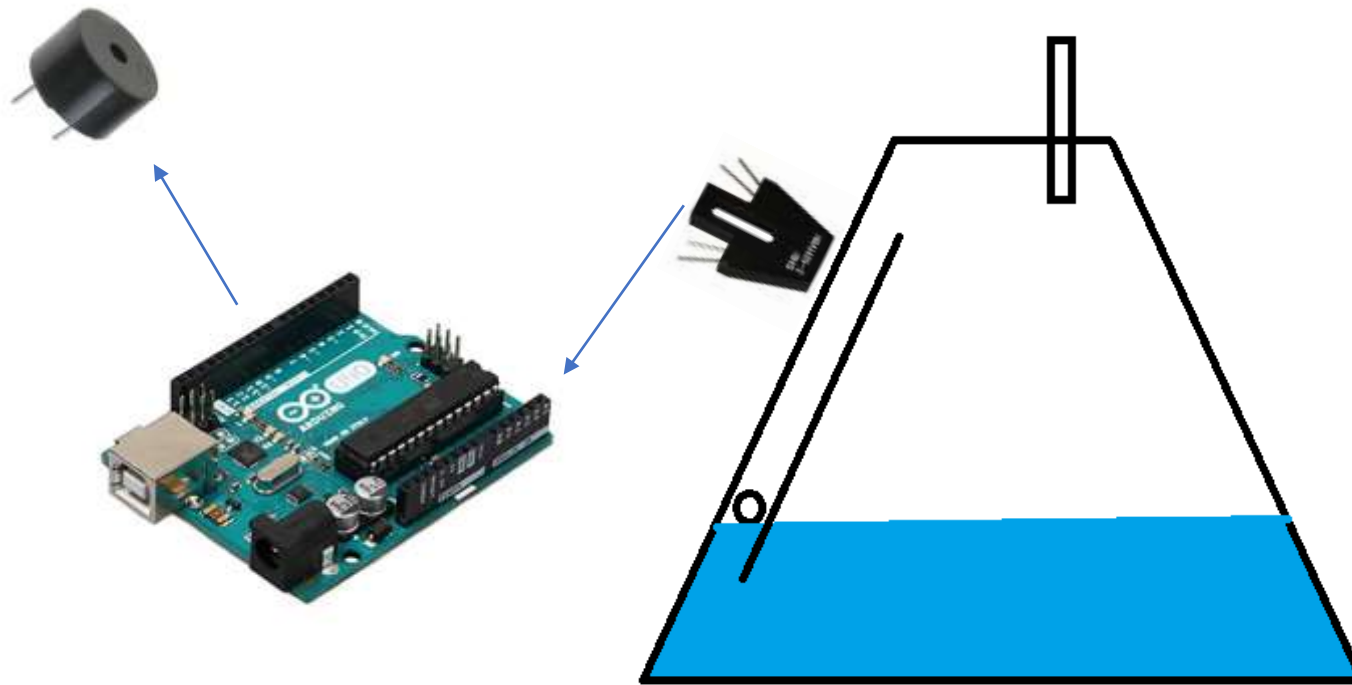
- 4 computer fans
- Placed below the grid of the fear conditioning box
- Command with Arduino



Sandro Lecci

Alarm level for patch setup liquid waste

(By Jean-Yves Chatton)



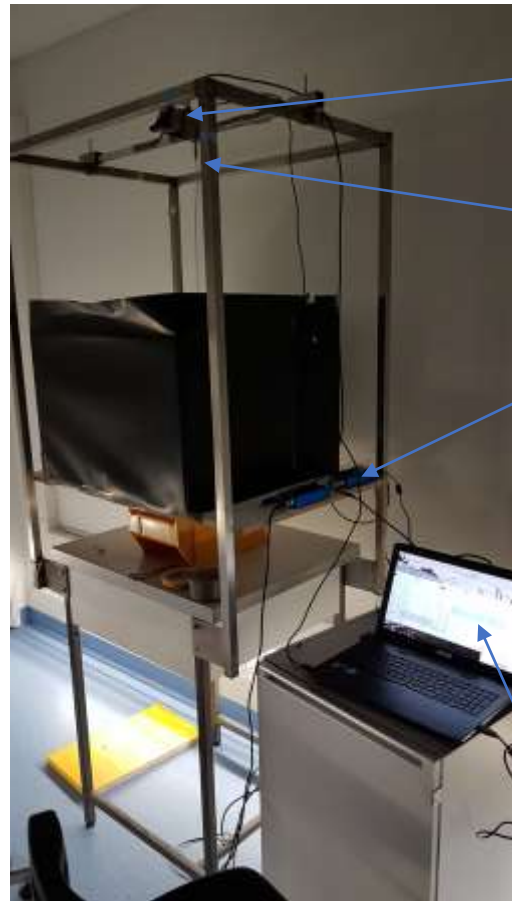
Problem : If the water reach the top, it is sucked in the pump and it breaks the DNF

Solution : Buzzer when it's too high

The ball goes up with the liquid and is detected by the IR sensor.

In response, the Arduino activates the buzzer

Optogenetic in openfield



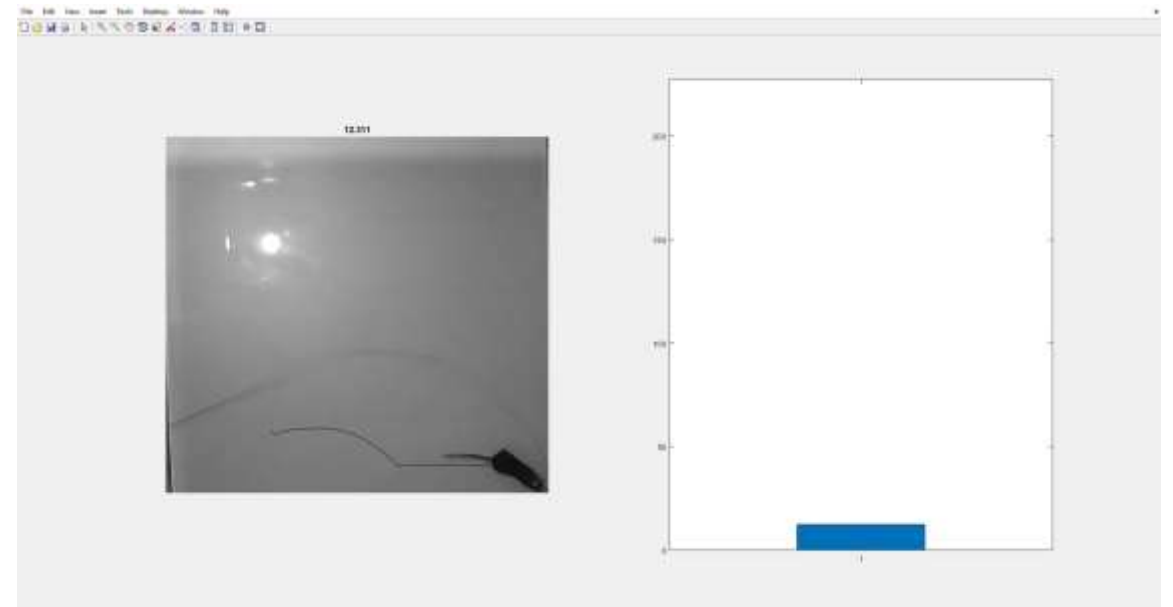
Webcam

Optogenetic
LED

LED driver connected to
arduino

Computer connected
to webcam and arduino

- Matlab code to control the webcam and record video
- The same code is sending serial signal to the Arduino to launch the optogenetic stimulation
- Position of the animal is detected afterward with another matlab code



Wheel activity counter

Can record the number of turn of the wheel

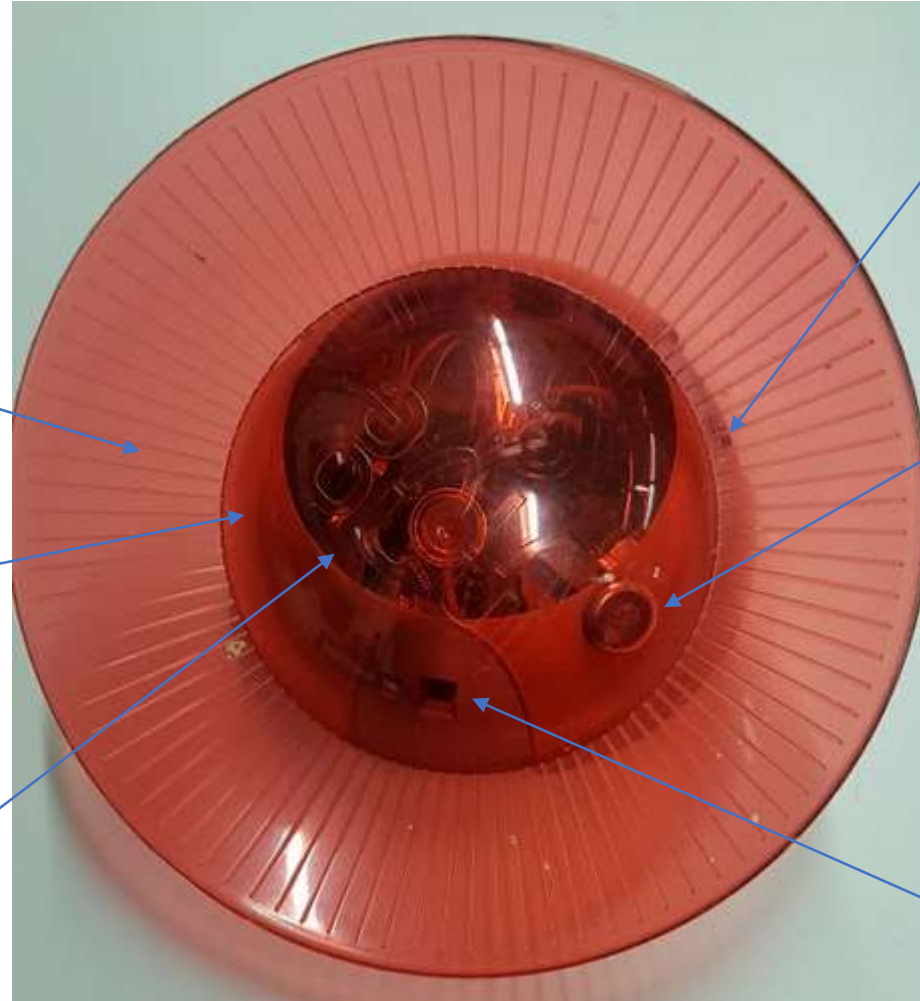
Problem : We need to know if the amount of activity has an influence on pain sensitivity

Solution : Recording the wheel

Innovive wheel

3D printed box

9 V battery inside



LED which gives the number of turn when button is pressed

Magnet

Hall sensor

Cat toy !

(random movement)

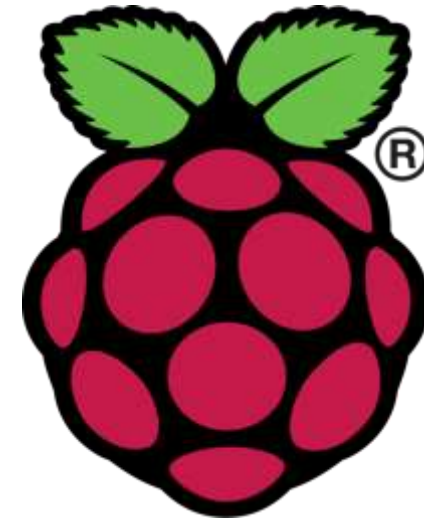
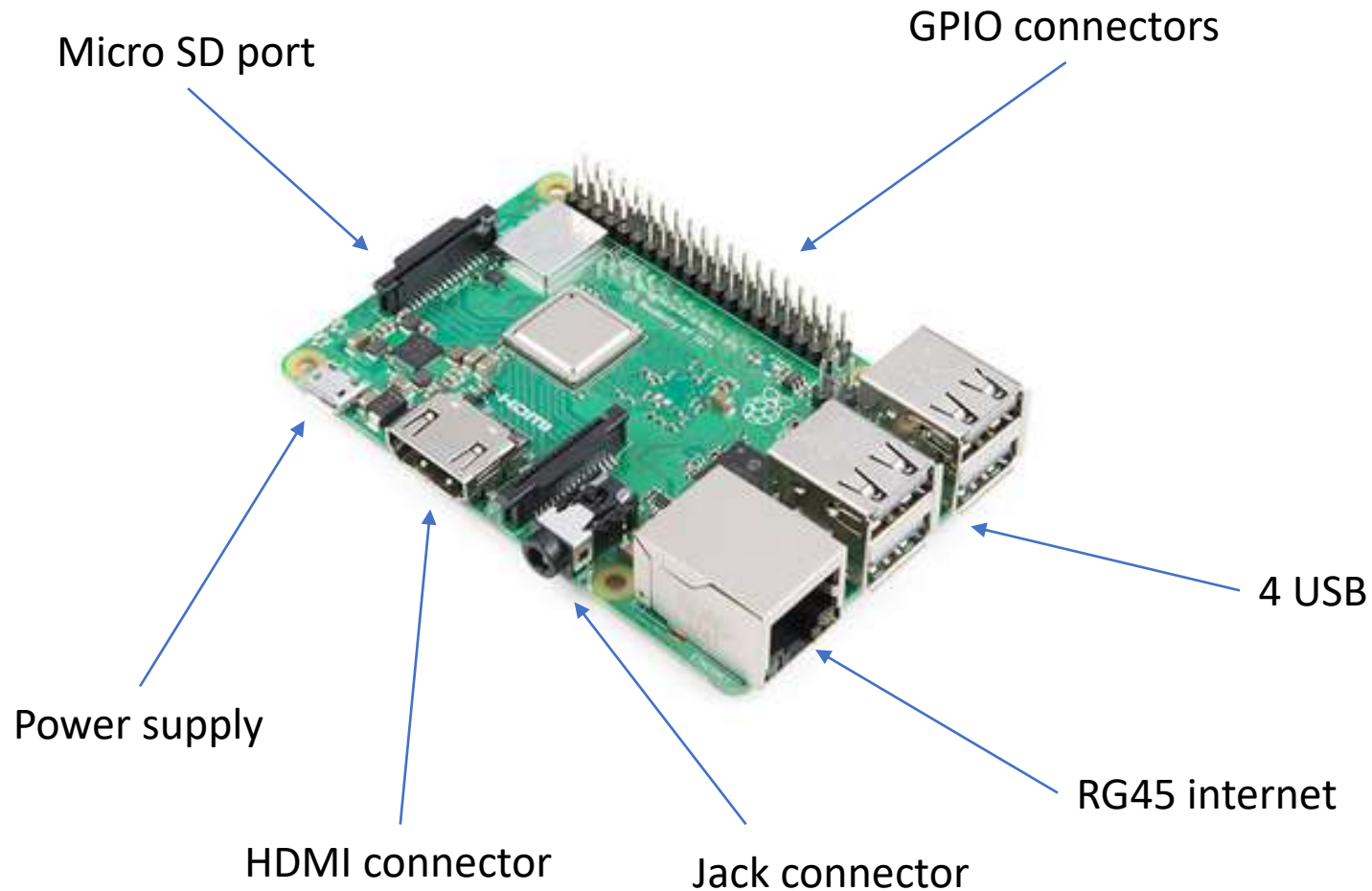


Problem : Cat is alone when human works

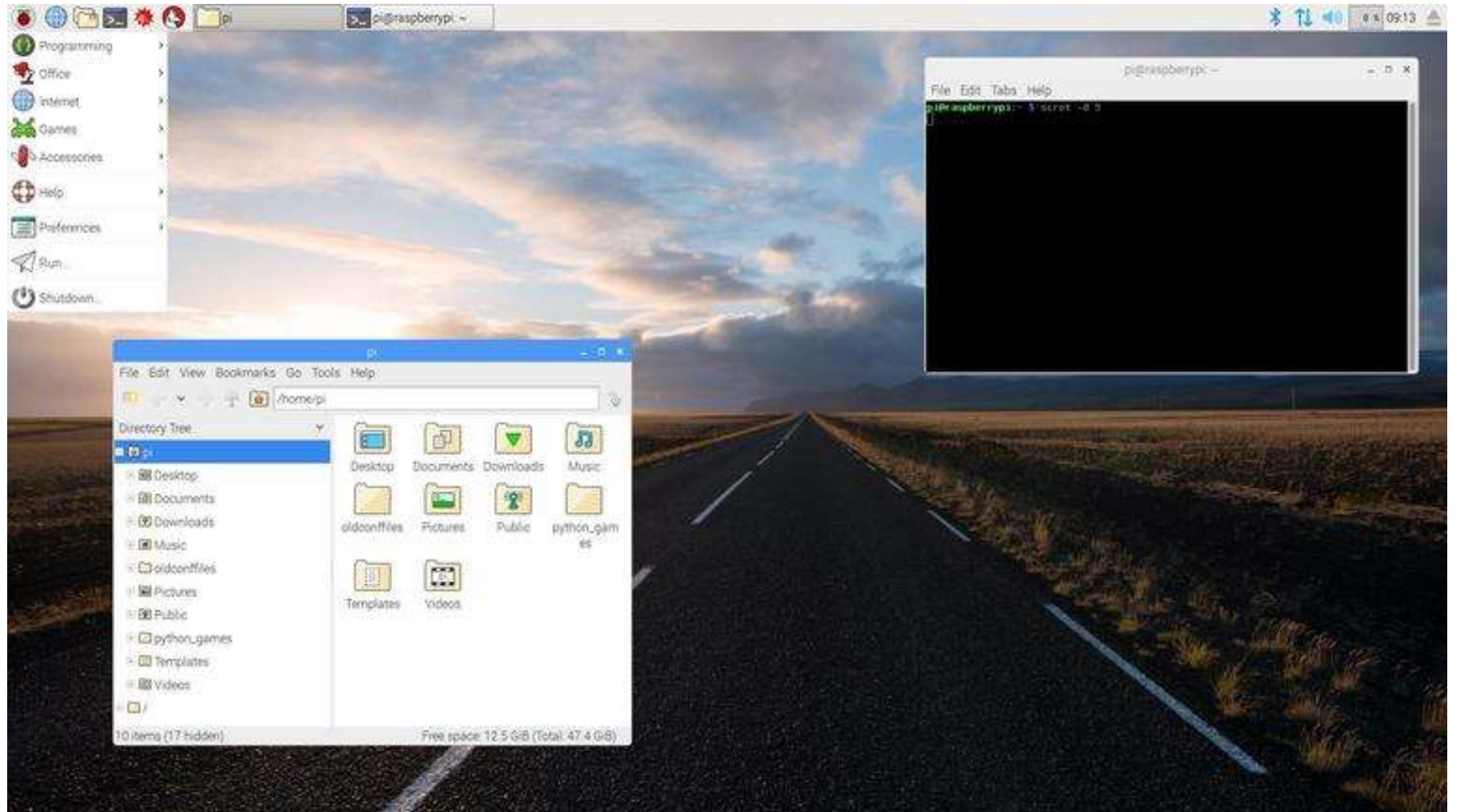
Solution : Catsitting with Arduino

What is a Raspberry pi

It's a programmable microcontroller integrated in a fully functional computer

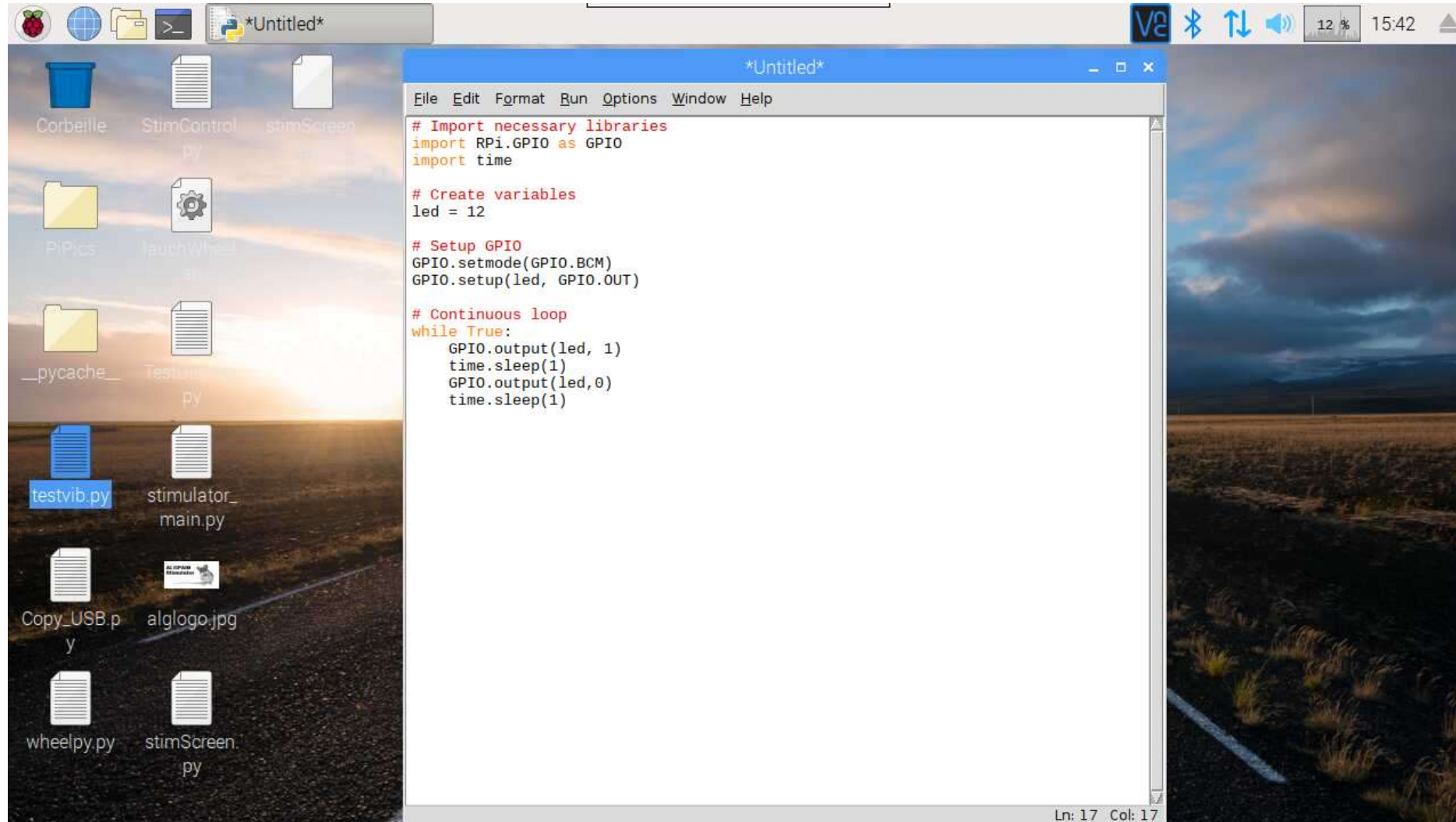


Raspbian OS



How to use it ?

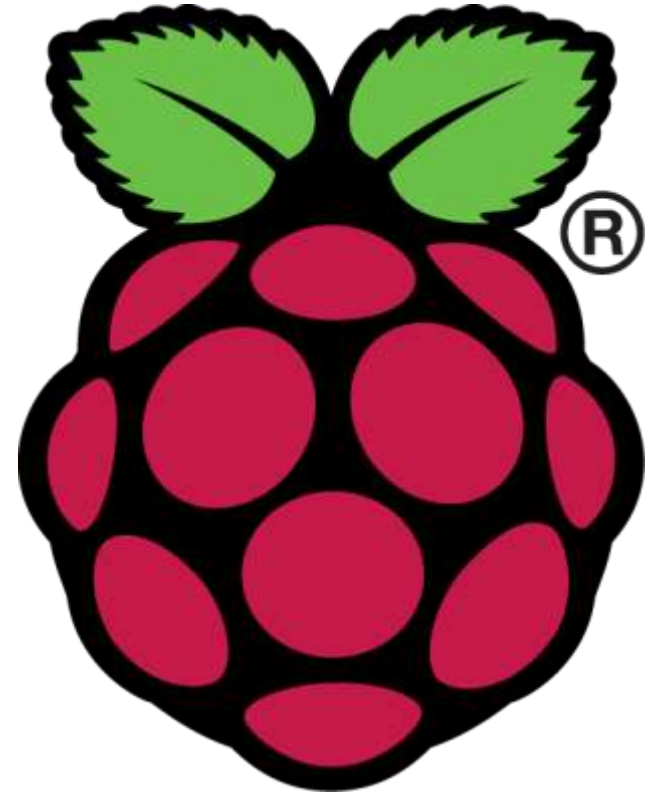
- Within the OS system, you can code in python to control the GPIOs in a very similar way as the Arduino



Comparison Arduino vs Raspberry

	Arduino	Raspberry pi
Easy to use	+++	+
Analog reader	+++	- (with supplementary module)
Multiprocessing	-	+
Number of GPIO	14	26
TTL logic	5 V	3.3 V
Power supply	5-30 V	5 V
Communication	+	+++
Processing power	+	+++
Camera module	-	+
Any python analysis tool	-	+
Memory	- (external SD possible)	+++

Example of use



- 4 mice close loop system:

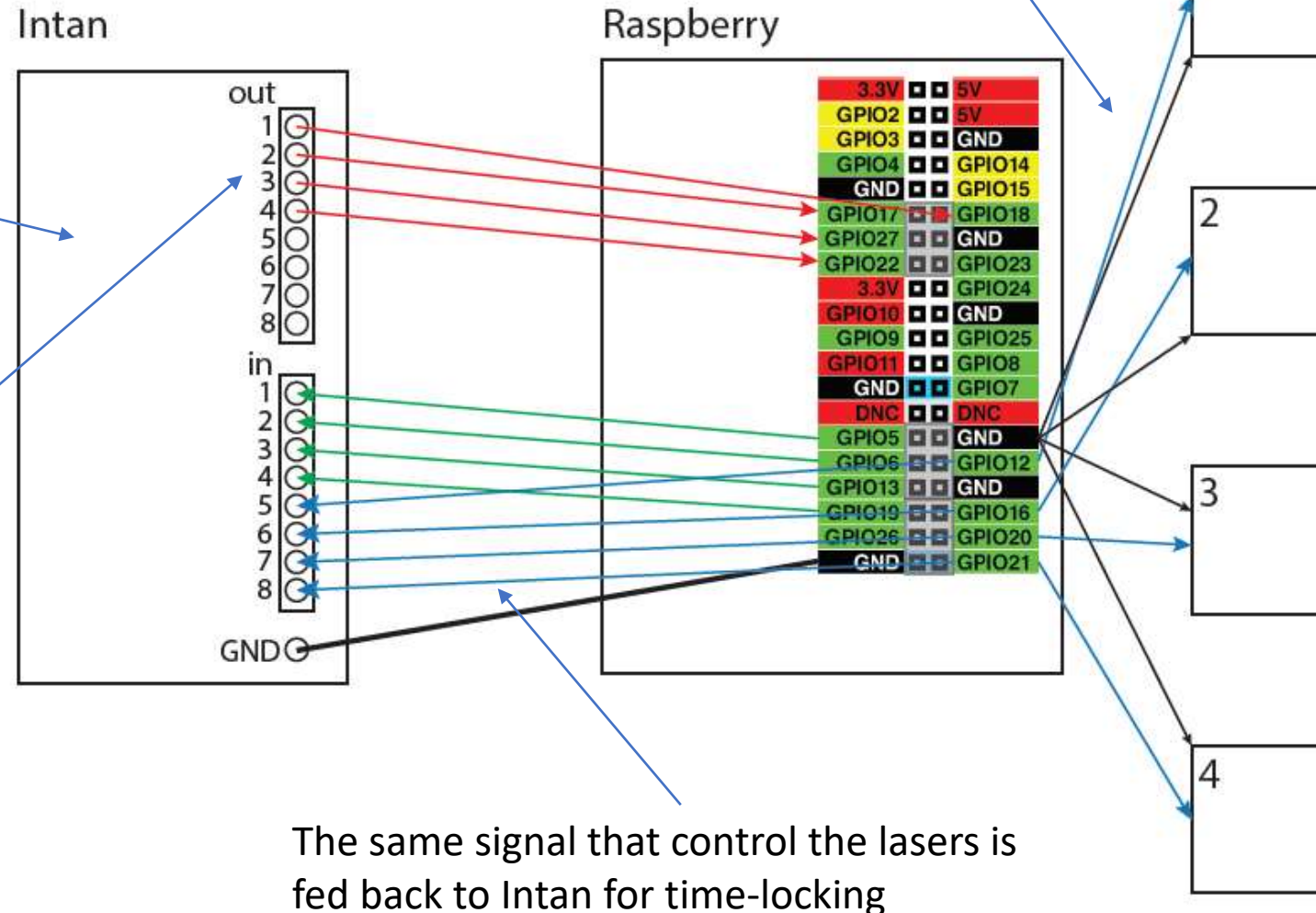
Interface for Ypnos close loop

Intan board is controlled with matlab for acquisition and online analysis of sleep (Detection of NREMS)

When one animal is in NREMS, the out corresponding is HIGH

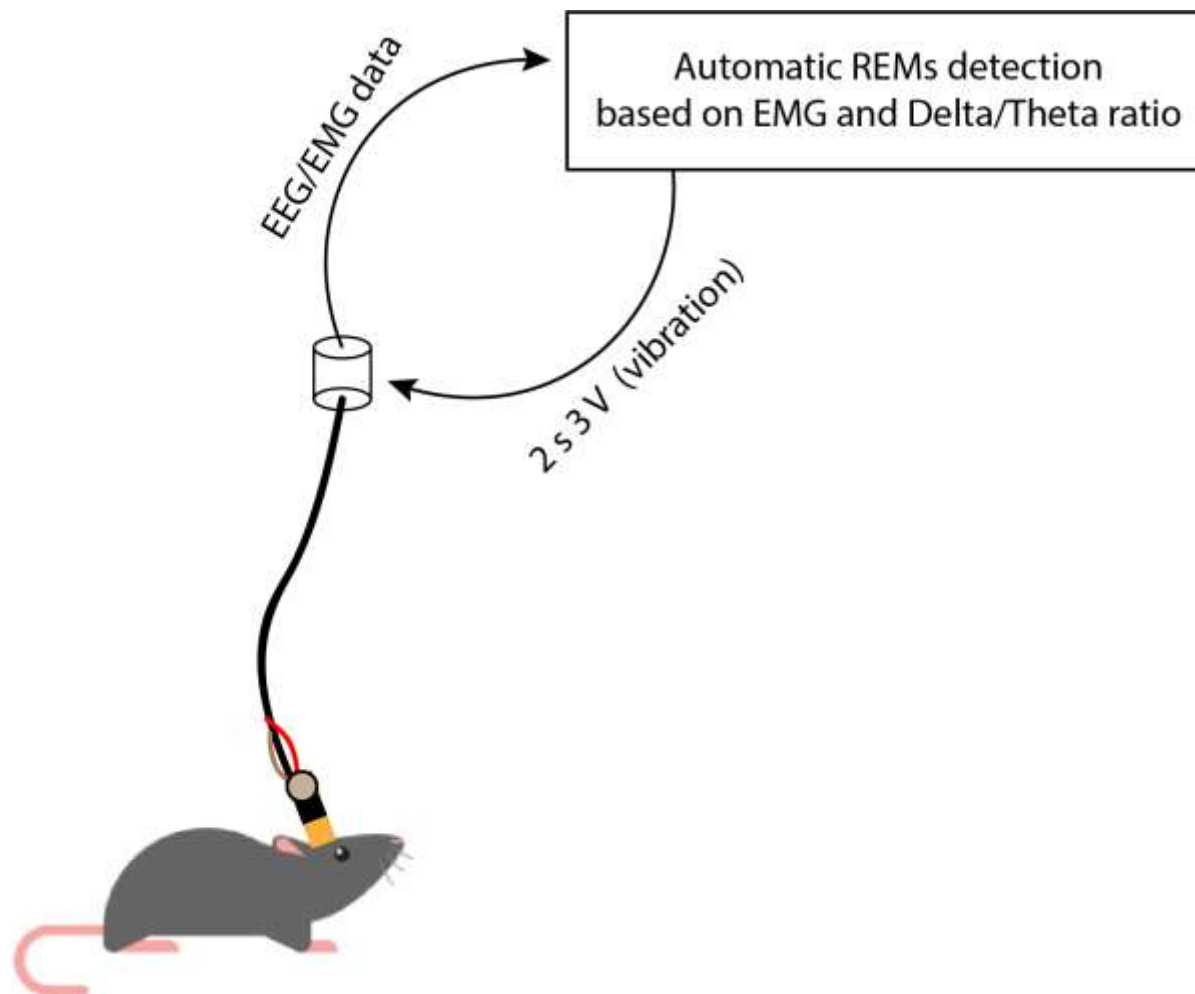
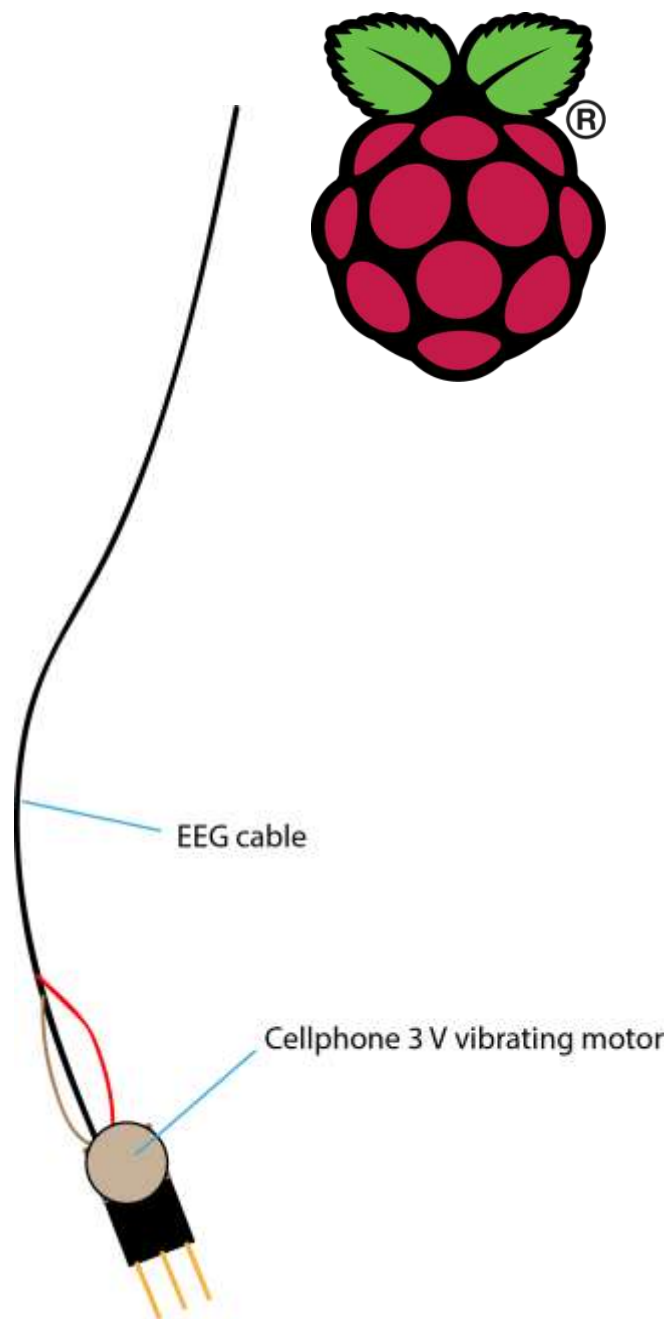
The raspberry is necessary here for its multiprocessing capacity since 4 animals are sampled at the same time.

It could be replaced by 4 Arduinos



The raspberry detects the HIGH and launch a 20 Hz optogenetic stimulation for the right animal

The same signal that control the lasers is fed back to Intan for time-locking







ALGPAIN Wheel activity counter

- A console used to record up to 10 wheels at the same time
- Advantage of the Raspberry used:
 - Storage capacity for the DATA
 - Internet connection for track of 24h-time to record the exact time of each turn and map activity
- UBS connection to gather the DATA

Conclusion

With Arduino or Raspberry, you add
senses to your projects and a **body** to
give answer

