Workshop Basic Raspberry Class 1 – Raspberry Fundamentals

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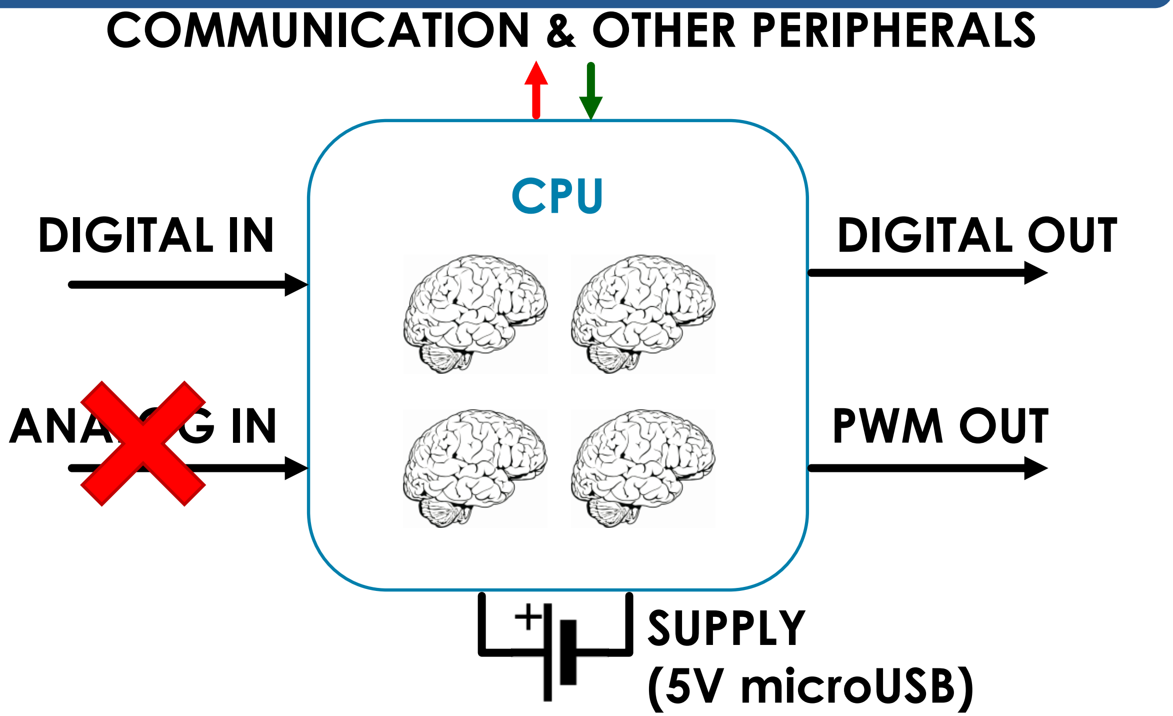
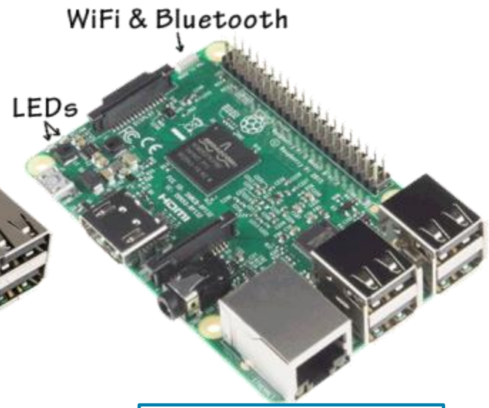
Raspberry

- ¿What is?
  - Embebbed single board computer (SBC).
  - Allows creation of computational and basic electronic projects.
  - Allows installation of different operative systems (based on Linux).
  - Can be connected to an Arduino to expand his I/O Peripherals.
  - Used mostly for computation and processing (multi-core ARM processor).
  - Commonly used for Python Learning.
- Raspberry Types

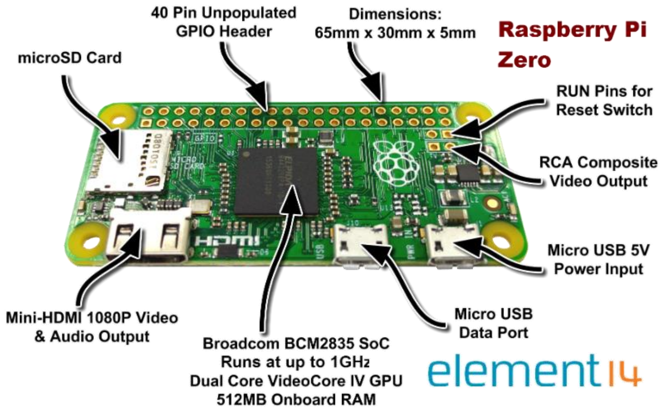


Raspberry Pi B+

Raspberry Pi 2



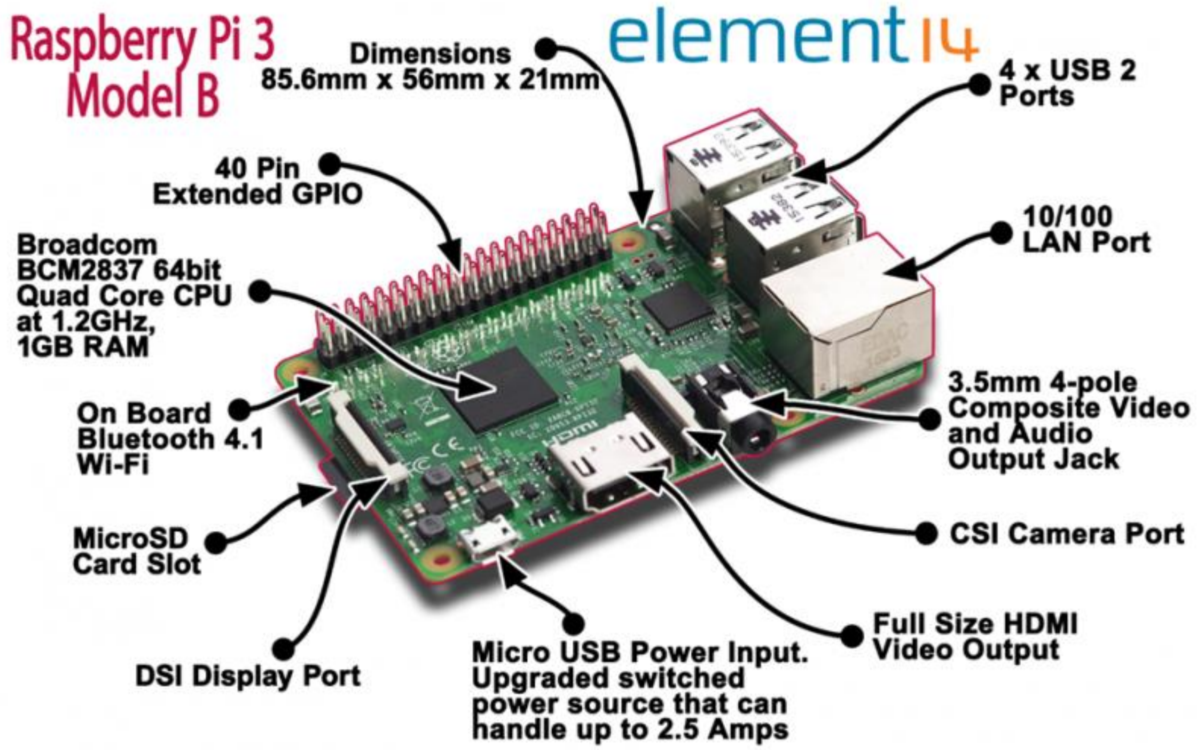
Raspberry Pi 3
Model B


40 Pin Unpopulated GPIO Header
Dimensions: 65mm x 30mm x 5mm
Raspberry Pi Zero
microSD Card
RUN Pins for Reset Switch
RCA Composite Video Output
Micro USB 5V Power Input
Micro USB Data Port
Mini-HDMI 1080P Video & Audio Output
Broadcom BCM2835 SoC Runs at up to 1GHz Dual Core VideoCore IV GPU 512MB Onboard RAM
element14

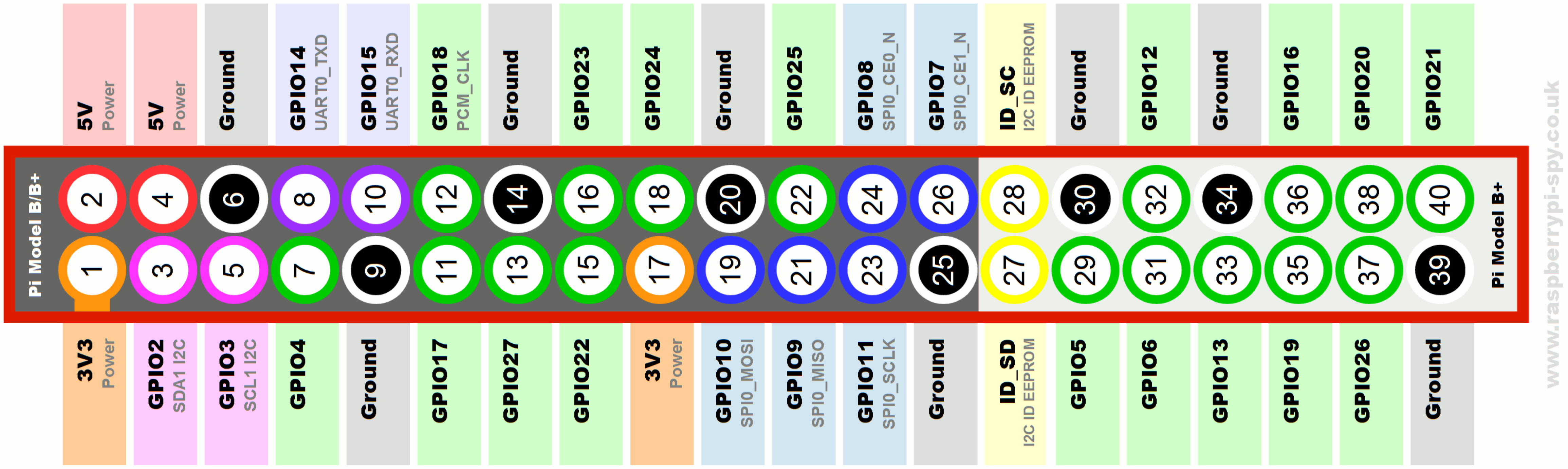
Raspberry Zero

Rasberry Pi 3 Model B Specs

- CPU **1.2GHz 64-bit quad-core ARMv8 64 bits**.
- **Supply:** Using micro USB with **5V**.
- On board **Bluetooth 4.1**, **Wi-Fi 802.11n** & **10/100 LAN**.
- **4 x USB 2.0** Ports.
- **26 x General Purpose Input Output** (GPIO) pins at **3.3V**.
- **1 x Full size HDMI** Video Output.
- **1 x 3.5 mm Audio Output** Jack.
- **1 x CSI Camera** Port.
- **Maximum current per I/O digital pin:** 16 mA (50 mA max for all connected GPIO).
- **GPU:** Broadcom VideoCore IV, OpenGL ES 2.0, MPEG-2 y VC-1, 1080p30 H.264/MPEG-4 AVC.
- **SDRAM:** 1 GB (shared with GPU).
- **microSD Card Slot** (min 8GB).
- **Electronic Communications:** Serial UART + I2C + SPI.


Raspberry Pi 3 Model B
element14
Dimensions 85.6mm x 56mm x 21mm
4 x USB 2 Ports
40 Pin Extended GPIO
10/100 LAN Port
Broadcom BCM2837 64bit Quad Core CPU at 1.2GHz, 1GB RAM
3.5mm 4-pole Composite Video and Audio Output Jack
On Board Bluetooth 4.1 Wi-Fi
CSI Camera Port
MicroSD Card Slot
Full Size HDMI Video Output
DSI Display Port
Micro USB Power Input. Upgraded switched power source that can handle up to 2.5 Amps

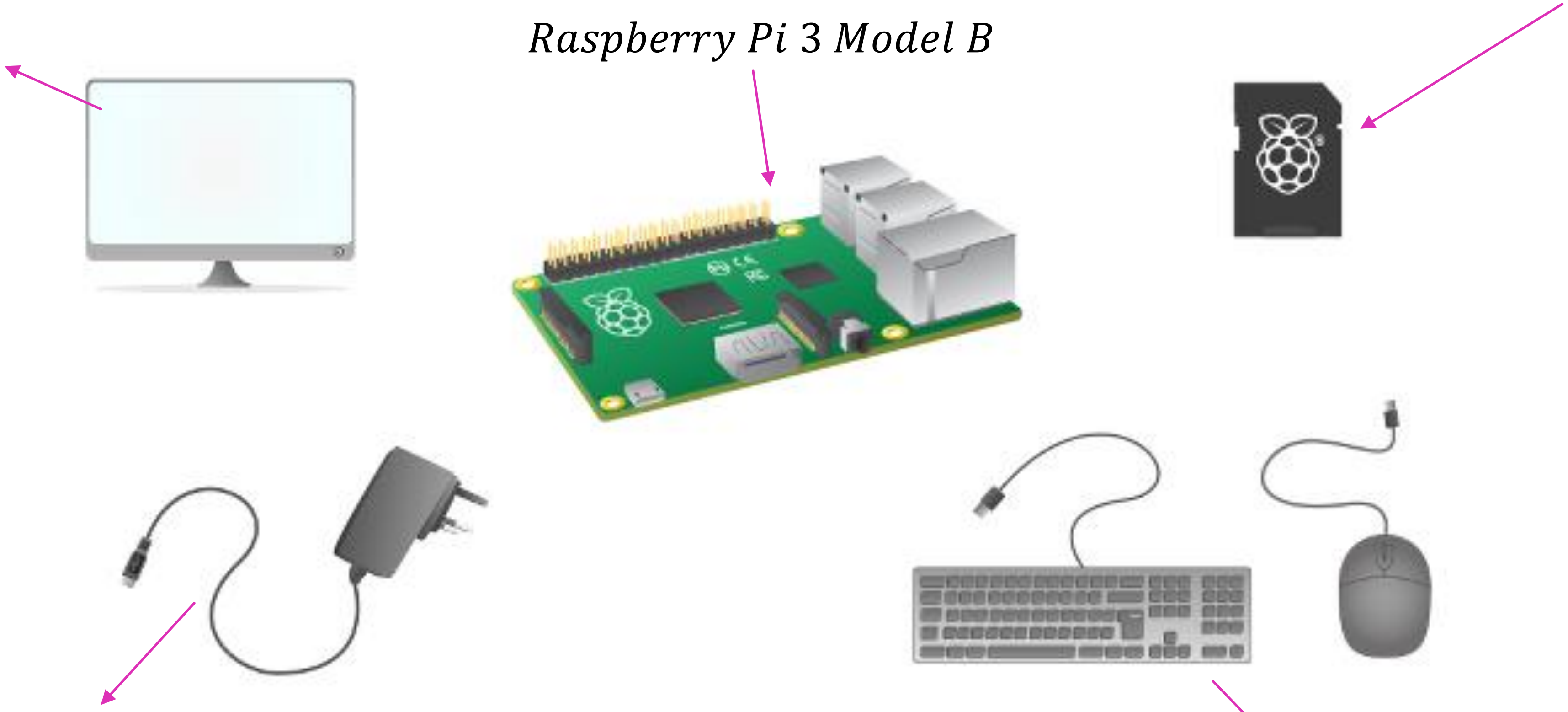
Detailed GPIO Pinout



3V3 Power	1	2	5V Power
GPIO2 SDA1 I2C	3	4	5V Power
GPIO3 SCL1 I2C	5	6	Ground
GPIO4	7	8	GPIO14 UART0_TXD
Ground	9	10	GPIO15 UART0_RXD
GPIO17	11	12	GPIO18 PCM_CLK
GPIO27	13	14	Ground
GPIO22	15	16	GPIO23
3V3 Power	17	18	GPIO24
GPIO10 SPI0_MOSI	19	20	Ground
GPIO9 SPI0_MISO	21	22	GPIO25
GPIO11 SPI0_SCLK	23	24	GPIO8 SPI0_CE0_N
Ground	25	26	GPIO7 SPI0_CE1_N
ID_SD I2C ID EEPROM	27	28	ID_SC I2C ID EEPROM
GPIO5	29	30	Ground
GPIO6	31	32	GPIO12
GPIO13	33	34	Ground
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
Ground	39	40	GPIO21

- **26 x GPIO** at 3.3V.
- **2 x 3.3V Supply** Pins.
- **2 x 5V Supply** Pins.
- **GPIO7..GPIO11: Serial Peripheral Interface (SPI)** Pins.
- **GPIO14, GPIO15: Serial (UART)** Pins.
- **GPIO2, GPIO3: I2C** Pins.
- **ID_SD, ID_SC: I2C ID EEPROM**.

Raspberry Pi 3 Required Equipment



microSD card 8GB min

HDMI Screen

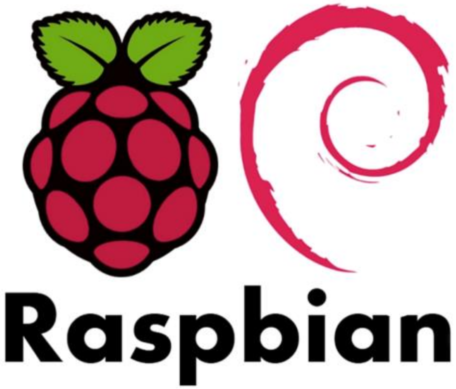
Raspberry Pi 3 Model B

5V microUSB Power Adaptor

USB Keyboard & Mouse

Raspberry Pi 3 Operative Systems

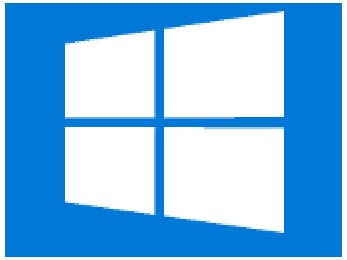
- Most common OS is based in **linux** distribution **Debian** (**Raspbian**).
  - To install it on the microSD download New Out Of the Box Software (**NOOBS**)



- There are other third party OS for Raspberry:

UbuntuMATE

- Ubuntu based custom image



Windows 10 IoT Core

- Windows 10 OS for IoT

OSMC

- Open Source Media Centre

recallbox

- Retro-console emulator

Raspbian Basic CLI Commands

- Raspbian is compatible with all linux terminal commands. Following are typical commands:

```
pwd: Prints the current directory
mkdir FOLDERNAME: Creates a new folder
cd FOLDER: Goes to specified directory
ls: Shows all the files in the current directory
lsusb: Shows all the USB connected devices
sudo COMMAND: Executes a command as Admin
sudo shutdown -h: Shutdowns the Raspberry
sudo shutdown -r now: Restarts the Raspberry
sudo raspi-config: Access the configuration
sudo apt-get update: Updates all packages from repo
sudo apt install arduino: Installs Arduino IDE
sudo apt install python-serial: Installs library to connect python with Serial port
ls /dev/tty*: Lists all the tty ports that can be used (e.g. Arduino connected to raspberry)
sudo apt install python-rpi.gpio: Installs Raspberry GPIO library for python
```

Python common functions with Raspberry

- `import`
    - Imports an external library and associates a name to use its functions.
    - Sintax: `import LIBRARY as OBJNAME`
        - `LIBRARY`: Required library to import
        - `OBJNAME`: Name given to use library functions as class object.

RPi.GPIO Library functions

- `import RPi.GPIO as GPIO`
    - Imports RPi.GPIO and names the library GPIO for using its functions

- `GPIO.setmode(MODE)`
    - Sets desired pins referencing allocation (using pin # in Raspberry board or the pin label as seen in the slide 5).
        - `MODE:` Selected MODE. This can be `GPIO.BOARD` for the corresponding pin # in the GPIO 40 pins or `GPIO.BCM` for pin label (see slide 5)

- `GPIO.setup(PORT/PIN, MODE)`
    - Configures the desired GPIO PORT/PIN in the required `MODE (input or output)`
        - `PORT/PIN:` The pin # that will be configured.
        - `MODE:` `GPIO.IN` or `GPIO.OUT`.

- `GPIO.output(PORT/PIN, VALUE)`
    - Writes a logical state to an output pin: a HIGH logic state (3.3V) or a LOW logic state (0V)
        - `PORT/PIN`: The pin # that will be written
        - `VALUE`: `1` or `0` / `True` or `False`.

- `GPIO.input(PORT/PIN)`
    - Reads and returns the logic state value of a digital input pin
        - `PORT/PIN:` The input pin # that will be read
        - Returns `1` or `0` depending on the logic state value of the input pin that was read

time Library functions

- `import time`
    - Imports time library.

- `time.sleep(SECS)`
    - Pauses the program execution for a desired time (in seconds)
        - SECS: The number of secs that is desired to pause the program

Python Variables

- Python doesn’t require explicit declaration of variables.
- Automatically declares variable type after assignation (=).
- Example:

```
counter = 80          # An integer assignment
temp    = 27.6        # A floating point
name    = "David"     # A string

print counter
print miles
print name
```

- Output:

```
80
27.6
David
```

Python Typical Operators

	SYMBOL	DESCRIPTION
ARITHMETIC	=	Assignment
	+	Addition
	-	Subtraction
	*	Multiplication
	/	Division
	%	Module
COMPARATIVE	==	**Equal to:** $x == y$ is equivalent to: x is equal to y?
	<>	**Not equal to:** $x <> y$ is equivalent: x is not equal to y?
	<	Less than
	>	Greater than
	<=	Less than or equal to
	>=	Greater than or equal to
BOOLEANS	&	AND
	|	OR
	~	Negation (NOT)
ACCUMULATORS	+=	**Addition assignment:** $y += x$ is equivalent to: $y = y + x$
	-=	**Subtraction assignment:** $y -= x$ is equivalent to: $y = y - x$
	*=	**Multiplication assignment:** $y *= x$ is equivalent to: $y = y * x$
	/=	**Division assignment:** $y /= x$ is equivalent to: $y = y/x$

Python Program Structure for HW

Library declaration(e.g: `import RPi.GPIO as GPIO`)

I/O Pin Labeling (e.g: `LEDPIN = 36`)

Constant declaration (e.g: `CONTMAX = 10`)

Variable declaration (e.g: `temperature = 0.0`)

Subroutines or functions declaration:

Example for subroutine:

```
def hello():                    #Example of a subroutine that prints “Hello” in the console output
     print(“Hello World”)       #Prints “Hello World”
```

Example for function:

```
def sum(x, y):                  #Example of a function that sums two numbers “x” y “y” and returns the result
     return x + y
```

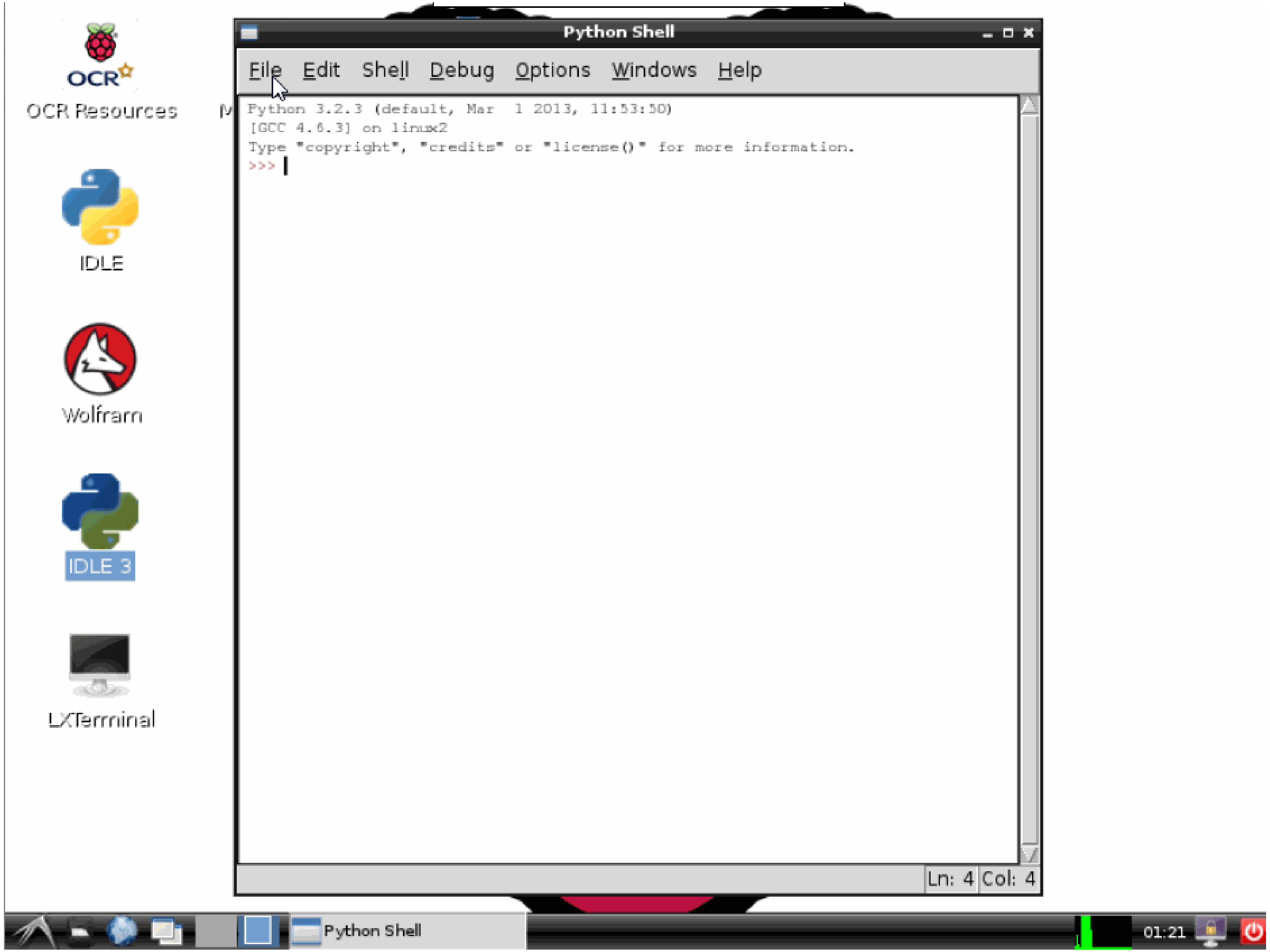
Pin configuration and cleaning:

```
#SETUP
#CONFIGURATION: Indicate which pins are inputs and which are outputs
#->setmode and setup functions must be used for this part
#CLEANING: For safety, it is important to clean used outputs with the purpose that they are turned off at the beginning
of the program. Use the function GPIO.output(PIN,False).
#COMMUNICATIONS: For example, for communications with Arduino, import Serial library at Library declaration and use the
function ser = serial.Serial("/dev/ttyACM0", 9600) to begin this communications.
```

Infinite loop (Main program - Execution):

```
#EXECUTION
while True:
     #Main program
```

Python IDE

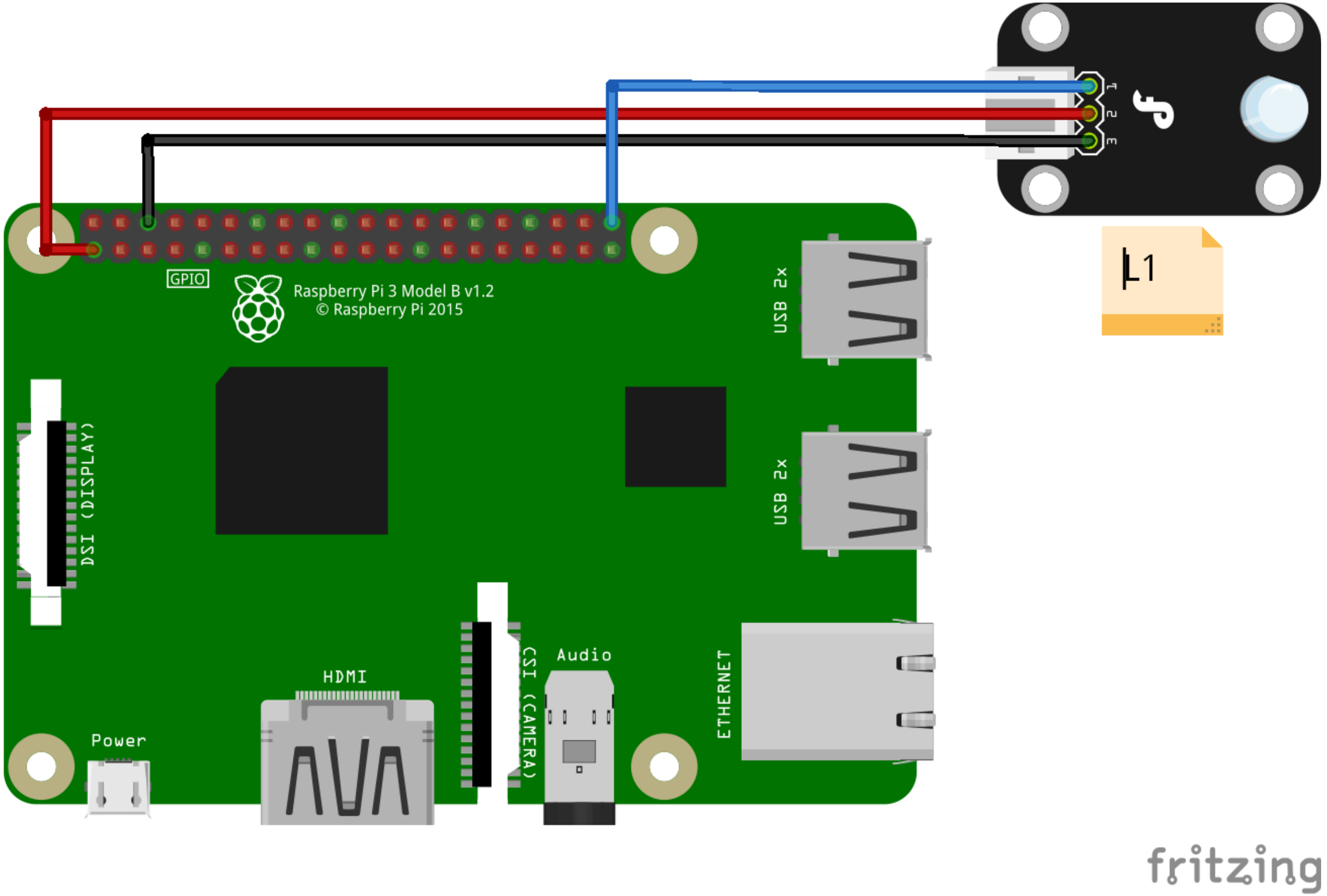


```
Python 3.2.3 (default, Mar  1 2013, 11:53:50)
[GCC 4.6.3] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> 
```

https://www.codeproject.com/KB/boards-embedded-devices/850842/Image7.gif

Example 1.1 – Python common used commands

- Example: In PIN 40 (GPIO21) there is a LED (L1) connected. Blink the LED ½ second ON and ½ second OFF.



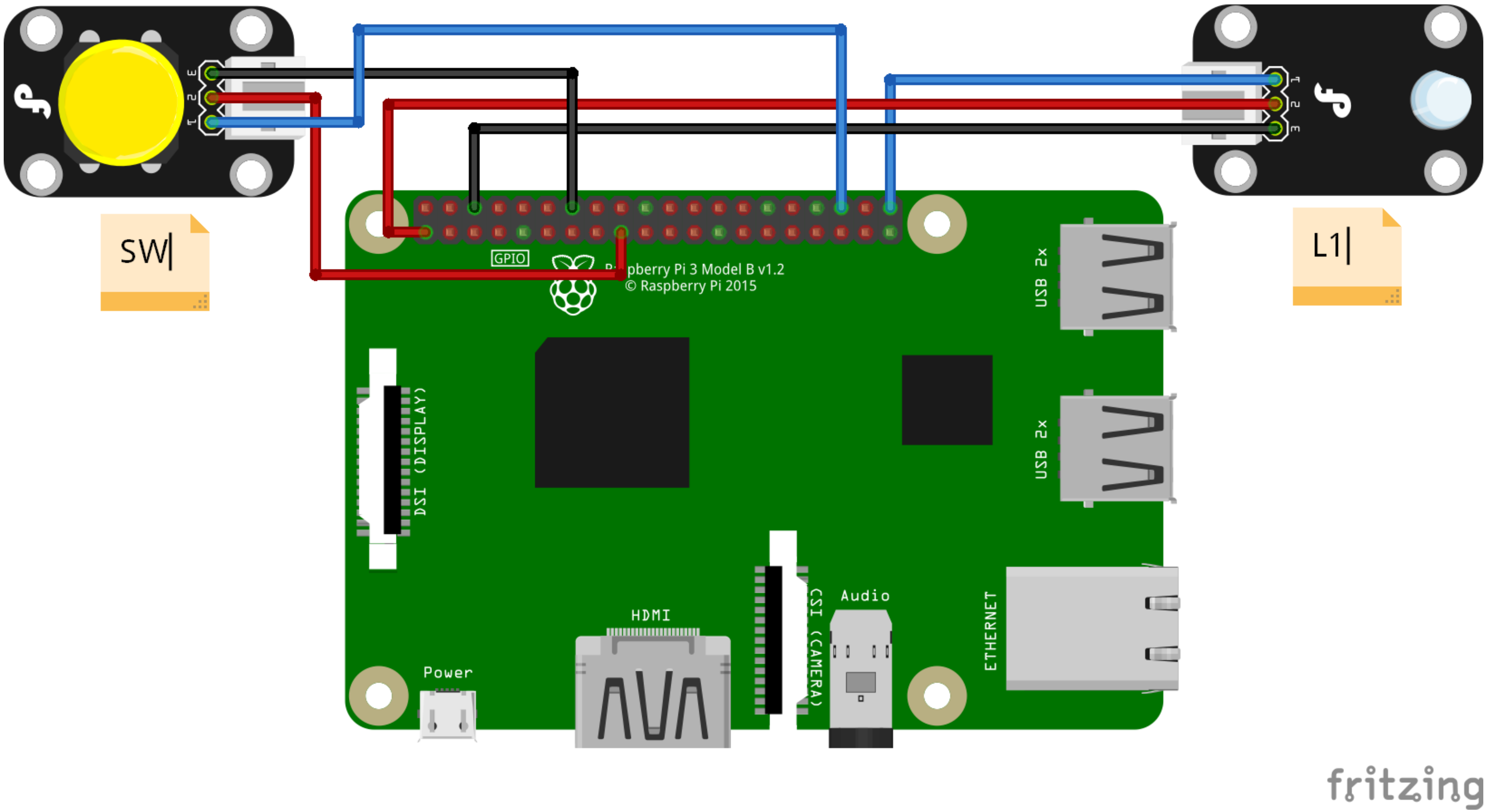
Example 1.1 – Arduino common used commands

```
#Library declaration
import RPi.GPIO as GPIO
import time

#I/O pin labeling
L1 = 40 #Label LED connected in pin 40 as “L1”

#Constant declaration
TBLINK = 0.5 #Blink constant TBLINK initialized on 0.5s

#SETUP
#I/O Pin Configuration
GPIO.setmode(GPIO.BOARD) #Configures all pins reference using pin #
GPIO.setup(L1, GPIO.OUT) #Set pin L1 as Output
#Output cleaning
GPIO.output(L1,0) #Turn OFF L1 (also posible GPIO.output(L1,False))

#EXECUTION
while True:
    GPIO.output(L1,1) #Turn ON L1
    time.sleep(TBLINK); #Delay of TBLINK secs(0.5s)
    GPIO.output(L1,0) #Turn OFF L1
    time.sleep(TBLINK); #Delay of TBLINK secs(0.5s)
```

For java, use the following example: http://pi4j.com/example/control.html

Example 1.2 – If statement with digital input

- Example: In the PIN 36 (GPIO16) there is a switch (SW) and in the PIN 40 there is a LED (L1). Turn ON the LED if the switch is activated, in other case, turn off the LED

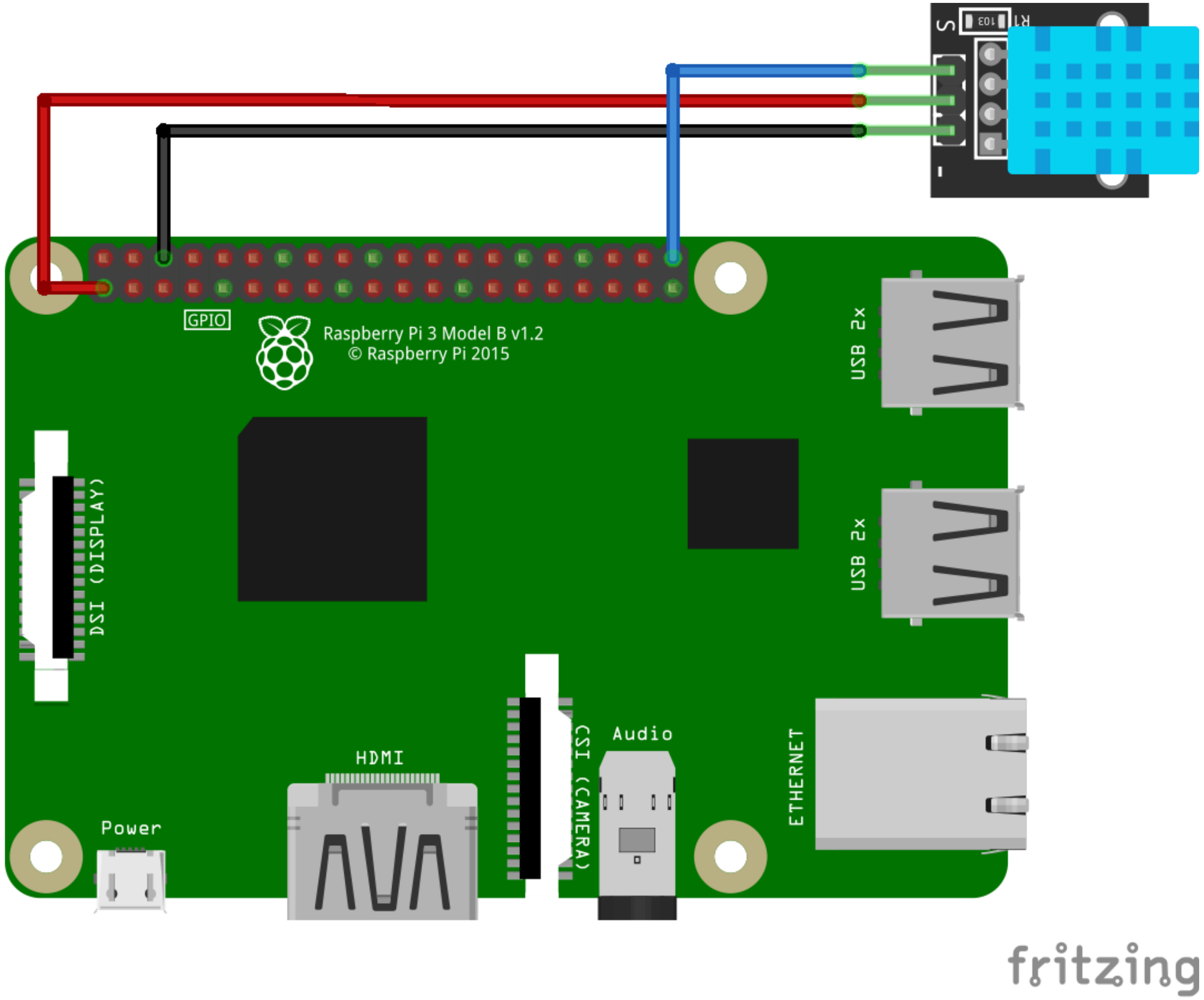


Example 1.2 – If statement with digital input

```
#Library declaration
import RPi.GPIO as GPIO

#I/O pin labeling
L1 = 40 #Label LED connected in pin 40 as “L1”
SW = 36 #Label Switch connected in pin 36 as “SW”

#SETUP
#I/O Pin Configuration
GPIO.setmode(GPIO.BOARD) #Configures all pins reference using pin #
GPIO.setup(L1, GPIO.OUT) #Set pin L1 as Output
GPIO.setup(SW, GPIO.IN) #Set pin SW as Output

#Output cleaning
GPIO.output(L1,0) #Turn OFF L1 (also posible GPIO.output(L1,False))

#EXECUTION
while True:
    if GPIO.input(SW) == 1:
        GPIO.output(L1,1) #Turn ON L1
    else:
        GPIO.output(L1,0) #Turn OFF L1
```

Example 1.3 – DHT11 sensor (Python 2.7)

- Example: Monitor the current temperature and humidity of the environment every second using a DHT11 connected to GPIO21 (PIN 40).



Example 1.3 – DHT11 sensor (Python 2.7)

- Install the Adafruit_Python_DHT Library (for more information about install process, follow [this guide]):

```
sudo apt-get install git-core
git clone https://github.com/adafruit/Adafruit_Python_DHT.git
cd Adafruit_Python_DHT
sudo apt-get install build-essential python-dev
sudo python setup.py install
```

- Program DHT11 in Python 2.7 (3.5 not supported for this library)

Example 1.3 – DHT11 sensor (Python 2.7)

```
#Library declaration
import time
import Adafruit_DHT

#I/O pin labeling
DHTPIN = 21 #Label DHT sensor connected in pin 40 (GPIO21) as “DHTPIN”
DHTTYPE = Adafruit_DHT.DHT11 #Specify the DHT sensor type

#Variable declaration
h = 0.0 #Variable to store humidity
t = 0.0 #Variable to store temperature

#EXECUTION
while True:
    h, t = Adafruit_DHT.read_retry(DHTTYPE, DHTPIN) #Reads current temp & humid and stores it
    print(“Temp: ” + str(t) + “Humid: ” + str(h)) #Prints in the console the t, h vars
```

FIN

Thanks!