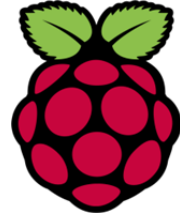


Pi Setup Guide

Core Objectives:

- C1. Preparing NOOBS
- C2. Setup Raspberry PI – Install Raspbian
- C3. Exploring PI
- C4. Setup Wifi for PI
- C5. Understand the Python coding environment on PI
- C6. Using Pi Camera with Python
- C7. Setup SSH for "headless" PI
- C8. Setup Remote Desktop for PI



Milestones (Ask Instructor / TA to check):

C4, C5, C6, C7, C8

C1. Hello NOOBS!

What are we doing?

Raspberry Pi, despite its cute size, is similar to all other PCs in that it requires an operating system (OS). NOOBS is one such OS installer.

1. Slot the 16Gb SD card into the SD Card reader, then plug the reader into your laptop.
2. The SD card should appear as a "drive" in file browser (depends on the OS on laptop). Open the SD card and you should see the following. These are the files and folders used by NOOBS. We have already copied them over to save you some time ☺.

Name	Date modified	Type	Size
defaults	10/3/2017 3:38 PM	File folder	
os	29/11/2017 12:05 ...	File folder	
overlays	17/3/2017 4:33 AM	File folder	
bcm2708-rpi-0-w.dtb	17/3/2017 4:33 AM	DTB File	15 KB
bcm2708-rpi-b.dtb	17/3/2017 4:33 AM	DTB File	14 KB
bcm2708-rpi-b-plus.dtb	17/3/2017 4:33 AM	DTB File	14 KB
bcm2708-rpi-cm.dtb	17/3/2017 4:33 AM	DTB File	14 KB
bcm2709-rpi-2-b.dtb	17/3/2017 4:33 AM	DTB File	15 KB
bcm2710-rpi-3-b.dtb	17/3/2017 4:33 AM	DTB File	16 KB
bcm2710-rpi-cm3.dtb	17/3/2017 4:33 AM	DTB File	15 KB
bootcode.bin	17/3/2017 4:38 AM	VLC media file (.bin)	50 KB
BUILD-DATA	17/3/2017 4:38 AM	File	1 KB
INSTRUCTIONS-README.txt	17/3/2017 4:36 AM	Text Document	3 KB
recovery.cmdline	17/3/2017 4:38 AM	CMDLINE File	1 KB
recovery.elf	17/3/2017 4:38 AM	ELF File	640 KB
recovery.img	17/3/2017 4:38 AM	Disc Image File	2,598 KB
recovery.rfs	17/3/2017 4:38 AM	RFS File	27,452 KB
RECOVERY_FILES_DO_NOT_EDIT	17/3/2017 4:38 AM	File	0 KB
recovery7.img	17/3/2017 4:37 AM	Disc Image File	2,667 KB
riscos-boot.bin	17/3/2017 4:36 AM	VLC media file (.bin)	10 KB

More about NOOBS:

As you can see, it is quite easy to setup NOOBS. You just need to copy the files and folders onto a newly formatted SD Card!

The appropriately named NOOBS (New Out Of Box Software) is essentially a OS installer for ~~noob~~... **first time user** like you 😊. It provides an easy to use interface and requires only a SD Card with NOOBS files on it. NOOBS also help to recover / reinstall your main OS should something goes drastically wrong (and it probably will...).

C2. Setup Raspberry PI – Install Raspbian**What are we doing?**

The SD Card functions as the "hard disk" for the PI. With the NOOBS file on it, we can now install an operating system Raspbian on it.

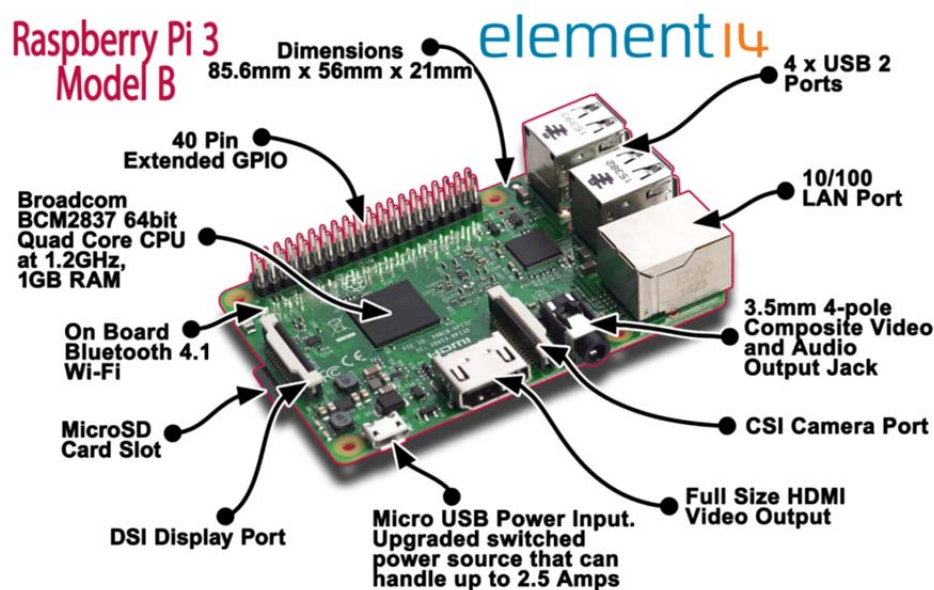


Figure 1. Raspberry PI 3 - Model B (image taken from element14)

Steps:

1. Insert microSD card into RPi's microSD Card Slot (see above image for the slot).
2. Connect a HDMI to DVI cable to the HDMI output then connect to the monitor.
3. Connect USB Keyboard + Mouse.

4. Use Micro USB power cable to connect the Pi to a power source, e.g. Power Bank.
Note that connecting to laptop / desktop USB port may not work well as Pi 3 requires optimally **5 Volt at 2.5 Ampere**.
5. As soon as power is supplied, you should see LED blinking near the Micro USB power input. Pi should boot to the NOOBS installer as shown on next page.

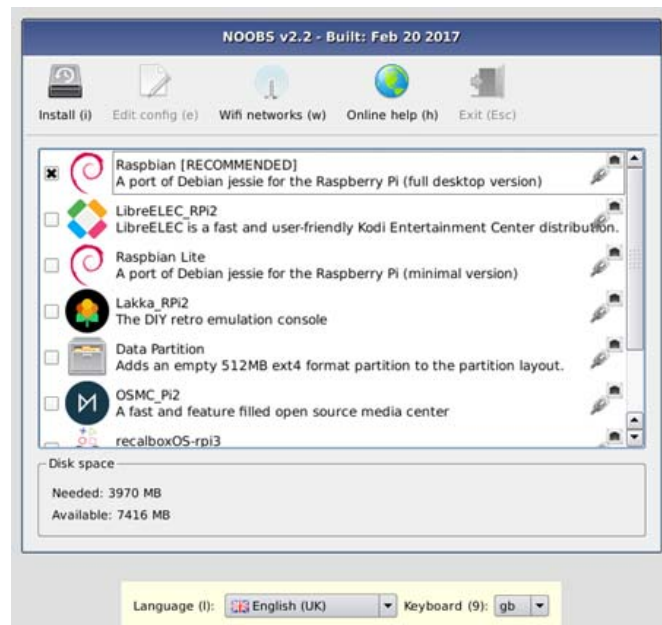


Figure 2. NOOBS (note: image is from slightly older version)

6. **Select Language and Keyboard layout as US.**
7. Select "Raspbian" (check box) and click "Install (I)" from the menu at the top.
Confirm the operation.
8. Drink coffee / tea while waiting ☺
9. Once the Pi rebooted, you will see the default GUI desktop. Before we proceed any further, let's finish a few important configurations:
 - a. Click on "Menu→Applications →Preferences→Raspberry Pi Configuration"
 - b. Go to "Interfaces" Tab, enable SSH. Take note of other options, you may need to turn them on in future studios.
 - c. Go to "Localisation" tab:
 - i. "Set locale"→ set "Country" to US
 - ii. "Set timezone" → set to "Singapore"
 - iii. "Set Keyboard" → set to "US" and "English(US)". Verify the keyboard binding by typing these special characters below "@[]~\$%".
 - iv. "Set WiFi Country" → set to "SG Singapore".
 - v. Click Ok and Reboot Pi if you are asked to.

C3. Exploring PI

Key Idea:

Raspberry Pi is simply a very tiny computer. The major obstacle for most users is that OS used on Pi seems unfamiliar. Raspbian, the OS that we have just installed, is a **Debian**-based Linux variant. So, if you are familiar with other Linux/Unix based OS distributions, e.g. Ubuntu, CentOS, Fedora etc, you should be quite at home!

Raspbian come with a standard GUI desktop. Feel free to browse around in the menu options. Below are several simple tasks to familiarize you with the environment.

1. Create a **Project** folder on the desktop.
2. Create a simple Readme.txt file under the Project directory.
3. Find out how to write a "hello world" Python program and execute it.
4. [Hidden Quest] Play **minecraft**.

Although it is very convenient to use a GUI environment, you are likely to use only command line input (CLI) interface for your project. Not only CLI is much lighter on the processing power / memory, it is actually equally powerful as the GUI. The only drawback is that you need to know / memorize some of useful commands.

A small set of useful commands are summarized below:

Linux Command	Functionality
man XXXX	Get the manual (help page) on XXXX command if available. Useful way to learn more about a command.
ls	List the content of the current directory
cd YYYY	Change directory to YYYY
cd	Change directory to home directory
rm ZZZZ	Delete file ZZZZ
sudo AAAA	Execute the command AAAA as the superuser. Needed for restricted command that make changes to the system. Use with care.
apt-get	Command to install additional packages for Raspbian. Need to use together with "sudo", e.g. "sudo apt-get install vim" which install the vim editor on Pi.
sudo reboot now	Reboot Pi immediately.
sudo shutdown now	Shutdown Pi immediately.

There are a couple of text editors installed in Raspbian by default:

1. **nano** (simple, command list on the bottom (use ctrl-<key> to activate).
2. **vi/vim** (powerful, hard to learn ☺)

C4. Setup Wifi

What are we doing?

Like all computing devices nowadays, Pi works much better with an internet connection. Wifi is the easiest / most common choice to setup.

Wifi networking on Pi can be quite simple for most wireless network setup. From the GUI desktop, clicking on the wifi icon can help you to log onto **most** wifi network effortlessly.

However, NUS wifi network uses very tight authentication method and requires additional setup. Follow the following steps carefully.

1. Enter `"sudo vi /etc/wpa_supplicant/wpa_supplicant.conf"` into terminal. If you are not familiar with the vi editor, you can use the simpler editor `"nano"`, i.e. `"sudo nano /etc/wpa_supplicant/wpa_supplicant.conf"`
2. Append the following configuration to the file, pay attention to the identity and password portion. Please use your NUSNET id and password. Also, the parser is quite unforgiving, so please follow exactly the following:

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
ap_scan=1
network={
    ssid="NUS_STU_2-4GHz"
    key_mgmt=WPA-EAP
    eap=PEAP
    identity="nusstu\t0123456"
    password="mypassword"
    phase2="auth=MSCHAPv2"
}
```

Check whether your id's domain is **nusstu** or **nusext**

3. Once you have finished editing and saving the .conf file. Reboot your Pi.
4. With the wifi connection, you can now surf the web / perform software installation / update. For example, get/upgrade the **vim** software packages for Raspbian:
 - `sudo apt-get install vim` (if you are familiar with vim editor)
 - A minimalistic of vim configuration can be found at <https://github.com/mhinz/vim-galore/blob/master/static/minimal-vimrc.vim>

Show Instructor / TA that you are able to surf the web (e.g. show a YouTube video?).

Alternative

Should NUS Wifi refuses to cooperate, don't panic! Ask one of your group members to "donate" his/her mobile data bandwidth (not more than 10Mb) by setting up a mobile hotspot. Use the GUI wifi icon to locate and log on to the mobile hotspot for internet access.

C5. Understand the Python 3 coding environment on PI

If you are new to Python, don't panic. It is a relatively simple language to learn (especially if you have background in C/C++ or Java). Python has extensive documentation on the web. To familiarize yourself with i) how to edit Python program, and ii) how to execute Python program, we have a simple coding exercise for you. Note that we are using **Python 3** in all our example codes.

Given a user input integer N ($N > 0$), write a **Python 3 program** to display (print on screen) a pyramid of height N (i.e. N lines) with the following layout:

```
Enter N = 4 (sample user input)
  *
 *#*
*##*#*
*****
//note the pyramid has different "inner layers"
```

Optional (Surprise Us!):

Using the same idea (User input only a positive integer), think of the craziest shape you that can generate using a program. Attempt this part only when you have ahem... too much time on your hands.

Show your instructor / TA once you are satisfied with the program.

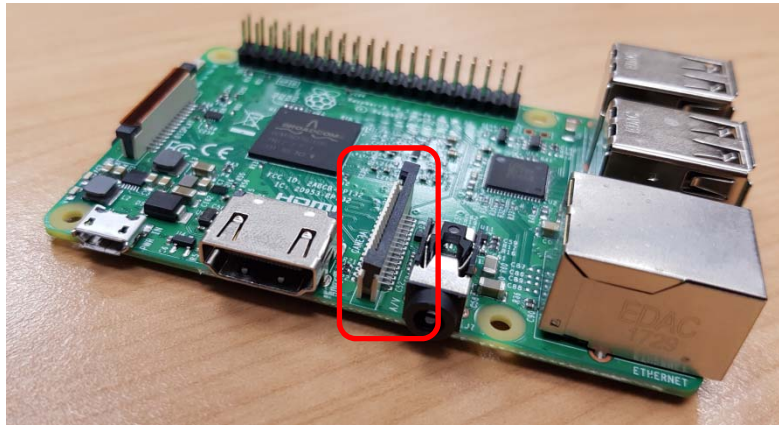
C6. Using Pi Camera with Python

1. Encase the Pi Camera with the plastic casing:

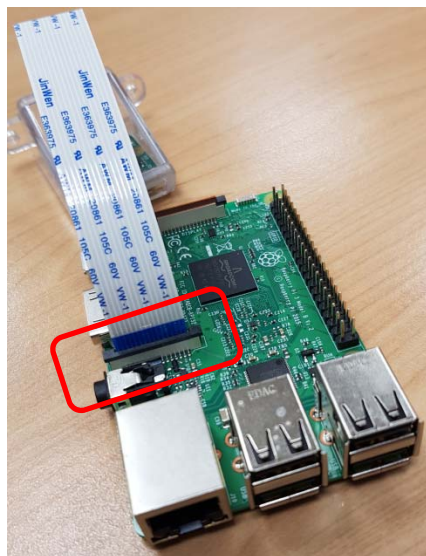


2. **Shutdown and remove power supply from the Pi.** Take the following steps to connect the Pi Camera.

You have to lightly pull up the indicated black color "cap":

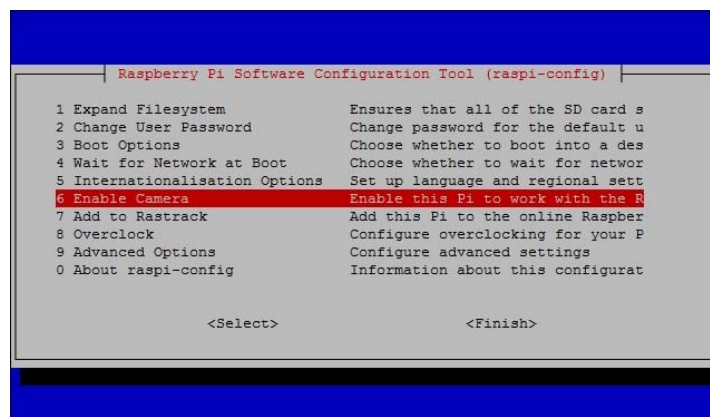


Insert the Pi Camera cable (notice that the blue color side is facing the Ethernet port), then **push down the black color cap**:



Pull the cable **lightly** to check whether it is secured properly.

3. Boot up your Pi. Use "**sudo raspi-config**" (Or use the GUI equivalent) to enable the Pi Camera interface:



4. Transfer the Pi Camera demo code "**PiCameraDemo.py**" over to your Pi (simplest way = Use USB stick). Run the code to ensure the Pi Camera is working.
5. Write a new program "**PiSnapshot.py**" that perform the following:
 - a. The program shows camera feed **until the user type "t"** (for "taking" picture).
 - b. A picture is taken and save on the Pi Desktop with the file name "**snapshot.jpg**"

Ask your instructor / TA to take a group photo with you once you are done!

C7. Setup SSH for "headless" PI

Why?

Our Raspberry PI setup is a little cumbersome with all the peripherals attached (monitor, keyboard, mouse). We are going to setup **remote connection** capability so that you can talk to the Pi through network!

Key Idea

As long as you know the IP address of the Pi, you can easily SSH into it from your laptop. The tricky part is that to know the IP address you need to run some commands on the Pi first, i.e. a Chicken-and-Egg Problem.

Caveat

Due to many possible configurations of your laptop / desktop, there is no single set of universal steps. We suggest two most common setups for you to try out. Please don't be overly stressed if they don't work out for you.

Option 1. Direct Ethernet Cable with No Additional Configuration

1. Connect the Ethernet cable from your Pi to your laptop **then Reboot Pi**.
2. Open a terminal window and key the command "**ifconfig**", check the interface "**eth0**" (Ethernet adapter 0) for IP address.
3. If you see a valid IP address, something like "**inet XXX.XXX.XXX.XXX**", note down the IP address then proceed to section "**SSH from your laptop**".
4. [Exploration] It is worthwhile to setup this option for your own project later as it requires only an Ethernet cable between your laptop and the Pi. One common option is to setup a "Static IP Address" (i.e. fixed IP address for eth0, so that you can always connect).

Option 2. Via Mobile Hotspot (Ethernet Cable not needed)

1. Connect your Pi and laptop to a mobile hotspot that you control.
2. Check the wireless IP address (mouse over the wifi icon on the top menu bar). Note down the IP address, proceed to section "**SSH from your laptop**".
3. [Exploration] Note that this option works even better if you can discover the IP address of Pi from your mobile device. There are "IP scanner" or similar Apps that can help with this.

SSH from your laptop (If you succeeded using one of the previous methods)

On your **laptop**:

1. Install a SSH Client, e.g. PuTTY (<https://www.putty.org/>) if needed.
2. Connect to the Pi using the following information:

host: (the ip address you get for the Raspberry Pi) user id: pi password: raspberry
--

Once connected, you can use the terminal to enter command.

You now have the ability to interact with Pi via SSH on a laptop! In future, you can remove the monitor, keyboard and mouse from the Pi and use the laptop as the main way to interact.

Show the instructor / TA how you can execute the Python program in C5 using SSH.

C8. Setup Remote Desktop

What are we doing?

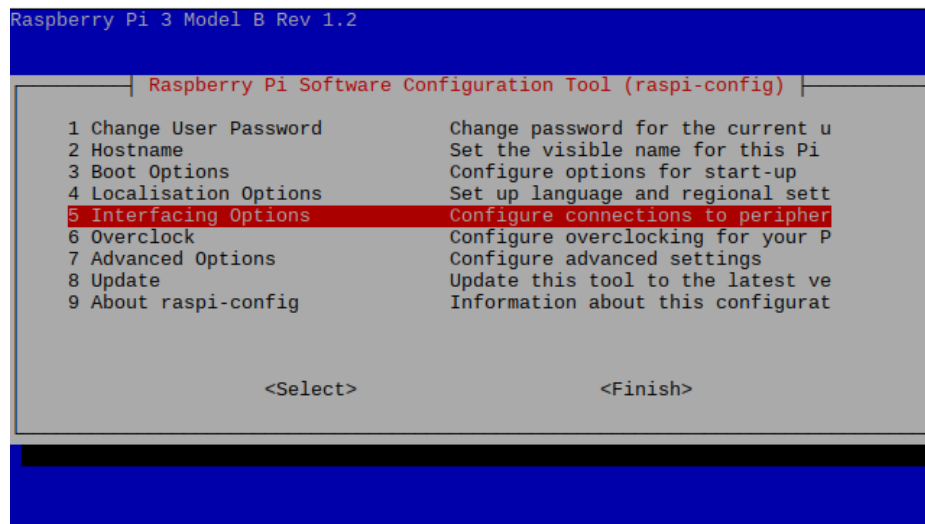
Using SSH is one of the most common way to work with "headless" Pi. However, the biggest limitation is that SSH Client does not handle GUI (more specifically, X-Windows clients). For example, the Python IDLE 3 IDE won't work under SSH.

In this section, we will look at enabling Remote Desktop, which allows you to "transport" the GUI desktop of Pi onto your laptop directly.

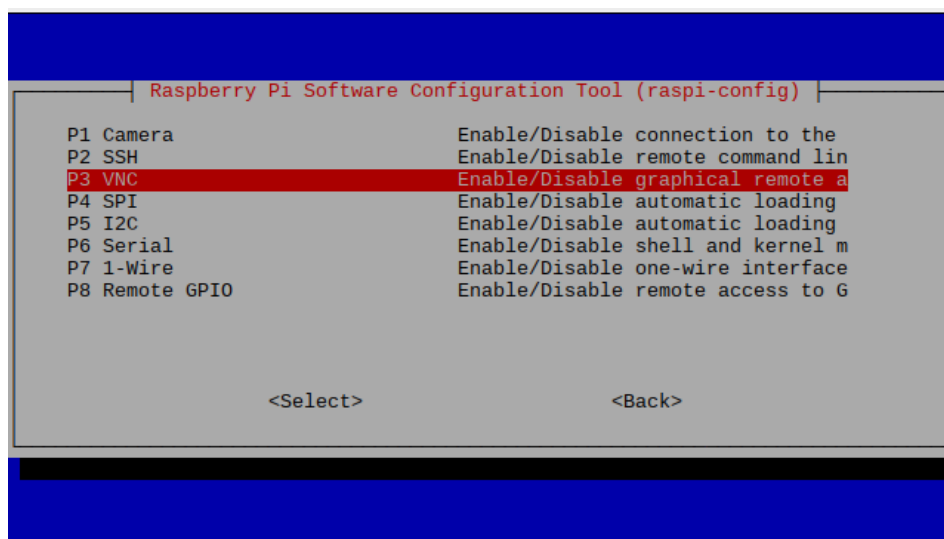
1. SSH into Pi and enter the following command:

```
sudo raspi-config
```

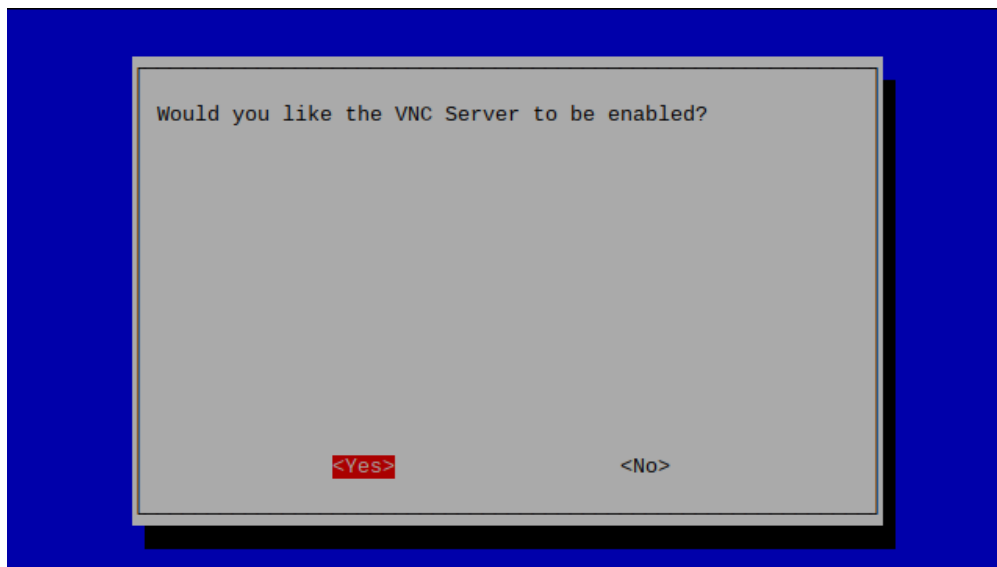
2. Choose "5 Interfacing Options":



3. choose P3 VNC:

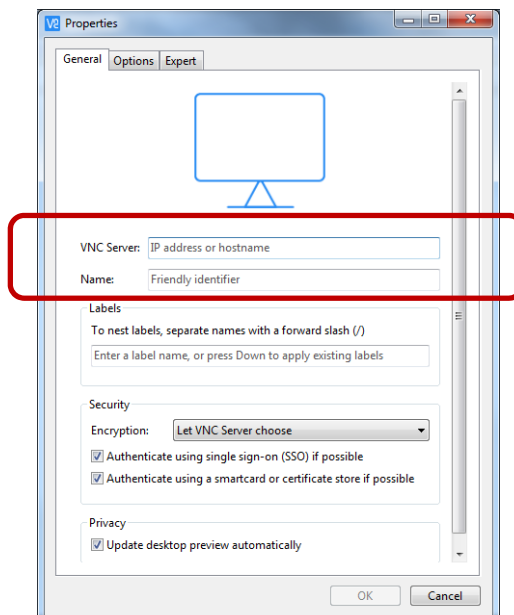


4. Enable the VNC Server by choosing **<Yes>**:



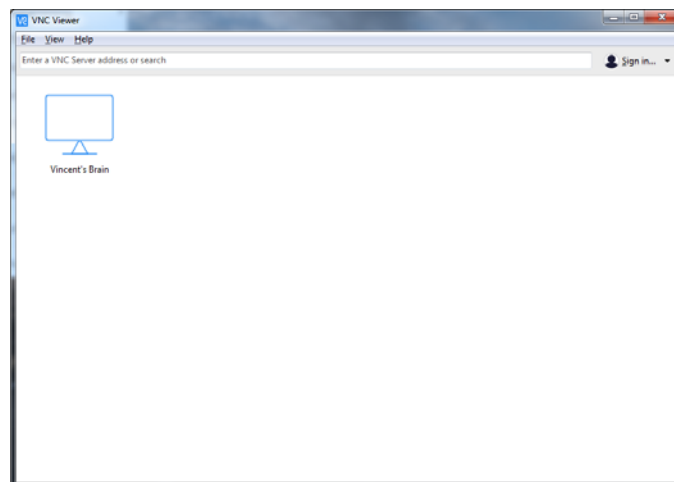
Once the server is enabled and you are back to the main menu, select **<Finish>** to exit.

5. Download and install VNC Viewer from <https://www.realvnc.com/en/connect/download/viewer/> on your laptop.
6. Start VNC Viewer. Select **File → New Connection**:



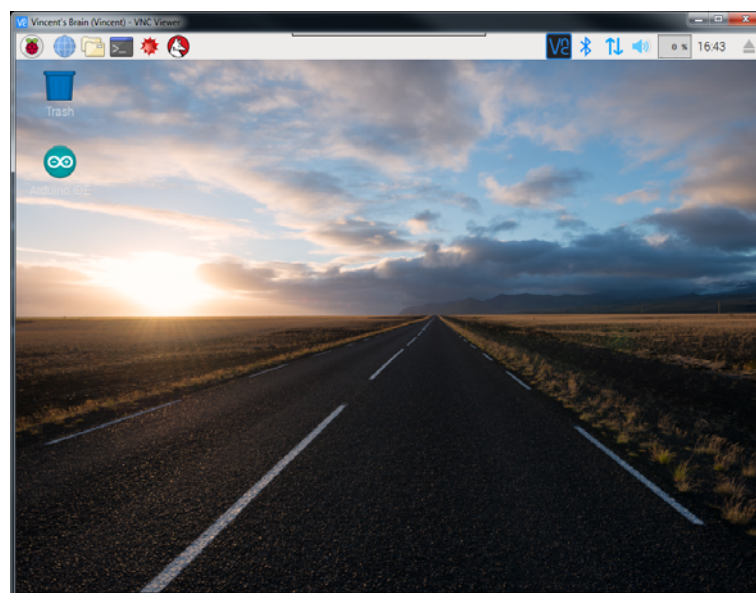
Fill in the IP address of the Pi and enter a suitable name (e.g. "Pi@Ethernet"). There is no need to change the remaining fields.

7. You will now see a new session in the VNC Viewer window.



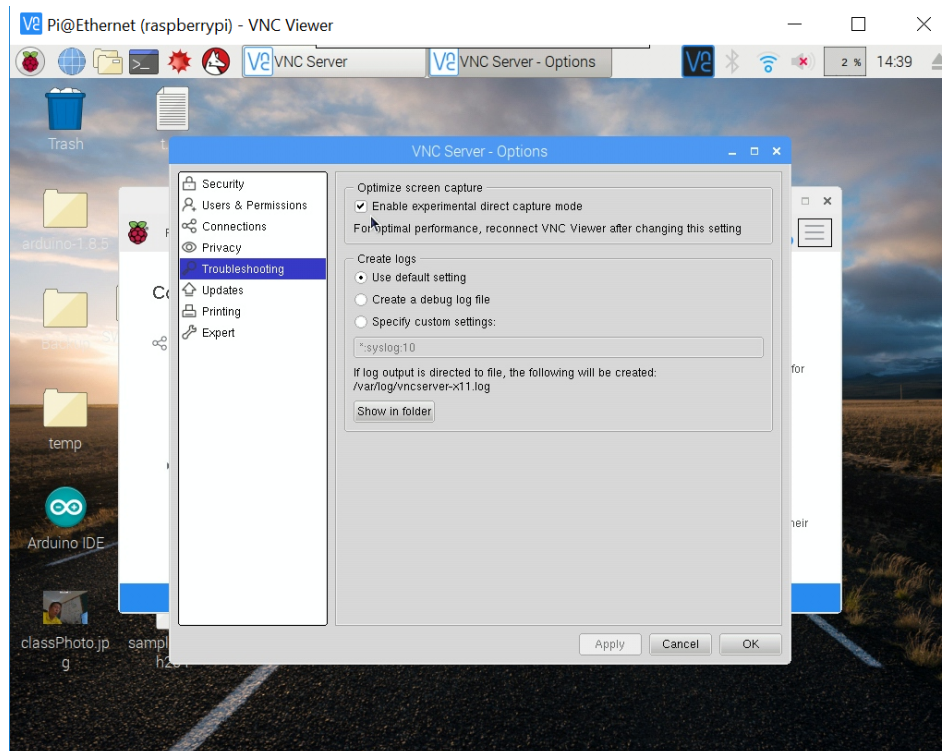
8. Double click on the icon to start your session. You will be prompted for your username and password. Enter the same credentials you use for ssh connection.

If successful you should see the Pi's desktop on your laptop:



9. For typical usage, the remote desktop setup up till step (8) should be sufficient. However, since we need Pi Camera view via VNC, we need to do a few more steps. If you notice, Pi Camera "takes over" the screen when you use it as it bypass the normal desktop manager. So, additional steps must be taken to allow VNC to capture these images.

10. Click on the **Pi's VNC server icon** on the top of the screen, then select "Menu" (on the top right). Select "Troubleshooting" from the list of option and click "Enable experimental direct capture mode":



11. Click "ok" to close the menu. You may need to restart the VNC connection.

Show the instructor / TA that you can execute the C6. Pi Camera Program via VNC!

References / Resources:

1. Raspberry Pi official website (<https://www.raspberrypi.org>)
2. Python 3 Documentation (<https://docs.python.org/3/index.html>)
3. Putty / SSH client (<https://www.putty.org/>)
4. VNC client (<https://www.realvnc.com/en/connect/download/viewer/>)