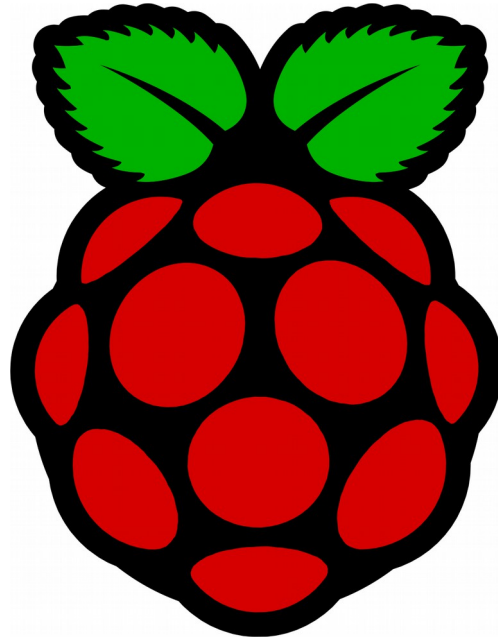# Physical computing
with Python and Raspberry Pi

Ben Nuttall
Raspberry Pi Foundation
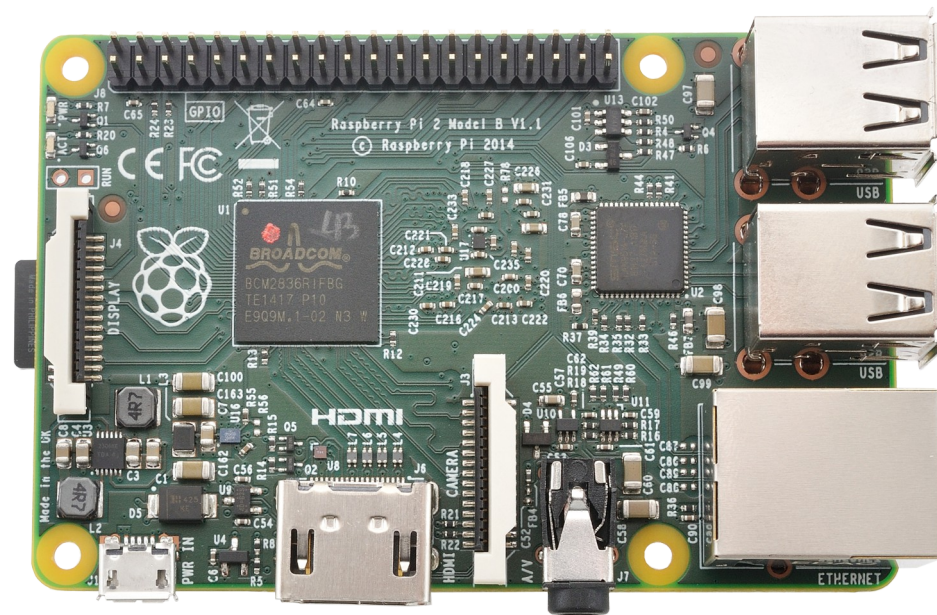
EUROPYTHON

EDUCATION SUMMIT 2015

Ben Nuttall

- Education Developer Advocate at Raspberry Pi Foundation
  - Software & project development
  - Learning resources & teacher training
  - Outreach
- Based in Cambridge, UK
- @ben_nuttall on Twitter
- Speaker at EuroPython, PyConUK, PySS, PyCon Ireland & EuroSciPy in 2014

Raspberry Pi 2

- 900MHz quad core ARM7

- 1GB RAM

- Backwards-compatible with Pi 1

- Same form factor as B+
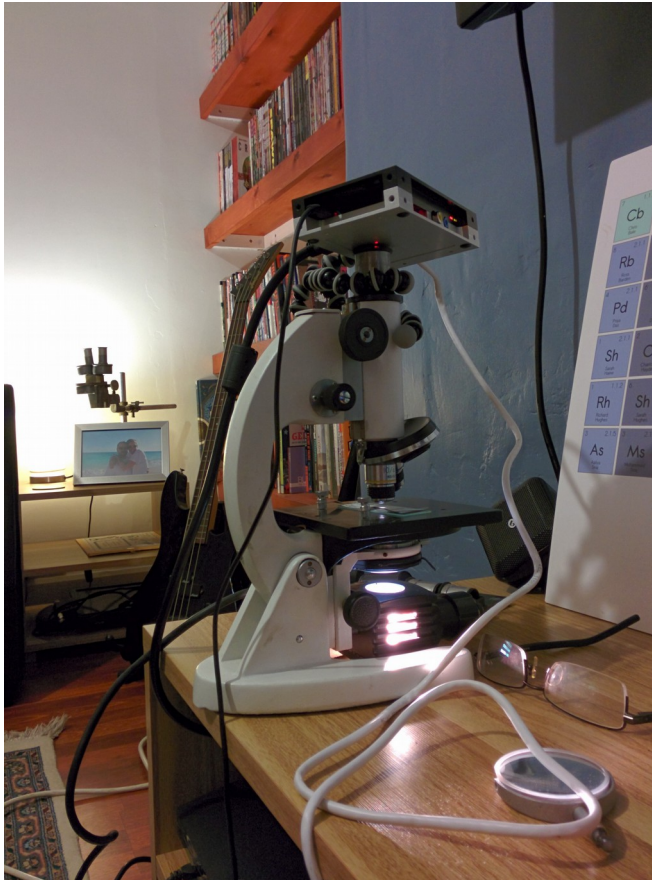
- Still $35 (B+ now $25, A+ $20)

All about Education

- Raspberry Pi Foundation, registered UK charity 1129409

- Founded in 2009 to aid computing education

- On general sale since 2012, available to all worldwide

  - Sold to education, industry and hobbyists

  - Sold 6 million to date

- Free learning resources for makers and educators

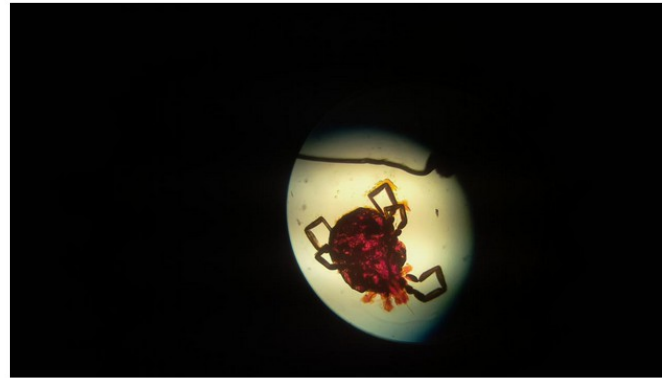- Free teacher training - Picademy (currently UK, soon USA)

Ben Croston – beer brewing

Dave Jones - microscopy

picamera.readthedocs.org

Raspbian

- Foundation-issued Debian-based distribution
  - Currently based on Wheezy
  - Jessie image coming soon
- Image supports Pi 1 and Pi 2
- Software pre-installed
  - Python 3 (also Python 2), Ruby, Java, Mathematica, etc.
  - GPIO, Picamera, (soon pip too)
- Alternative distributions are available, but not supported, e.g:
  - Ubuntu MATE (Pi 2)
  - Ubuntu Snappy Core (Pi 2)
  - Arch Linux

www.raspberrypi.org/downloads

GPIO Pins – General Purpose Input/Output
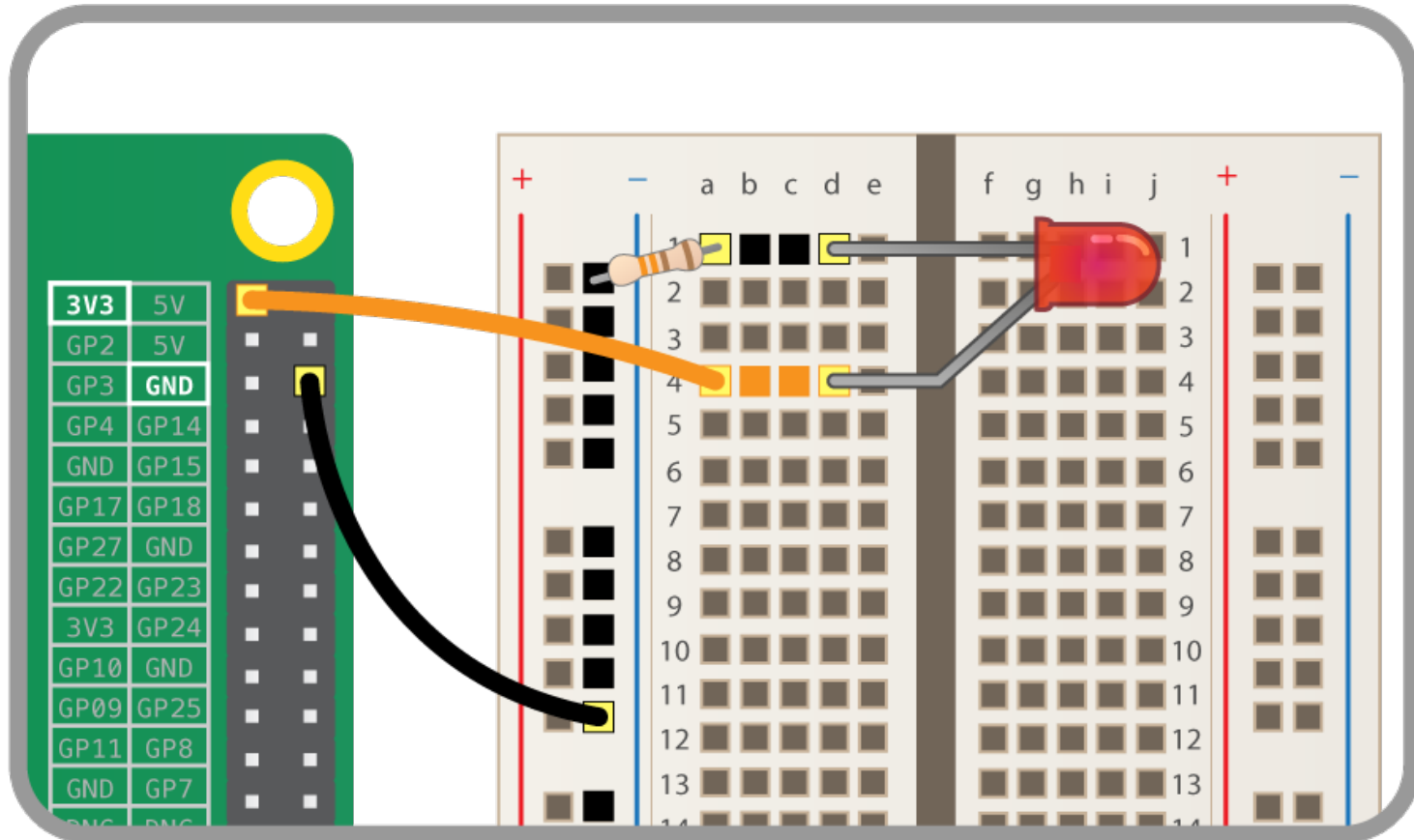

rasp.io

Analogue?

- No native analogue on Raspberry Pi

- Options:

  - Analogue inputs can be read via ADC

  - Various Arduino-compatible add-on boards available

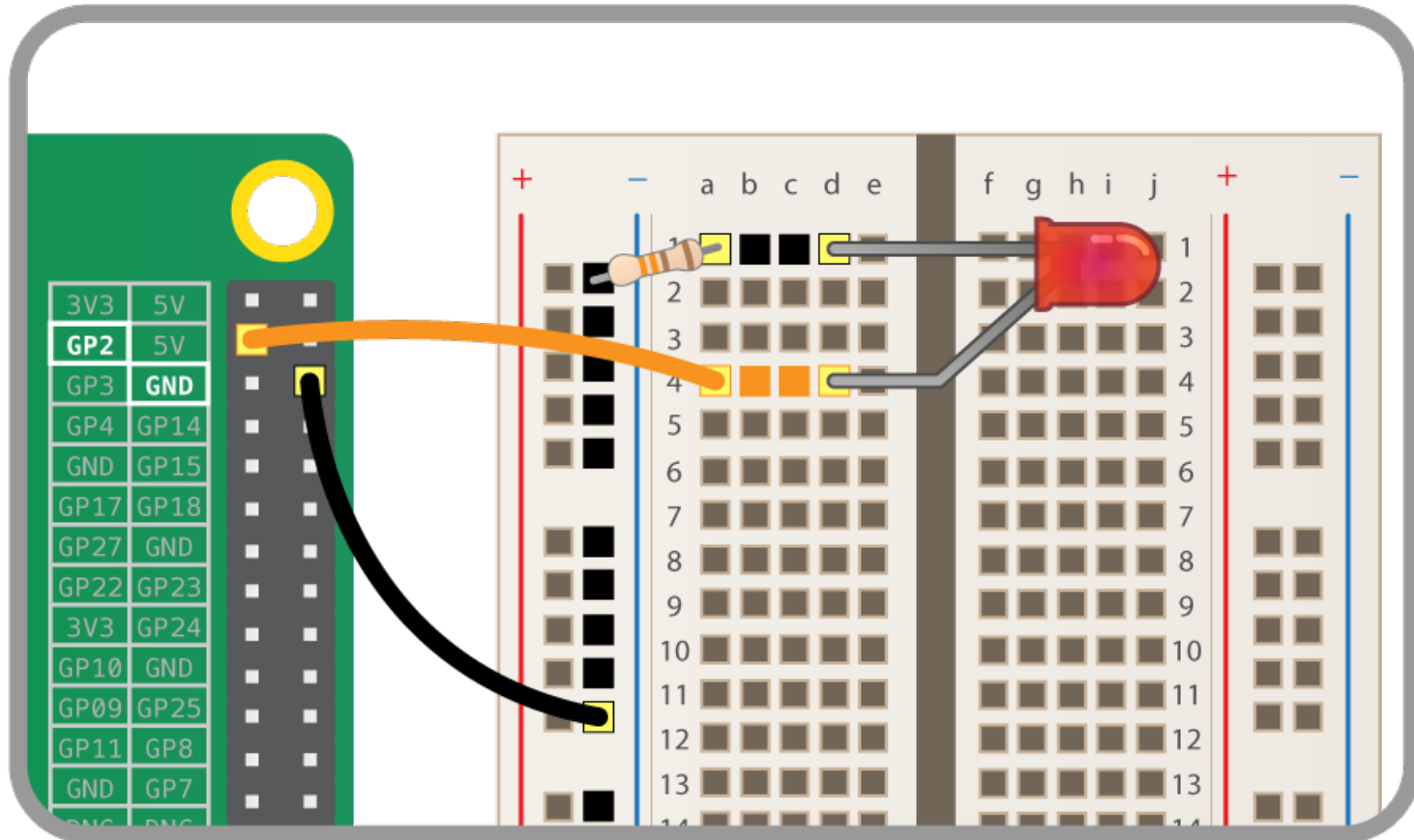 - Use PySerial to read Arduino inputs over USB

Python library - RPi.GPIO

- Included in Raspbian

- Implemented in C

- Features:

  - Configure pins as input/output

  - Read inputs (high/low)

  - Set outputs (high low)

  - Wait for edge (wait for input to go high/low)

  - Pin event detection (callback on input pin change)

3V3 = always on

GPIO = user controllable
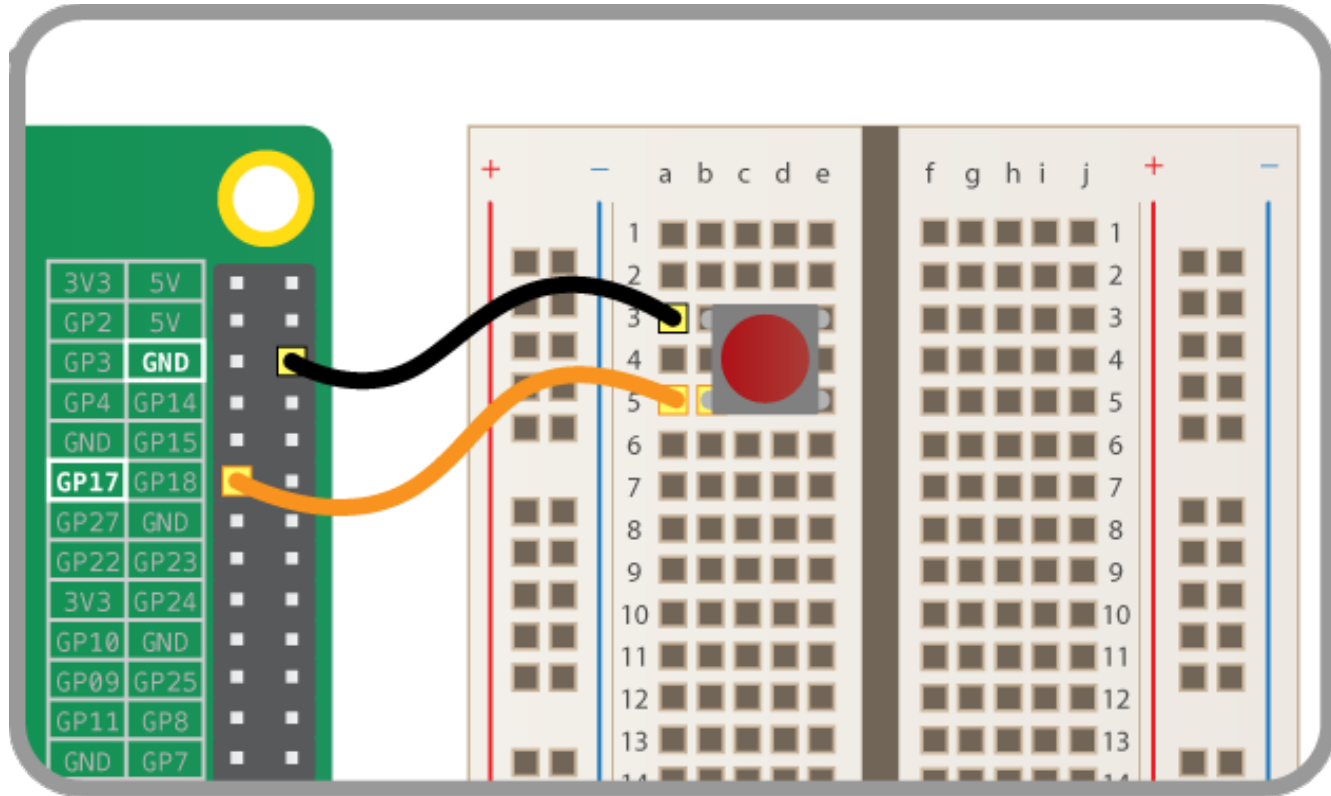
Flash LED with RPi.GPIO

```python
from RPi import GPIO
from time import sleep

GPIO.setmode(GPIO.BCM)

led = 2
GPIO.setup(led, GPIO.OUT)

while True:
    GPIO.output(led, True)
    sleep(1)
    GPIO.output(led, False)
    sleep(1)
```

Push button stop motion

Push button stop motion

```
from picamera import PiCamera

from RPi import GPIO

from time import sleep


button = 17


GPIO.setmode(GPIO.BCM)

GPIO.setup(button, GPIO.IN, GPIO.PUD_UP)
```
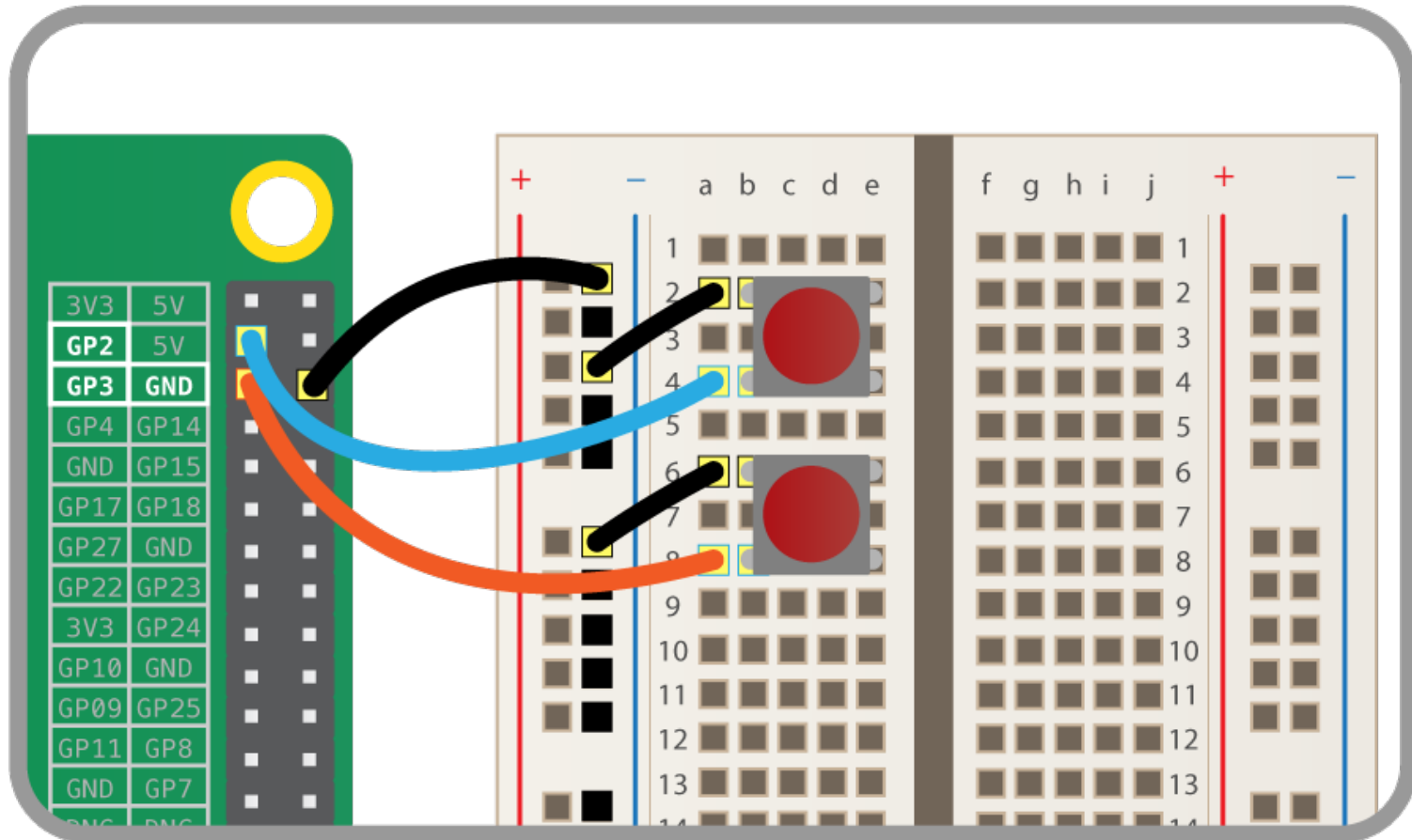
Push button stop motion

```python
with PiCamera() as camera:

    camera.start_preview()

    frame = 1

    while True:

        GPIO.wait_for_edge(button, GPIO.FALLING)

        camera.capture('/home/pi/animation/frame%03d.jpg' % frame)

        frame += 1

    camera.stop_preview()
```

GPIO Music Box
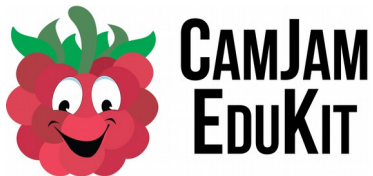
GPIO Music Box – GPIO events

```
GPIO.add_event_detect(
    button,
    GPIO.FALLING,
    callback=play,
    bouncetime=1000
)
```

www.raspberrypi.org/learning/gpio-music-box/

GPIO Music Box – GPIO events

```python
sound_pins = {
    2: drum,
    3: cymbal,
}


def play(pin):
    sound = sound_pins[pin]
    sound.play()
```
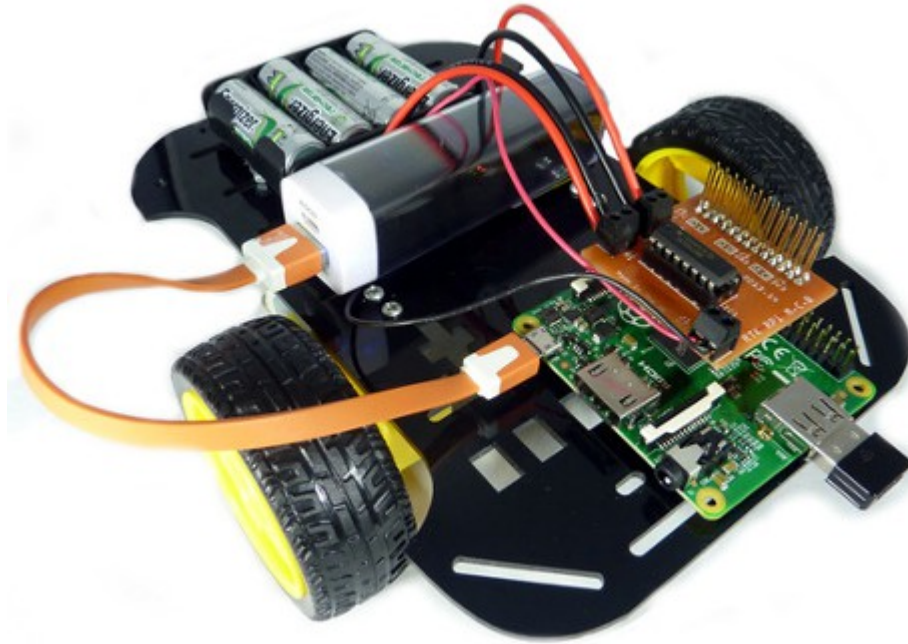
www.raspberrypi.org/learning/gpio-music-box/

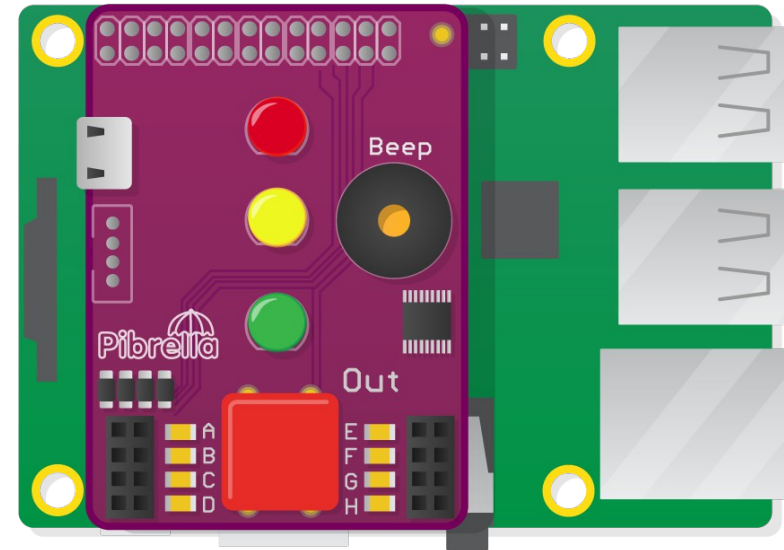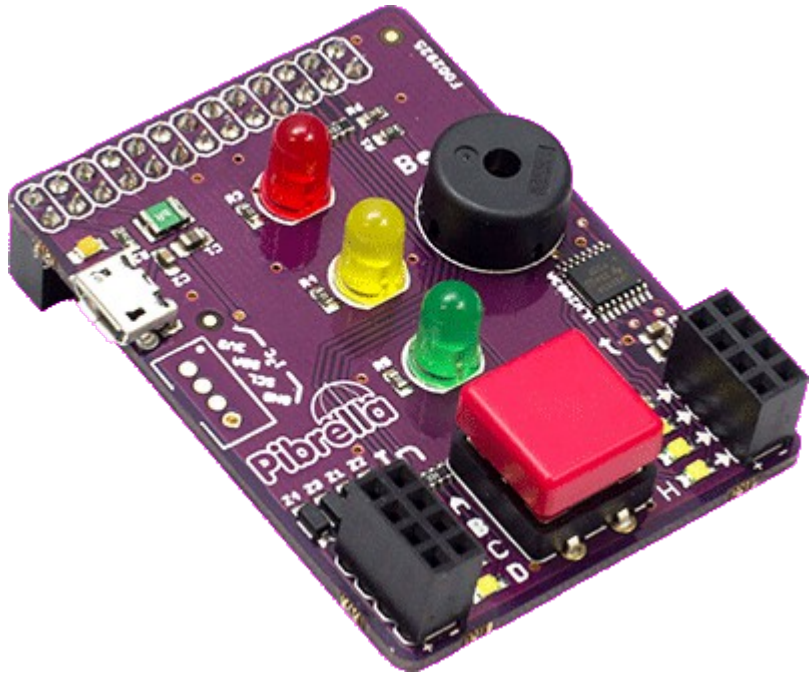# CamJam EduKit

camjam.me/edukit

The Gertboard

Ryanteck RPi Motor Controller Board
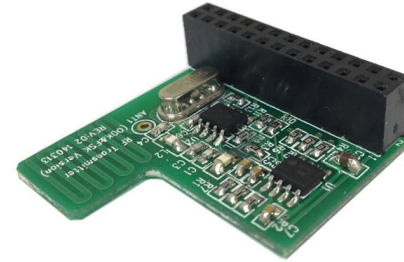
Pimoroni - Pibrella

Pibrella – traffic lights

```
import pibrella
from time import sleep

pibrella.light.green.on()
sleep(1)
pibrella.light.amber.on()
sleep(1)
pibrella.light.red.on()
```

Pibrella – button press event

```
def flash(pin):
    pibrella.light.on()
    sleep(1)
    pibrella.light.off()


pibrella.button.pressed(flash)
```

Energenie – remote controlled power sockets

Energenie – remote controlled power sockets

```
import energenie
from time import sleep


energenie.switch_on()
sleep(5)
energenie.switch_off()
```
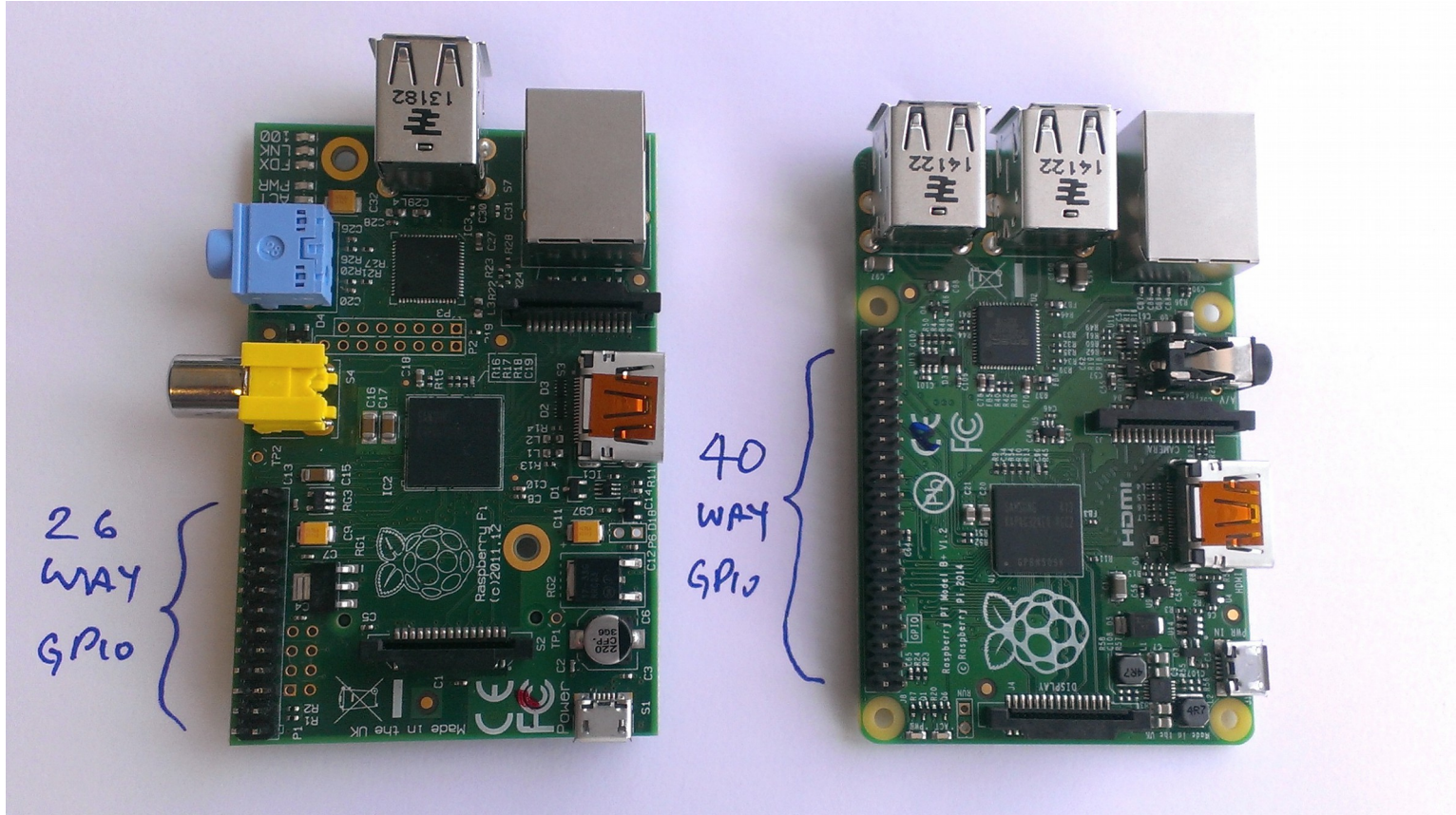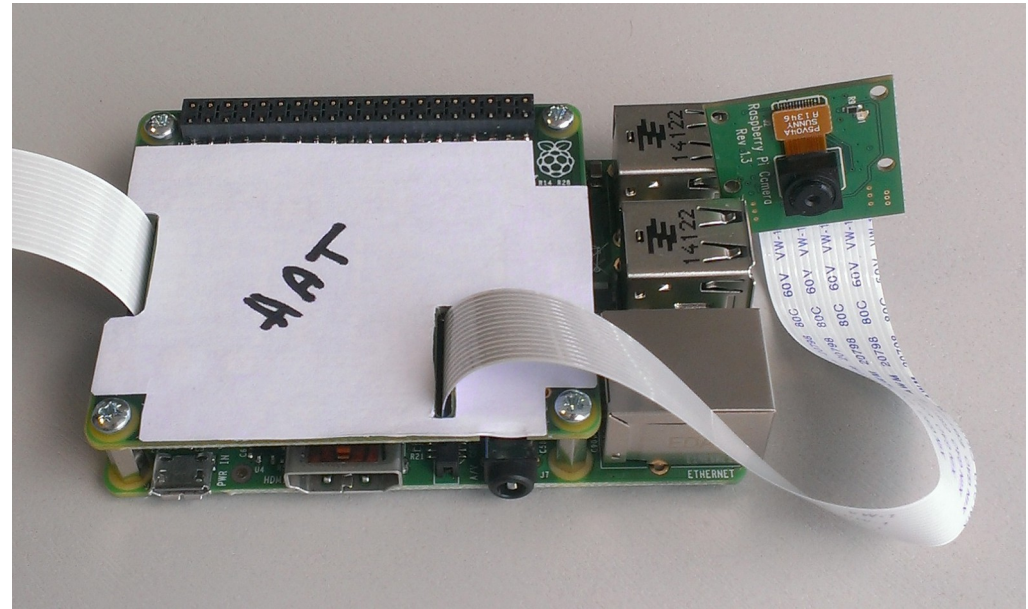
pythonhosted.org/energenie

Energenie – web app

pythonhosted.org/energenie
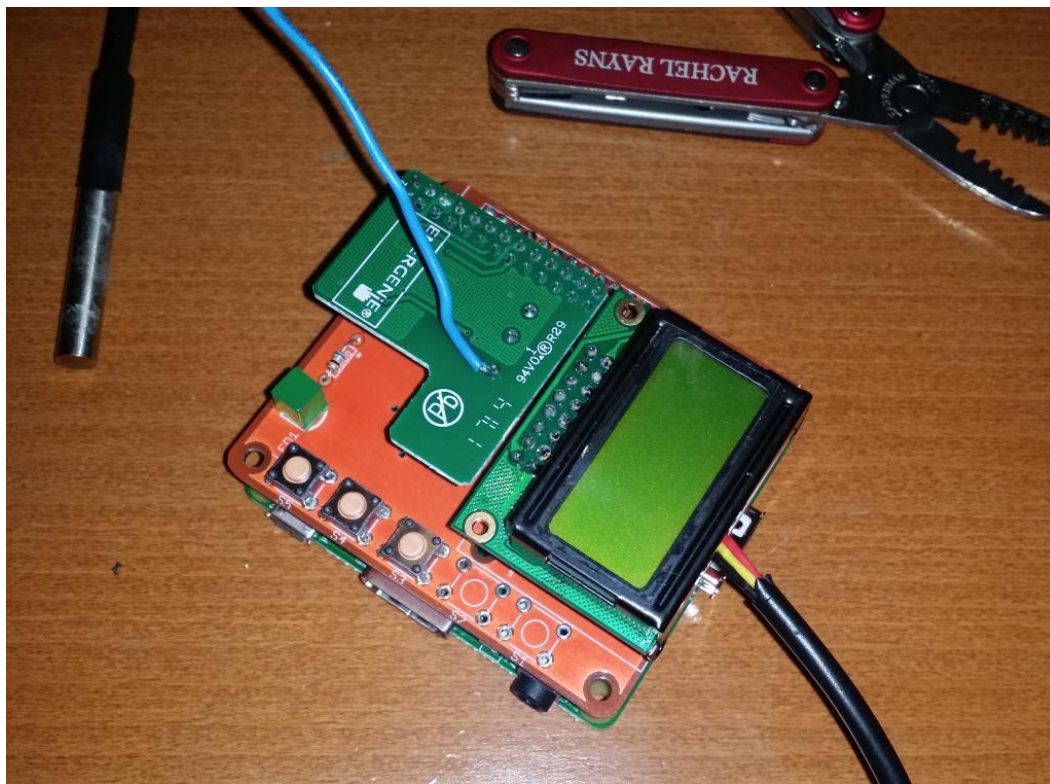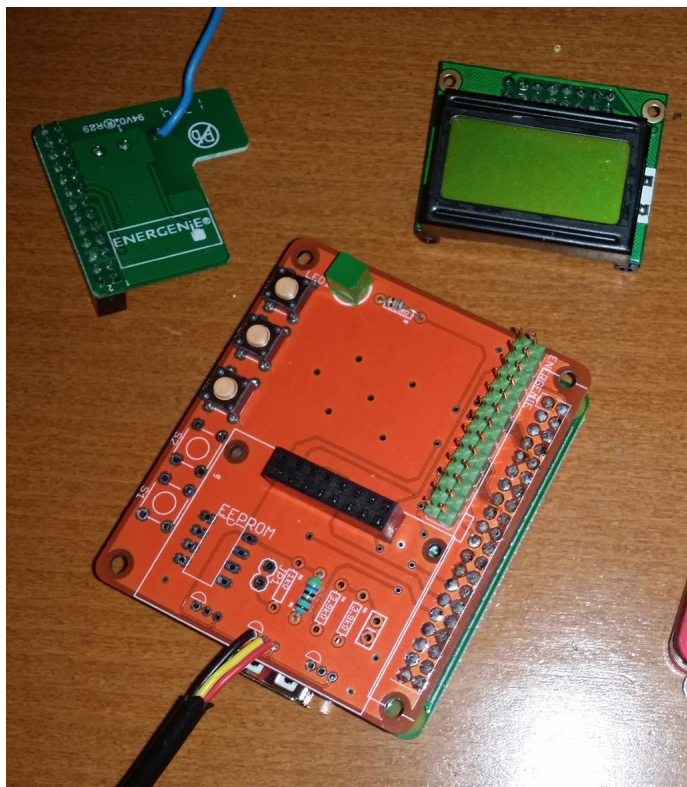/examples/web/

26->40 pin header

Raspberry Pi HATs – Hardware Attached on Top

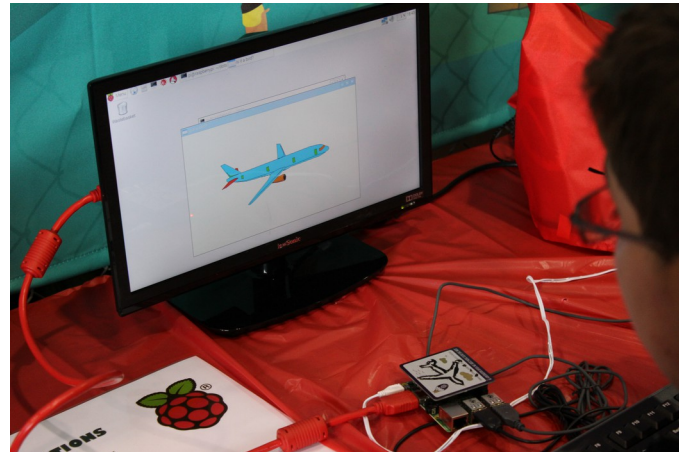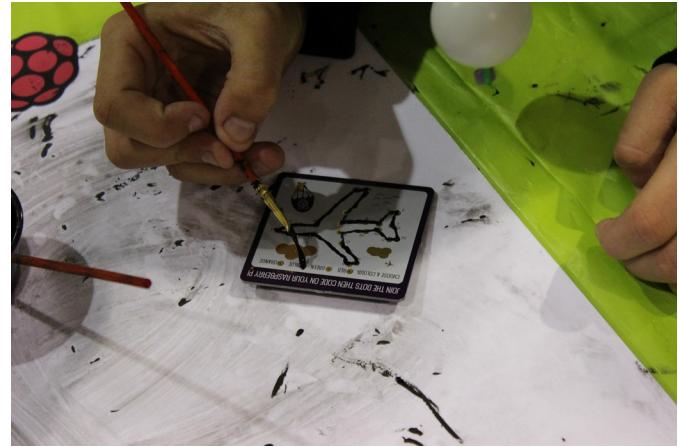# Sous Vide cooking

Chef HAT

WIP – github.com/bennuttall/chef-hat
pypi.python.org/pypi/chef-hat

Chef HAT – temperature moderation

```python
if self.temperature < self.target_temperature:
    self.turn_cooker_on()
else:
    self.turn_cooker_off()
```

DOTS board
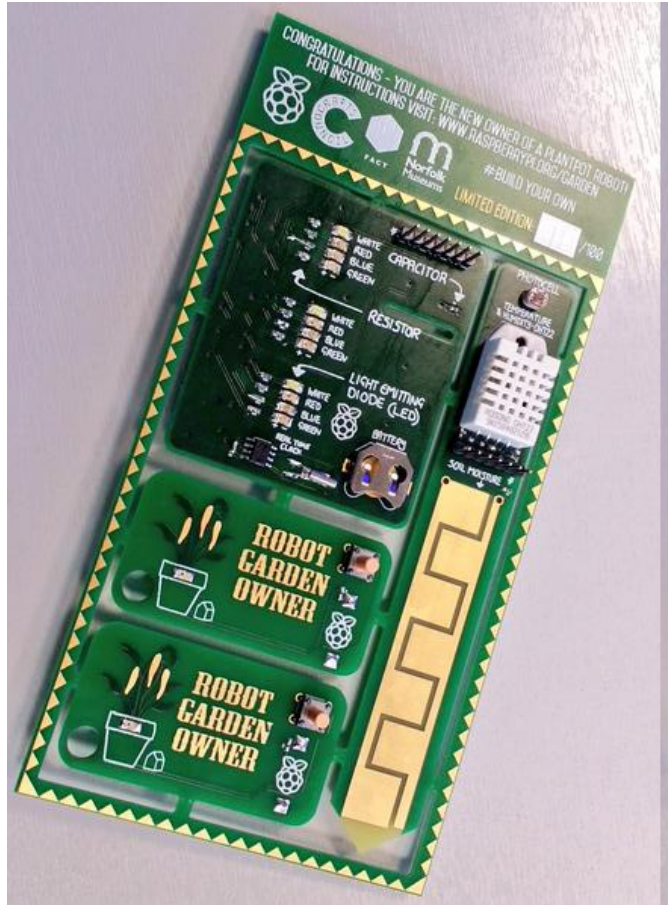

www.raspberrypi.org/dots

DOTS board software

```python
def get_selected_colors():
    return [COLOR_PINS[pin] for pin in COLOR_PINS if pin_is_active(pin)]


def enough_dots_connected():
    active_pins = sum(pin_is_active(pin) for pin in DOT_PINS)
    return active_pins > MINIMUM_DOTS_REQUIRED


def pin_is_active(pin):
    GPIO.setup(pin, GPIO.IN, GPIO.PUD_UP)
    state = GPIO.input(pin)
    GPIO.setup(pin, GPIO.IN, GPIO.PUD_OFF)
    return state == 0
```
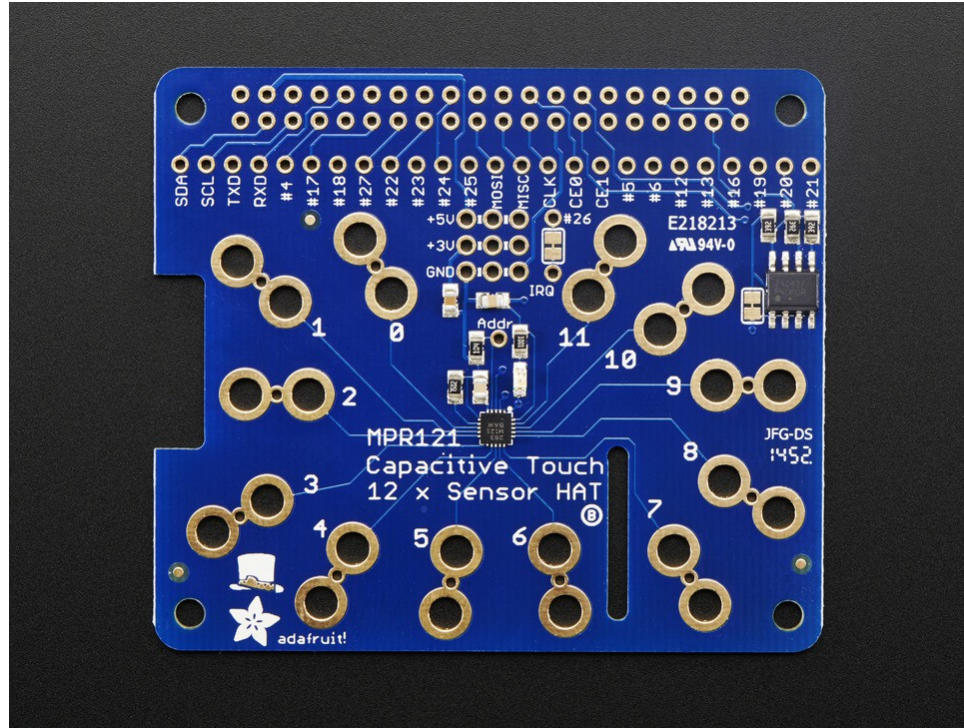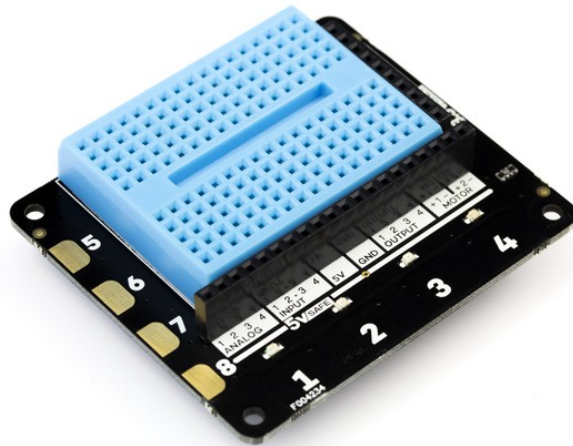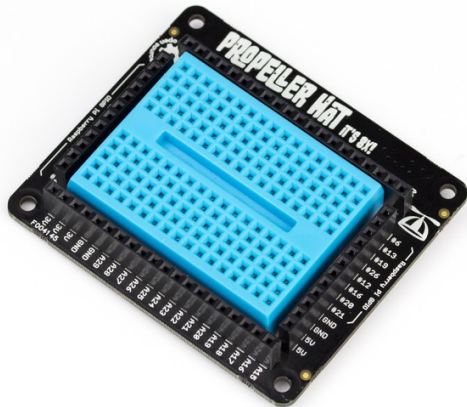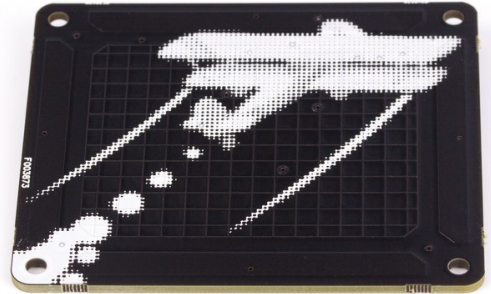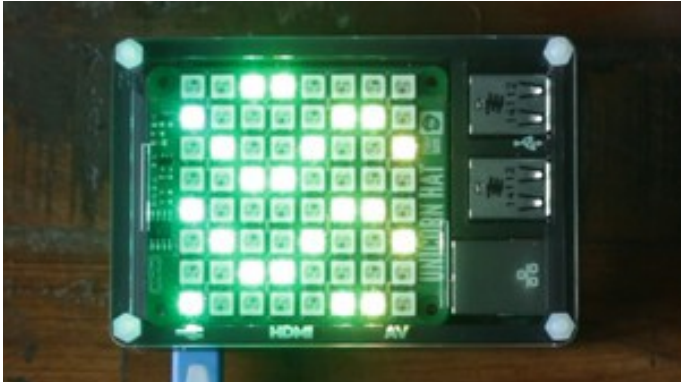
Plantpot Greenhouse

Capacitive Touch HAT

Pimoroni - HATs

http://shop.pimoroni.com/collections/hats

Weather Station kit

- Air quality
- To main board
- To soil temperature probe
- Humidity
- Pressure
- Snap here
- GPIO header
- Built in UBEC
- RTC and crystal
- PoE power in barrel jack
- RTC backup battery
- To AIR board
- To rain gauge
- To wind vane / anemometer
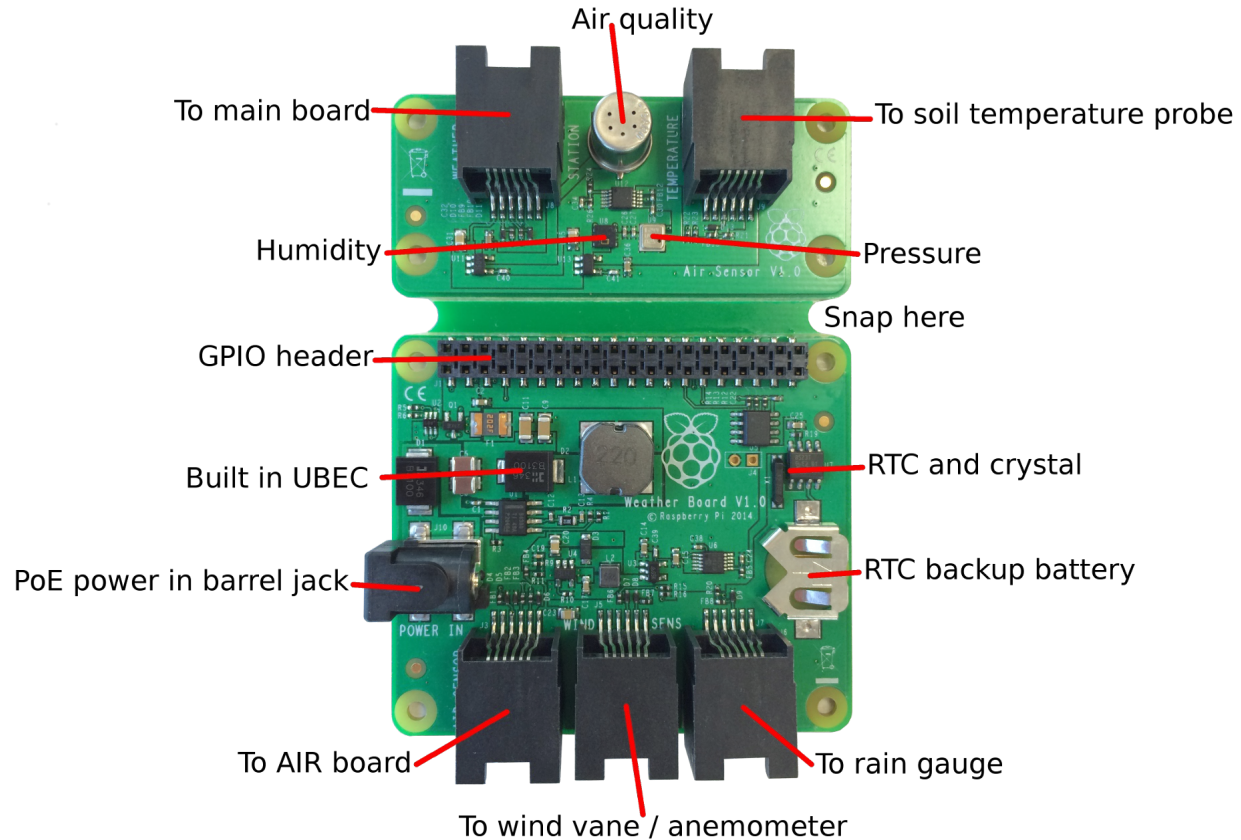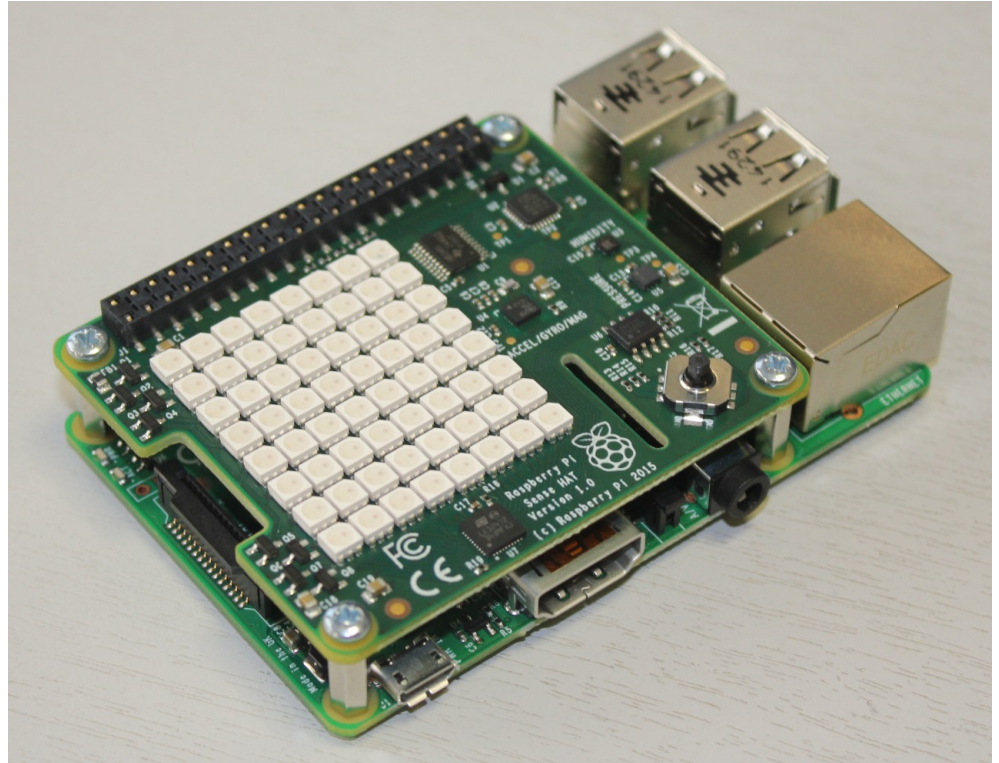
Astro Pi

Astro Pi / Sense HAT

- 8x8 RGB LED matrix
- Temperature
- Humidity
- Pressure
- Accelerometer
- Gyroscope
- Magnetometer
- Mini joystick

pypi.python.org/pypi/astro-pi

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Thank you - any questions?