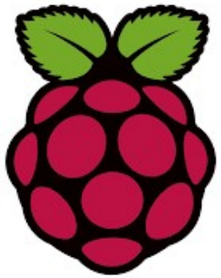
ENPM 809T

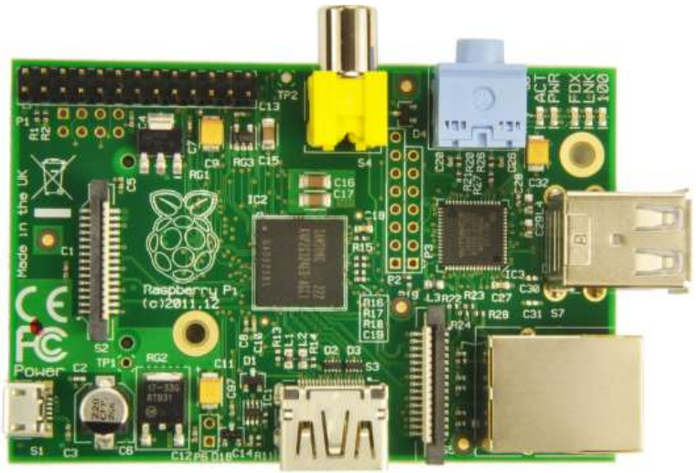
UMCP, Mitchell, Summer 2019

Raspberry Pi



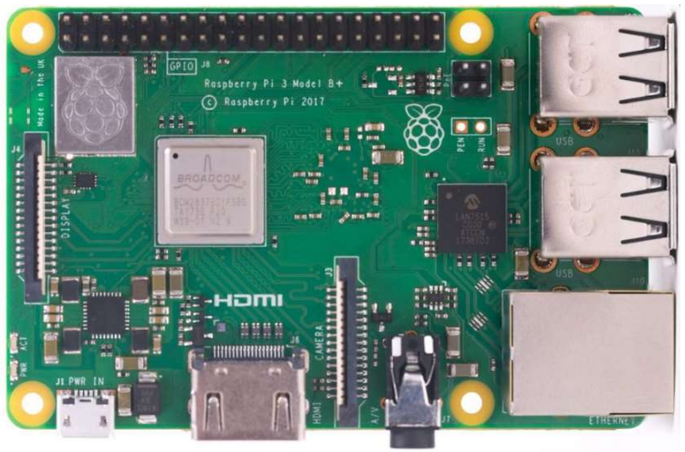
- Eben Upton 2006
  - Google widely used
  - Facebook accessible to everyone
  - Twitter's first tweet
- 2009 Raspberry Pi Foundation
  - Registered educational charity foundation based in UK
  - Goal: help students learn to program at low cost ($30)
- 2012 first release of Raspberry Pi to the public

Raspberry Pi



B: 2012 $35

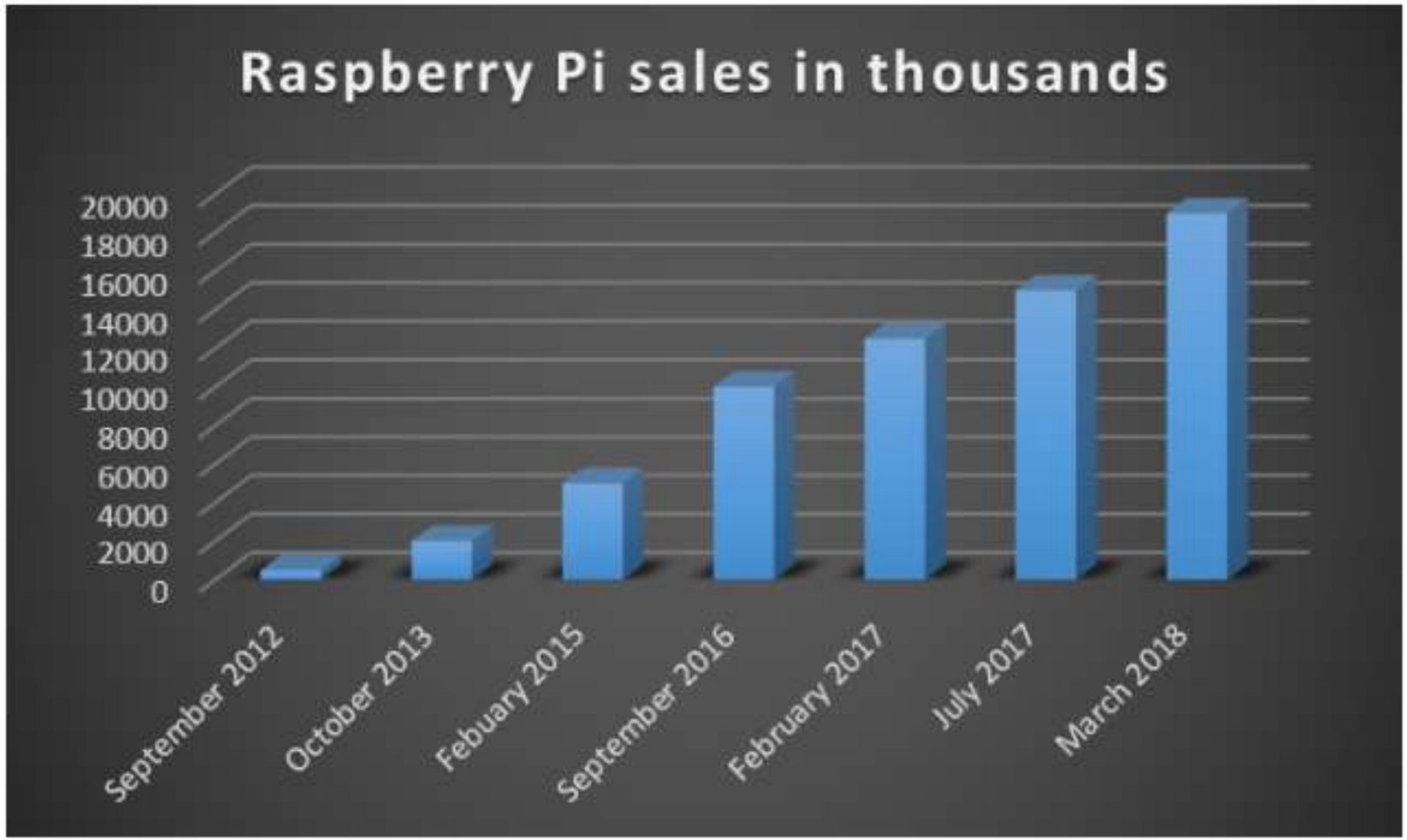
Zero W: 2017 $10



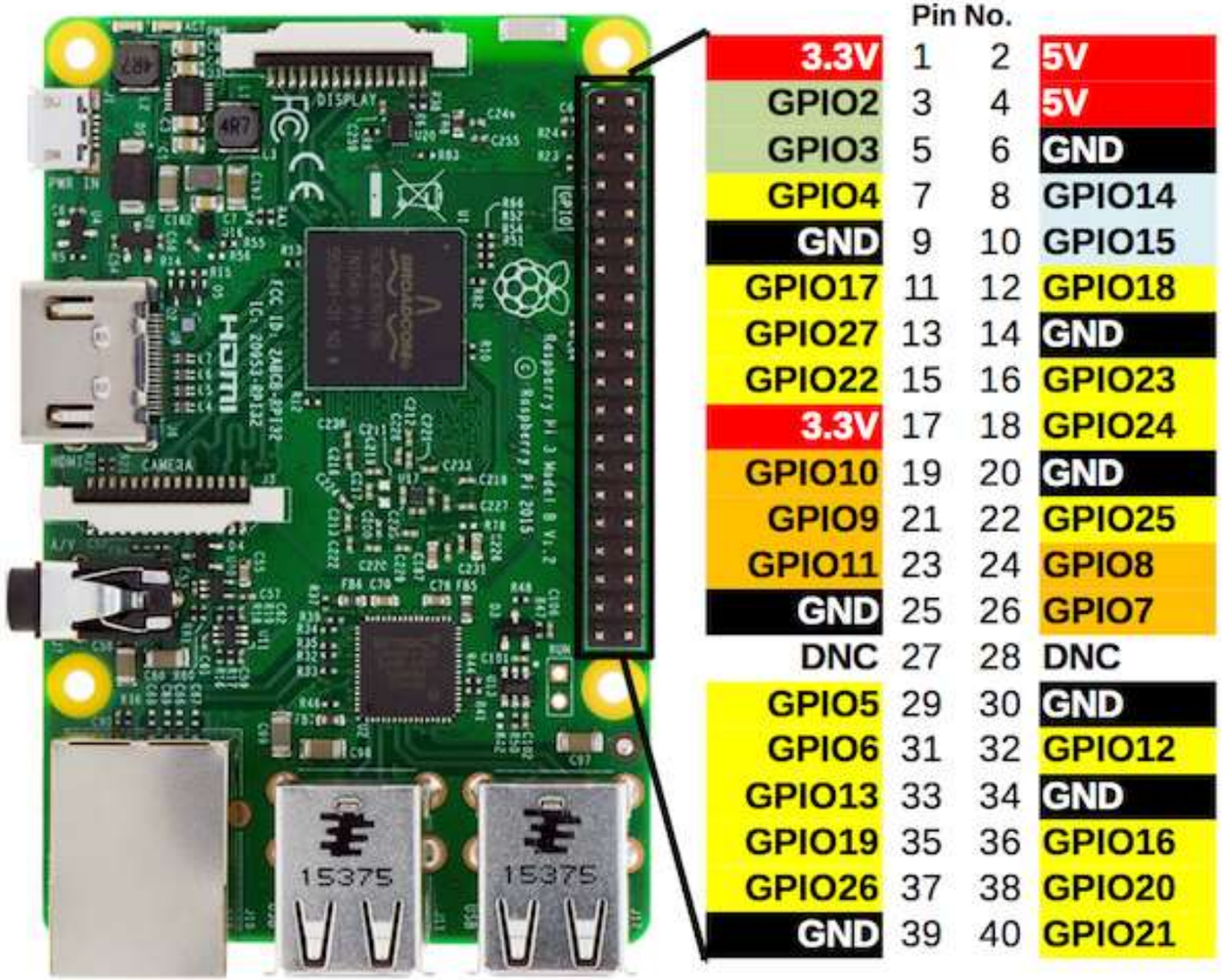
B+: 2018 $35

http://socialcompare.com/en/comparison/raspberrypi-models-comparison

Raspberry Pi



Raspberry Pi

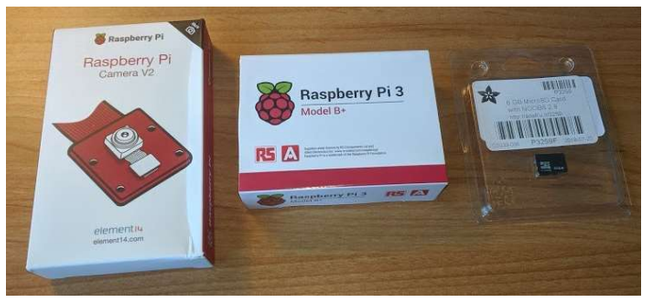


	Pin No.		
3.3V	1	2	5V
GPIO2	3	4	5V
GPIO3	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7
DNC	27	28	DNC
GPIO5	29	30	GND
GPIO6	31	32	GPIO12
GPIO13	33	34	GND
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
GND	39	40	GPIO21

Setup

- Materials required to setup the Raspberry Pi:

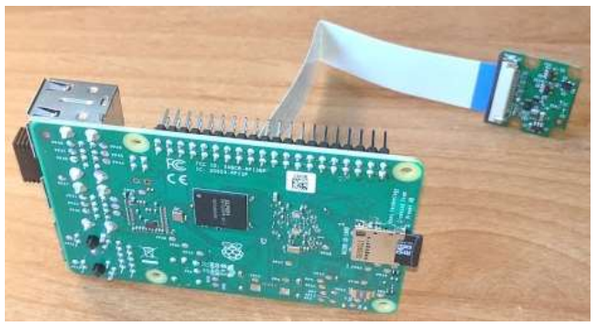
1. Raspberry Pi 3 Model B+
2. Raspberry Pi Camera v2 8 MP
3. 8 GB MicroSD Card with NOOBS
4. Monitor with HDMI connection
5. USB Keyboard & mouse
6. Power supply: wall or battery pack with USB cable



Setup

- To begin, assemble the required hardware:

1. Unpack Rpi, SD card, and Pi camera from shipping boxes
2. Insert SD card into Pi
3. Plug Pi camera into Pi, ensuring proper polarity
4. Connect USB keyboard/mouse to Pi
5. Connect HDMI connector and monitor to Pi



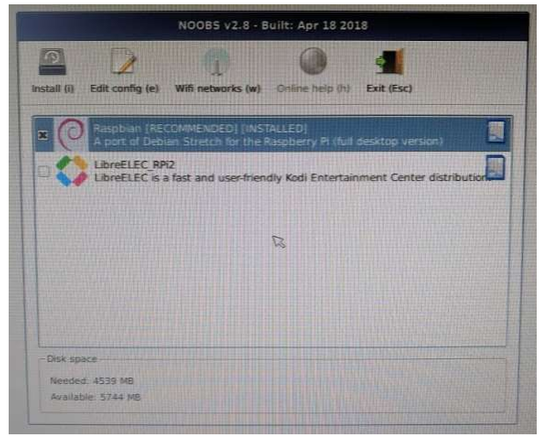
Setup

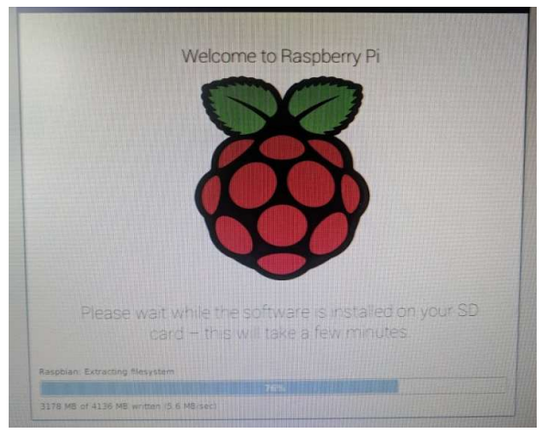
REQUIRES KEYBOARD/MONITOR

- Let's begin from the ground up:

Time to complete: 15:00

1. Apply 5V power to Pi….this will boot up Pi
2. When prompted, **hold down the shift key** to enter safe mode
3. Select and install Raspbian
4. Confirm "Yes" when prompted to install the selected OS
5. Once complete, a prompt will appear stating "OS(es) Installed Successfully"
6. Press "Ok" to restart the Pi





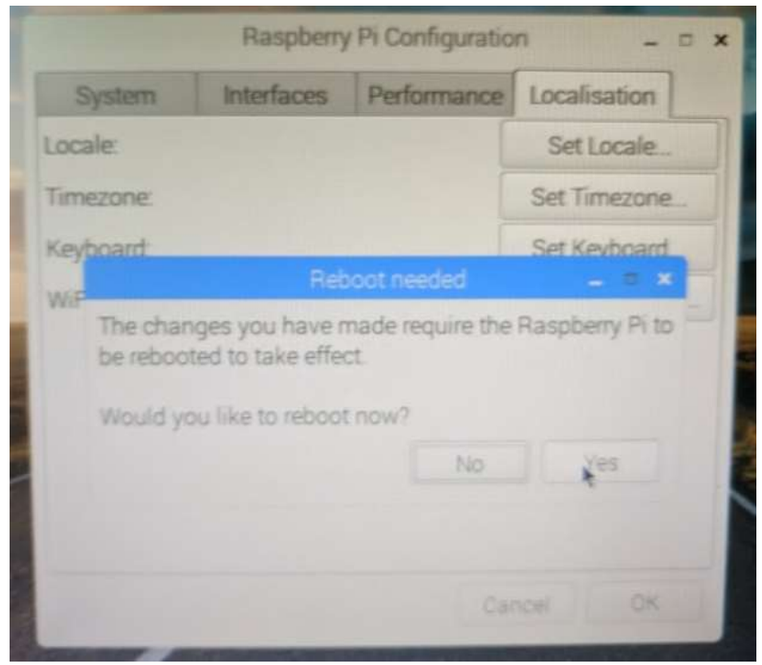
Setup

REQUIRES KEYBOARD/MONITOR

- Once restarted, configure the Pi as follows:

1. Click RPi logo > Preferences > Raspberry Pi Configuration
2. Interfaces tab > enable Camera, SSH, VNC
3. Localization tab > set Locale > Country as US (United States)
4. Localization tab > set Timezone > Area as EST
5. Localization tab > set Keyboard > Keyboard Layout as United States > English (US)
6. Localization tab > set WiFi Country > WiFi Country Code as US United States
7. Press OK
8. Selected YES to reboot the Pi

Time to complete: 8:00



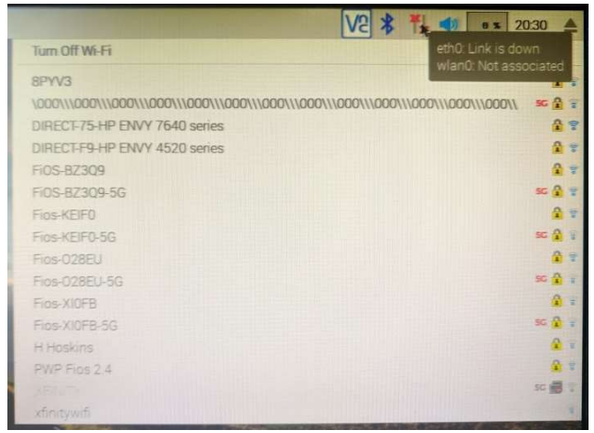
Setup

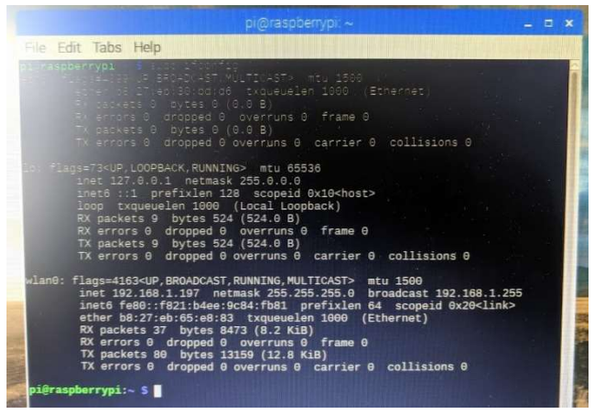
REQUIRES KEYBOARD/MONITOR

- Once the Pi has rebooted:

Time to complete: 5:00

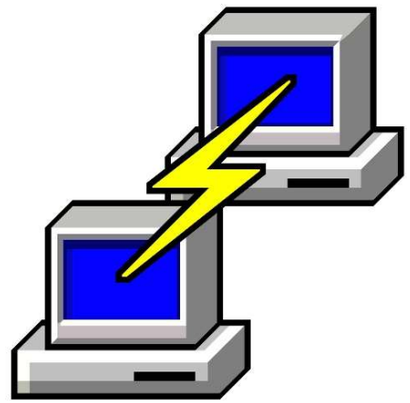
1. Click on WiFi button on top right of toolbar
2. Connect Pi to wifi
3. Click Terminal icon in upper left to open a terminal window
4. **Make a note of the Pi's IP address** by typing **sudo ifconfig** and hitting enter
5. For example, connection in image at left: 192.168.1.197





Setup

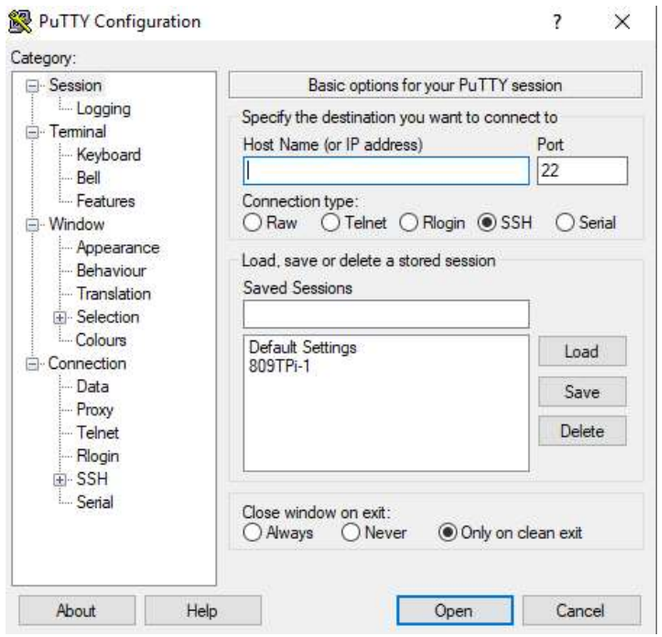
- From this point forward ***the use of a monitor & keyboard/mouse is optional***
- Typically prefer to interface with the Pi using a **headless** setup
- Recommend Putty (Windows) or Terminal (Mac)

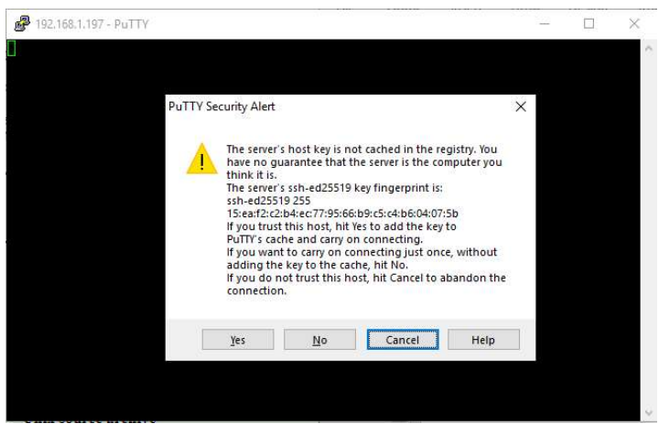


https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html

Setup

- From this point forward ***the use of a monitor & keyboard/mouse is optional***
- Typically prefer to interface with the Pi using a **headless** setup
- Recommend Putty (Windows) or Terminal (Mac)
- Create a connection using the Pi's IP address
  - Wifi or Ethernet cable
  - Serial connection

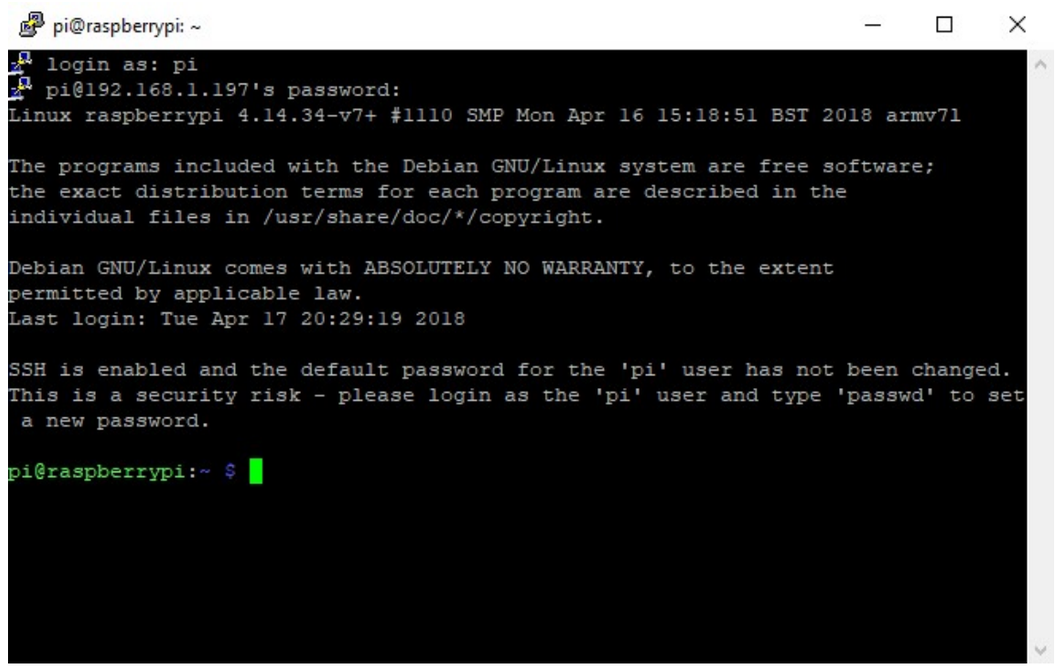




https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html

Setup

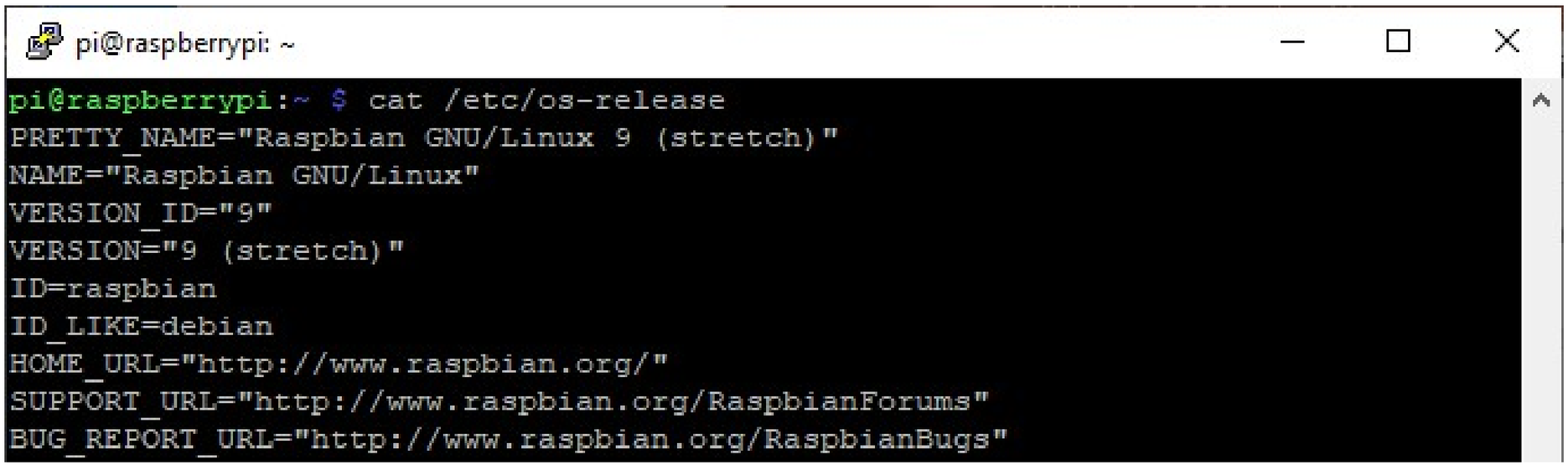
- Standard login information
  - user: **pi**
  - password: **raspberry** or **raspberr**



Setup

- Once logged in, confirm your Raspberry Pi is running Raspbian Stretch

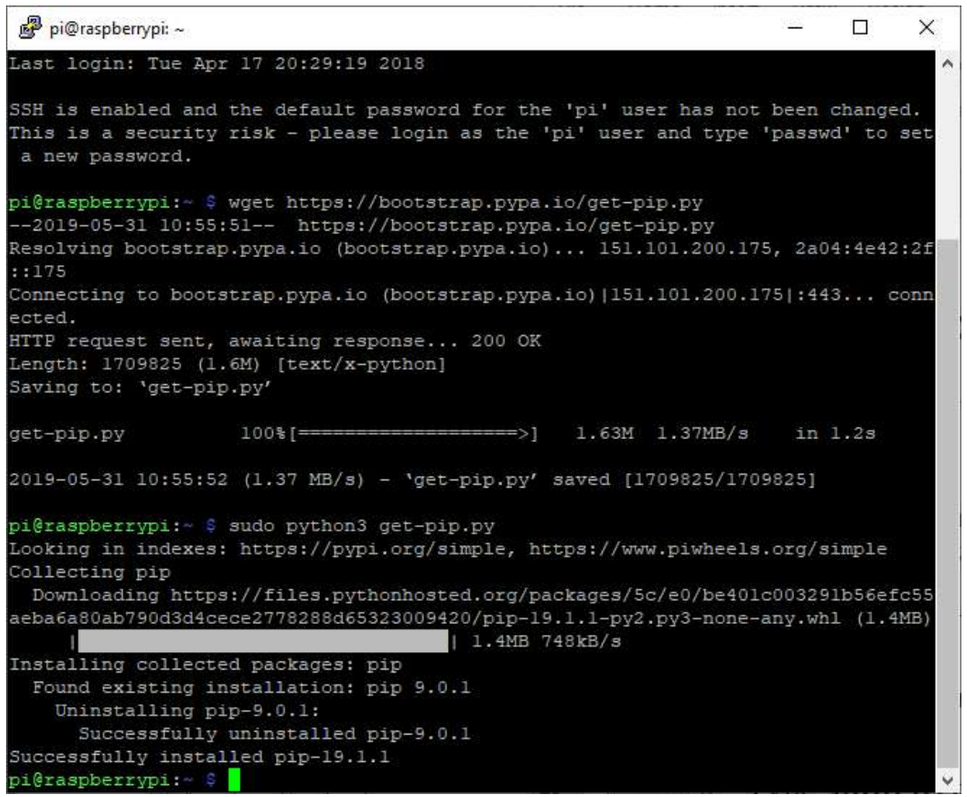
1. Type **cat /etc/os-release** and hit enter



Setup

- Install the Python packages required for ENPM 809T
- Begin by installing the Python package manager **pip** on your Rpi:

1. Open a Terminal Window
2. Type **wget https://bootstrap.pypa.io/get-pip.py** and hit enter
3. Type **sudo python3 get-pip.py** and hit enter



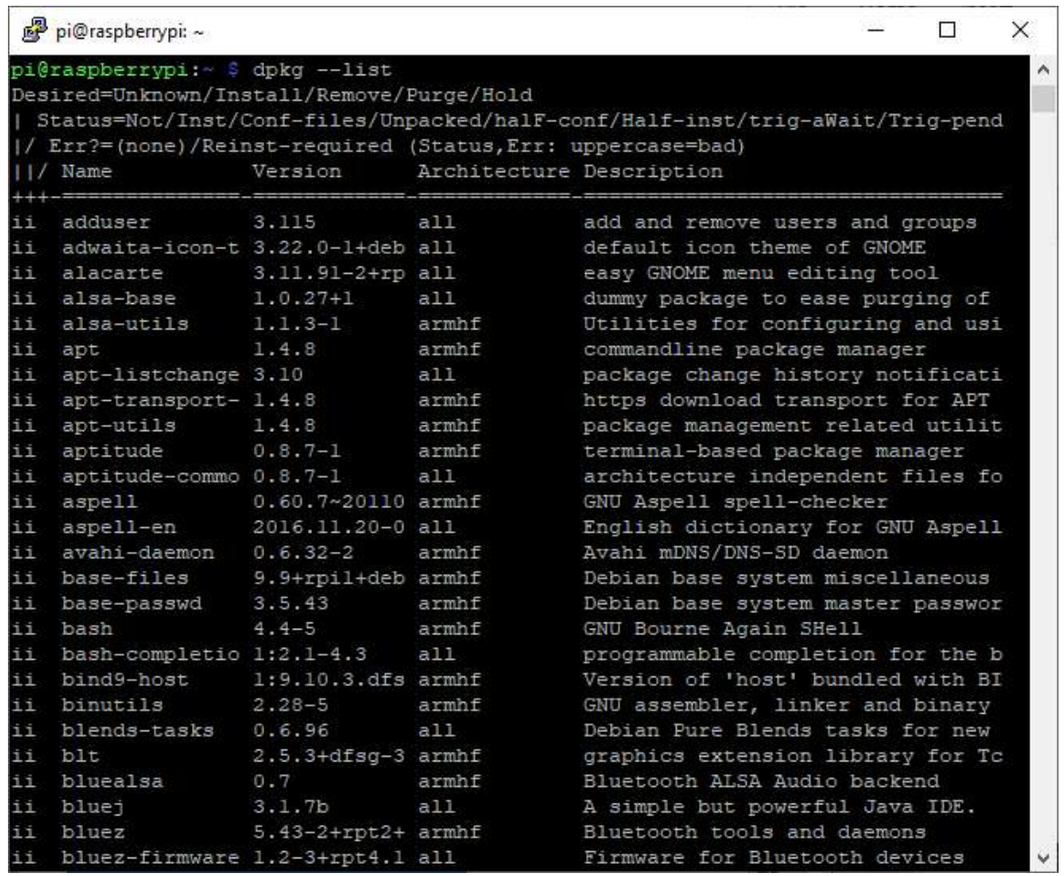
https://pypi.org/project/pip/

https://www.gnu.org/software/wget/

Setup

- To view a list of the packages are a installed on the Pi:

1. Open a Terminal Window
2. Type **dpkg --list** and hit enter

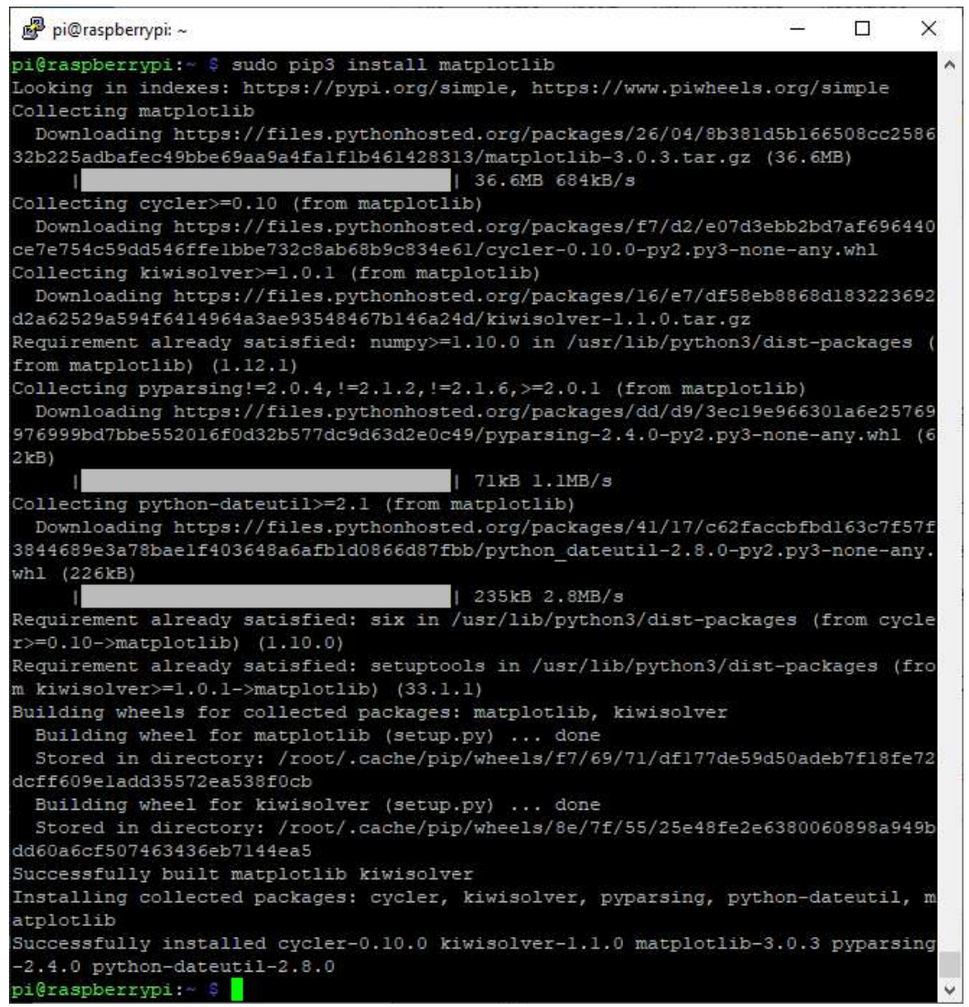


Setup

- Install the packages required for 809T

1. Open a Terminal Window
2. Type **sudo pip3 install matplotlib** and hit enter

Time to complete: 7:00

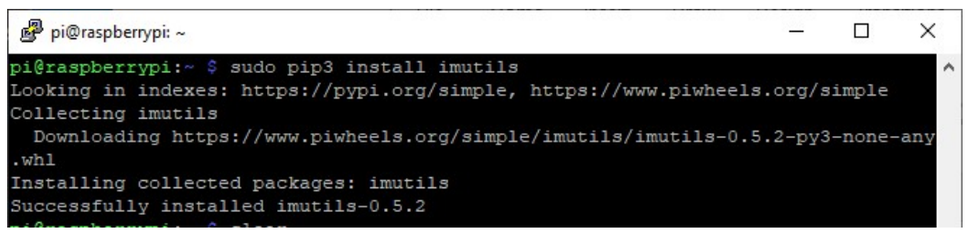


Setup

- Repeat the process to install all required packages

1. Open a Terminal Window
2. Type **sudo pip3 install matplotlib** and hit enter
3. Type **sudo pip3 install imutils** and hit enter

Time to complete: 1:00



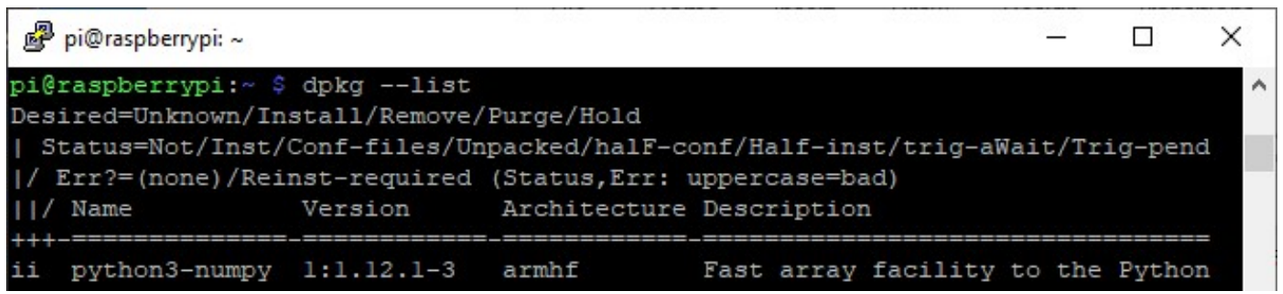
Setup

- Repeat the process to install all required packages

1. Open a Terminal Window
2. Type **sudo pip3 install matplotlib** and hit enter
3. Type **sudo pip3 install imutils** and hit enter
4. If required, type **sudo pip3 install numpy** and hit enter

It is likely that NumPy is already be installed

Re-installing will take time

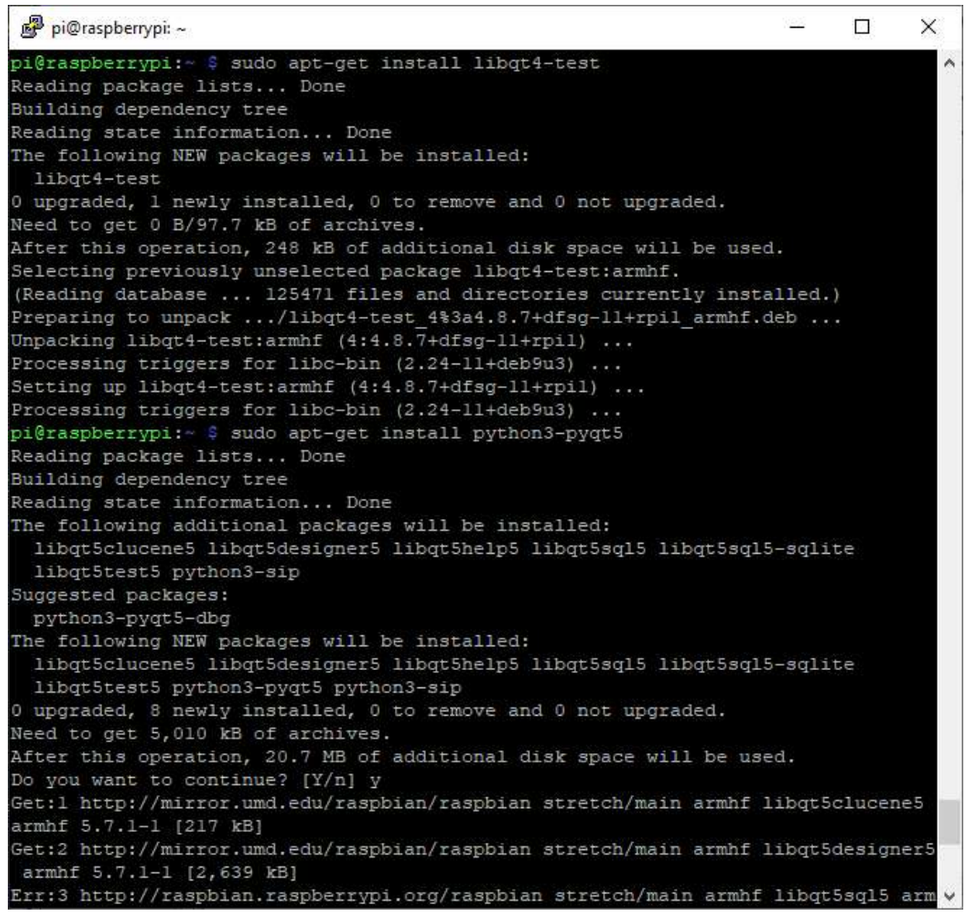


Setup

- Begin OpenCV installation by manually installing dependencies
- Enter **y** for "yes" and hit enter when asked

Time to complete: 12:00

1. Open a Terminal Window
2. Type **sudo apt-get install libhdf5-dev** and hit enter
3. Type **sudo apt-get install libhdf5-serial-dev** and hit enter
4. Type **sudo apt-get install libhdf5-100** and hit enter
5. Type **sudo apt-get install libqtgui4** and hit enter
6. Type **sudo apt-get install libqtwebkit4** and hit enter
7. Type **sudo apt-get install libqt4-test** and hit enter
8. Type **sudo apt-get install libqt4-dev** and hit enter
9. Type **sudo apt-get install python3-pyqt5** and hit enter
10. Type **sudo apt-get install libatlas-base-dev** and hit enter
11. Type **sudo apt-get install libjasper-dev** and hit enter
12. Type **sudo apt-get install libcblas-dev** and hit enter



Setup

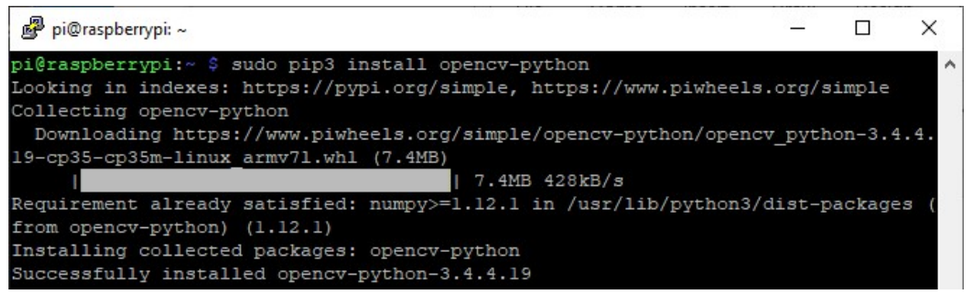
- Finally, install OpenCV

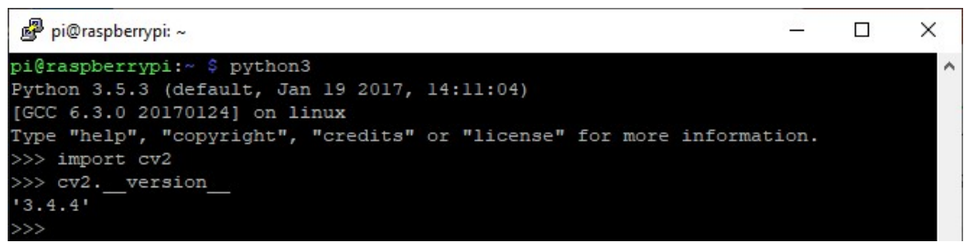
1. Open a Terminal Window
2. Type **sudo pip3 install opencv-python** and hit enter

- Once installation is complete, confirm proper installation

1. Enter Python 3 by typing **python3** and hit enter
2. Once inside Python 3, type **import cv2** and hit enter
3. Type **cv2.__version__** and hit enter
4. Python should display the version of OpenCV, such as '3.4.4'

Time to complete: 1:00

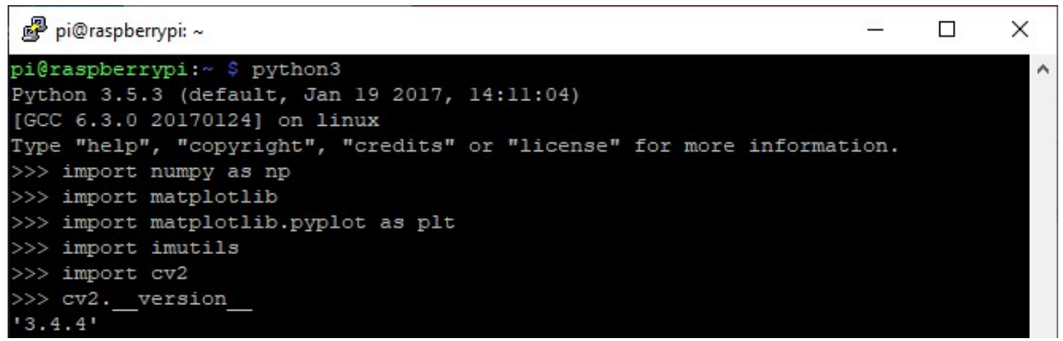




Setup

- Confirm packages have been installed and will properly import into Python

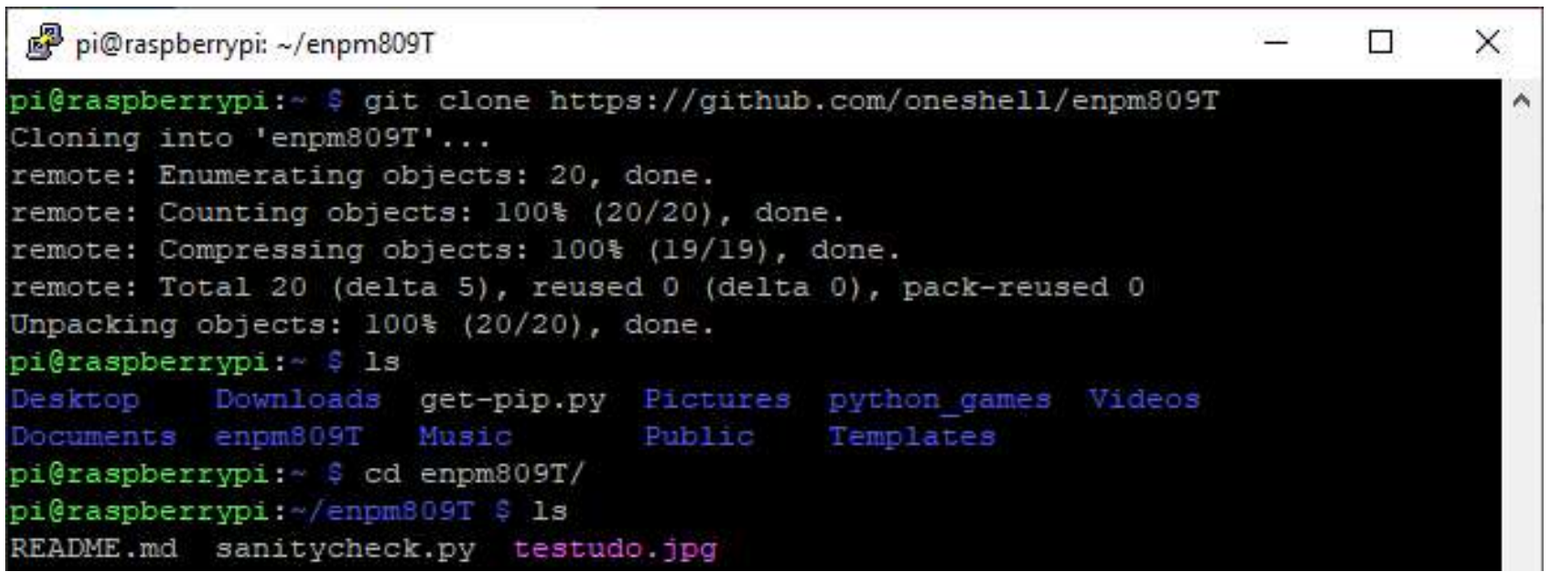
1. Type **import numpy as np** and hit enter
2. Type **import matplotlib** and hit enter
3. Type **import matplotlib as plt** and hit enter
4. Type **import imutils** and hit enter
5. Type **import cv2** and hit enter



https://github.com/oneshell/enpm809T

Setup

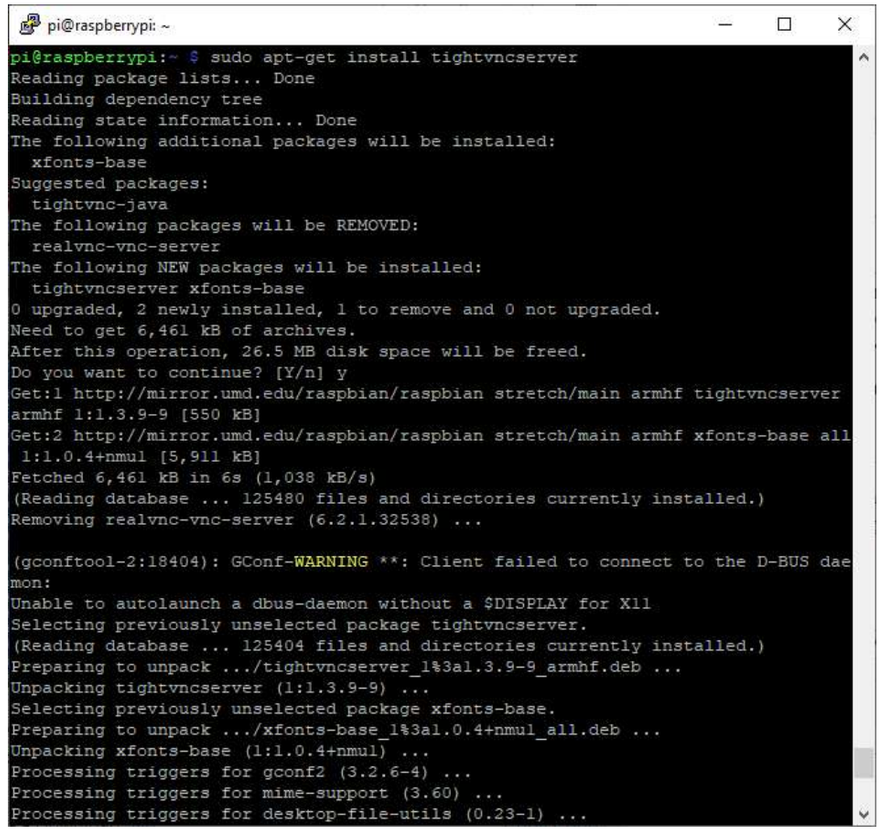
- Once all packages are installed and properly import into Python, clone the ENPM 809T GitHub repository onto your Rpi:



Setup

- In order to run the sanitycheck.py script and view the proper outputs, we have to first install VNC
- Putty/Terminal will not display images/videos
- To begin, open a Terminal Window

1. Type **sudo apt-get install tightvncserver** and hit enter
2. Type “y” for yes when prompted



https://learn.adafruit.com/adafruit-raspberry-pi-lesson-7-remote-control-with-vnc/installing-vnc

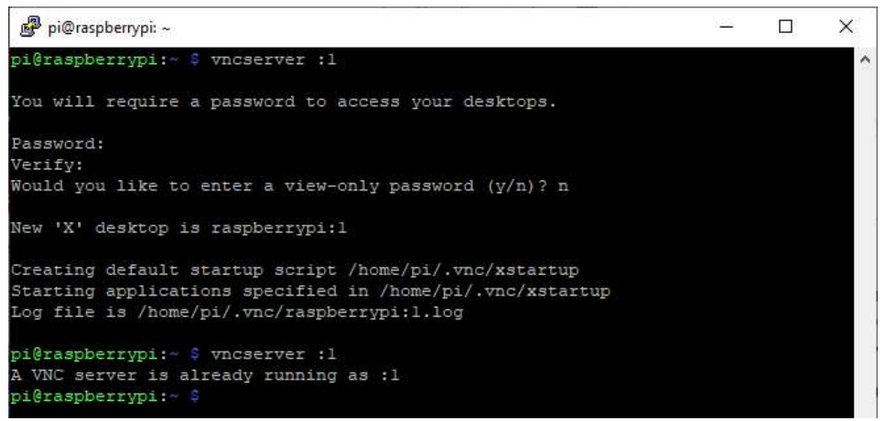
Setup

- To run the VNC server:

1. Type **vncserver :1** and hit enter
2. When prompted, enter an 8-character password such as **raspberr**

- In the future, to start the VNC server:

1. Login to the Pi using Putty/Terminal
2. Open a Terminal Window
3. Type **vncserver :1** and hit enter



https://learn.adafruit.com/adafruit-raspberry-pi-lesson-7-remote-control-with-vnc/installing-vnc

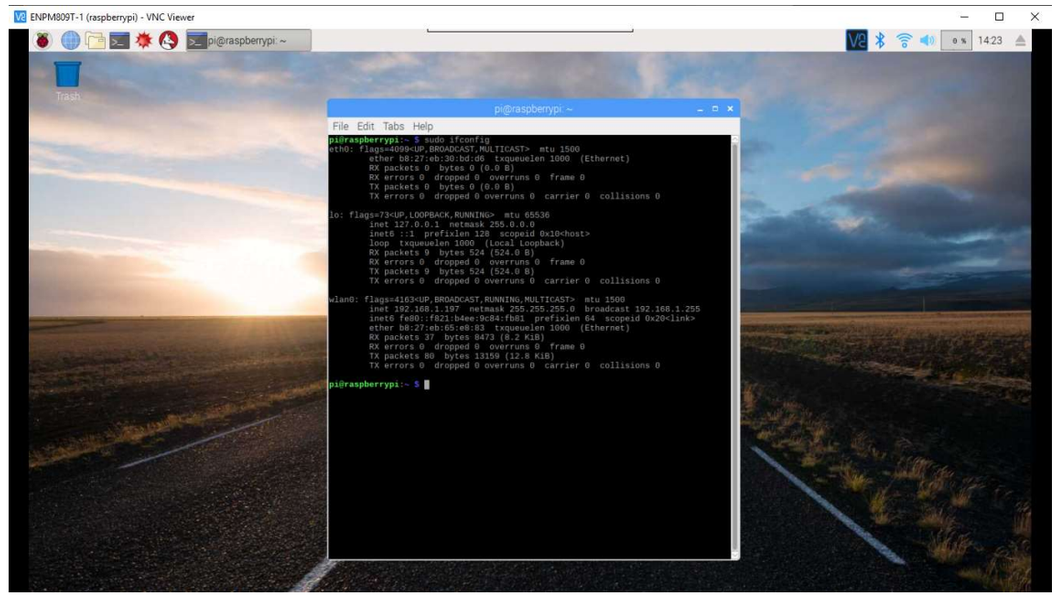
Setup

- Install VNC Viewer on your laptop:

  https://www.realvnc.com/en/connect/download/viewer/

- Open VNC Viewer

1. Create New Connection
2. Enter IP address of Raspberry Pi
3. Click “Continue” when prompted
4. Log in to the Pi



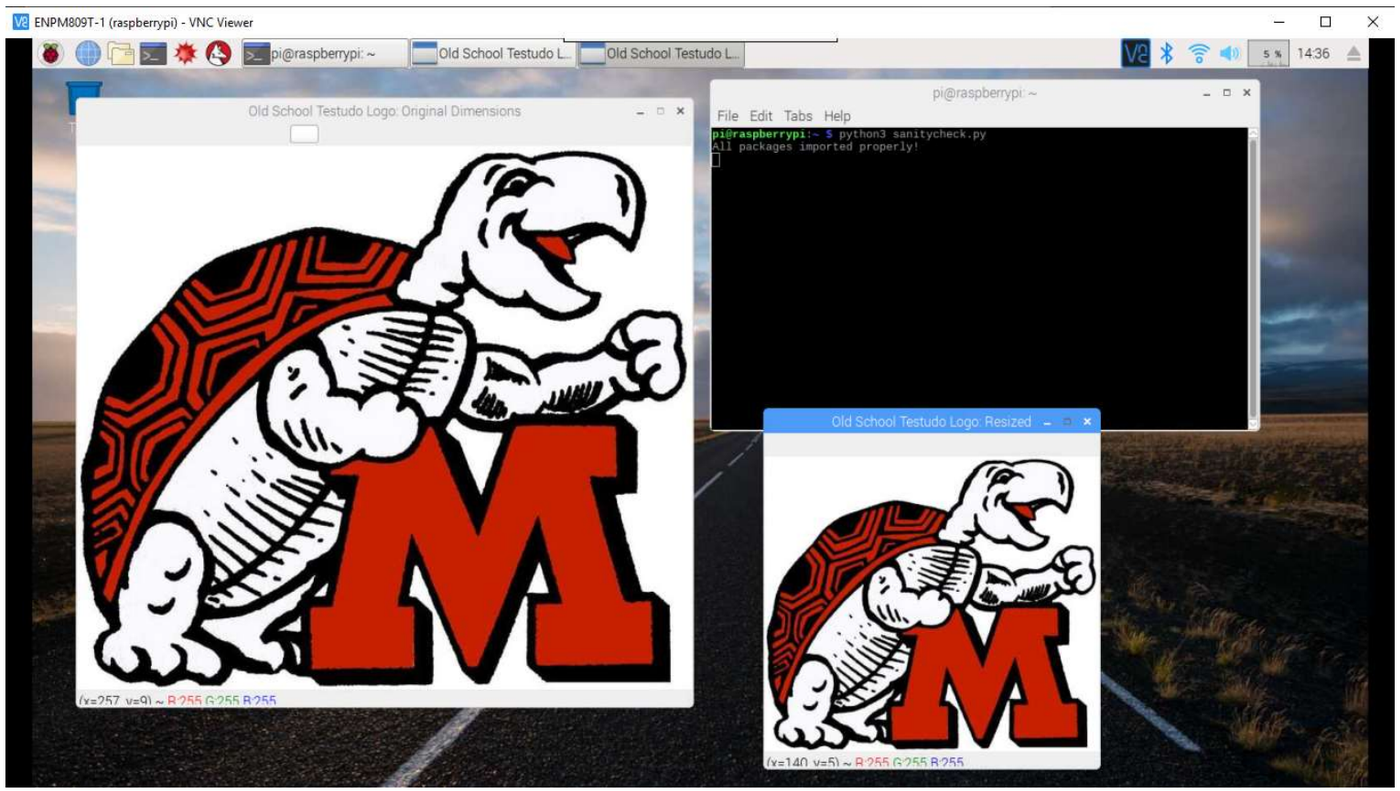
Note: often the IP address entered into VNC must include :1 at the end

Setup

- We need to run the **sanitycheck.py** script to confirm all packages have been installed properly
- ***First, recall that Python 3 and our packages are installed in the root directory
- Therefore, move all files in /enpm809T up to the root directory:

Setup

- Run the **sanitycheck.py** script to confirm all packages have been installed properly by typing **python3 sanitycheck.py**



Transferring Files

- Transferring files from the Raspberry Pi to your laptop can be accomplished in a number of ways:

1. Upload files to Gmail
2. Insert a USB into the Pi and transfer files
3. FTP into the Pi from your laptop using an FTP client such as WinSCP

https://winscp.net/eng/index.php

Setup

- Finally, verify the Pi camera has been properly installed

1. Record an image using raspistill
2. Type **raspistill –o testpic.jpg** and hit enter
3. View image by typing **xdg-open testpic.jpg** and hit enter

https://www.raspberrypi.org/documentation/usage/camera/raspicam/raspistill.md

Setup

- Finally, verify the Pi camera has been properly installed
- First, install MP4Box by typing **sudo apt-get install gpac** and hit enter, then respond “y” for yes when prompted

1. Record video using raspivid
2. Type **raspivid -o testvideo.h264 –t 5000** and hit enter
3. Type **MP4Box –add testvideo.h264 testvideo.mp4** and hit enter
4. Transfer video file to your laptop to view

https://www.raspberrypi.org/documentation/usage/camera/raspicam/raspivid.md

Picamera

- Package that provides Python interface to the Raspberry Pi camera module

```
# import the necessary packages
from picamera.array import PiRGBArray
from picamera import PiCamera
import time
import cv2
```

https://picamera.readthedocs.io/en/release-1.13/

```
# initialize the Raspberry Pi camera
camera = PiCamera()
camera.resolution = (640, 480)
camera.framerate = 25
rawCapture = PiRGBArray(camera, size=(640,480))

# allow the camera to warmup
time.sleep(0.1)

# keep looping
for frame in camera.capture_continuous(rawCapture, format="bgr", use_video_port=False):

    # grab the current frame
    image = frame.array

    # show the frame to our screen
    cv2.imshow("Frame", image)
    key = cv2.waitKey(1) & 0xFF

    # clear the stream in preparation for the next frame
    rawCapture.truncate(0)

    # press the 'q' key to stop the video stream
    if key == ord("q"):
        break
```

https://picamera.readthedocs.io/en/release-1.10/api_camera.html

Picamera

- Camera can be operated with a variety of settings:

https://www.raspberrypi.org/documentation/hardware/camera/

https://picamera.readthedocs.io/en/release-1.12/fov.html

Picamera

- To save video file:

```
# define the codec and create VideoWriter object
fourcc = cv2.VideoWriter_fourcc(*'XVID')
out = cv2.VideoWriter('videoname.avi', fourcc, 10, (640, 480))
```

```
# write frame to video file
out.write(image)
```

Shutting down the Pi

- To reboot the Raspberry Pi, type **sudo reboot** and hit enter
- To shutdown the Raspberry Pi, type **sudo shutdown 0** and hit enter
  - 0 for “zero seconds from now”

References

- *The Awesome Story of Raspberry Pi*
  - https://raspberrytips.com/raspberry-pi-history/
- Raspberry Pi Blog
  - https://www.raspberrypi.org/blog/
- Benching Raspberry Pi GPIO Speed
  - https://codeandlife.com/2012/07/03/benchmarking-raspberry-pi-gpio-speed/
- Adrian Rosebrock via PyImageSearch: pip install opencv
  - https://www.pyimagesearch.com/2018/09/19/pip-install-opencv/