Raspberry Pi GPIO

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Nano shortcuts

```
Ctrl-O to save
Ctrl-X to exit

Ctrl-^ to set mark, then move cursor to select
Alt-^  to copy
Ctrl-K to cut
Ctrl-U to paste (uncut)

Ctrl-_ to go to a line number
Ctrl-W to find
Alt-W  to find next
Ctrl-\ to find and replace

Alt-} to block indent
Alt-{ to block unindent
```

Edit /etc/nanorc to change settings.

Recommended settings:

```
set tabsize 4
set tabstospaces
```

```
$ python3
```

```
>>> 1 + 3
>>> 9 - 7
>>> 6 * 3
>>> 3 / 2
>>> 3 // 2
>>> 4 + 2 * 3
>>> (4 + 2) * 3
>>> 2 ** 3
```

加減乘除
先乘除 後加減
括號

```
>>> type(3)
>>> type(3.0)
>>> float(3)
>>> int(3.0)
>>> int(3.9)
```

數字分種類，int 或 float

```
>>> type('3')
>>> '3' == 3
```

還有 string 字串，單雙引號均可
'3' 等於 3 嗎？

```
>>> 'abd' + 'xyz'
>>> 'abc' * 3
```

```
>>> x = 1
>>> y = 2
>>> x + y
>>> x * y
```

代數

```
>>> z = 'How are you?'
>>> len(z)
>>> z[0]
>>> z[-1]
>>> z[1:4]
```

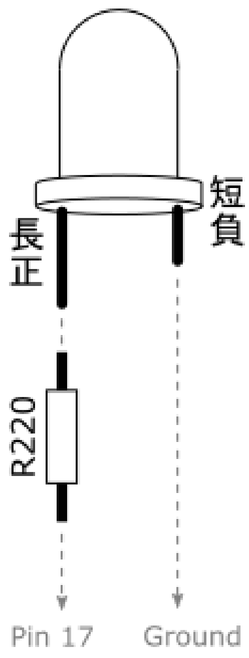
list

```
>>> a = [1,2,3,4,5,6]
>>> type(a)
>>> len(a)
>>> a[0]
>>> a[-1]
>>> a[1:4]

>>> b = [7,8,9]
>>> a + b
>>> a * 3

>>> a.append(4)
>>> a.pop(0)
>>> a.remove(3)
```

dictionary

```
>>> d = { 'x':1, 'y':2, 'z':3 }
>>> type(d)
>>> d['x']

>>> d['z'] = 99
>>> d
>>> del d['x']
>>> d
```

LED



Raspberry Pi interacts with the outside world via **General-purpose Input Output (GPIO)** pins. We are going to control the pins using Python.

```
$ python3

>>> from RPi import GPIO
>>> GPIO.setmode(GPIO.BCM)     # use Broadcom numbering
>>> GPIO.setup(17, GPIO.OUT)   # setup pin 17 as output
>>> GPIO.output(17, 1)         # turn it on
>>> GPIO.output(17, 0)         # turn it off
>>> GPIO.cleanup()
```

Can you write a program that blinks the LED?

blink.py

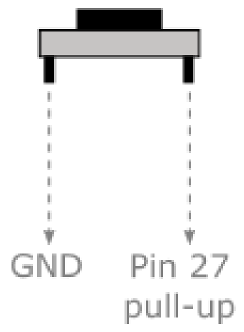
```
import time
from RPi import GPIO

led = 17 ❶

GPIO.setmode(GPIO.BCM)
GPIO.setup(led, GPIO.OUT)

while 1:
    GPIO.output(led, 1)
    time.sleep(0.5) ❷
    GPIO.output(led, 0)
    time.sleep(0.5) ❸
```

❶ Define the LED pin number. If you change pin, this is the only place you need to change.

❷ Keep the light on for 0.5 second.

❸ Keep the light off for 0.5 second.

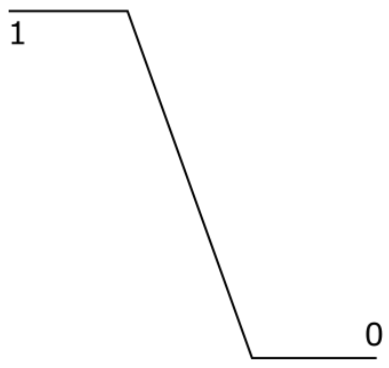
Button



Because it is pulled up, pin 27 is normally **HIGH (1)**.
On pressed, it becomes **LOW (0)**.

There are several methods to detect button presses.

A button press is a <u>change of voltage</u> from HIGH to LOW.



We call that a **falling edge.**

waitforedge.py

```
from RPi import GPIO

button = 27

GPIO.setmode(GPIO.BCM)
GPIO.setup(button, GPIO.IN, pull_up_down=GPIO.PUD_UP)

while True:
    GPIO.wait_for_edge(button,
                       GPIO.FALLING, ❶
                       bouncetime=300)  ❷
    print('Edge falling')
```

❶ Blocks until a falling edge occurs

❷ Keep reading for an explanation of **`bouncetime`**

While **wait_for_edge()** is waiting, we can't do anything else. Another method is to set up a **callback**, and let the GPIO library invoke the callback when it detects a falling edge.

detect.py

```
import time
from RPi import GPIO

button = 27

GPIO.setmode(GPIO.BCM)
GPIO.setup(button, GPIO.IN, pull_up_down=GPIO.PUD_UP)

def button_pressed(channel): ❶
    print('Pressed on channel %d' % channel)

GPIO.add_event_detect(button,
                      GPIO.FALLING,
                      callback=button_pressed, ❷
                      bouncetime=300)  ❸

while True: ❹
    time.sleep(1)
```

❶ Define a callback function

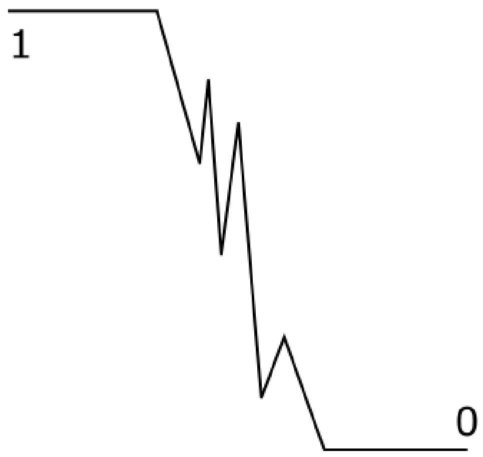
❷ Tell GPIO to invoke the callback function on a falling edge

❸ See the following page for an explanation of **bouncetime**

❹ Keep the program running. Otherwise, we would lose the edge detection.

What is bouncetime?

A push button is imperfect. The voltage change from HIGH to LOW is not a smooth edge as depicted before. In reality, it looks more like this:



The button **bounces**.

bouncetime=300 tells GPIO to ignore the bounces for 300 milliseconds.

If we don't tell it to ignore bounces, it would report multiple falling edges for a single button press.

Try removing **bouncetime=300** from the above code. What do you expect?

Experiment with various **bouncetime**. Which values do you prefer?

Quick reaction game

Now that you know how to handle LED and push button, let's check how quick your reaction is. Make a reaction timer as follows:

1. Turn on LED
2. User presses button to "start the clock". LED is turned off.
3. After a random number of seconds (say, 2-10 seconds), LED is turned back on!
4. User has to press button as soon as he can. Print out his reaction time.

Which strategy would you use to detect button press?

reaction.py

```
import random, time
from RPi import GPIO

GPIO.setmode(GPIO.BCM)

led = 17
button = 27

GPIO.setup(led, GPIO.OUT)
GPIO.setup(button, GPIO.IN, pull_up_down=GPIO.PUD_UP)

GPIO.output(led, 1)

GPIO.wait_for_edge(button, ❶
                   GPIO.FALLING,
                   bouncetime=300)
GPIO.output(led, 0)

delay = random.uniform(2, 10)
time.sleep(delay) ❷

light_on = time.time() ❸
GPIO.output(led, 1)

GPIO.wait_for_edge(button, ❹
                   GPIO.FALLING,
                   bouncetime=300)
pressed = time.time() ❺
GPIO.output(led, 0)

reaction = pressed - light_on
print('Reaction time: %.3f sec' % reaction)

GPIO.cleanup()
```

❶ Wait for user to "start the clock"

❷ Delay for a random number of seconds (2-10)

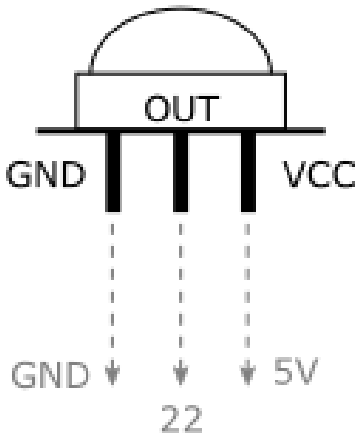
❸ Remember the time when LED is turned on

❹ Wait for user to press

❺ Remember the time when user presses the button

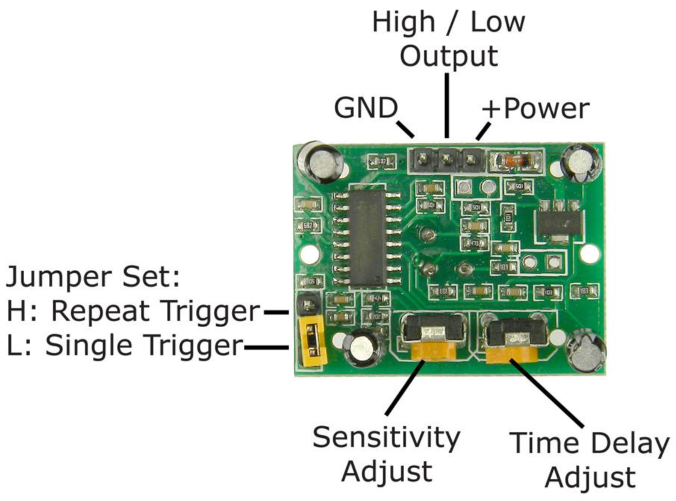
HC-SR501

PIR (Passive Infra-red) motion sensor



This motion sensor outputs **HIGH** when motion is detected, **LOW** otherwise.

Sensitivity and **delay** may be adjusted by turning a screw on the back of the sensor - **clockwise** to **increase** sensitivity and **lengthen** delay.



Note: The following code sample only works if you set the jumper to **Repeat Trigger**.

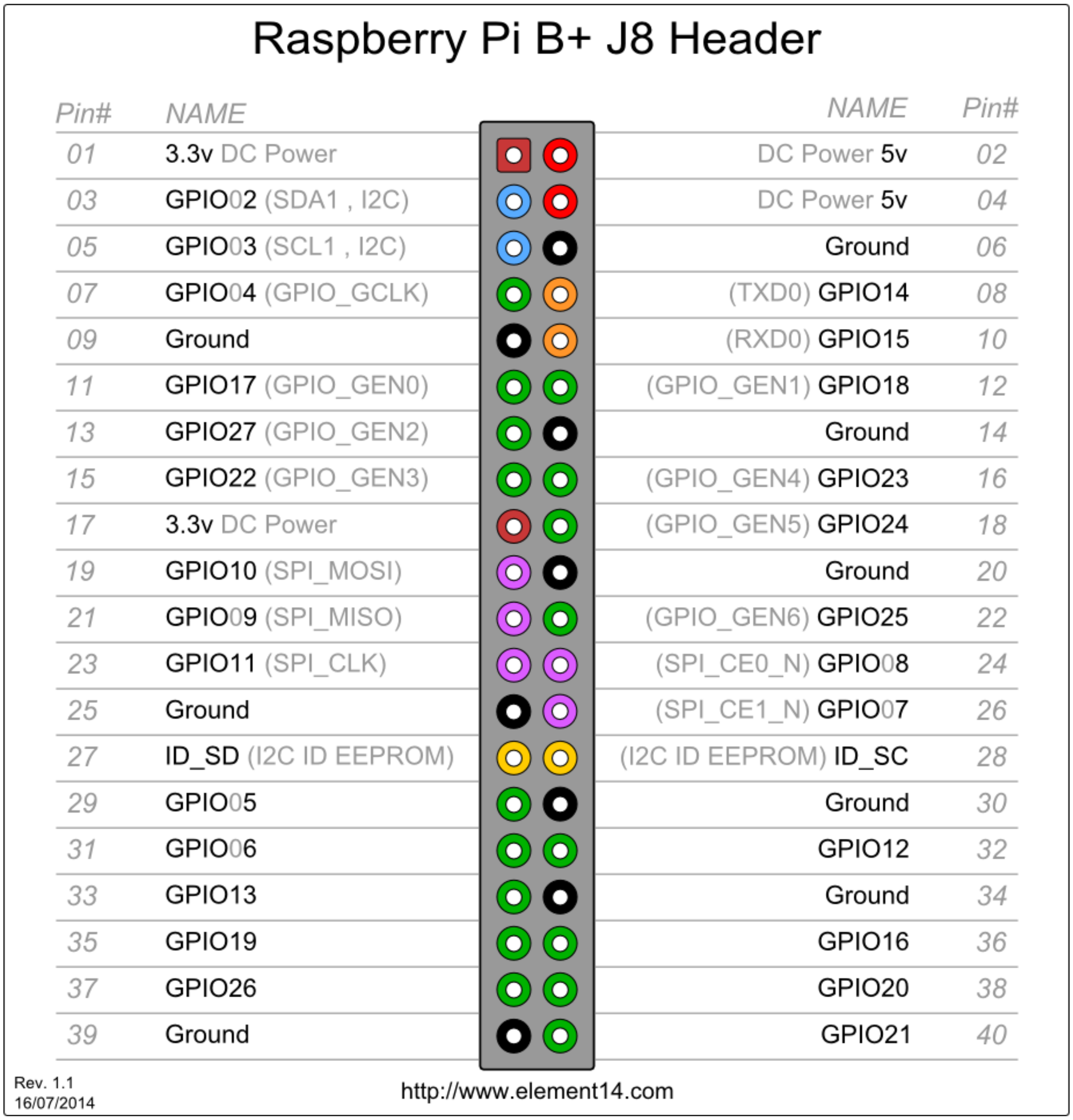
motion.py

```
import time
from RPi import GPIO

GPIO.setmode(GPIO.BCM)

motion = 22

GPIO.setup(motion, GPIO.IN)

def motion_changed(channel):
    if GPIO.input(channel): ❶
        print('Somebody')
    else:
        print('Nobody')

GPIO.add_event_detect(motion,
                      GPIO.BOTH, ❷
                      callback=motion_changed) ❸

while True:
    time.sleep(1)
```

❶ Have to check whether it is currently HIGH or LOW because ...

❷ We are catching both rising and falling edges.

❸ No `bouncetime` needed because motion sensor's output has been smoothed by its internal circuit.



Raspberry Pi B+ J8 Header

Pin#	NAME			NAME	Pin#
01	3.3v DC Power	🟥	🔴	DC Power 5v	02
03	GPIO02 (SDA1 , I2C)	🔵	🔴	DC Power 5v	04
05	GPIO03 (SCL1 , I2C)	🔵	⚫	Ground	06
07	GPIO04 (GPIO_GCLK)	🟢	🟠	(TXD0) GPIO14	08
09	Ground	⚫	🟠	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	🟢	🟢	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	🟢	⚫	Ground	14
15	GPIO22 (GPIO_GEN3)	🟢	🟢	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	🔴	🟢	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	🟣	⚫	Ground	20
21	GPIO09 (SPI_MISO)	🟣	🟢	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	🟣	🟣	(SPI_CE0_N) GPIO08	24
25	Ground	⚫	🟣	(SPI_CE1_N) GPIO07	26
27	ID_SD (I2C ID EEPROM)	🟡	🟡	(I2C ID EEPROM) ID_SC	28
29	GPIO05	🟢	⚫	Ground	30
31	GPIO06	🟢	🟢	GPIO12	32
33	GPIO13	🟢	⚫	Ground	34
35	GPIO19	🟢	🟢	GPIO16	36
37	GPIO26	🟢	🟢	GPIO20	38
39	Ground	⚫	🟢	GPIO21	40

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