Internet of Things Practical

Week 1-2 Manual

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Preparation for OS: Configure Installation and Basic Setting

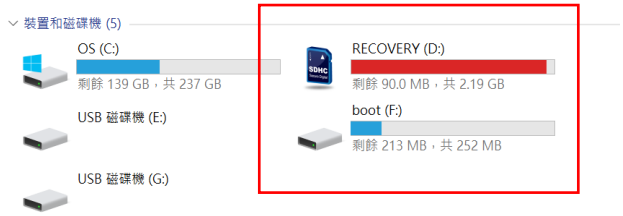
1. Complete the Box

The box has 6 pieces of plastic, one of them is the top. Make up the four surrounding broads and place the mother broad in. Place the bottom and the top at last. Be careful with the sides, otherwise The box would look like the pictures below.

2. Format SD Card

You would need a SD card formatter, the Windows default formatter cannot return “a SD card that divided into 2 slots” back to one slot. Download at: https://www.sdcard.org/downloads/formatter_4/.

First you read the raspberry pi, you would see a *recovery slot* and another *boot slot*, using the formatter upon then a clean, newly SD card is here.



← 2 slots initially, make it 1.

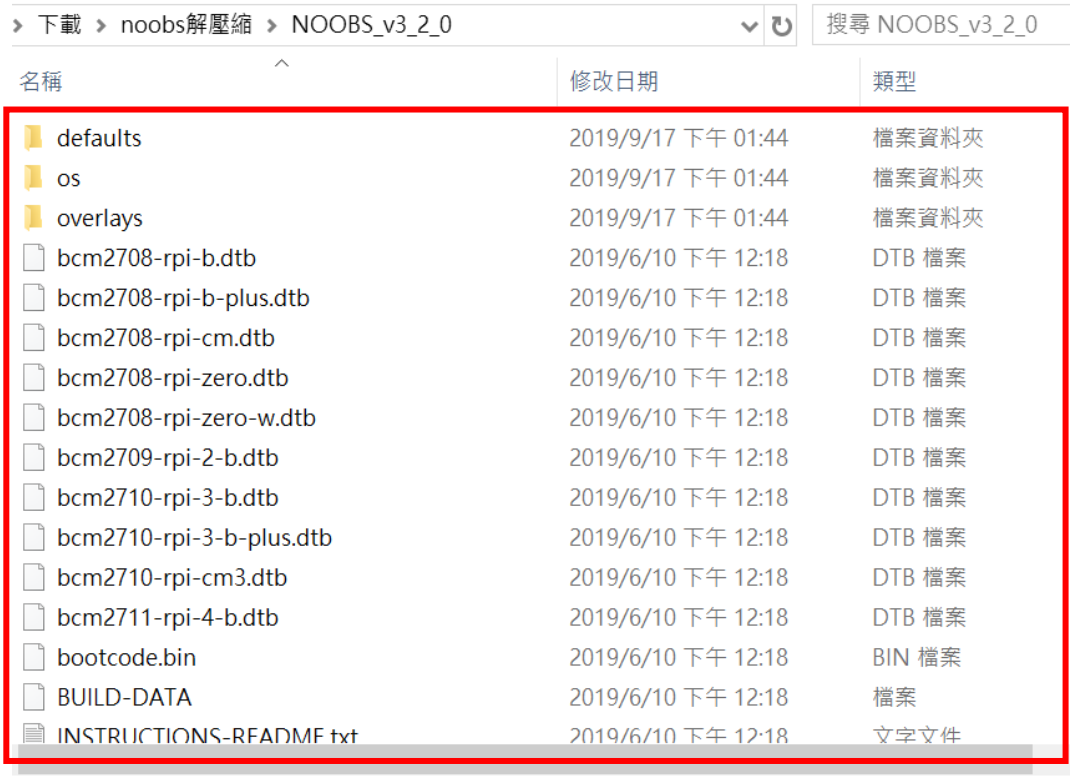
⚠ Notice The SD card slot on raspberry pi is fragile, pull out carefully.

3. Install OS with NOOBs

This resource explains how to install a Raspberry Pi operating system on an SD

card. We recommend most users download NOOBS, which is designed to be very easy to use. *New Out Of Box Software (NOOBS)* is an easy operating system installation manager for the Raspberry Pi.

Unzip the zip file on Windows, copy the files under NOOBS folder into the Raspberry Pi's SD card. Then you can boot the Raspberry Pi. Note that do not copy the root folder directly.



4. First Boot & Basic Setting

⚠ Notice	Your Raspberry Pi doesn't have a power switch, only when you connect it to a power outlet, it will turn on.

You need to prepare an addition set of mouse, key broad, and screen in order to connect the Raspberry Pi. Plug the USB power supply into a socket and connect it to your Raspberry Pi's power port. The steps are as follow:

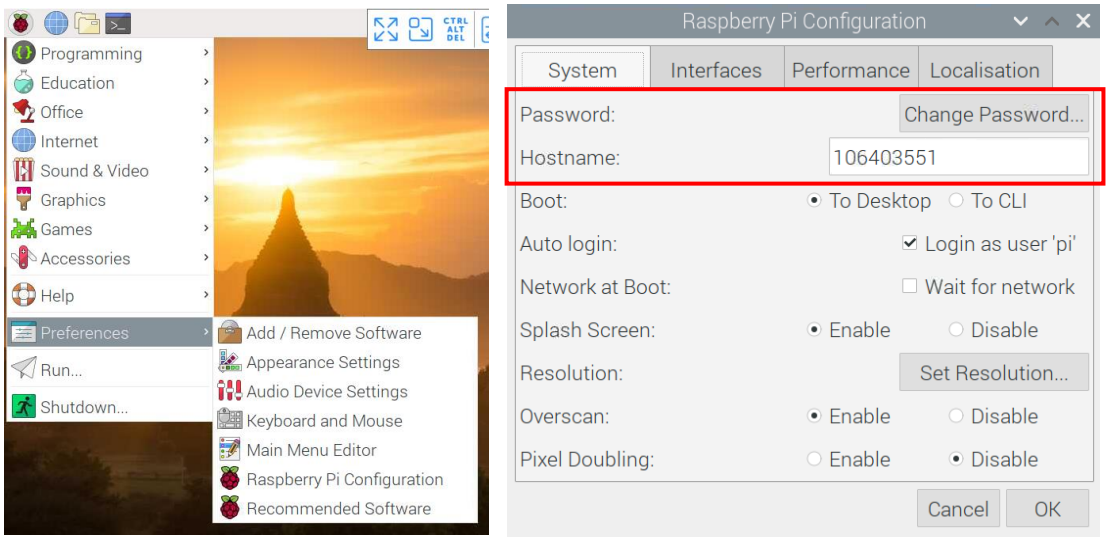
- Choose raspbian operating system
- Wait for installation
- Have basic settings done, Wi-Fi connection is recommended
- For full info, visit: https://projects.raspberrypi.org/en/projects/raspberry-pi-setting-up/5
- Settings info for: https://projects.raspberrypi.org/en/projects/raspberry-pi-

setting-up/6

After booting, the Raspbian Desktop will appear.

5. First Login

Now you have logged in with root user “pi”, remember to set its password. Go to “Preferences > Raspberry Pi Configuration” or enter `raspi-config` in terminal. See more at https://www.raspberrypi.org/documentation/linux/usage/users.md and https://www.raspberrypi.org/documentation/configuration/raspi-config.md.



6. Remote Raspberry Pi with VNC Viewer

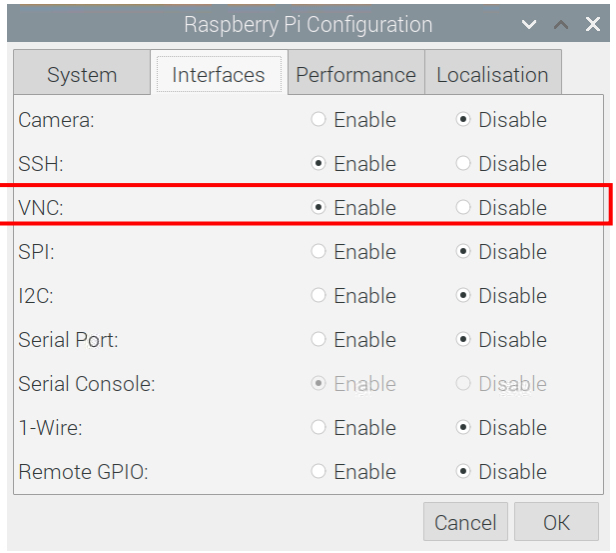
Is it inconvenient to control raspberry pi with an additional mouse and monitor? Let's try VNC Viewer, a remote-control application.

To do with VNC viewer, follow the steps below:

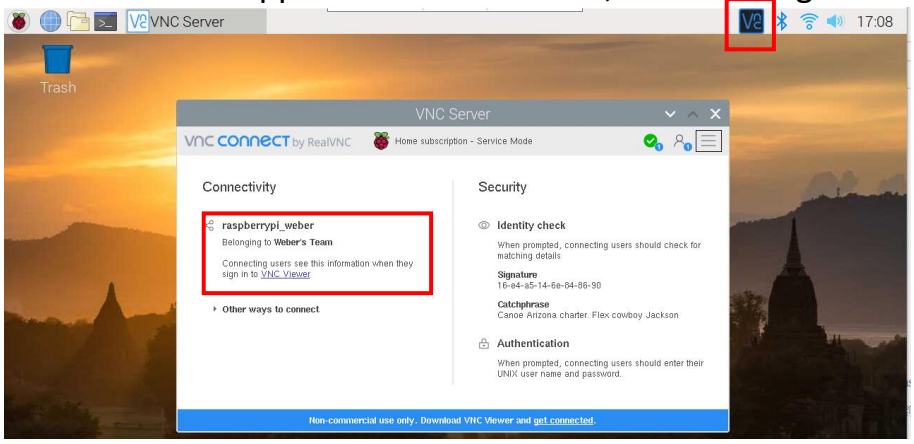
- Register a VNC account
- Enable VNC on raspberry pi
- Login your VNC account on raspberry pi
- Install VNC viewer on PC and login
- Start connecting

Download and register at: https://www.realvnc.com/en/connect/download/viewer/.

Go to "Preferences > Raspberry Pi Configuration" or enter `raspi-config` in terminal. Find the VNC setting and make it work.



A VNC icon will appear on the menu bar, click it to login.



Last, login your account on PC's VCN viewer, enter the hostname, the root account "pi" and its root password. Feel free to remote the Raspbian.

⚠ Notice	Make sure your Raspbian Pi has the access to Wi-Fi, or you won't be able to remote it by VNC. It will be definitely a disaster. Insure that it is connected to your smart phone hot spot at least.

7. Edit the config.txt for Video Output

Tutor: https://www.raspberrypi.org/documentation/configuration/config-txt/
Details: https://www.raspberrypi.org/documentation/configuration/config-txt/video.md
Process: https://www.makeuseof.com/tag/edit-boot-config-file-raspberry-pi/

The default video output for Raspbian Pi is terrible. Access the *config.txt* file to select a better output. You can have this done via editing config.txt file, or via entering `raspi-config` in terminal by using GUI to change video settings, or via

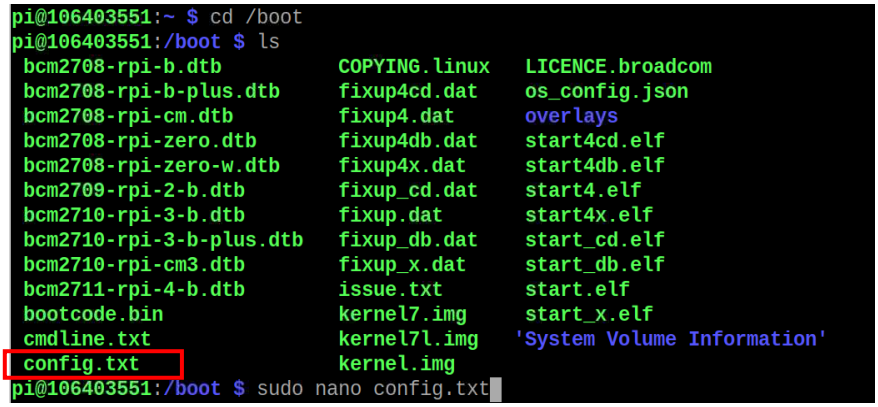
reading the SD card by PC/Mac and edit the file directly.

The Raspberry Pi uses a configuration file instead of the BIOS you would expect to find on a conventional PC. The system configuration parameters, which would traditionally be edited and stored using a BIOS, are stored instead in an optional text file named *config.txt*.

> ⚠ Notice
> This file is normally accessible as /boot/config.txt from Linux, and must be edited as root.

Go to terminal, use nano (a Linux editor) to edit config.txt, tap

```
cd /boot
sudo nano config.txt
```



Uncomment hdmi_group and set it for DMT (Display Monitor Timings) standard

```
# Set monitor mode to DMT
hdmi_group=2
```

Uncomment hdmi_mode and set it for 1280x720 in resolution at 60Hz

```
Hdmi_mode=85
```

Uncomment hdmi_drive and set it to be normal hdmi mode

```
hdmi_drive=2
```

Once the changes have been made, press **Ctrl + X** to save and exit. Remember to reboot your Raspberry Pi after making changes.

```
Ctrl + O (save)
Enter (edit filename)
```

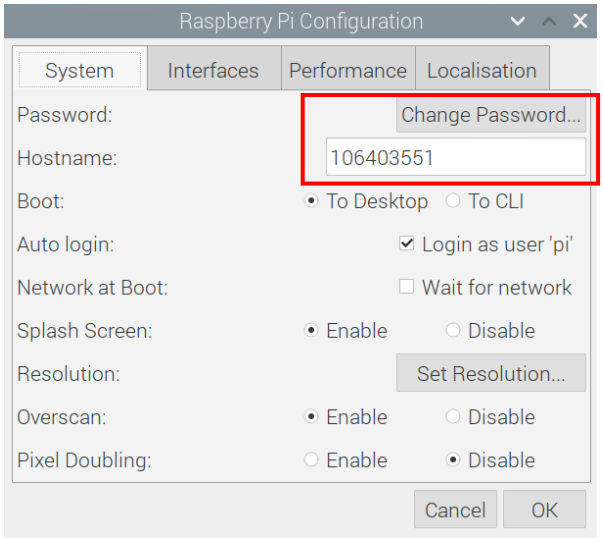
```
Ctrl + X
```

```
# uncomment if hdmi display is not detected and composite is being output
hdmi_force_hotplug=1

# uncomment to force a specific HDMI mode (this will force VGA)
hdmi_group=2
hdmi_mode=85

# uncomment to force a HDMI mode rather than DVI. This can make audio work in
# DMT (computer monitor) modes
hdmi_drive=2


^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Uncut Text^T To Spell  ^_ Go To Line
```

8. Reset Hostname & Create New Root User

Official document: https://www.raspberrypi.org/documentation/configuration/raspi-config.md

Set the host name to an identical name in order not to be hacked, for instance, your student number. Go to “Preferences > Raspberry Pi Configuration” or enter `raspi-config` in terminal.



For security reason, do not use the root account “pi” to often, create a new user with root permission. Next week we’ll use this new user to install python environment.

Full Docs visit https://www.raspberrypi.org/documentation/linux/usage/users.md.

Add user

```
sudo add user weber
```

Switch to the root user, make weber as sudoer

```
sudo su
sudo visudo
```

Then edit the file in /etc/sudoers

```
# User privilege specification

root  ALL=(ALL:ALL) ALL

weber  ALL = NOPASSWD: ALL
```

⚠ Notice	Be careful, it's possible to remove your own sudo rights by accident.

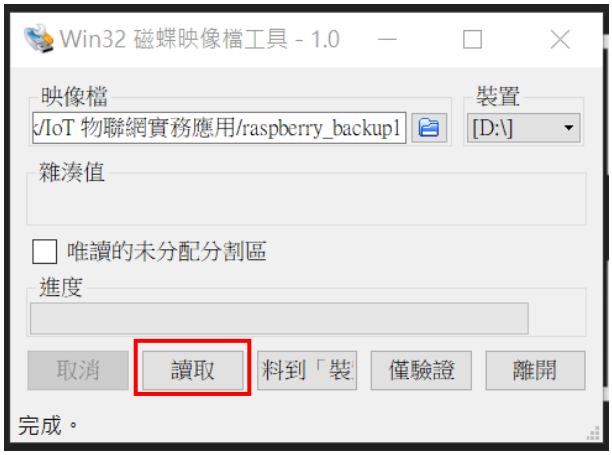
Preparation for Python: Installing Package Manager Conda & Editer Jupyter Notebook

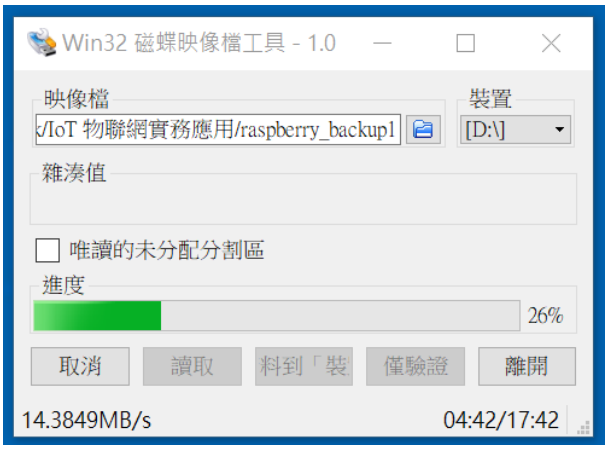
1. Back up your Raspbian OS (Optional)

It might be frustrating when raspberry pi got crashed during your programming time, or the testing phrase. Try to back up the OS, its environment and accounts. You may restore your OS if by any chance.

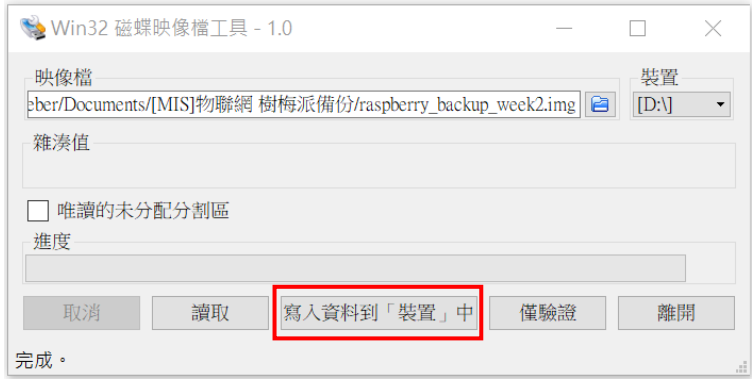
There are 3 main ways to back up raspberry pi, copying the entire SD card image is the most direct method, you may find other 2 ways at here, or Chinese ver.

First, take out the SD card. Then download Win32 Disk Imager, enter filename you want to keep, click “read”, and it’s done.





Click “write” to write an image file back to SD card if restore is needed. You have to format the SD card before restoring it.



⚠ Notice It might take over 15(30) minutes to copy(restore) the 16G SD card.

2. Download & Install Conda with New User

To run python on your raspberry pi, we should have our own python package manager, *pip* or *conda*. Some of the functionality of these two tools overlap, but pip has the latest version of python package, conda may contain software written in any language. To see more differences between pipi and conda, click here.

Here we choose *conda* as our package manager tool. There are 3 kinds of condas: *Anaconda*, *Miniconda*, and *Berryconda* respectively.

- Anaconda: With 150+ packages install at once, but storage costing.
- Miniconda: Only few packages, must download others manually.
- Berryconda: Same as miniconda, more suitable for raspberry pi.

After comparing these condas, install *Berryconda* by the construction of github site. Visit https://github.com/jjhelmus/berryconda.

First download the file using the raspberry terminal, then execute it.

```
chmod +x Berryconda3-2.0.0-Linux-armv7l.sh
./Berryconda3-2.0.0-Linux-armv7l.sh
```

You can execute the following codes as well. Referance.

```
wget
https://github.com/jjhelmus/berryconda/releases/download/v2.0.0/Berryconda3-2.0.0-Linux-armv7l.sh
bash Berryconda3-2.0.0-Linux-armv7l.sh
```

Remember to use default settings and path, please choose *"yes"* for all the options. The setting processes would be:

⚠ Notice	You should complete these processes with the "new user account" created on previous step. And make sure it's installed under the "new user folder". Finally, do NOT use "sudo" statement, or you may have to gain root privilege every time while accessing berryconda.

*Switching use by `su – username` (change folder as well), or `su username` (using current folder).

*Check your python version after installing conda, because it'll automatically change default python path to its python 3.

- Before:

```
weber@106403551:/home/pi $ python -V
Python 2.7.16
weber@106403551:/home/pi $ python3 -V
Python 3.7.3
weber@106403551:/home/pi $ pip -V
^[[A^[[Cpip 18.1 from /usr/lib/python2.7/dist-packages/pip (python 2.7)
weber@106403551:/home/pi $ pip3 -V
pip 18.1 from /usr/lib/python3/dist-packages/pip (python 3.7)
```

- After:

```
weber@106403551:~ $ python -V
Python 3.6.1
```

3. Install Jupyter Notebook

As the saying goes, “Good craftsmanship depends on use of the right tools.” Before starting on python programming, we still need an editing tool. It is Jupyter Notebook.

Enter `conda install -c rpi jupyter` to install it. `-c` or `--channel` means select a channel, `rpi` means for raspberry pi.

```
weber@106403551:~ $ conda install -c rpi jupyter
Fetching package metadata .....
Solving package specifications: .

Package plan for installation in environment /home/weber/berryconda3:

The following NEW packages will be INSTALLED:

    backcall:           0.1.0-py_0
    bleach:             2.1.4-py_1
    decorator:          4.3.0-py_0
```

Enter “y” to continue download. As we use berryconda, a kind of mini conda, we should install packages related with Jupyter.

```
The following packages will be UPDATED:

    conda:              4.3.22-py36_0         --> 4.5.11-py36_0
    conda-env:          2.6.0-0               --> 2.6.0-1
    pycosat:            0.6.1-py36_0          --> 0.6.3-py36hdff2a78_1

Proceed ([y]/n)? y

conda-env-2.6. 100% |################################| Time: 0:00:00 269.81 kB/s
libsodium-1.0. 100% |################################| Time: 0:00:03 305.77 kB/s
```

4. Create a virtual environment using Conda (Optional 2)

⚠ Notice	Remember to witch the virtual environment to “ipykernel_py3”, install these packages in “ipykernel_py3”.

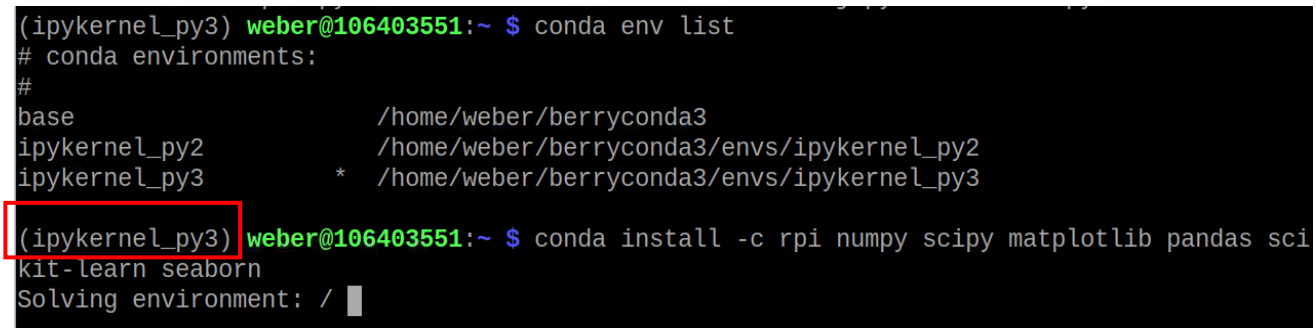
Using Conda to create a virtual environment, in which you will use conda to install a number of packages. Note that although having a virtual environment is optional, it is recommended for managing different python environments.
Packages required:

- numpy
- scipy
- matplotlib
- pandas
- scikit-learn
- seaborn
- rpi.gpio (This is not available in conda repository. Use pip to install it)

Open the terminal, install packages at once by

```
conda install -c rpi numpy scipy matplotlib pandas scikit-learn seaborn
pip install RPi.GPIO
```

Your terminal will look like:



5. Make the kernel in virtual environment available in Jupyter notebook (Optional 3)

Chinese Tutor: https://medium.com/datainpoint/jupyter-kernels-3151a6408bab
Ipython docs: https://ipython.readthedocs.io/en/stable/install/kernel_install.html

List all the conda virtual environment and jupyter kernel, there should be python 3 for base environment initially.

```
conda env list
jupyter kernelspec list
```

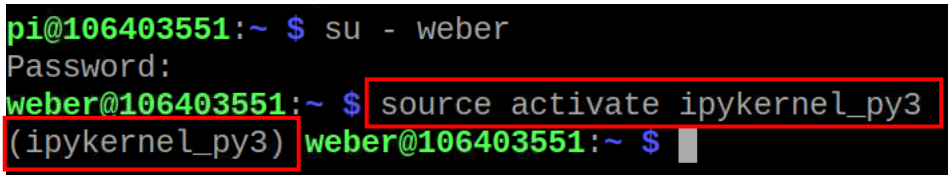
Create a new conda virtual environment and jupyter kernel, which name is “ipykernel_py3”.

```
conda create -n ipykernel_py3 python=3 ipykernel
source activate ipykernel_py3
python -m ipykernel install --user
```

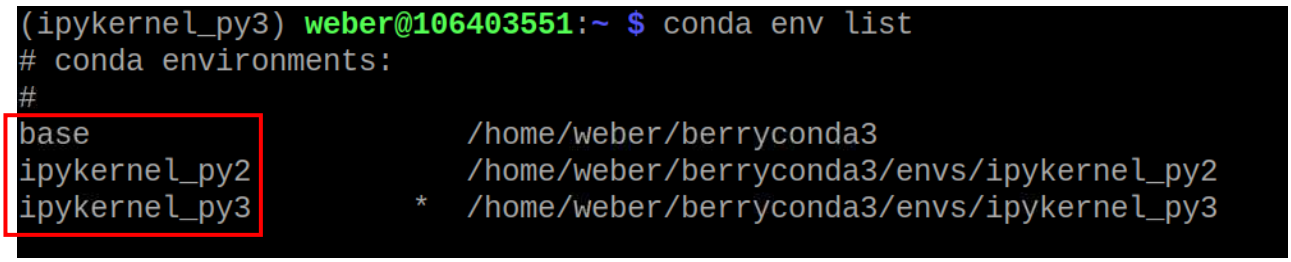
If you want to activate an exist virtual environment, just enter

```
source activate envname
```

When you activate a virtual environment, there will be a virtual environment surrounded with parentheses.



Check the environment again, you’ll find a new python 3 environment and new kernel.



Now run jupyter notebook again, a python 3 environment is well done.

To deactivate the environment when you want to close the server.

```
source deactivate
```

6. Run a Jupyter Notebook with the above installed packages

⚠ Notice	Remember to witch the virtual environment to “ipykernel_py3”, the required packages are in it.

Full tutor: https://realpython.com/jupyter-notebook-introduction/#installation

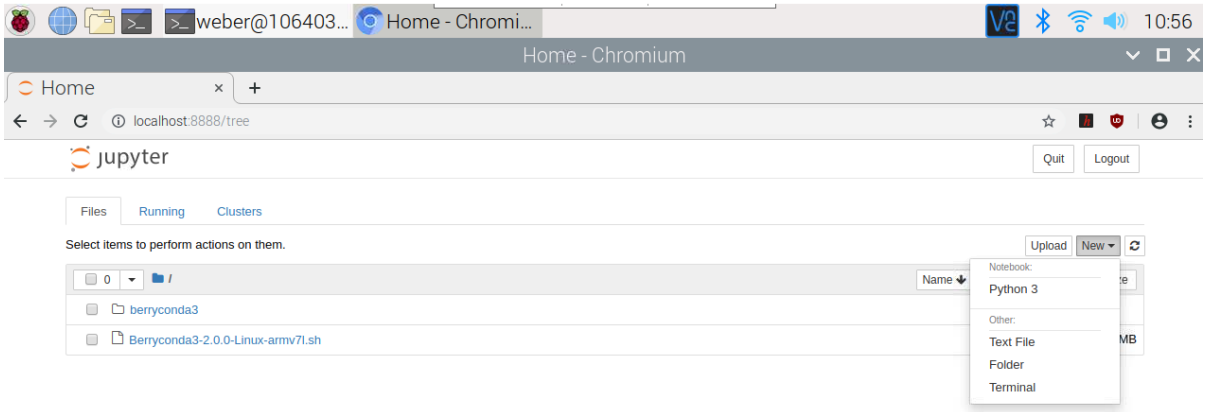
Once you install jupyter notebook, why not try to run a simple program? Follow the steps on terminal.

```
jupyter notebook
```

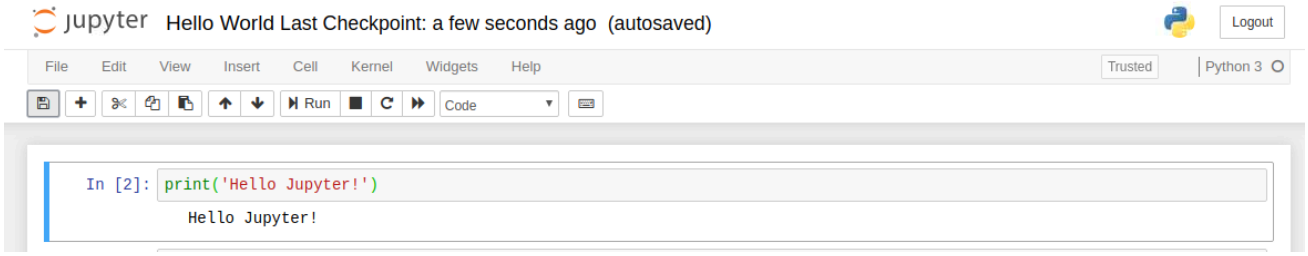
```
weber@106403551:~ $ jupyter notebook
[I 10:53:14.676 NotebookApp] Writing notebook server cookie secret to /home/weber/.local/s
hare/jupyter/runtime/notebook_cookie_secret
[I 10:53:17.043 NotebookApp] Serving notebooks from local directory: /home/weber
[I 10:53:17.043 NotebookApp] The Jupyter Notebook is running at:
[I 10:53:17.044 NotebookApp] http://localhost:8888/?token=b73183373d61d5daccf969745eb246f4
cfeaacf0c0b1aa81
[I 10:53:17.044 NotebookApp] Use Control-C to stop this server and shut down all kernels (
twice to skip confirmation).
[W 10:53:17.046 NotebookApp] No web browser found: could not locate runnable browser.
[C 10:53:17.047 NotebookApp]

    Copy/paste this URL into your browser when you connect for the first time,
    to login with a token:
        http://localhost:8888/?token=b73183373d61d5daccf969745eb246f4cfeaacf0c0b1aa81
[I 10:54:04.802 NotebookApp] 302 GET /?token=b73183373d61d5daccf969745eb246f4cfeaacf0c0b1a
a81 (::1) 4.22ms
```

This will start up Jupyter and your default browser should start (or open a new tab) to the following URL: http://localhost:8888/tree.

Your browser should now look something like this:



A Notebook's cell defaults to using code whenever you first create one, and that cell uses the kernel that you chose when you started your Notebook. Add some python code to run the cell.



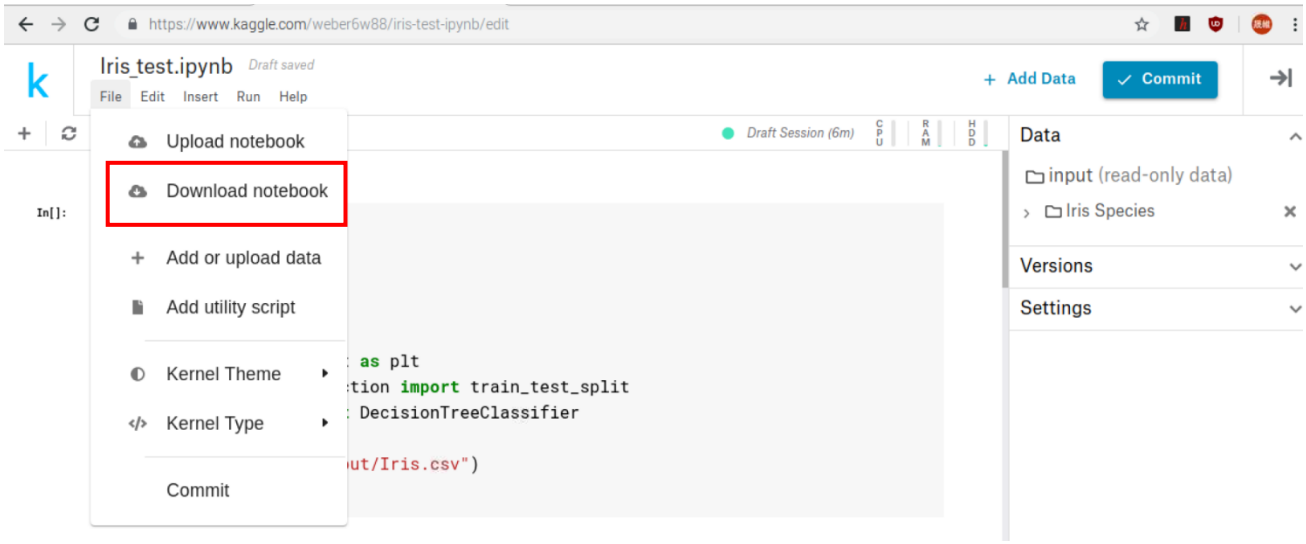
Enter CTRL + C to shutdown the notebook. Have fun!

7. Fork a Jupyter Note from Kaggle and run it on your RPi (Optional 4)

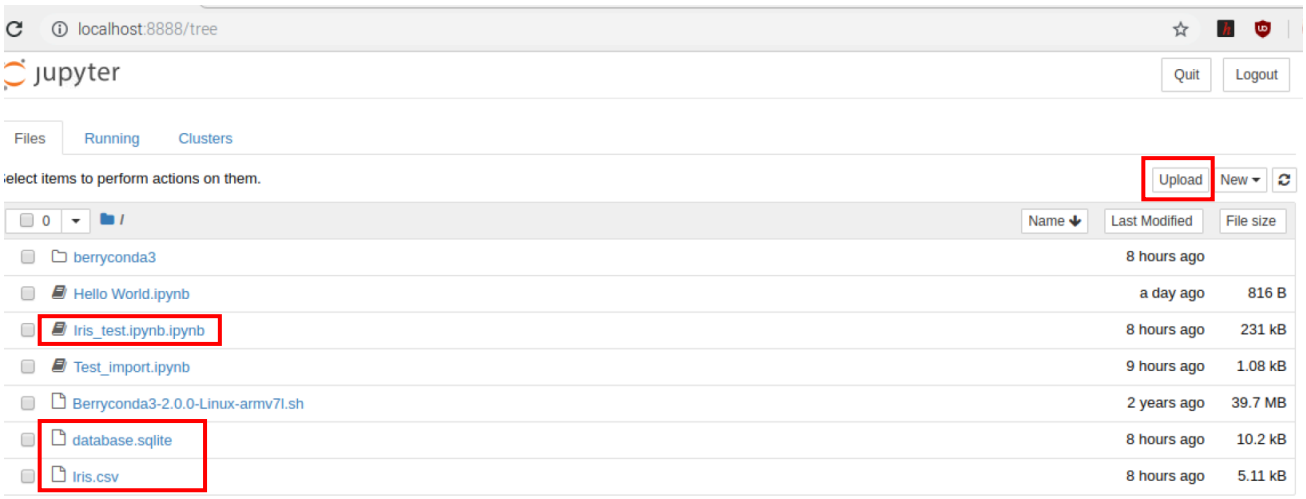
One of the advantages of jupyter notebook is you could utilize the cloud. As a result, you could download a notebook from the cloud. Let's begin an easy demonstration.

First, we need to sign up a Kaggle account. It is a community of data science. Kaggle got its start by offering machine learning competitions and now also offers a public data platform, a cloud-based workbench for data science.

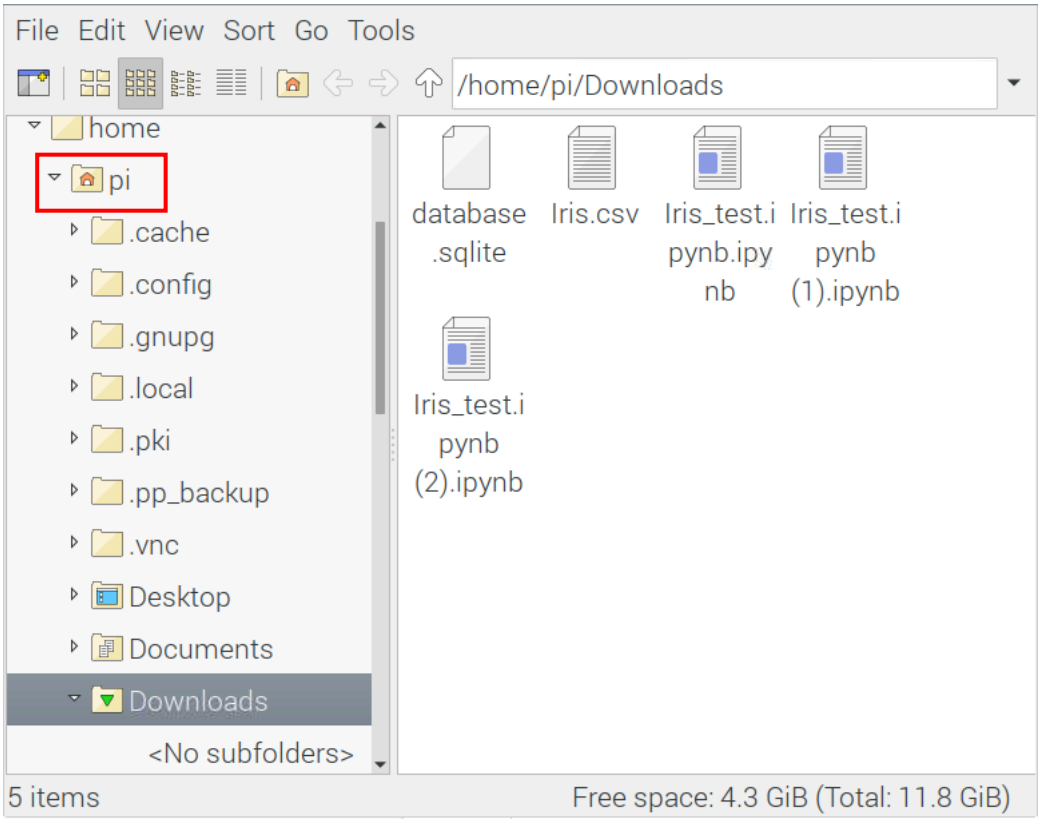
Log in with google chrome on the Raspbian Pi. Then visit the example notebook https://www.kaggle.com/alexxela12345/iris-test-ipynb. Login Kaggle and click copy and edit to fork the sample codes, the notebook will appear in your Kaggle account, and you can also download the file into the Raspbian Pi.



Next, download and update the data as well. Download “Iris.csv” and “database sqlite” from the sample website. Go back to homepage of Jupyter notebook, click the “upload” button to upload these 2 files and the “Iris_test.ipynb” notebook file. Congratulate! Here the preparing process ends.



⚠ Notice	Chrome will download the files in root user “pi” folder. Not in the current “weber” folder.

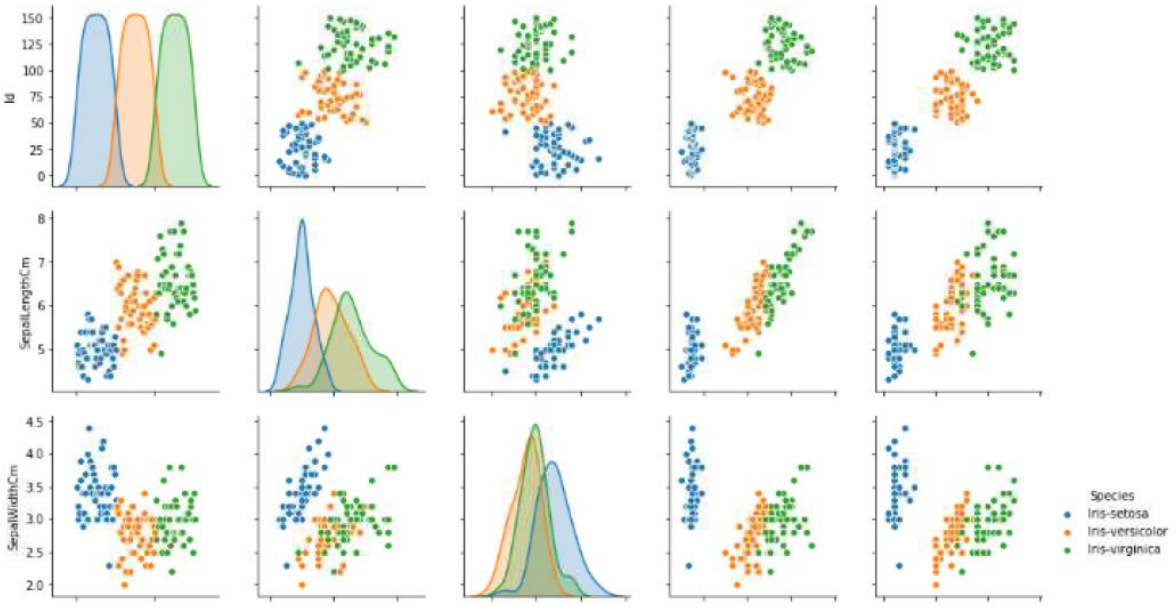


Now, run the program cell by cell, the result will look like as follow.

```
In [1]: %matplotlib inline

        import pandas as pd
        import numpy as np
        import seaborn as sns
        import matplotlib.pyplot as plt
        from sklearn.model_selection import train_test_split
        from sklearn.tree import DecisionTreeClassifier

        df = pd.read_csv("./Iris.csv")
```

```
In [3]: df.isnull().any()

Out[3]: Id              False
        SepalLengthCm   False
        SepalWidthCm    False
        PetalLengthCm   False
        PetalWidthCm    False
        Species         False
        dtype: bool
```

```
Out[7]: <seaborn.axisgrid.PairGrid at 0x66161030>
```



⚠ Notice	You have to change the path of the csv file. And you may not have the “seaborn” package installed, if not install it when error occurs.