物聯網與微處理機系統設計
Internet of Things and Microprocessor System Design

Lecture 02 – RPi Basics

Lecturer: 陳彥安 Chen, Yan-Ann

YZU CSE

Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

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- OS installation
- RPi environment settings
- Remote shell access
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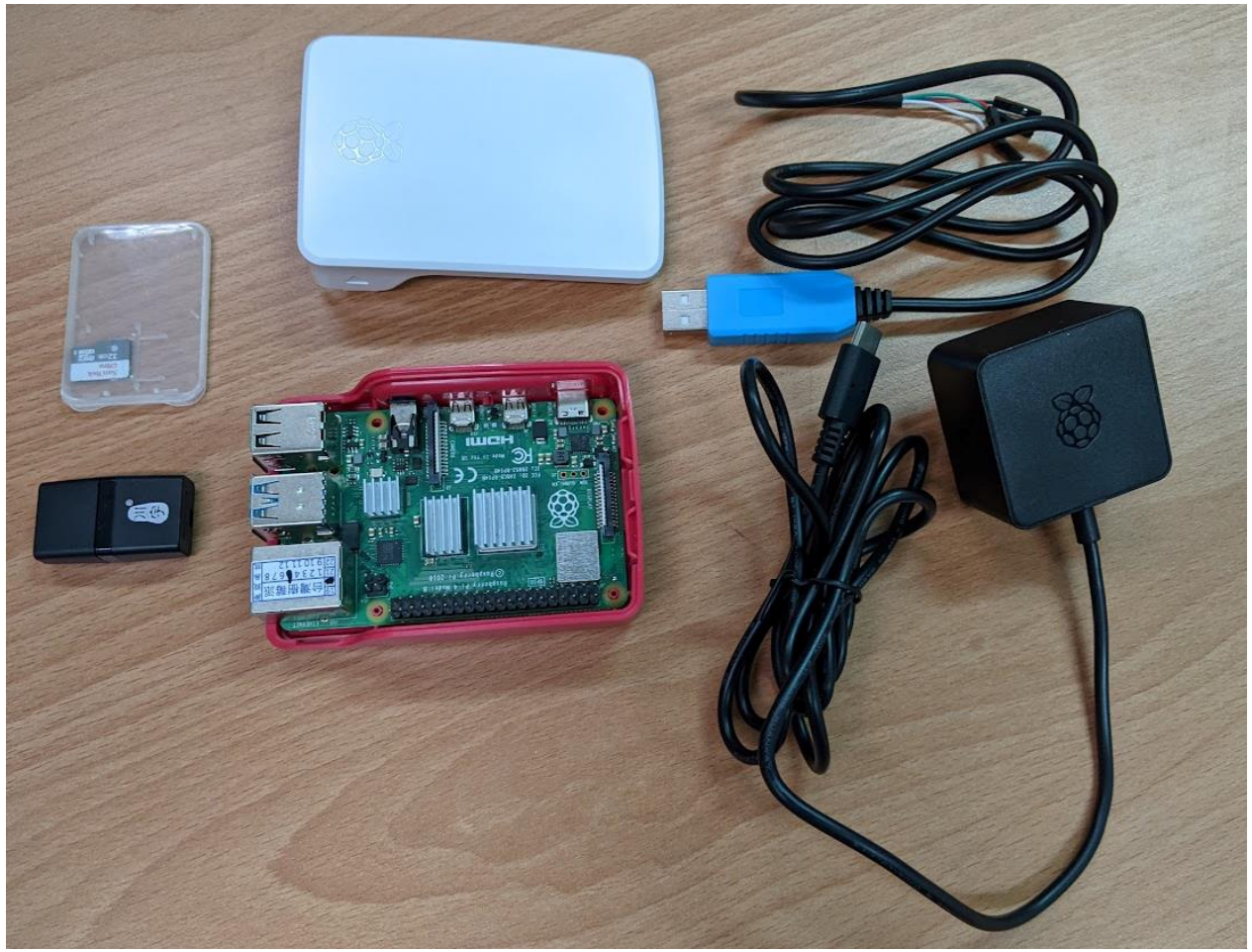
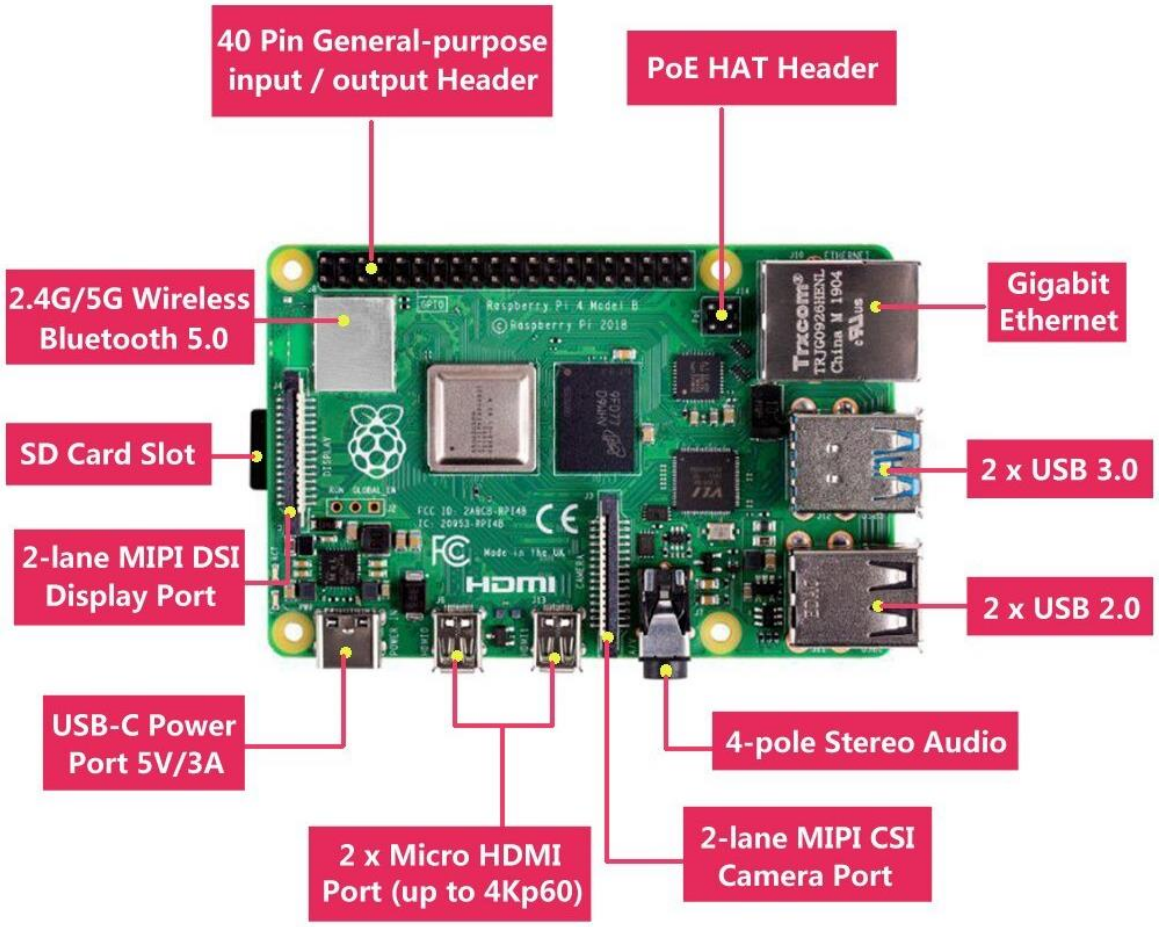
- Programming on RPi

Equipment



- Raspberry Pi 4
- Type-C USB power adapter
- Micro SD card 32GB
- USB SD card reader
- USB-to-TTL cable
- Others will give you in the following courses.

RPi Hardware



DO NOT put the bare board on materials with conductivity while powering on.

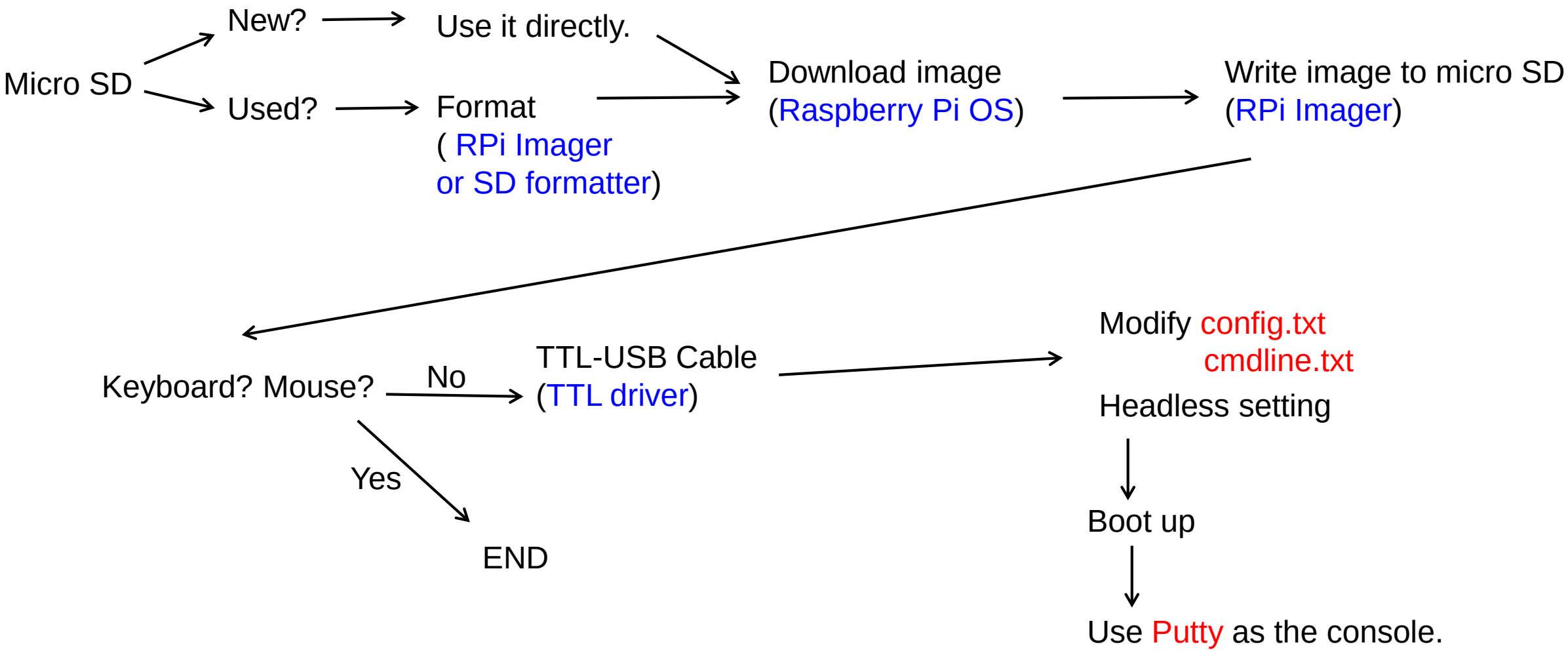
RPi External Interfaces

- SD Card -> File System
- Micro HDMI -> LCD Monitor
- USB Type A -> Keyboard, Mouse, Microphone, …
- RJ45 -> Ethernet
- Type-C USB -> Power 5V/3A
- Wi-Fi and BT functions are embedded.

Software Installation

- OS Installation (Raspberry Pi OS)
- RPi environment settings
  - Set Wi-Fi by command lines.
  - Use apt-get to install packages.
- Remote access
  - SSH
- Remote desktop
  - VNC
- File transfer

Installation Flow



Preparing

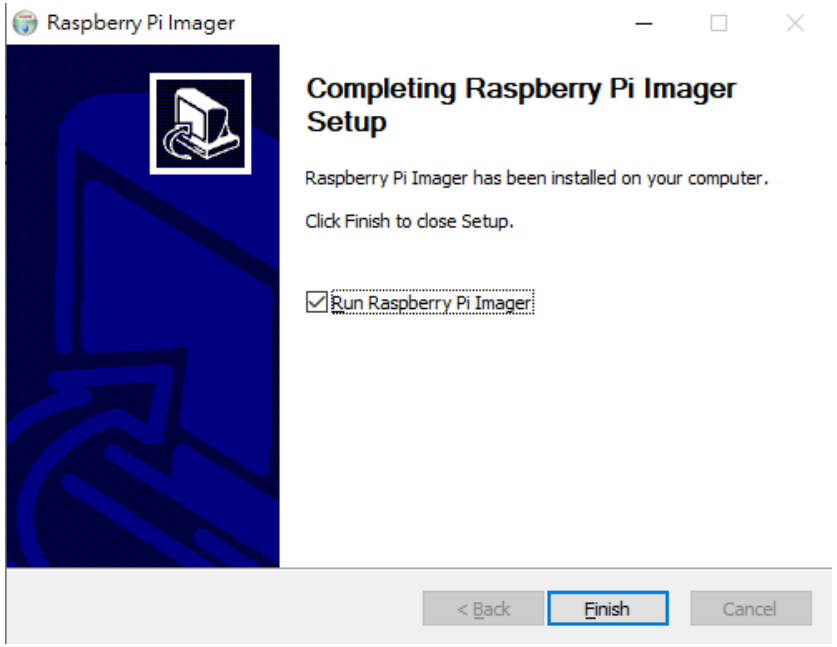
- Raspberry Pi Imager
  - https://downloads.raspberrypi.org/imager/imager_latest.exe
- USB TTL driver
  - PL2303_Prolific_GPS_1013_20090319.exe
  - https://reurl.cc/ldDV0Y
- Putty
  - https://the.earth.li/~sgtatham/putty/latest/w64/putty.exe
- WinSCP
  - https://winscp.net/eng/download.php
- SD Formatter (optional)
  - https://www.sdcard.org/downloads/formatter/index.html
- Win32diskimager (optional for backup)
  - https://win32diskimager.download/download-win32-disk-imager/

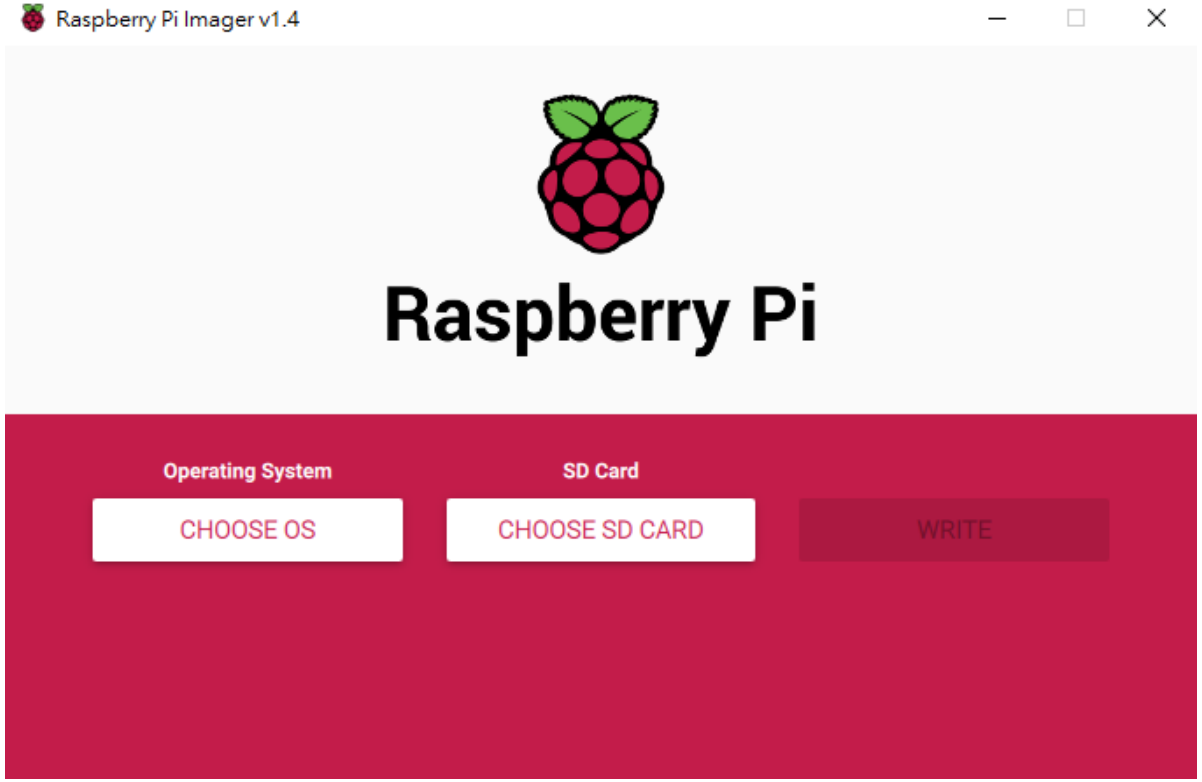
OS Installation

- Step 1: Format micro SD
  - RPi imager
- Step 2: Write the image to the micro SD
  - RPi imager
- Step 3: Modify settings
  - config.txt
  - cmdline.txt
  - headless
- Step 4: Connect USB-TTL cable to the desktop and check the device manager.
  - TTL driver
- Step 5: Plug micro SD into the socket of RPi and power on.

Step 1.

- Download “Raspberry Pi Imager for Windows”
  - https://downloads.raspberrypi.org/imager/imager_latest.exe
- Install Raspberry Pi Imager



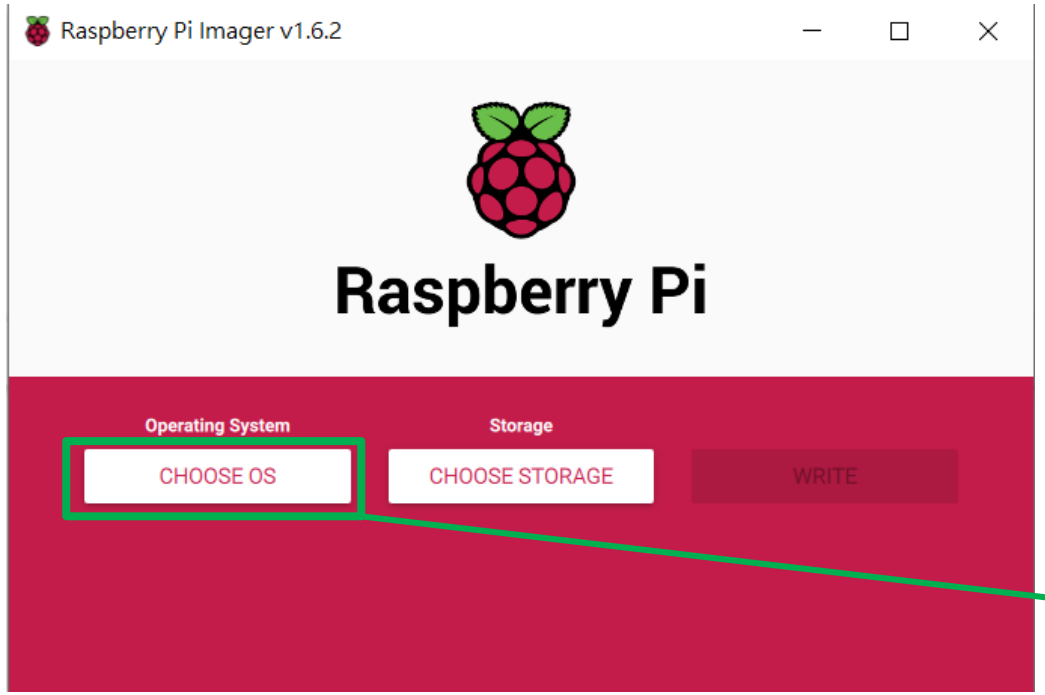


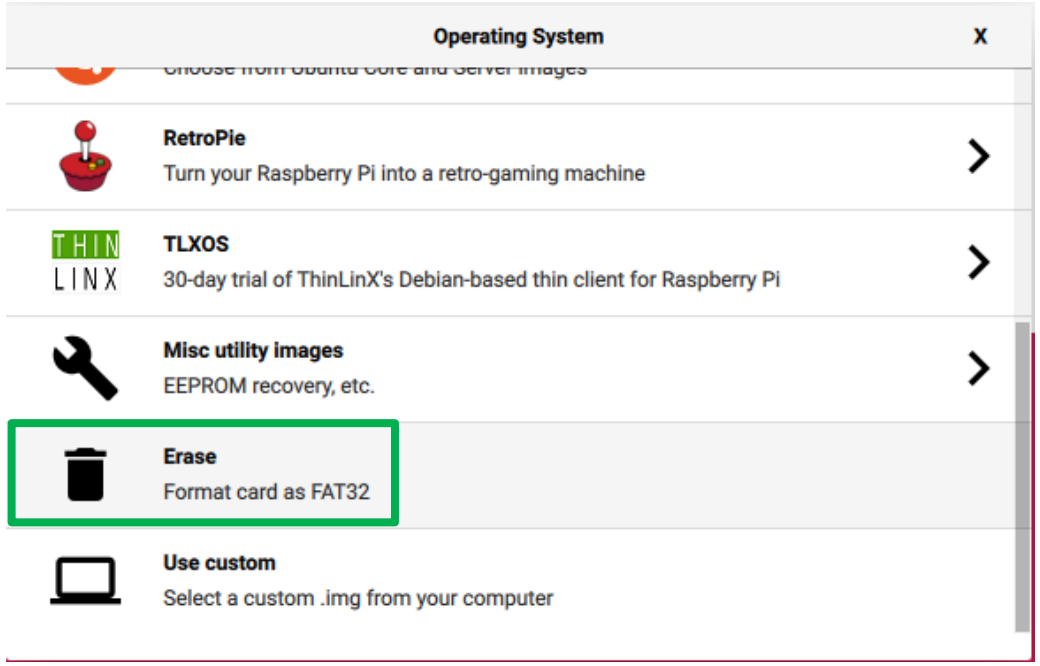
SD Card Reader

- Put your micro SD card into card reader and plug into USB port of the computer.

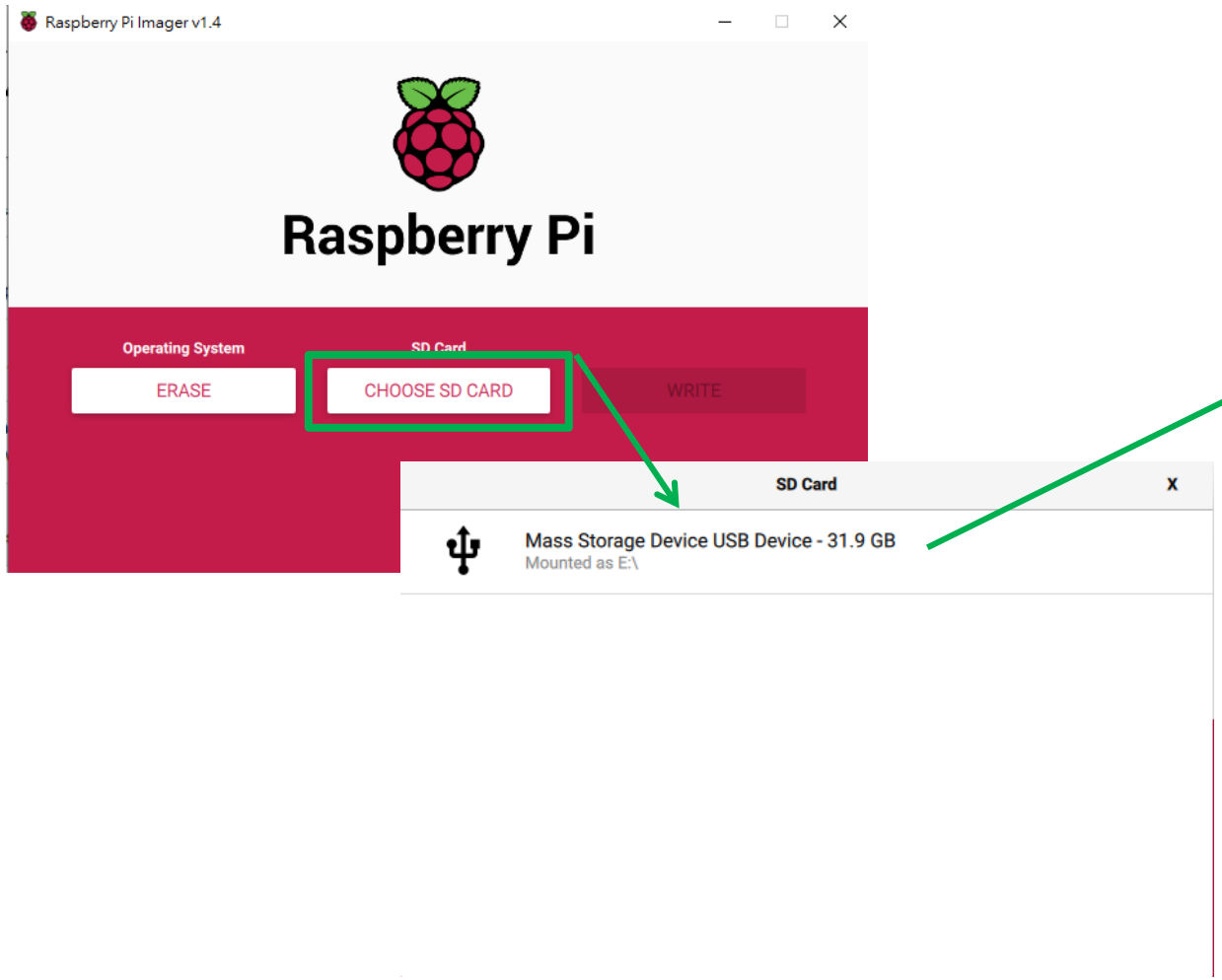
Storage Formation

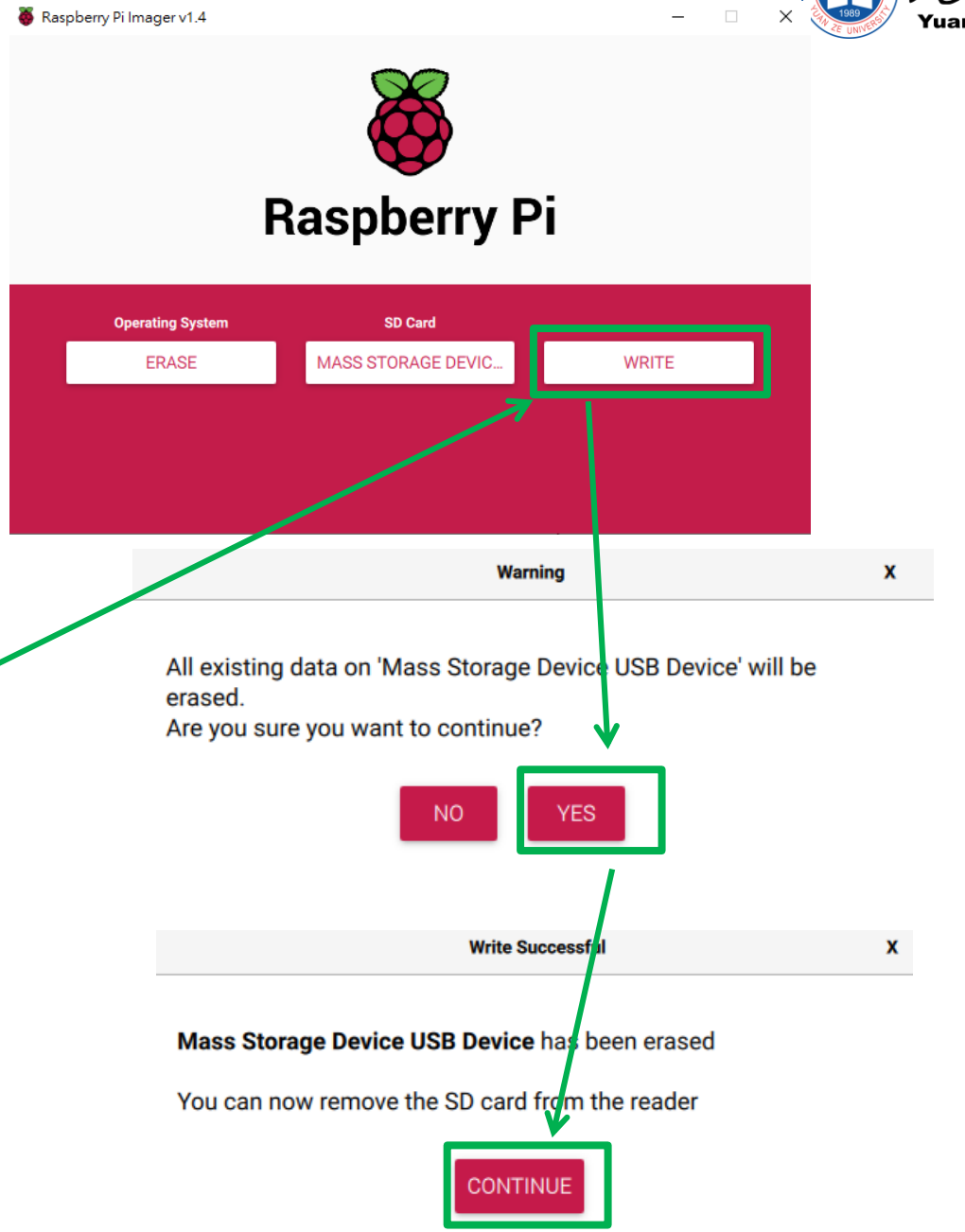
- Launch RPi imager





Storage Formation





Step 2.

- Official website
  - https://www.raspberrypi.com/software/operating-systems/
  - Raspberry Pi OS (Raspbian)

Operating system images

Many operating systems are available for Raspberry Pi, including Raspberry Pi OS, our official supported operating system, and operating systems from other organisations.

Raspberry Pi Imager is the quick and easy way to install an operating system to a microSD card ready to use with your Raspberry Pi. Alternatively, choose from the operating systems below, available to download and install manually.

Raspberry Pi OS

Compatible with:
All Raspberry Pi models

Raspberry Pi OS with desktop and recommended software

Release date: May 7th 2021
Kernel version: 5.10
Size: 2,867MB
Show SHA256 file integrity hash:
Release notes

Download
Download torrent

Raspberry Pi OS with desktop

Release date: May 7th 2021
Kernel version: 5.10
Size: 1,180MB
Show SHA256 file integrity hash:
Release notes

Download
Download torrent

Raspberry Pi OS Lite

Release date: May 7th 2021
Kernel version: 5.10
Size: 444MB
Show SHA256 file integrity hash:
Release notes

Download
Download torrent

Third-party software

Here are some other operating systems you can use with your Raspberry Pi

LibreElec

A Kodi Entertainment Center distribution

Download

Ubuntu Desktop

An open source desktop operating system that's widely used around the world, complete with all the essential applications for home, school, and work

Download

Ubuntu Server

A popular flavour of Linux for cloud and data centre environments

Download

Ubuntu Core

Ubuntu for embedded environments, optimised for security and reliable updates

Download

RetroPie

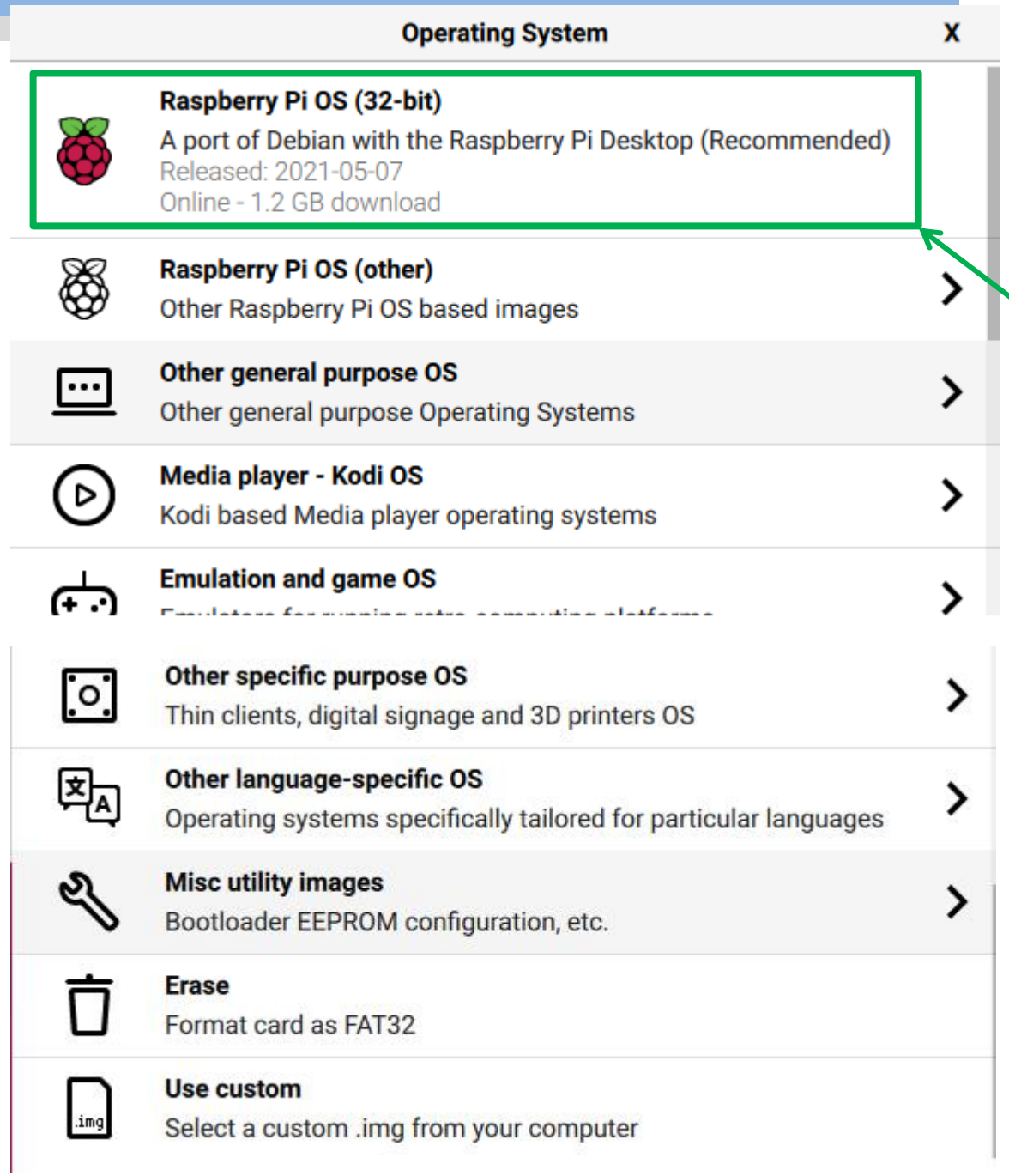
Turn your Raspberry Pi into a retro-gaming machine

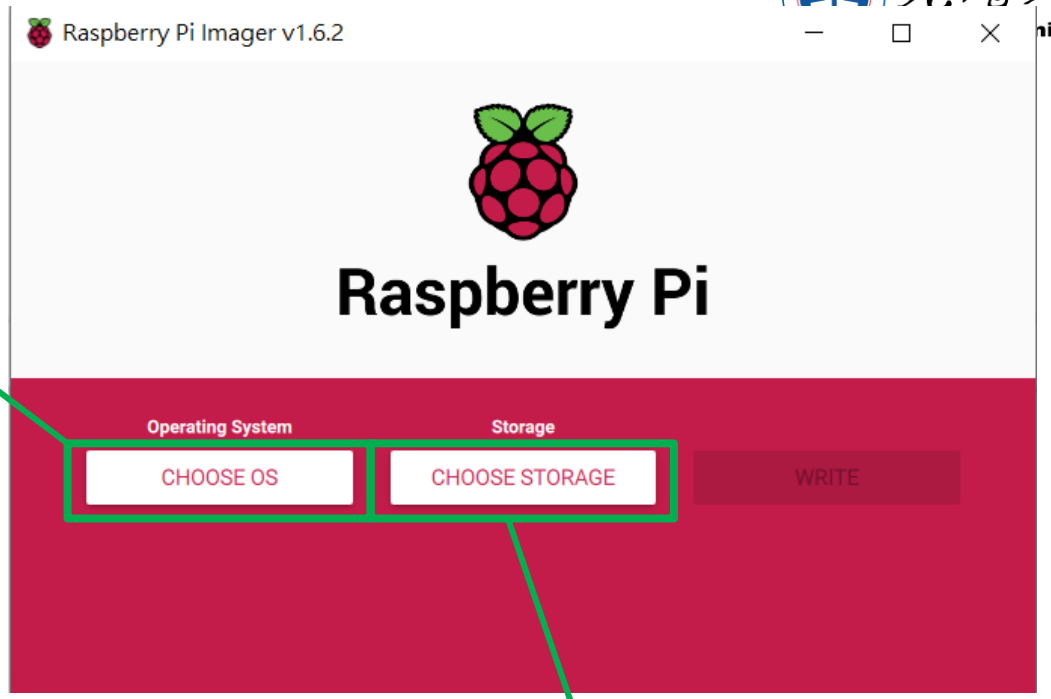
Download

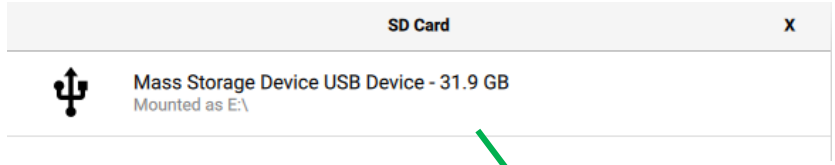
TLXOS

30-day trial of ThinLinX's Debian-based thin client for Raspberry Pi

Download


Operating System
X
Raspberry Pi OS (32-bit)
A port of Debian with the Raspberry Pi Desktop (Recommended)
Released: 2021-05-07
Online - 1.2 GB download
Raspberry Pi OS (other)
Other Raspberry Pi OS based images
Other general purpose OS
Other general purpose Operating Systems
Media player - Kodi OS
Kodi based Media player operating systems
Emulation and game OS
Other specific purpose OS
Thin clients, digital signage and 3D printers OS
Other language-specific OS
Operating systems specifically tailored for particular languages
Misc utility images
Bootloader EEPROM configuration, etc.
Erase
Format card as FAT32
Use custom
Select a custom .img from your computer


Raspberry Pi Imager v1.6.2
Raspberry Pi
Operating System
Storage
CHOOSE OS
CHOOSE STORAGE
WRITE


SD Card
X
Mass Storage Device USB Device - 31.9 GB
Mounted as E:\

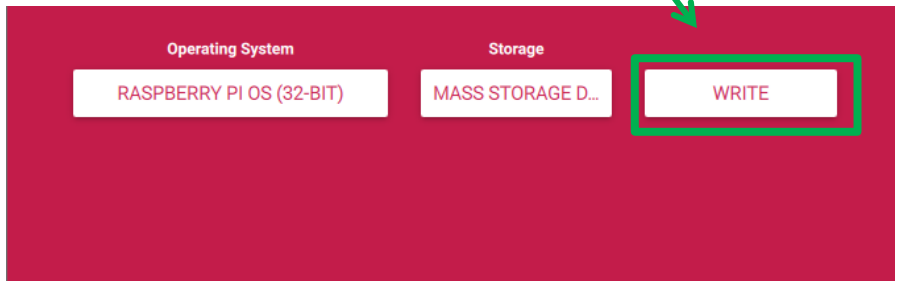
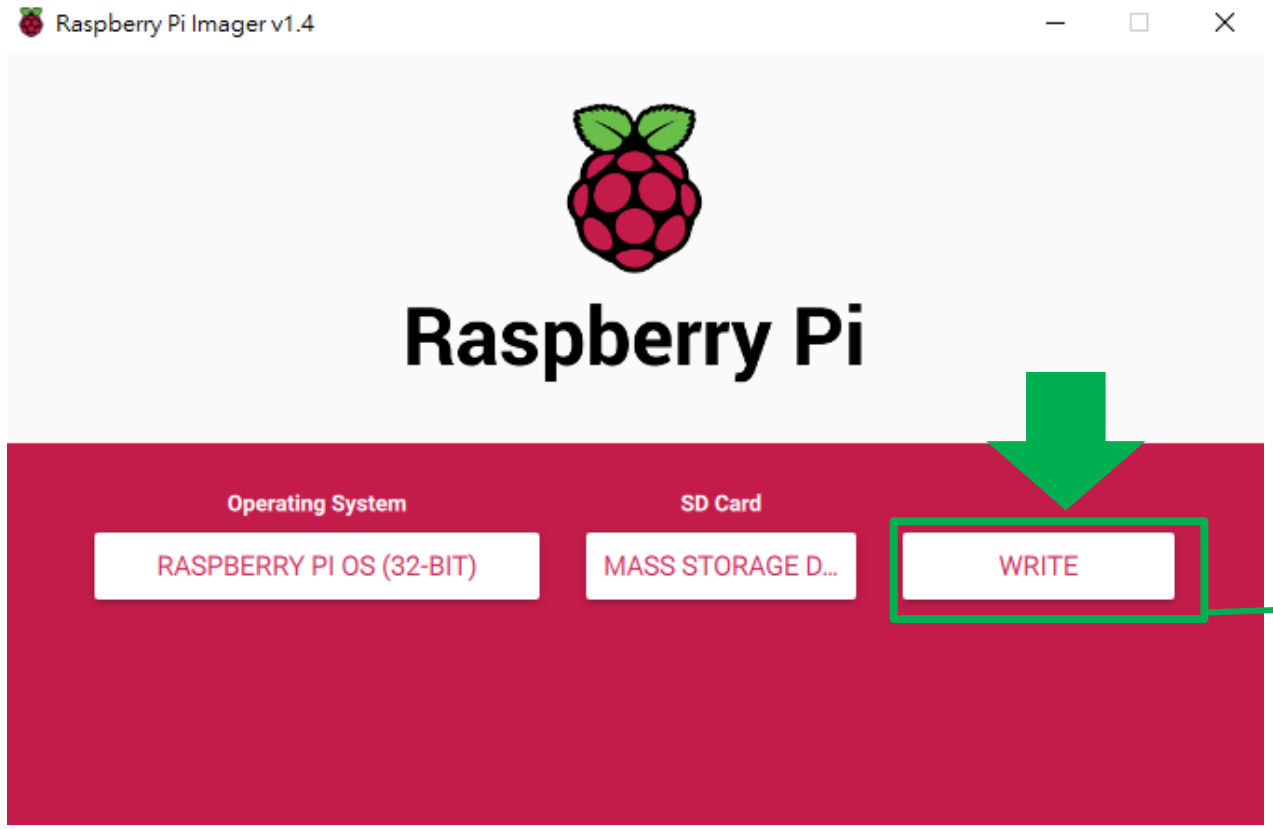

Operating System
Storage
RASPBERRY PI OS (32-BIT)
MASS STORAGE D...
WRITE

Image Installation



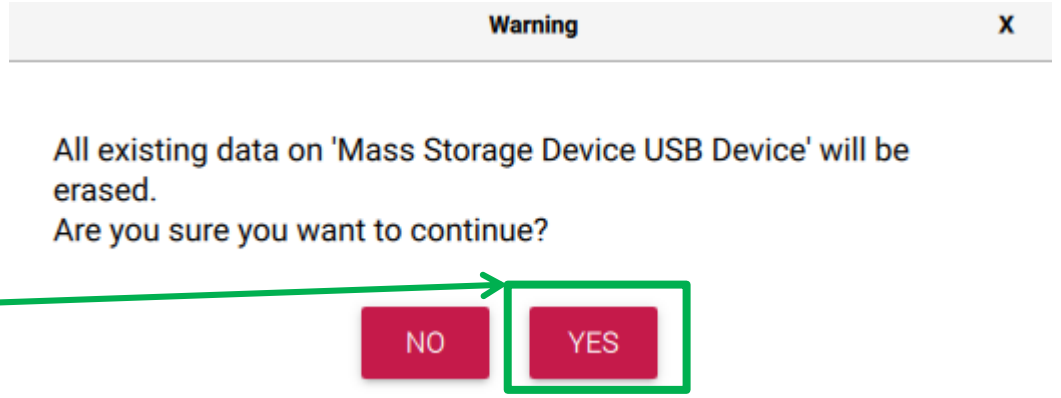
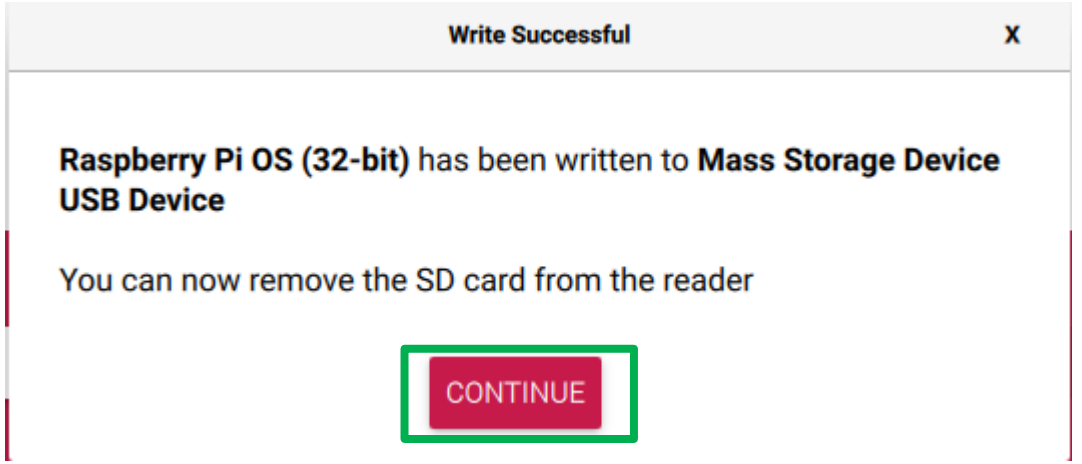


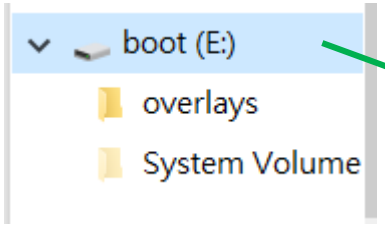
Image Installation

- Wait for 100% writing and 100% verifying.



Step 3.

- Unplug and plug the SD card reader again.
- Open file manager.



bcm2709-rpi-2-b.dtb	2021/3/3 下午 01:40	DTB 檔案	27 KB
bcm2710-rpi-2-b.dtb	2021/3/3 下午 01:40	DTB 檔案	27 KB
bcm2710-rpi-3-b.dtb	2021/3/3 下午 01:40	DTB 檔案	28 KB
bcm2710-rpi-3-b-plus.dtb	2021/3/3 下午 01:40	DTB 檔案	29 KB
bcm2710-rpi-cm3.dtb	2021/3/3 下午 01:40	DTB 檔案	27 KB
bcm2711-rpi-4-b.dtb	2021/3/3 下午 01:40	DTB 檔案	48 KB
bcm2711-rpi-400.dtb	2021/4/30 下午 02:01	DTB 檔案	48 KB
bcm2711-rpi-cm4.dtb	2021/3/3 下午 01:40	DTB 檔案	49 KB
bootcode.bin	2021/1/5 上午 07:30	BIN 檔案	52 KB
cmdline.txt	2021/5/7 下午 03:07	文字文件	1 KB
config.txt	2021/5/7 下午 02:43	文字文件	2 KB
COPYING.linux	2021/1/5 上午 07:30	LINUX 檔案	19 KB
fixup.dat	2021/4/30 下午 02:01	DAT 檔案	8 KB
fixup_cd.dat	2021/4/30 下午 02:01	DAT 檔案	4 KB
fixup_db.dat	2021/4/30 下午 02:01	DAT 檔案	11 KB
fixup_x.dat	2021/4/30 下午 02:01	DAT 檔案	11 KB
fixup4.dat	2021/4/30 下午 02:01	DAT 檔案	6 KB

MiniUART Configurations

- If you directly use keyboard and mouse, you can skip this step 3 and 4.
- In Windows, find the disk of SD card.
- Modify config.txt by adding

  dtoverlay=miniuart-bt

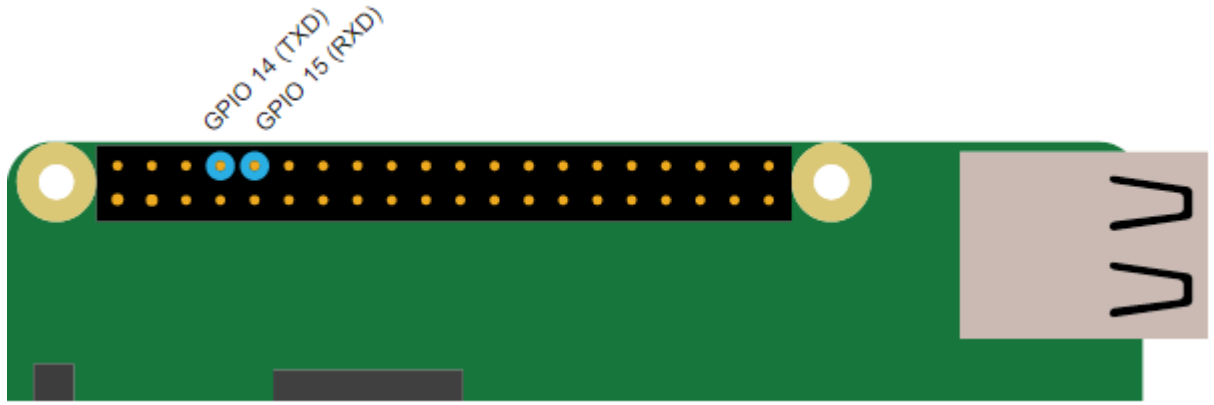
  core_freq=250

  enable_uart=1

```
64  [all]
65  #dtoverlay=vc4-fkms-v3d
66
67  dtoverlay=miniuart-bt
68  core_freq=250
69  enable_uart=1
70
```

UART Configuration

- https://www.raspberrypi.org/documentation/configuration/uart.md



Model	first PL011 (UART0)	mini UART
Raspberry Pi Zero	primary	secondary
Raspberry Pi Zero W	secondary (Bluetooth)	primary
Raspberry Pi 1	primary	secondary
Raspberry Pi 2	primary	secondary
Raspberry Pi 3	secondary (Bluetooth)	primary
Raspberry Pi 4	secondary (Bluetooth)	primary

Note: the mini UART is disabled by default, whether it is designated primary or secondary UART.

https://www.abelectronics.co.uk/kb/article/1035/raspberry-pi-3--4-and-zero-w-serial-port-usage

Booting Configurations

- Modify cmdline.txt
  - Remove “quiet”
  - Remove “plymouth.ignore-serial-consoles”

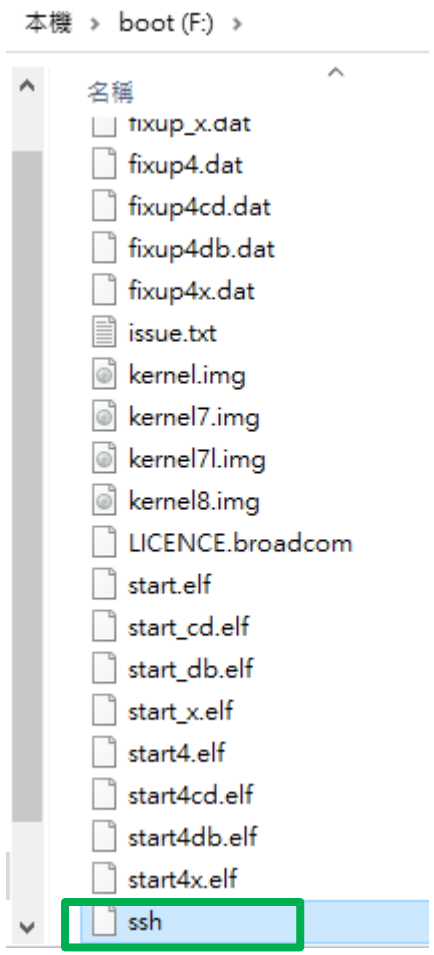
E: > cmdline.txt

```
1  console=serial0,115200 console=tty1 root=PARTUUID=f4481065-02 rootfstype=ext4 elevator=deadline fsck.repair=yes rootwait
   quiet init=/usr/lib/raspi-config/init_resize.sh splash plymouth.ignore-serial-consoles
2
```

- plymouth.ignore-serial-consoles: normally if the Plymouth module is enabled it will prevent boot messages from appearing on any serial console which may be present. This flag tells Plymouth to ignore all serial consoles, making boot messages visible again, as they would be if Plymouth was not running.

Headless Configurations

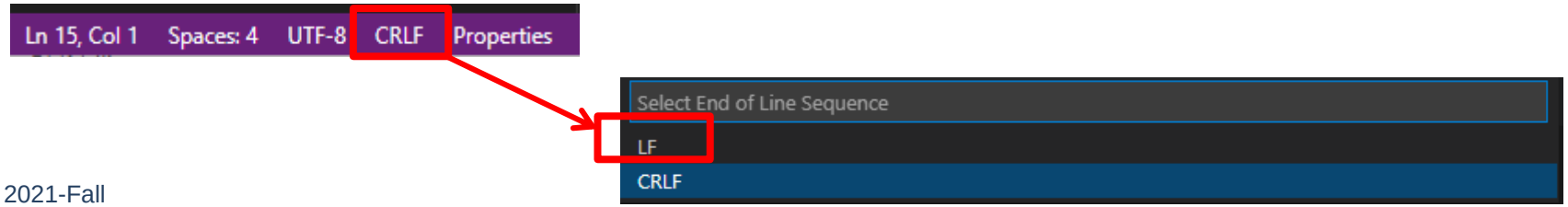
- https://www.raspberrypi.com/documentation/computers/configuration.html#setting-up-a-headless-raspberry-pi
- Enable ssh when booting up.
- Create a file called “ssh” without an extension.

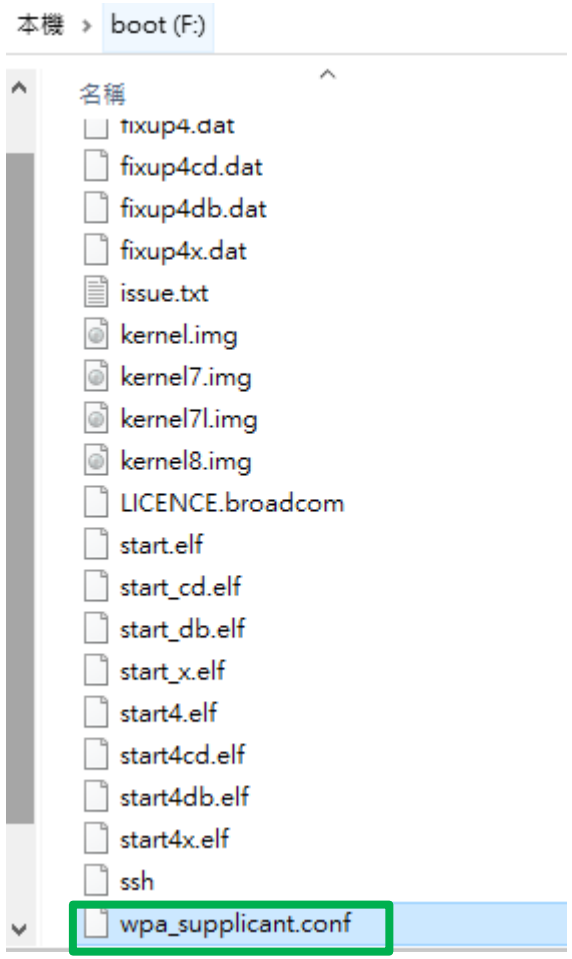


Headless Configurations

- Wi-Fi Configuration
- Create a new file called “wpa_supplicant.conf”

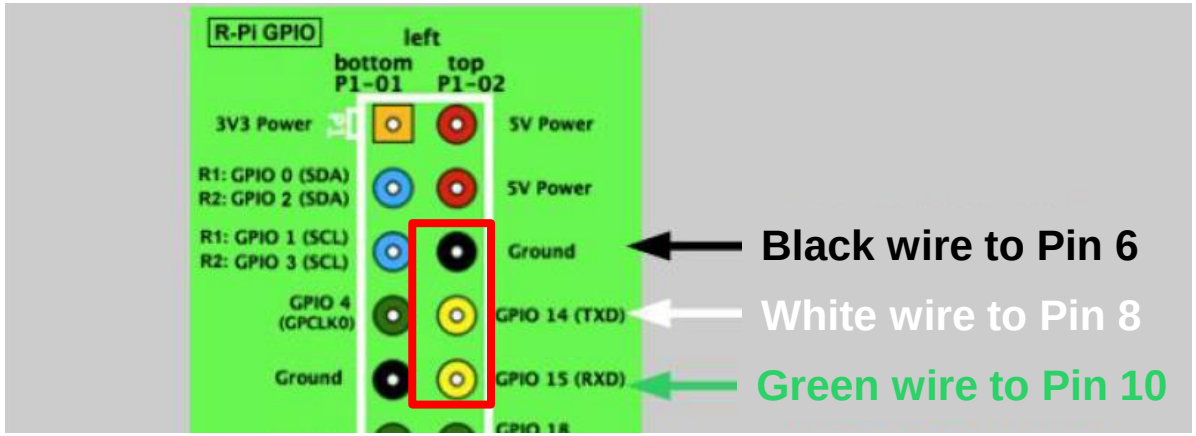
```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
country=TW
update_config=1

network={
  ssid="IoTAP"
  psk="yzucseiot2021"
  priority=1
}
```

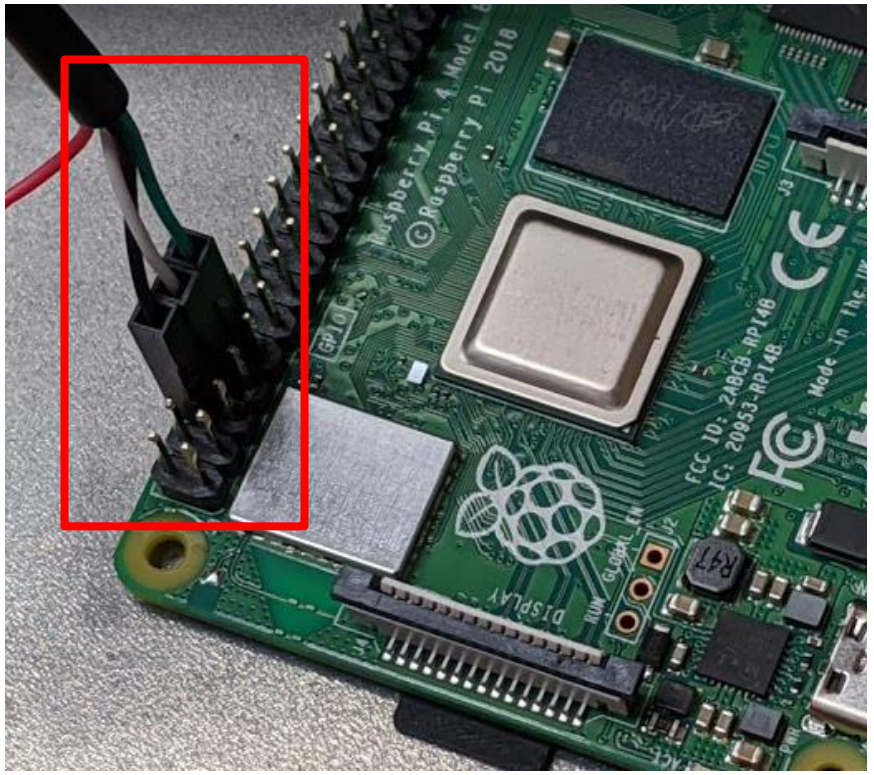




Step 4.

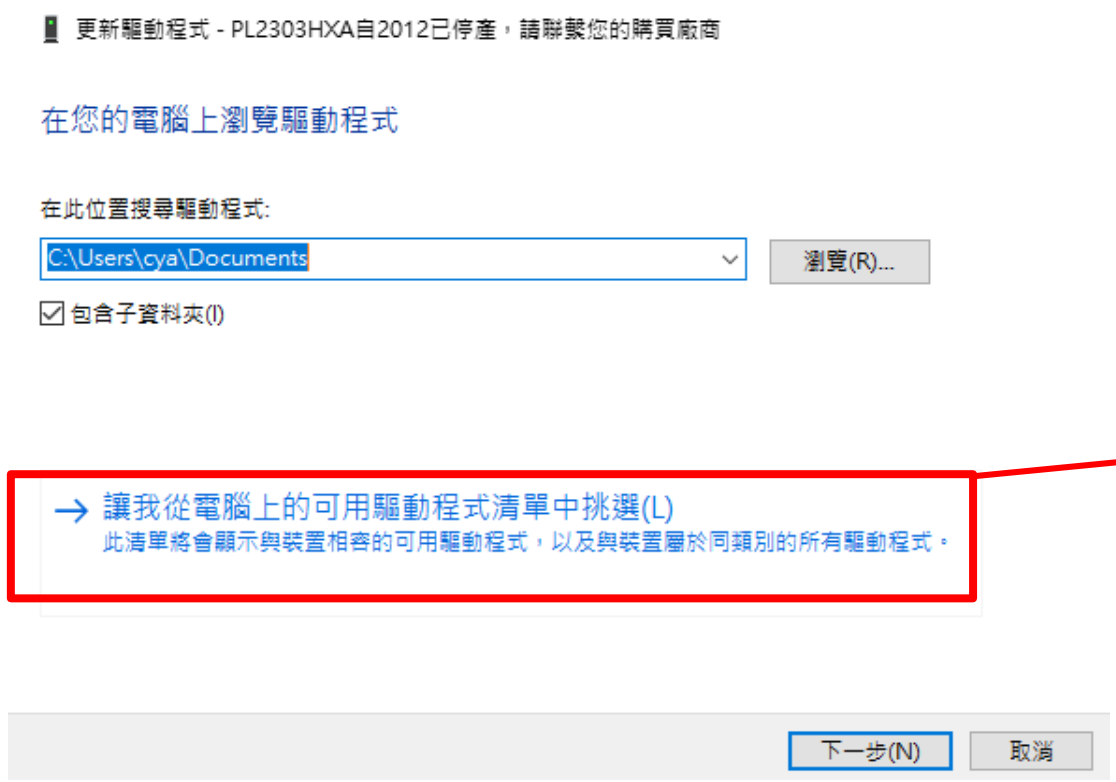
- We can use USB-TTL cable to communicate with RPi via the serial interface by a computer.
- Connect these three wires to the corresponding pins of RPi.
- USB connector connects to the computer.





Driver

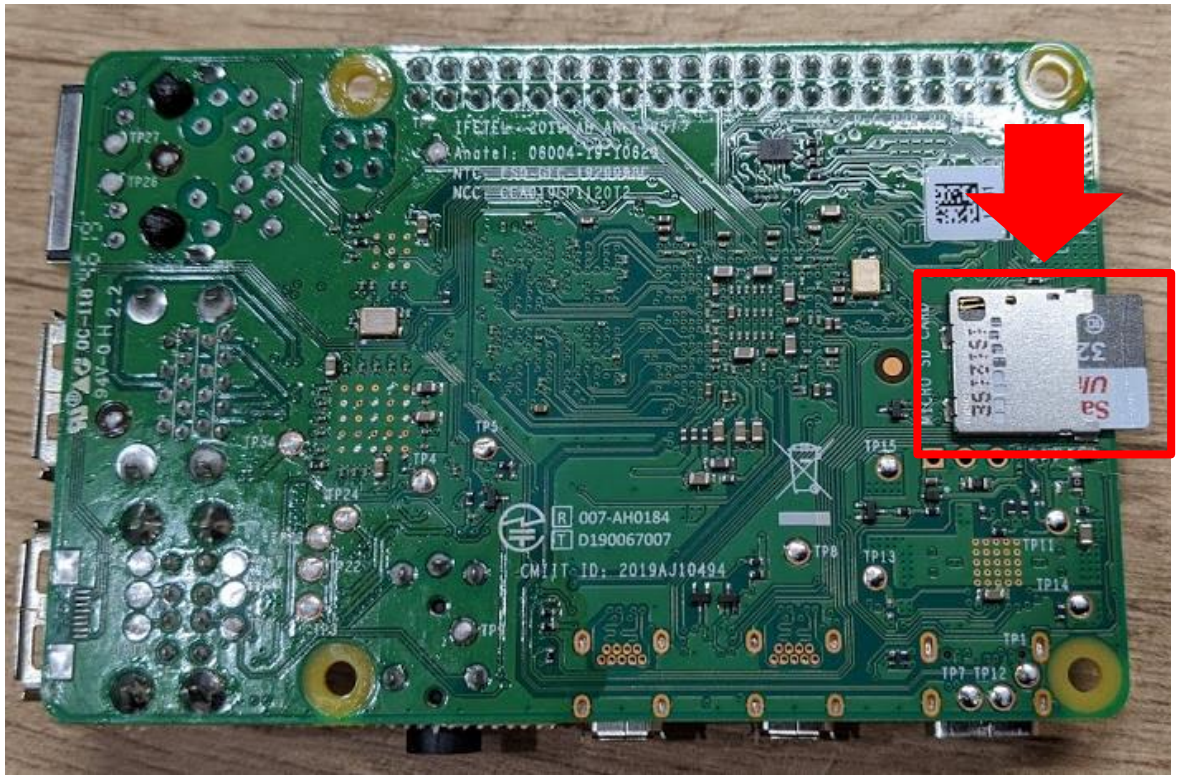
- Install the provided driver (If you want to install on your computer)
  - PL2303_Prolific_GPS_1013_20090319.exe
  - https://reurl.cc/ldDV0Y
- Driver problem


更新驅動程式 - PL2303HXA自2012已停產，請聯繫您的購買廠商
在您的電腦上瀏覽驅動程式
在此位置搜尋驅動程式:
C:\Users\cya\Documents
瀏覽(R)...
包含子資料夾(I)
讓我從電腦上的可用驅動程式清單中挑選(L)
此清單將會顯示與裝置相容的可用驅動程式，以及與裝置屬於同類別的所有驅動程式。
下一步(N)
取消


更新驅動程式 - PL2303HXA自2012已停產，請聯繫您的購買廠商
選取您要為這個硬體安裝的裝置驅動程式
請選擇您的硬體裝置製造商和機型，然後按 [下一步]。如果您想從磁片安裝其他驅動程式，請按 [從磁片安裝]。
顯示相容硬體(C)
型號
Prolific USB-to-Serial Comm Port 版本: 3.3.2.105 [2008/10/27]
Prolific USB-to-Serial Comm Port 版本: 3.8.31.0 [2019/7/30]
驅動程式已數位簽章。
告訴我為什麼驅動程式簽章很重要
從磁片安裝(H)...
下一步(N)
取消

Step 5.

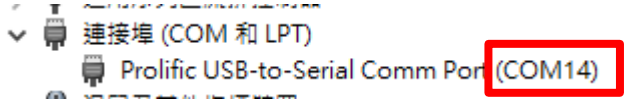
- Unplug the micro SD from the computer
- Plug micro SD card into the micro SD slot of RPi.

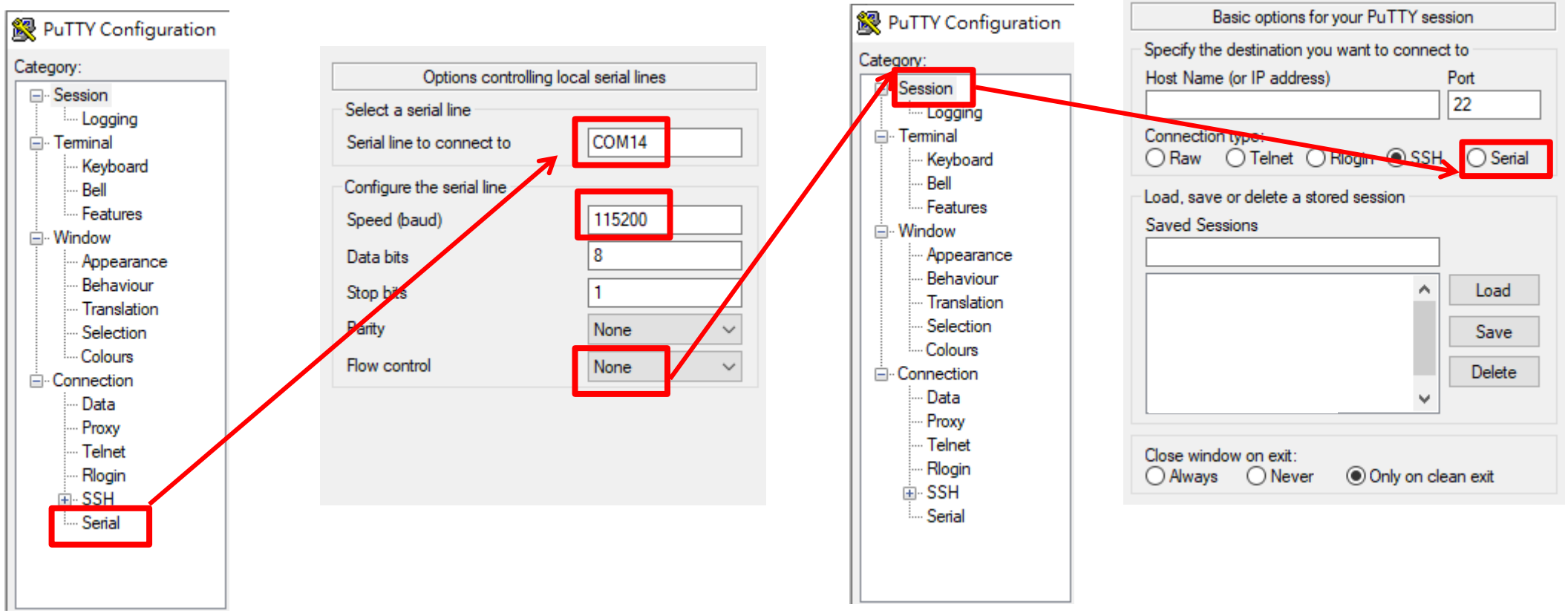


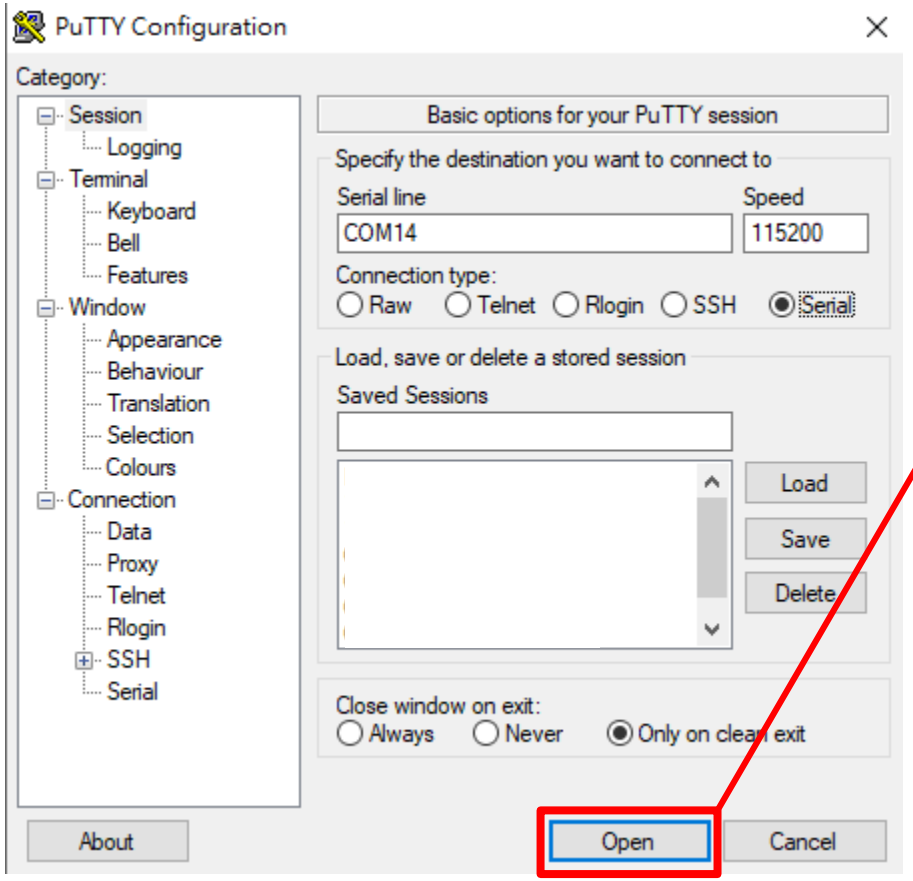
DO NOT put the bare board on materials with conductivity while powering on.

Putty

- Open device manager to check your COM port number.
- Launch “Putty”



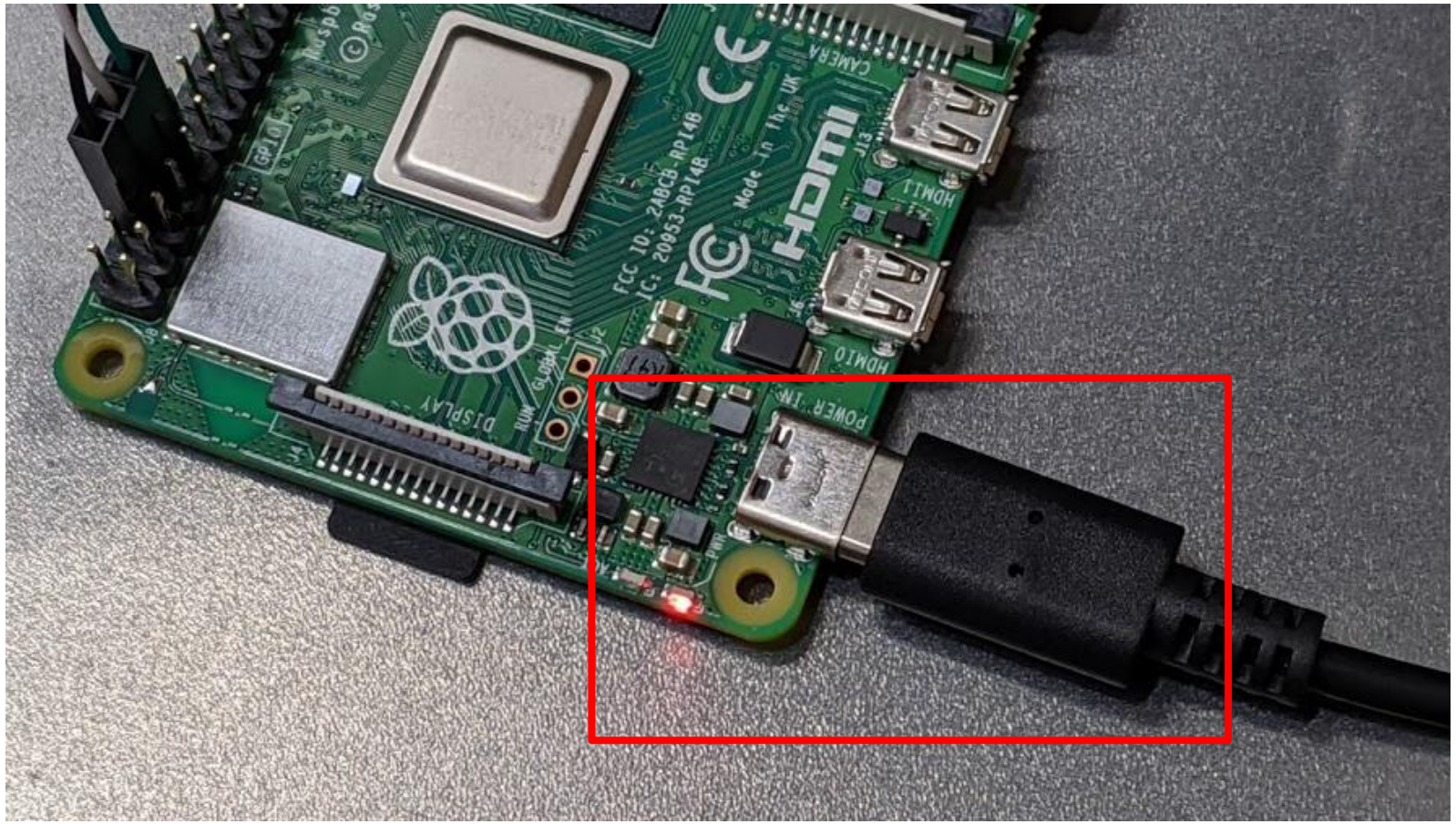



PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Specify the destination you want to connect to
Serial line
Speed
COM14
115200
Connection type:
Raw
Telnet
Rlogin
SSH
Serial
Load, save or delete a stored session
Saved Sessions
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Open
Cancel


COM14 - PuTTY

Power On

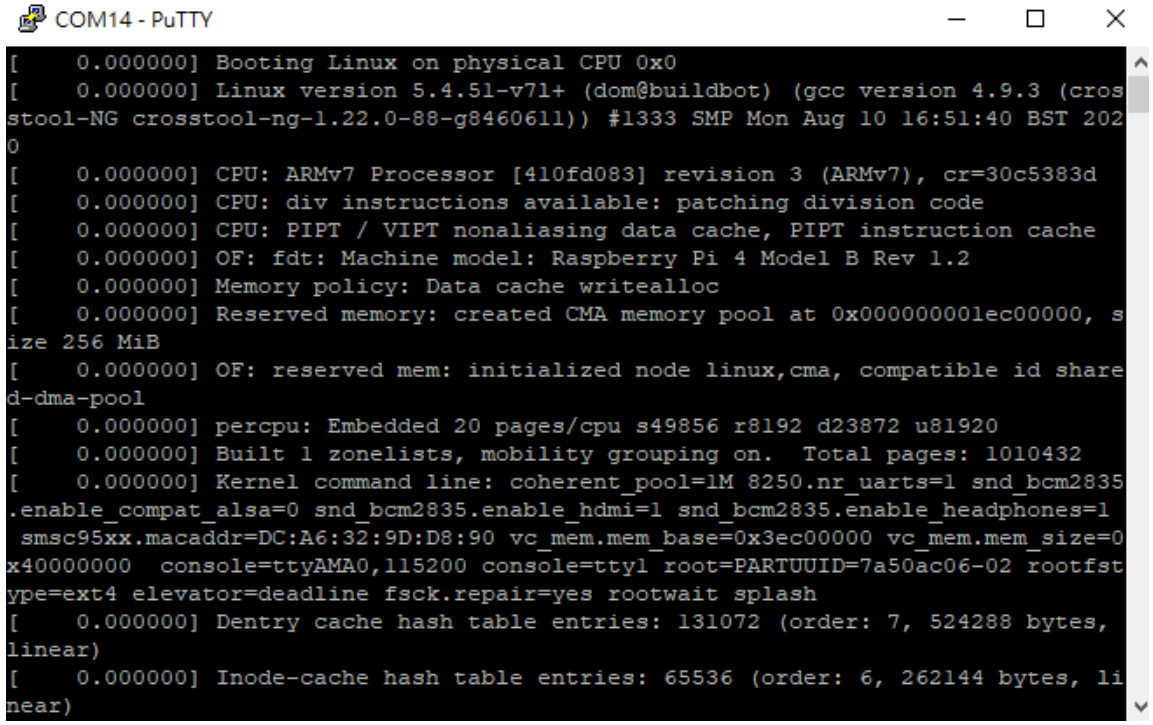
- Connect the USB-C cable to power on RPi.

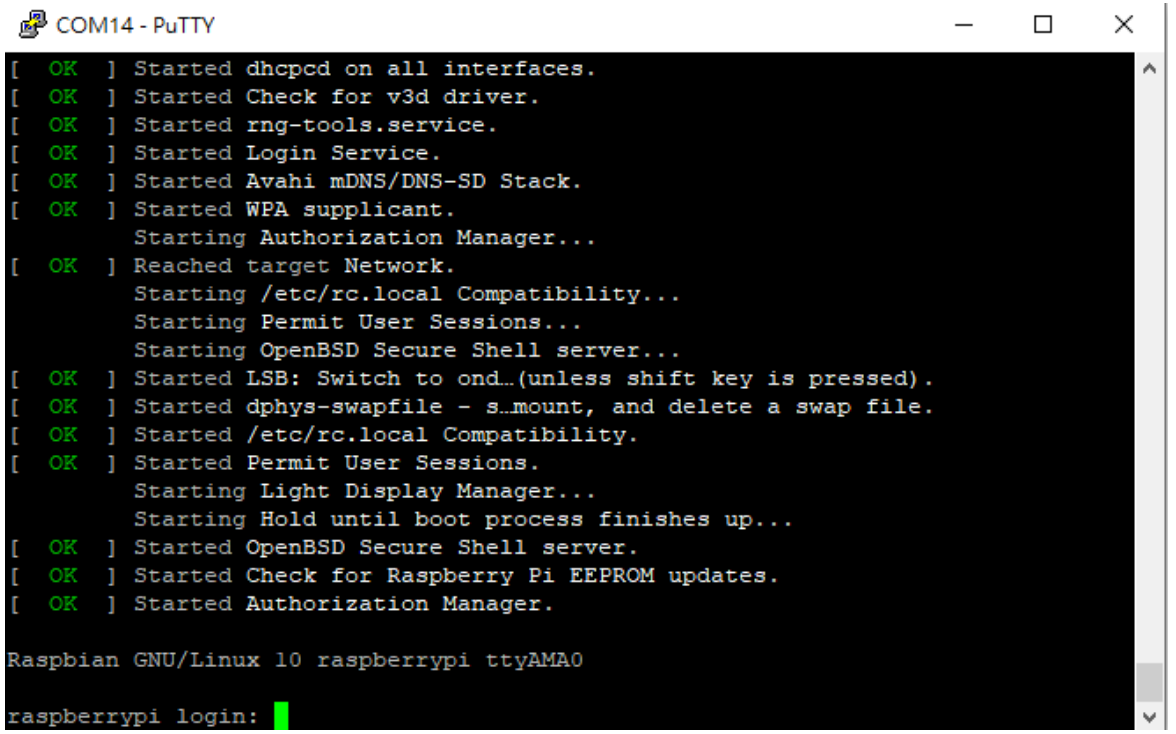


DO NOT put the bare board on materials with conductivity while powering on.

Lab 2-1

- Boot up RPi with Raspberry Pi OS.
- No demonstration



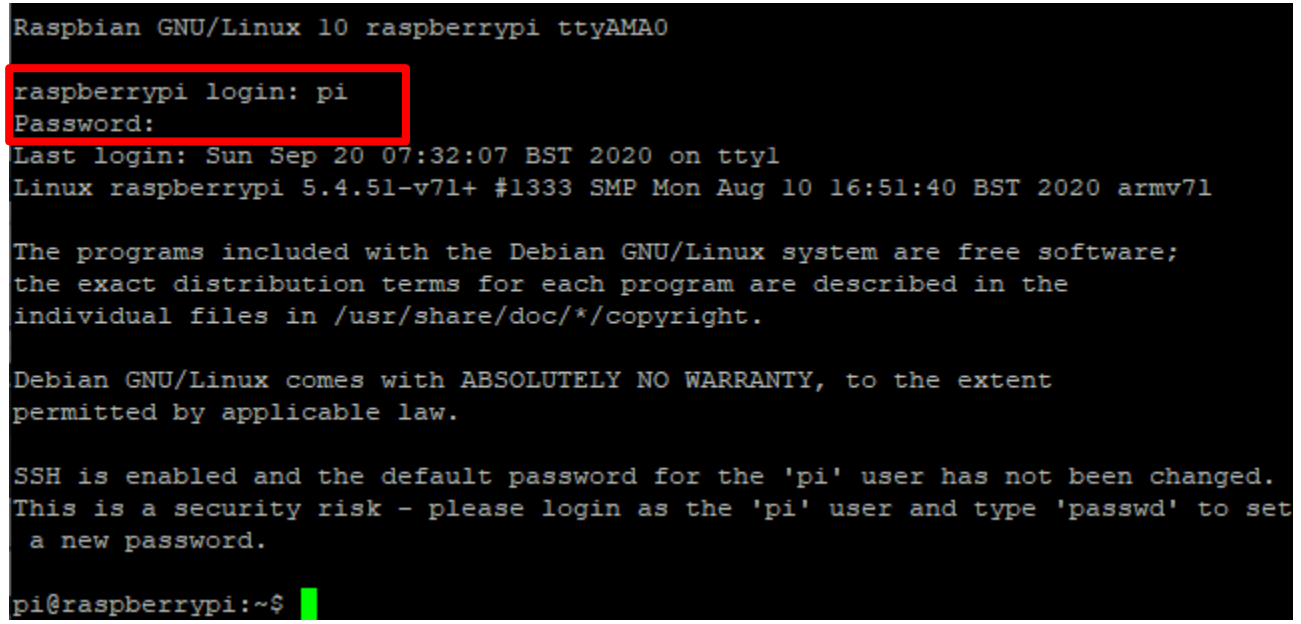


Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

RPi Log In

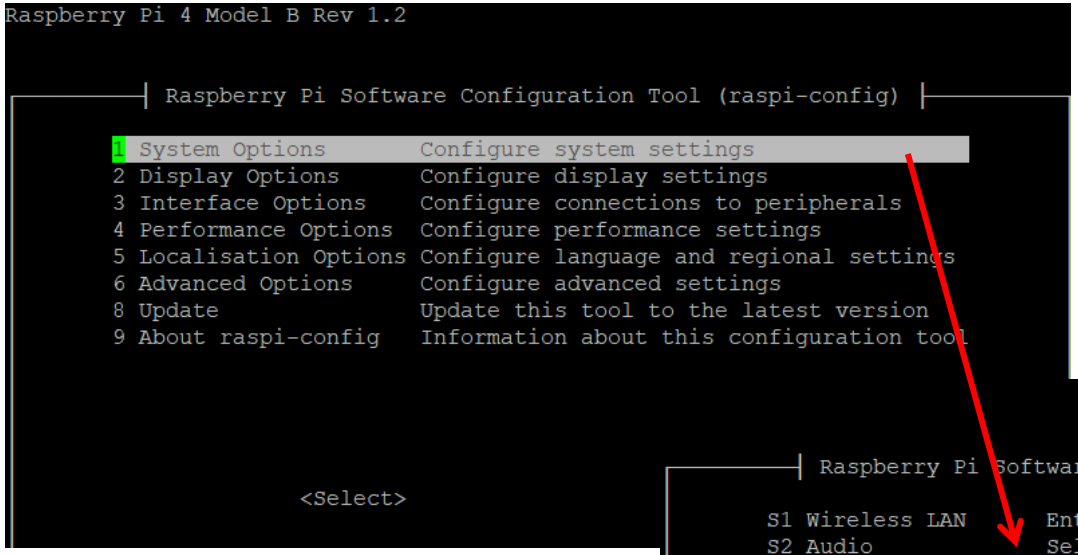
- Default ID: pi
- Default password: raspberry

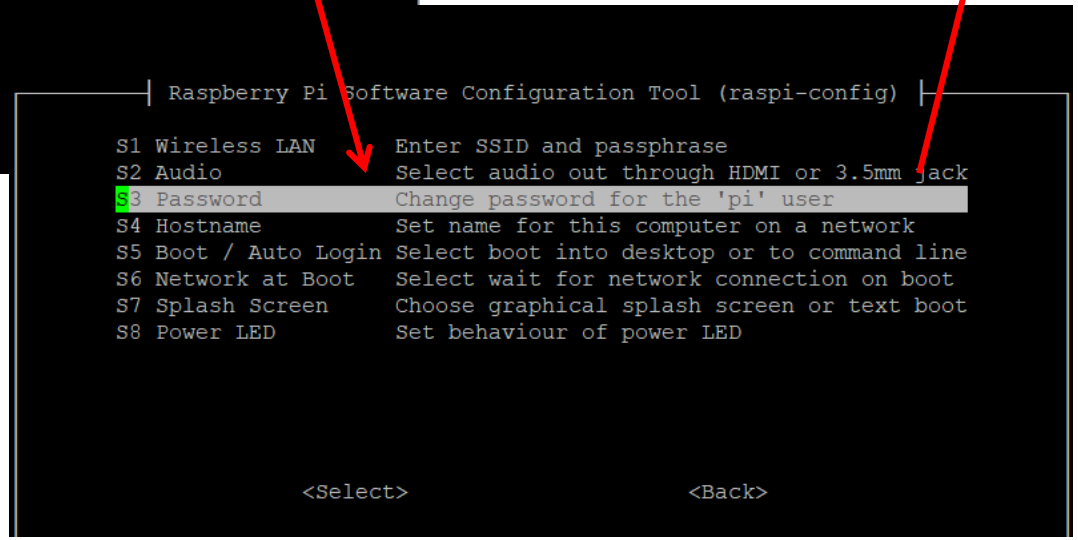


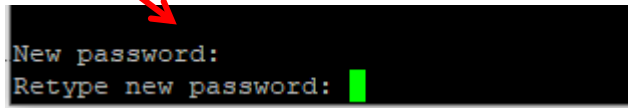
Password

- Change the password.

$ sudo raspi-config

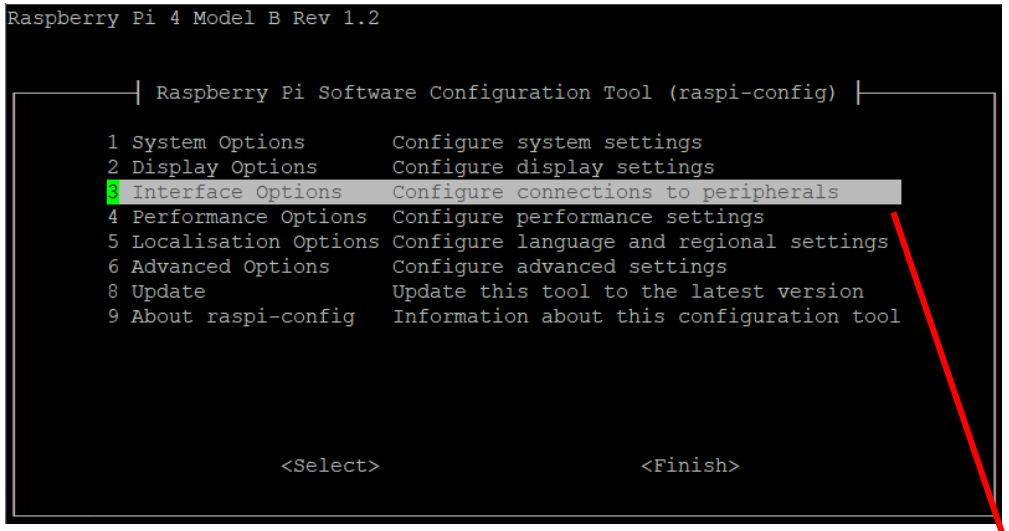


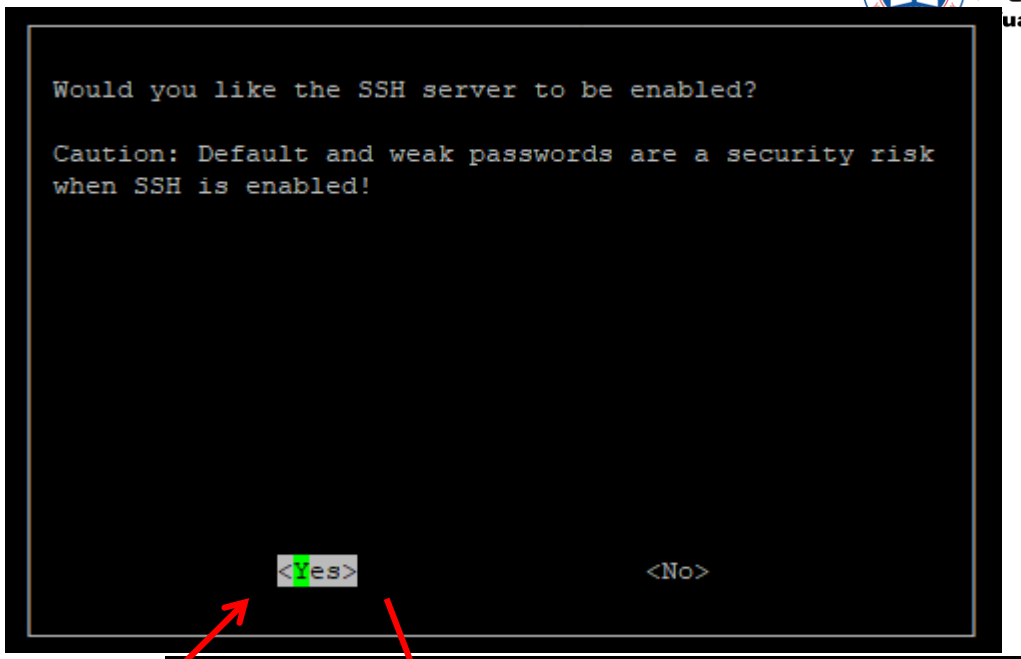


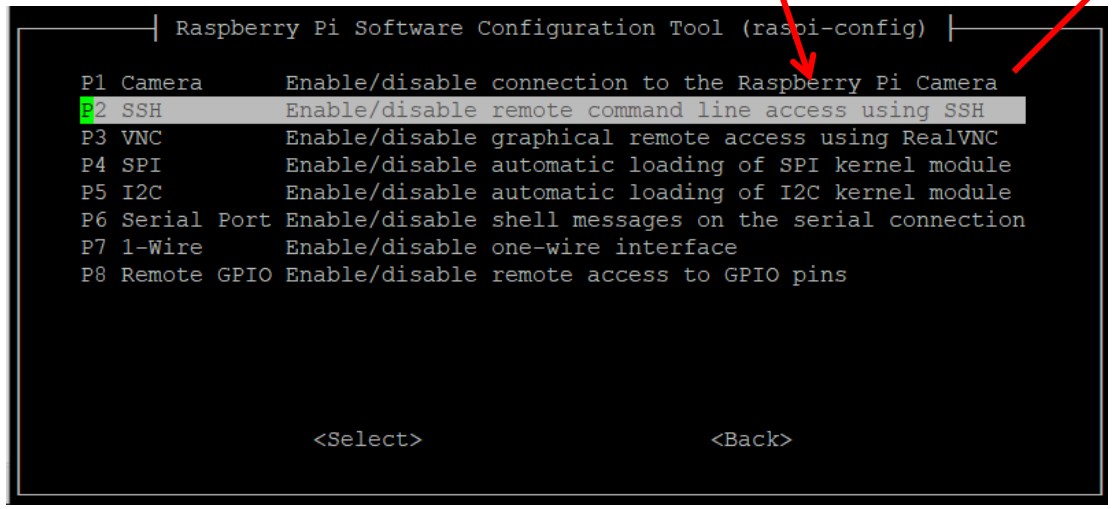


password: yzucse
(or set by yourself)

SSH

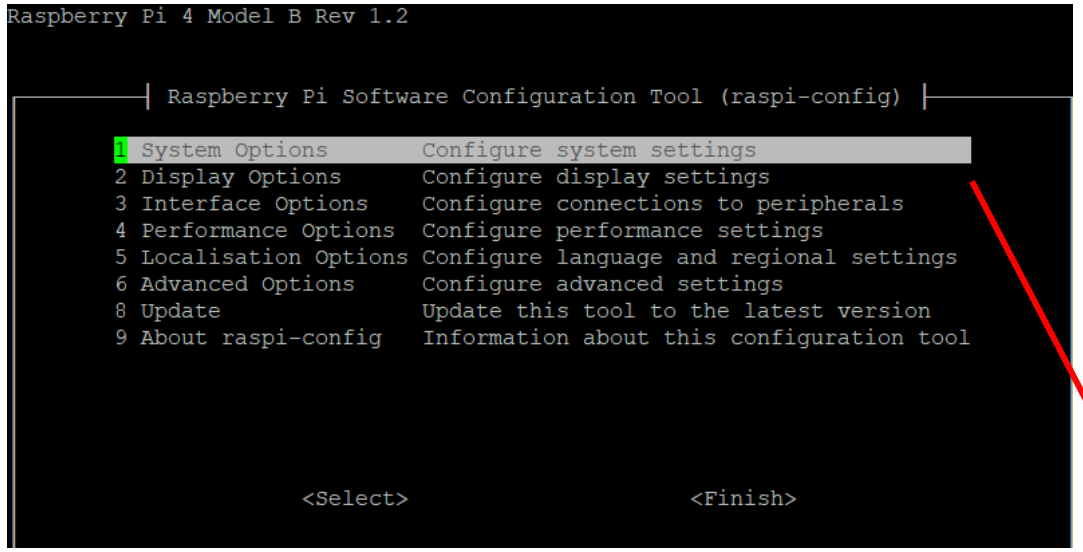

Raspberry Pi 4 Model B Rev 1.2
Raspberry Pi Software Configuration Tool (raspi-config)
1 System Options Configure system settings
2 Display Options Configure display settings
3 Interface Options Configure connections to peripherals
4 Performance Options Configure performance settings
5 Localisation Options Configure language and regional settings
6 Advanced Options Configure advanced settings
8 Update Update this tool to the latest version
9 About raspi-config Information about this configuration tool
<Select>
<Finish>


Would you like the SSH server to be enabled?
Caution: Default and weak passwords are a security risk when SSH is enabled!
<Yes>
<No>


Raspberry Pi Software Configuration Tool (raspi-config)
P1 Camera Enable/disable connection to the Raspberry Pi Camera
P2 SSH Enable/disable remote command line access using SSH
P3 VNC Enable/disable graphical remote access using RealVNC
P4 SPI Enable/disable automatic loading of SPI kernel module
P5 I2C Enable/disable automatic loading of I2C kernel module
P6 Serial Port Enable/disable shell messages on the serial connection
P7 1-Wire Enable/disable one-wire interface
P8 Remote GPIO Enable/disable remote access to GPIO pins
<Select>
<Back>


The SSH server is enabled
<Ok>

Hostname


Raspberry Pi 4 Model B Rev 1.2
Raspberry Pi Software Configuration Tool (raspi-config)
1 System Options Configure system settings
2 Display Options Configure display settings
3 Interface Options Configure connections to peripherals
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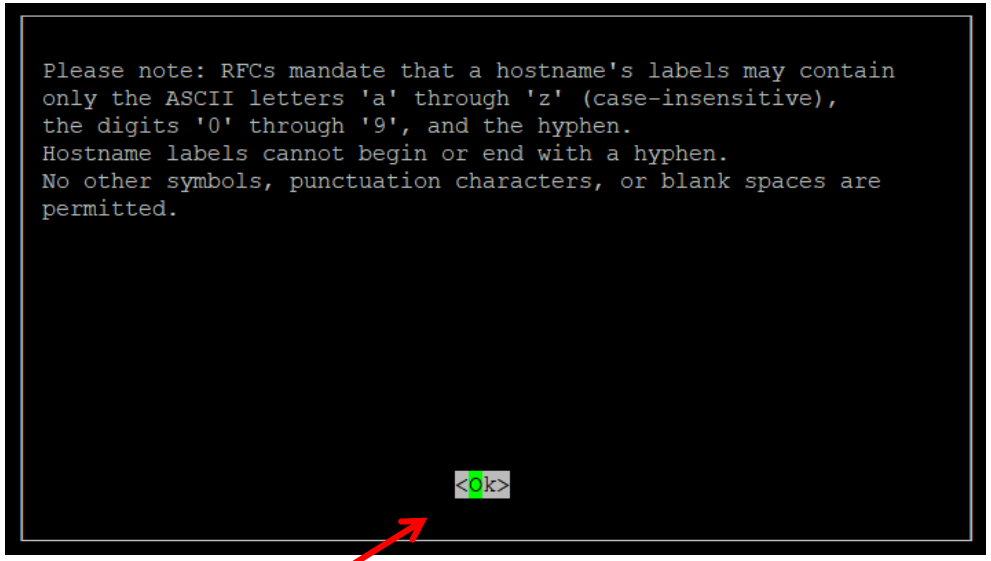
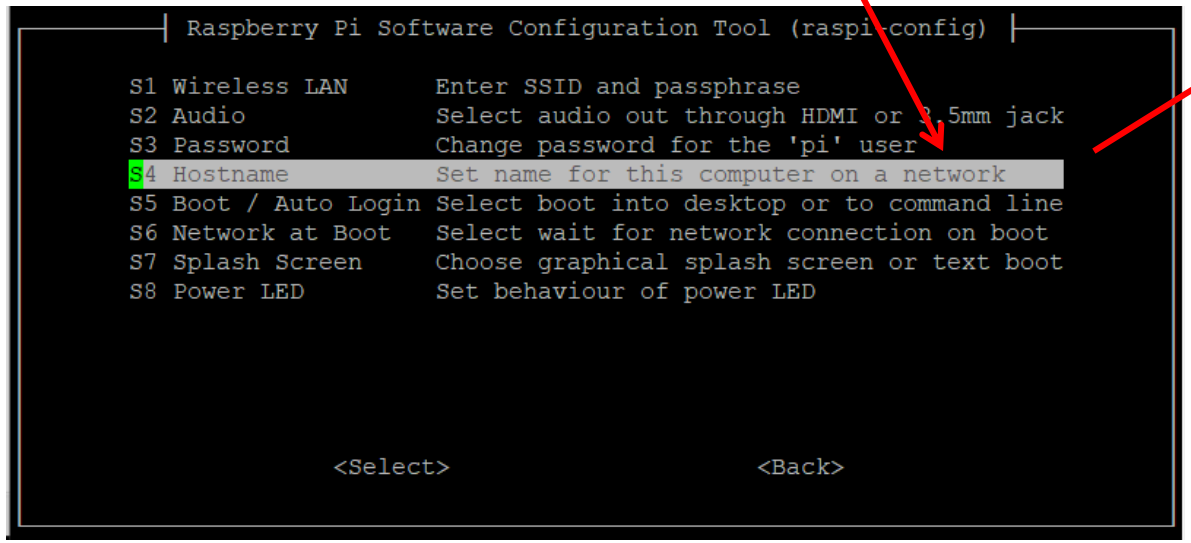
5 Localisation Options Configure language and regional settings
6 Advanced Options Configure advanced settings
8 Update Update this tool to the latest version
9 About raspi-config Information about this configuration tool
<Select>
<Finish>

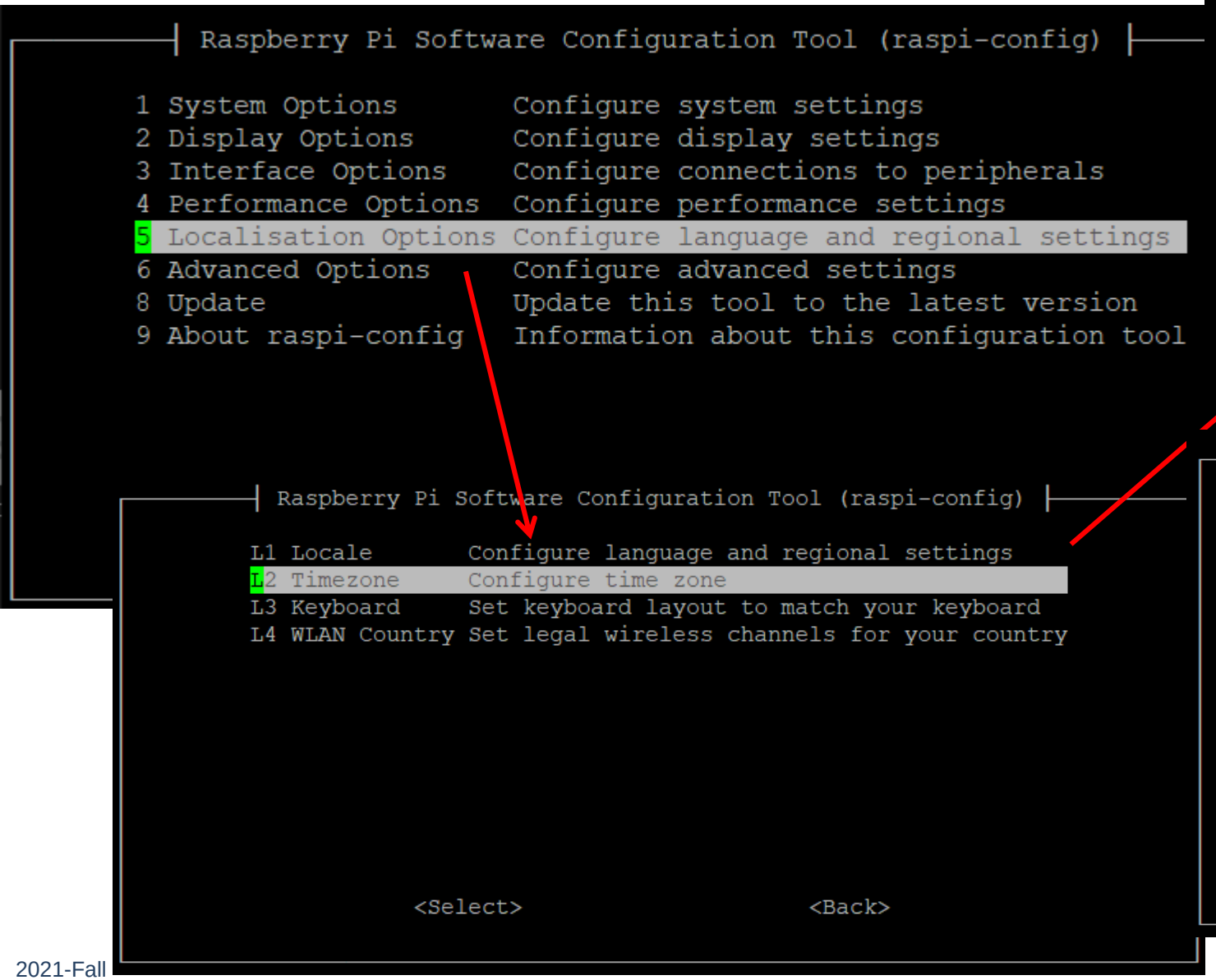

Please note: RFCs mandate that a hostname's labels may contain
only the ASCII letters 'a' through 'z' (case-insensitive),
the digits '0' through '9', and the hyphen.
Hostname labels cannot begin or end with a hyphen.
No other symbols, punctuation characters, or blank spaces are
permitted.
<Ok>

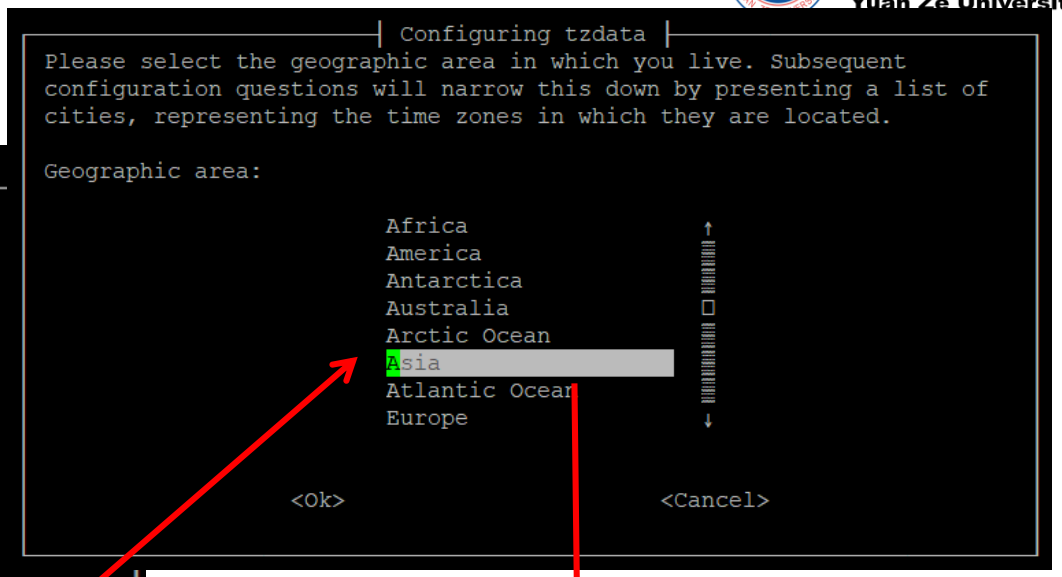

Raspberry Pi Software Configuration Tool (raspi-config)
S1 Wireless LAN Enter SSID and passphrase
S2 Audio Select audio out through HDMI or 3.5mm jack
S3 Password Change password for the 'pi' user
S4 Hostname Set name for this computer on a network
S5 Boot / Auto Login Select boot into desktop or to command line
S6 Network at Boot Select wait for network connection on boot
S7 Splash Screen Choose graphical splash screen or text boot
S8 Power LED Set behaviour of power LED
<Select>
<Back>

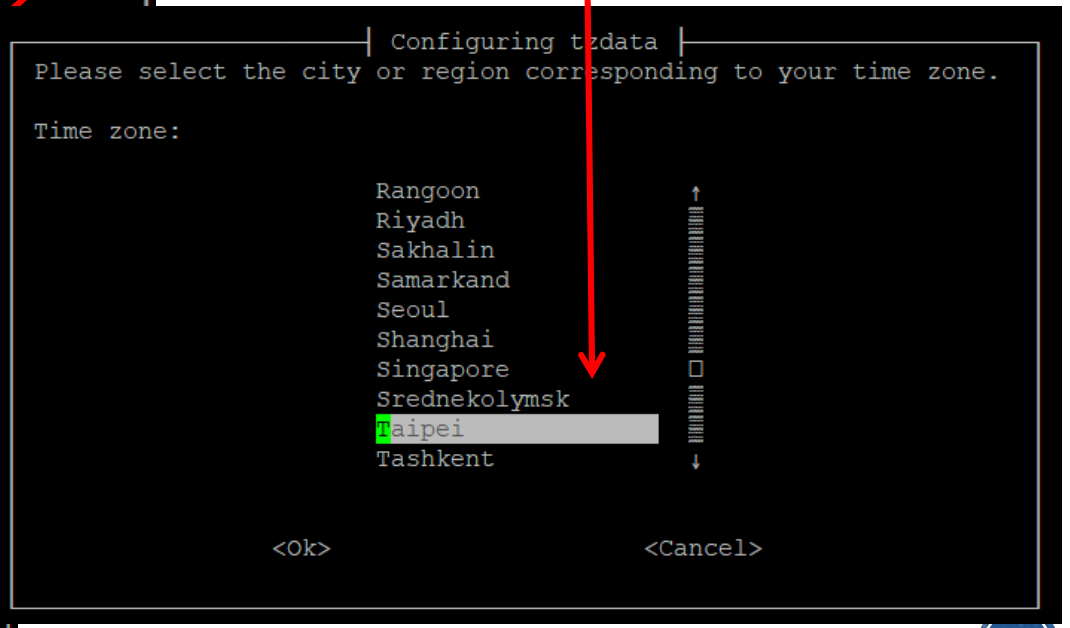
Hostname Rules

- Set your hostname to “rpi4-oxx”.
- o: CS348A uses ‘A’; CS348B uses ‘B’; IN303A uses ‘C’.
- xx: use the labelled number of your RPi.

TimeZone


Raspberry Pi Software Configuration Tool (raspi-config)
1 System Options Configure system settings
2 Display Options Configure display settings
3 Interface Options Configure connections to peripherals
4 Performance Options Configure performance settings
5 Localisation Options Configure language and regional settings
6 Advanced Options Configure advanced settings
8 Update Update this tool to the latest version
9 About raspi-config Information about this configuration tool
Raspberry Pi Software Configuration Tool (raspi-config)
L1 Locale Configure language and regional settings
L2 Timezone Configure time zone
L3 Keyboard Set keyboard layout to match your keyboard
L4 WLAN Country Set legal wireless channels for your country
<Select>
<Back>


Configuring tzdata
Please select the geographic area in which you live. Subsequent configuration questions will narrow this down by presenting a list of cities, representing the time zones in which they are located.
Geographic area:
Africa
America
Antarctica
Australia
Arctic Ocean
Asia
Atlantic Ocean
Europe
<Ok>
<Cancel>


Configuring tzdata
Please select the city or region corresponding to your time zone.
Time zone:
Rangoon
Riyadh
Sakhalin
Samarkand
Seoul
Shanghai
Singapore
Srednekolymsk
Taipei
Tashkent
<Ok>
<Cancel>

Reboot

- Press ESC to exit raspi-config
- Reboot

$ sudo reboot

```
pi@raspberrypi:~$ sudo reboot
```

- Log in with your new password.

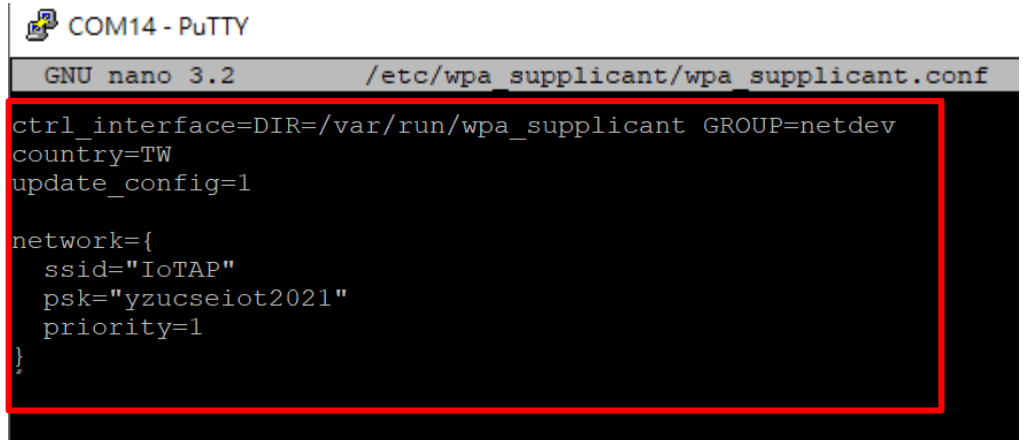
```
Raspbian GNU/Linux 10 rpi4-A00 ttyAMA0

rpi4-A00 login: pi
Password:
```

Wi-Fi

- Check your wi-fi setting

  $ sudo nano /etc/wpa_supplicant/wpa_supplicant.conf

- It's the settings we set in the SD card.



- "ctrl+x" to exit nano.

Wi-Fi

- Check if you can get an IP address from the Wi-Fi AP.

$ ifconfig wlan0

```
pi@rpi4-A00:~$ ifconfig wlan0
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.88.249  netmask 255.255.255.0  broadcast 192.168.88.255
        inet6 fe80::6d4:5b3b:a133:84da  prefixlen 64  scopeid 0x20<link>
        ether dc:a6:32:9d:d8:91  txqueuelen 1000  (Ethernet)
        RX packets 59  bytes 9694 (9.4 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 39  bytes 5500 (5.3 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

$ iwconfig

```
pi@rpi4-A00:~$ iwconfig
eth0      no wireless extensions.

wlan0     IEEE 802.11  ESSID:"IoTAP"
          Mode:Managed  Frequency:2.412 GHz  Access Point: E0:63:DA:AD:A2:34
          Bit Rate=24 Mb/s   Tx-Power=31 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Power Management:on
          Link Quality=70/70  Signal level=-32 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:2  Invalid misc:0   Missed beacon:0

lo        no wireless extensions.
```

Lab 2-2

- Check if your RPi acquires a private IP address.
- Check the internet connection.

$ ping www.google.com

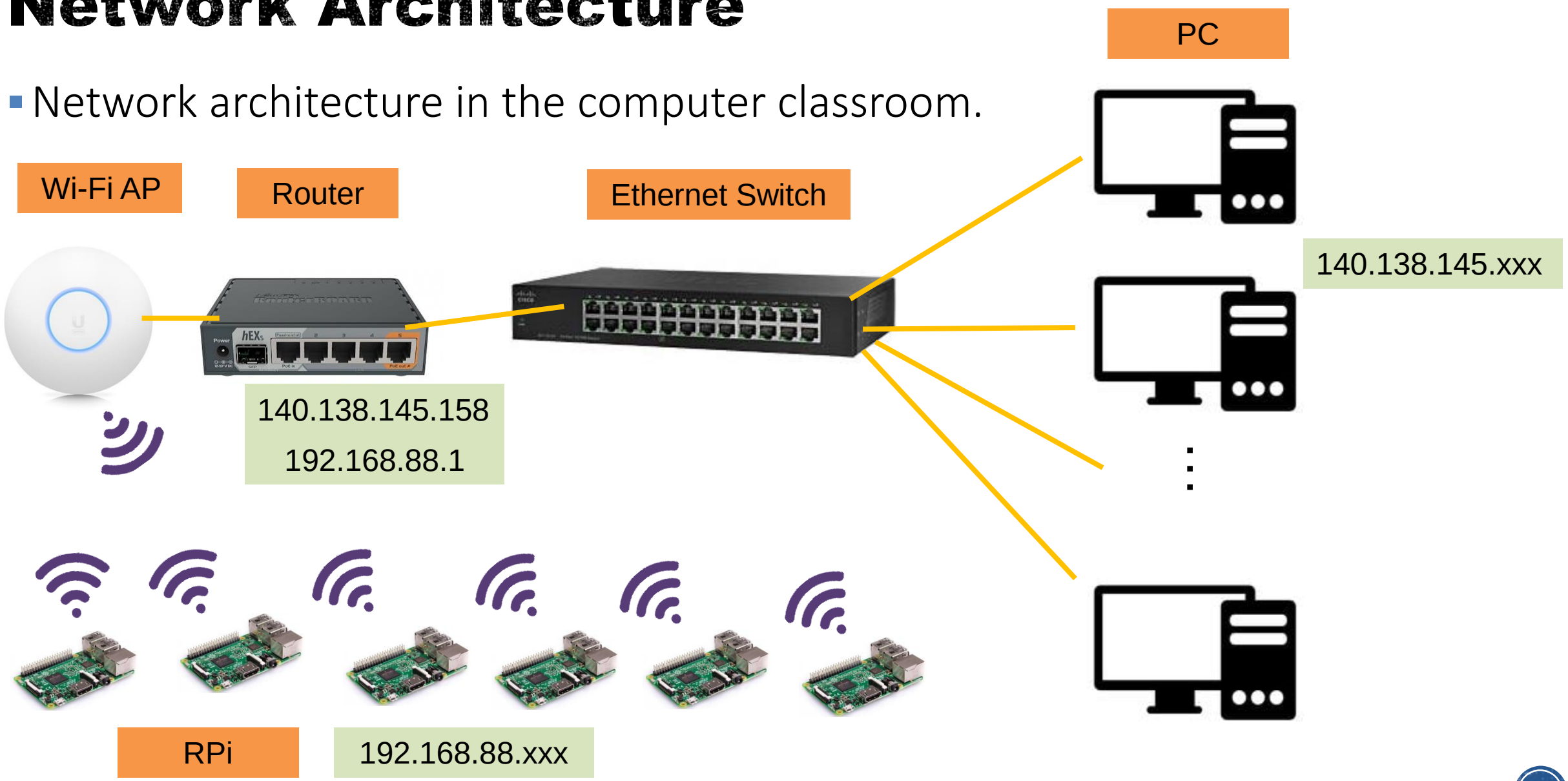
- No demonstration

Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

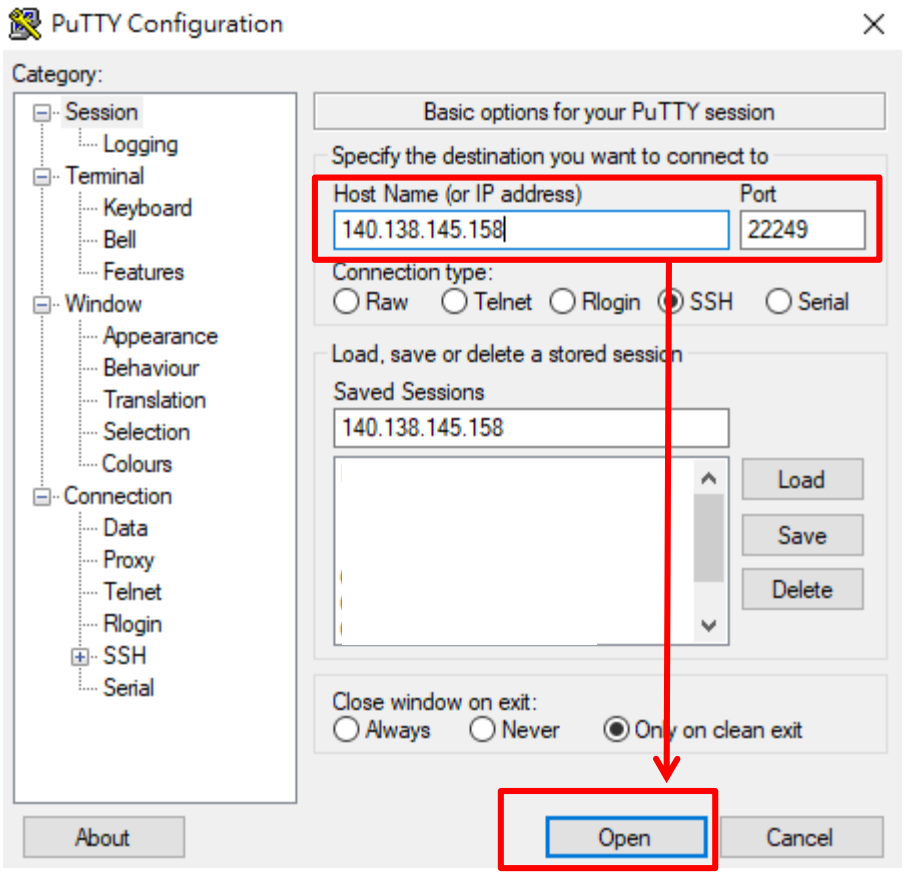
Network Architecture

- Network architecture in the computer classroom.

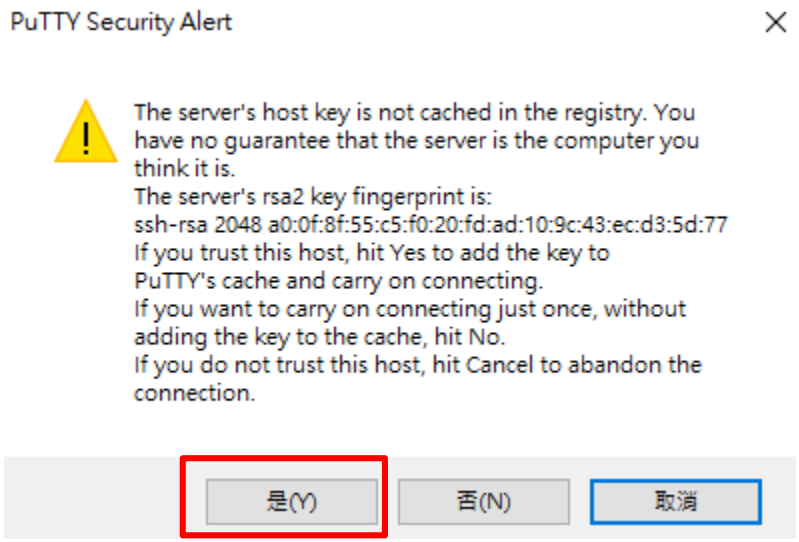


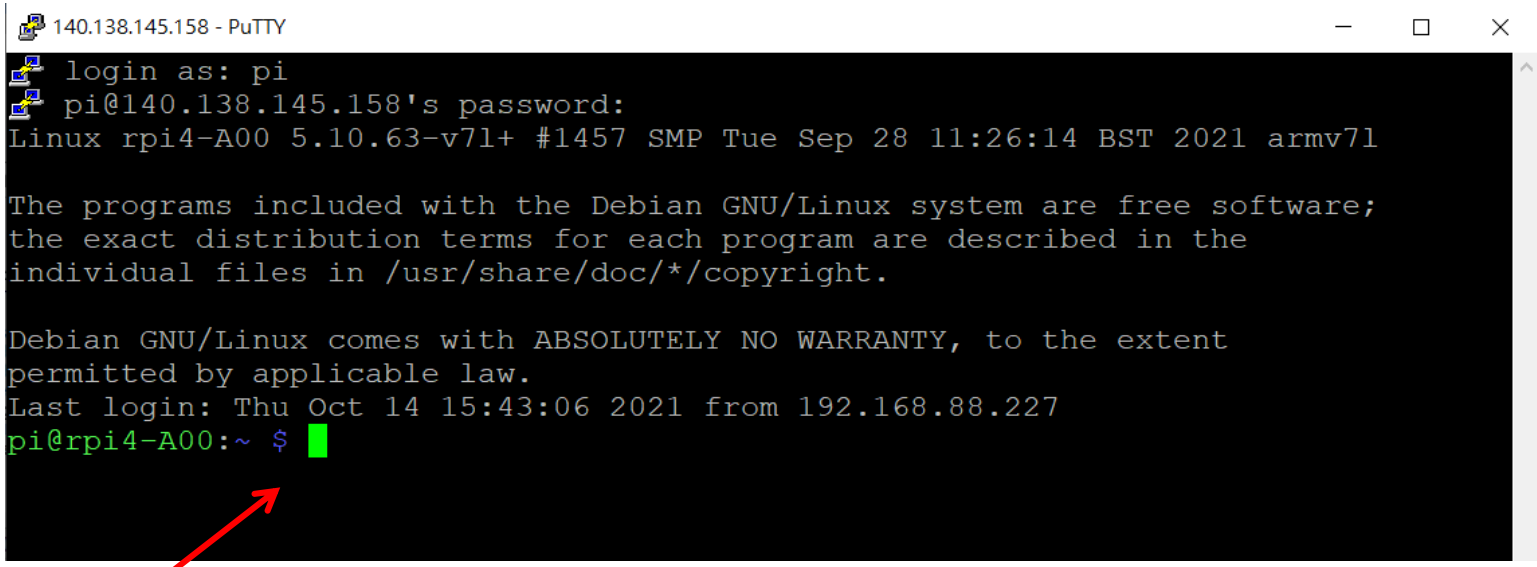
SSH

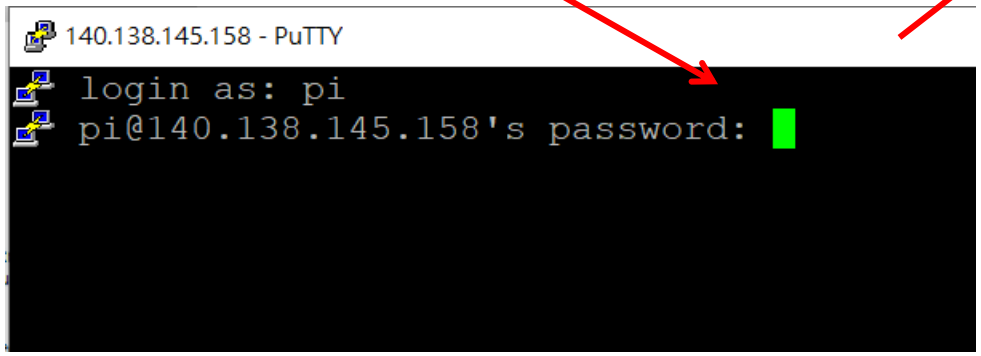
- Open “putty”
- The default port of SSH is 22.
- But, your RPi is under NAT of a router.
  - 192.168.88.xxx
- Set your ssh port to a number 22xxx where xxx is the last byte of your IP.
  - Ex: If your IP is 192.168.88.249, then your ssh port is 22249.
- Connect to 140.138.145.158:22xxx.



Log In


PuTTY Security Alert
The server's host key is not cached in the registry. You have no guarantee that the server is the computer you think it is.
The server's rsa2 key fingerprint is:
ssh-rsa 2048 a0:0f:8f:55:c5:f0:20:fd:ad:10:9c:43:ec:d3:5d:77
If you trust this host, hit Yes to add the key to PuTTY's cache and carry on connecting.
If you want to carry on connecting just once, without adding the key to the cache, hit No.
If you do not trust this host, hit Cancel to abandon the connection.
是(Y)
否(N)
取消


140.138.145.158 - PuTTY
login as: pi
pi@140.138.145.158's password:
Linux rpi4-A00 5.10.63-v7l+ #1457 SMP Tue Sep 28 11:26:14 BST 2021 armv7l
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu Oct 14 15:43:06 2021 from 192.168.88.227
pi@rpi4-A00:~ $


140.138.145.158 - PuTTY
login as: pi
pi@140.138.145.158's password:

Advanced Packaging Tools

- After you have the network connection, you can use install your required services. or packages.
  - Use apt-get to install compiled packages.
- Usages:
  - Update packages: sudo apt-get update
  - Install packages: sudo apt-get install <pkg_name>
  - Search packages: sudo apt-cache search <keyword>
  - Remove packages: sudo apt-get remove <pkg_name>
  - Upgrade packages: sudo apt-get upgrade

Update & Upgrade

$ sudo apt-get update

```
pi@rpi4-A00:~$ sudo apt-get update
Get:1 http://archive.raspberrypi.org/debian buster InRelease [32.6 kB]
Get:2 http://raspbian.raspberrypi.org/raspbian buster InRelease [15.0 kB]
Get:3 http://archive.raspberrypi.org/debian buster/main armhf Packages [331 kB]
Get:4 http://raspbian.raspberrypi.org/raspbian buster/main armhf Packages [13.0
MB]
Fetched 13.4 MB in 14s (981 kB/s)
Reading package lists... Done
```

$ sudo apt-get upgrade

```
pi@rpi4-A00:~$ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following package was automatically installed and is no longer required:
  python-colorzero
Use 'sudo apt autoremove' to remove it.
The following packages will be upgraded:
  aspell base-files bluez chromium-browser chromium-browser-l10n
  chromium-codecs-ffmpeg-extra debconf debconf-i18n debconf-utils dillo
```

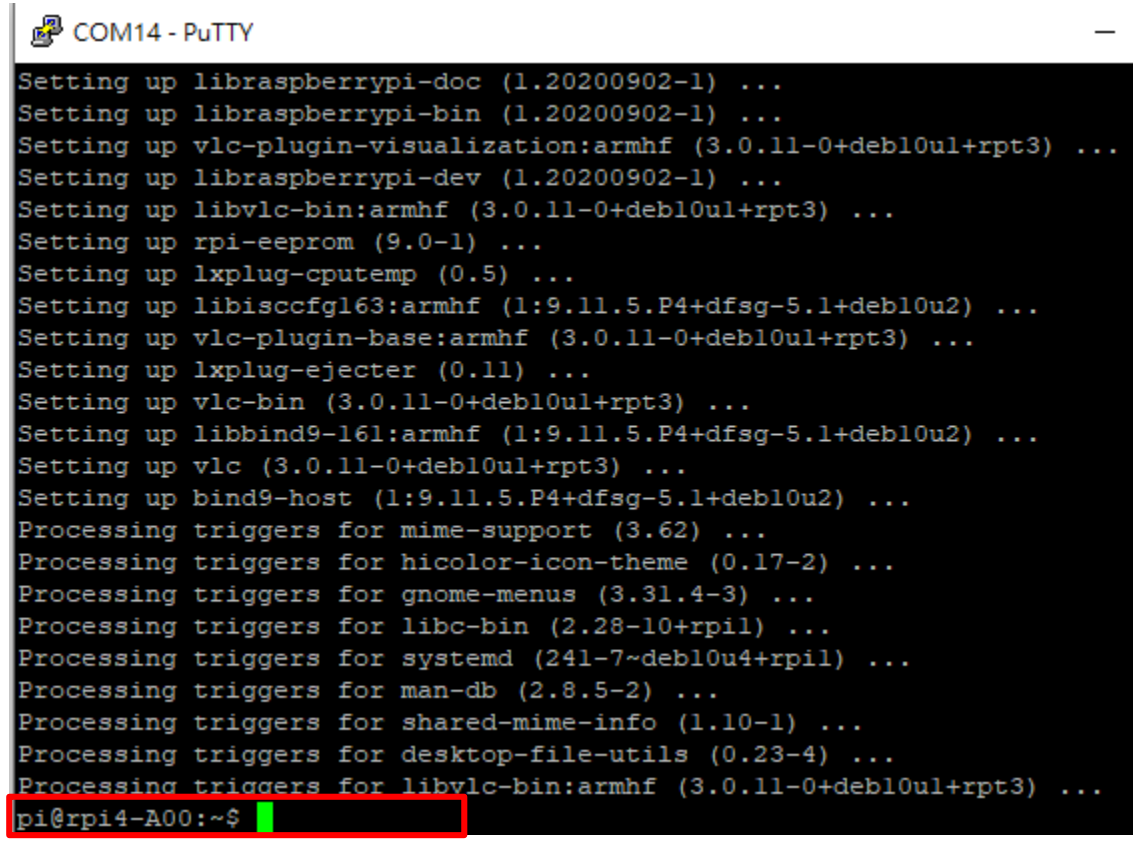
⋮

```
  vlc-plugin-skins2 vlc-plugin-video-output vlc-plugin-video-splitter
  vlc-plugin-visualization
119 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
Need to get 349 MB of archives.
After this operation, 51.1 MB of additional disk space will be used.
Do you want to continue? [Y/n]
```

Enter ‘Y’

Update & Upgrade

- The upgrade is complete when you see the prompt $.



Lab 2-3

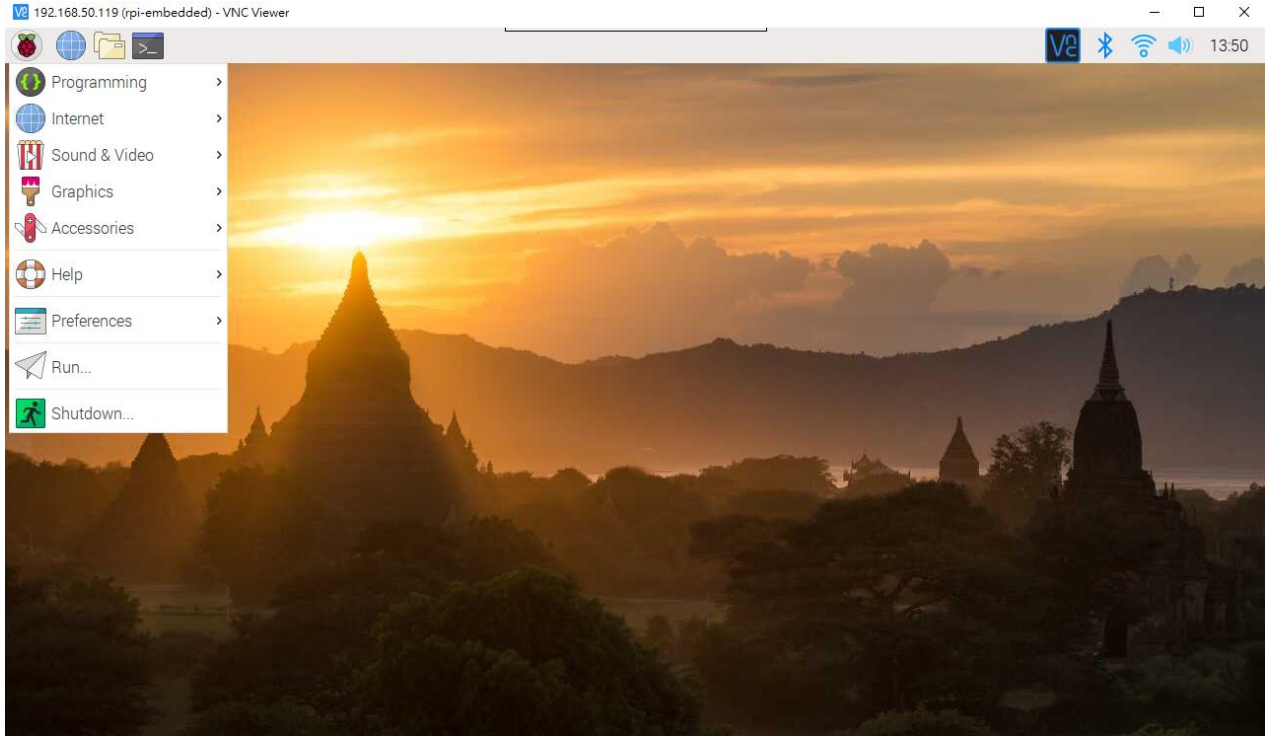
- Remote access via SSH.
- No demonstration.

Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

RPi GUI

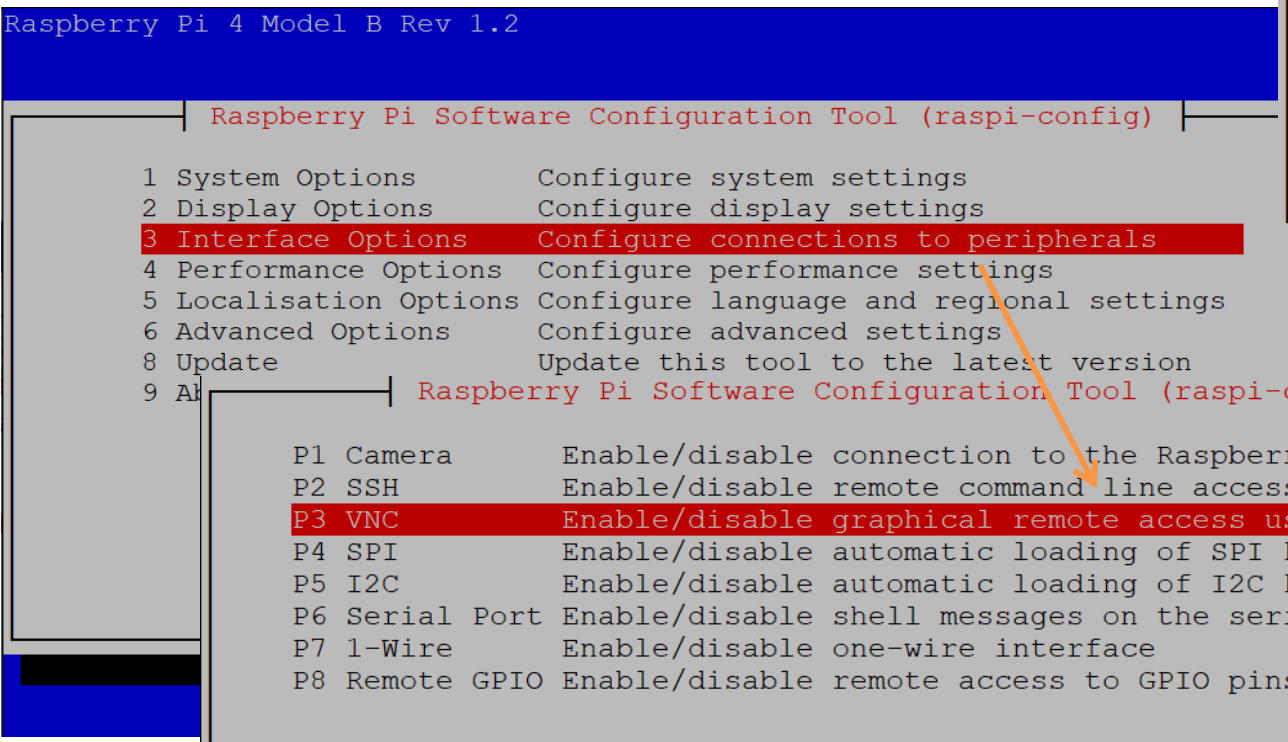
- Possible methods to access RPi with GUI
  - Local machine (Monitor, keyboard, and mouse)
  - VNC viewer
  - Remote desktop protocol (xrdp)

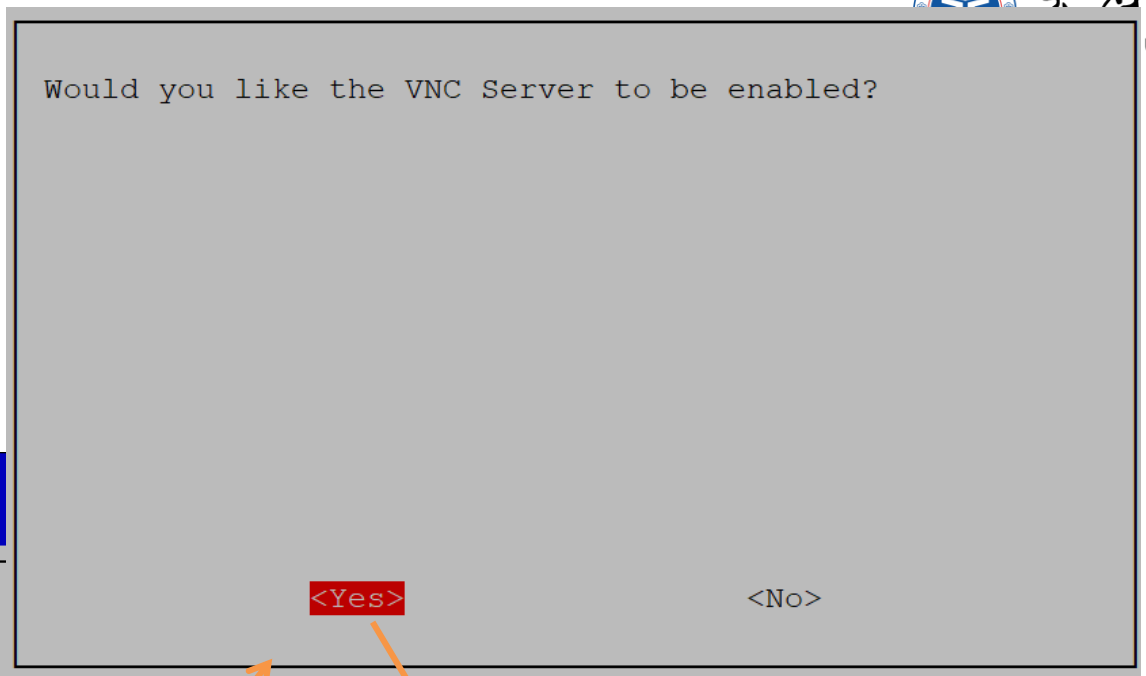


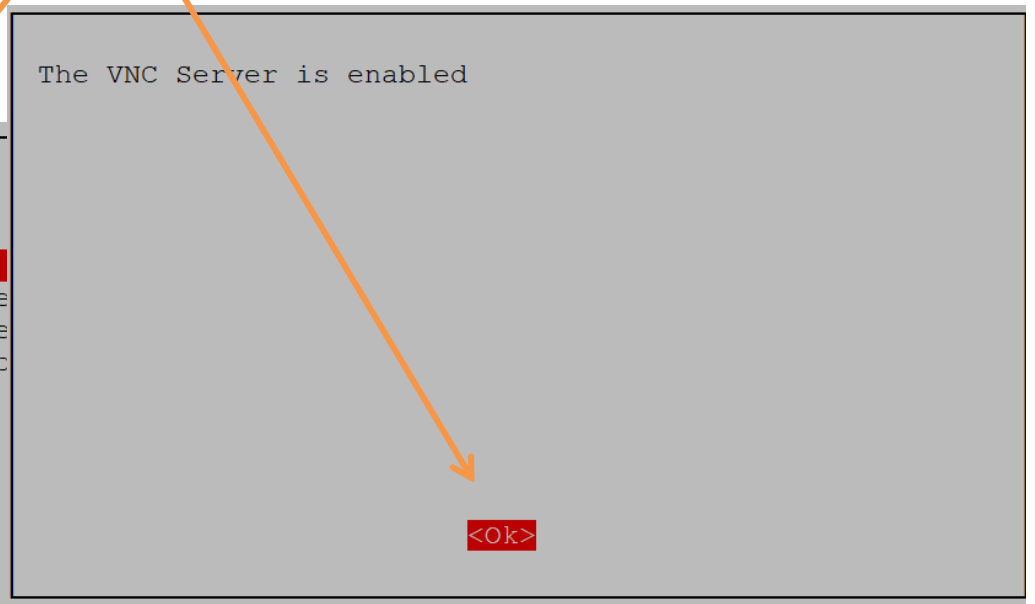
Remote Desktop

- Enable VNC.

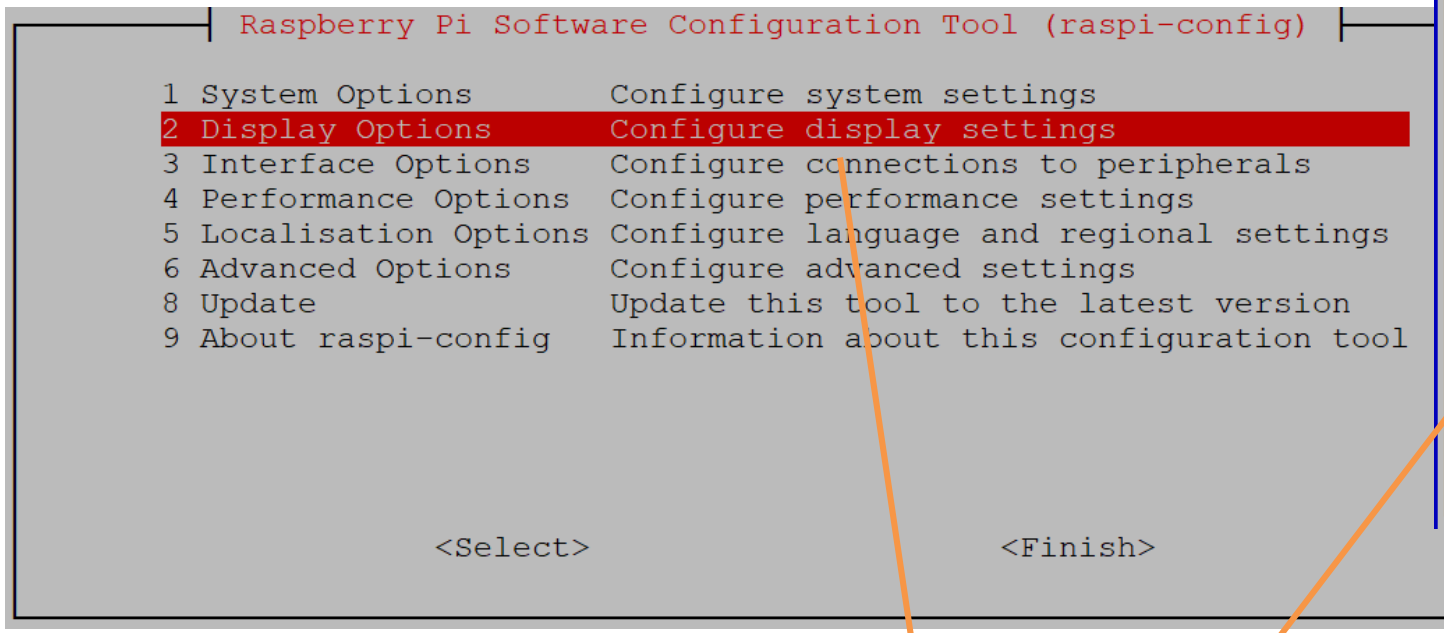
$ sudo raspi-config

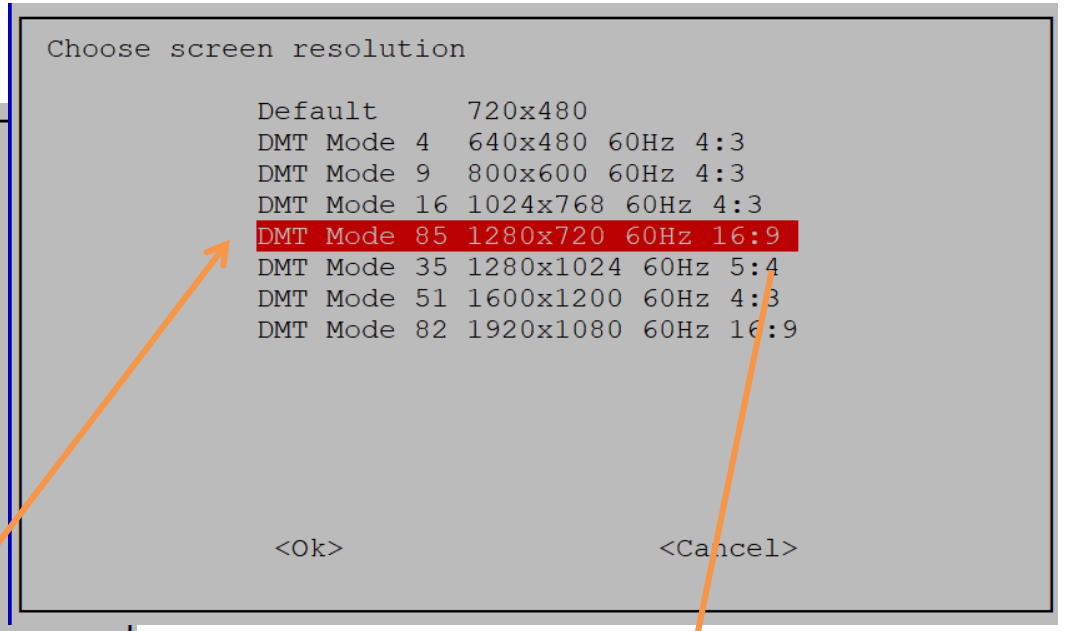


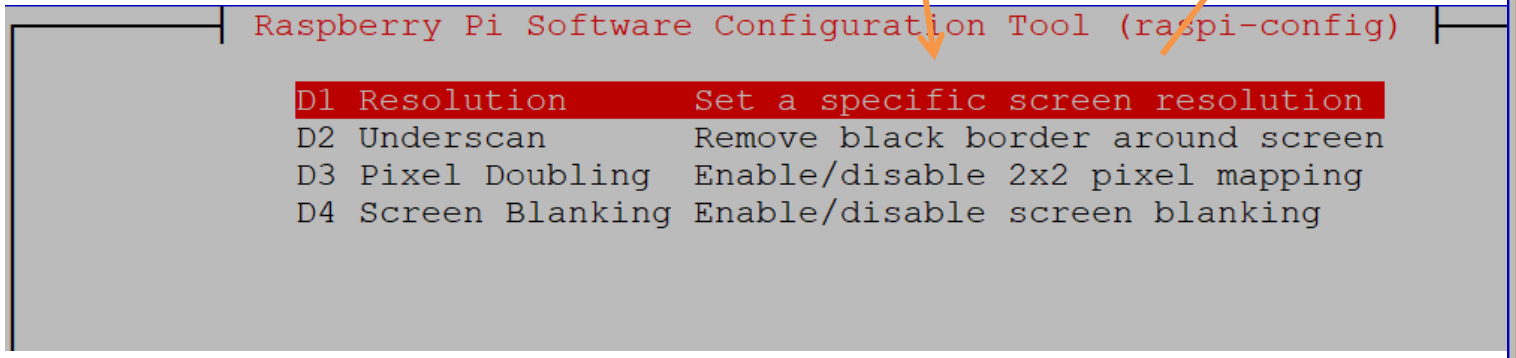


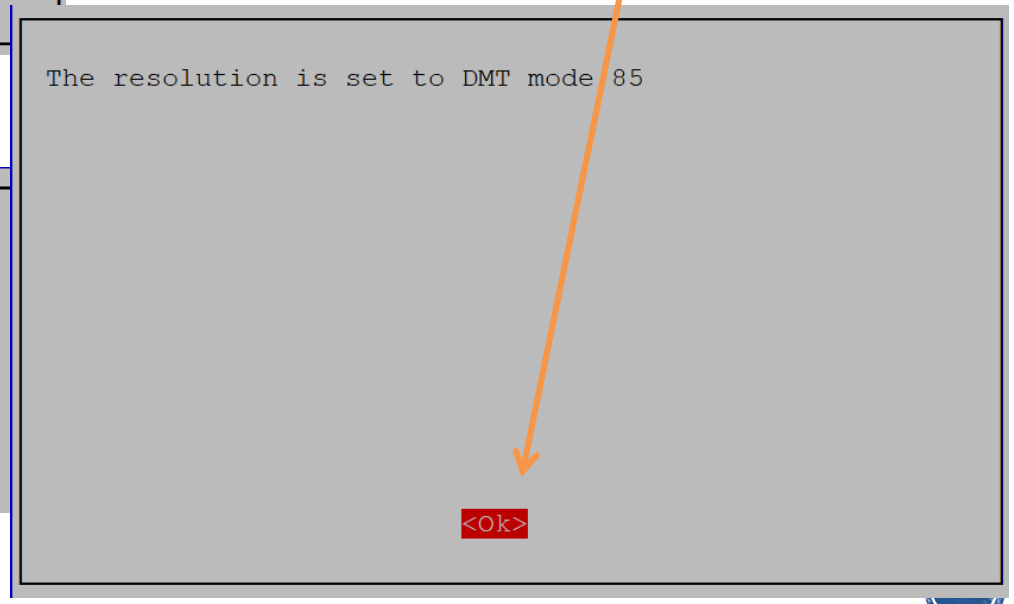


Resolution


Raspberry Pi Software Configuration Tool (raspi-config)
1 System Options Configure system settings
2 Display Options Configure display settings
3 Interface Options Configure connections to peripherals
4 Performance Options Configure performance settings
5 Localisation Options Configure language and regional settings
6 Advanced Options Configure advanced settings
8 Update Update this tool to the latest version
9 About raspi-config Information about this configuration tool
<Select>
<Finish>


Choose screen resolution
Default 720x480
DMT Mode 4 640x480 60Hz 4:3
DMT Mode 9 800x600 60Hz 4:3
DMT Mode 16 1024x768 60Hz 4:3
DMT Mode 85 1280x720 60Hz 16:9
DMT Mode 35 1280x1024 60Hz 5:4
DMT Mode 51 1600x1200 60Hz 4:3
DMT Mode 82 1920x1080 60Hz 16:9
<Ok>
<Cancel>


Raspberry Pi Software Configuration Tool (raspi-config)
D1 Resolution Set a specific screen resolution
D2 Underscan Remove black border around screen
D3 Pixel Doubling Enable/disable 2x2 pixel mapping
D4 Screen Blanking Enable/disable screen blanking


The resolution is set to DMT mode 85
<Ok>

Reboot

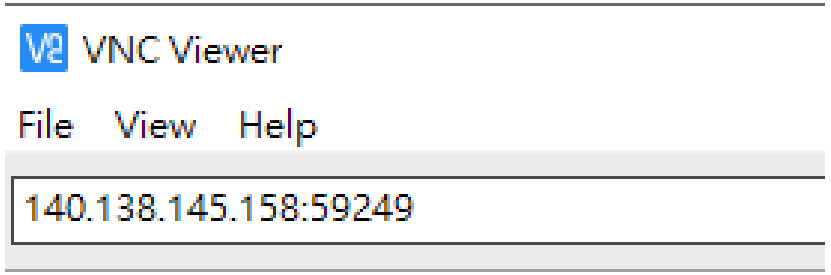
$ sudo reboot

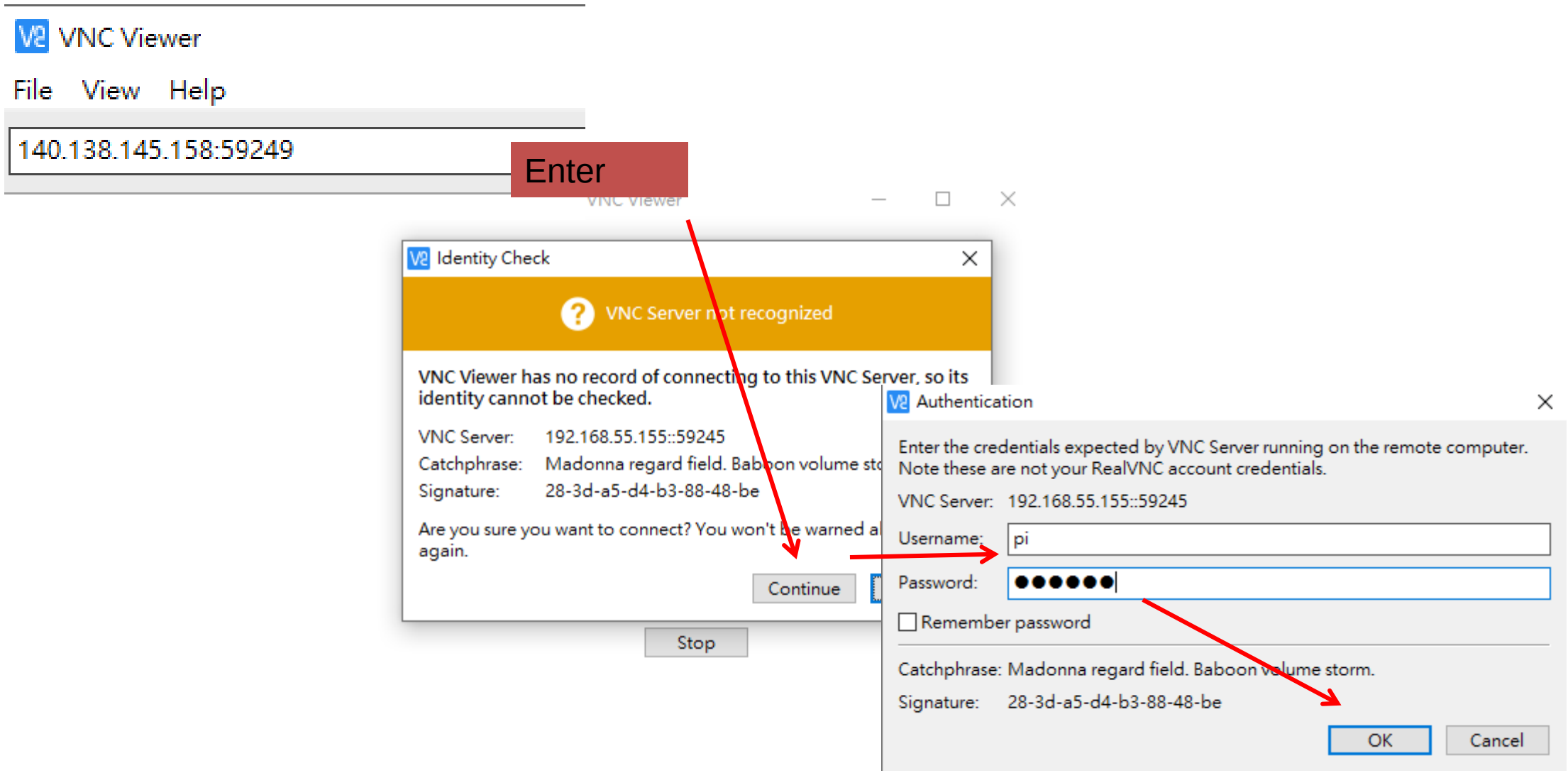
```
pi@rpi4-A00:~ $ sudo reboot
```

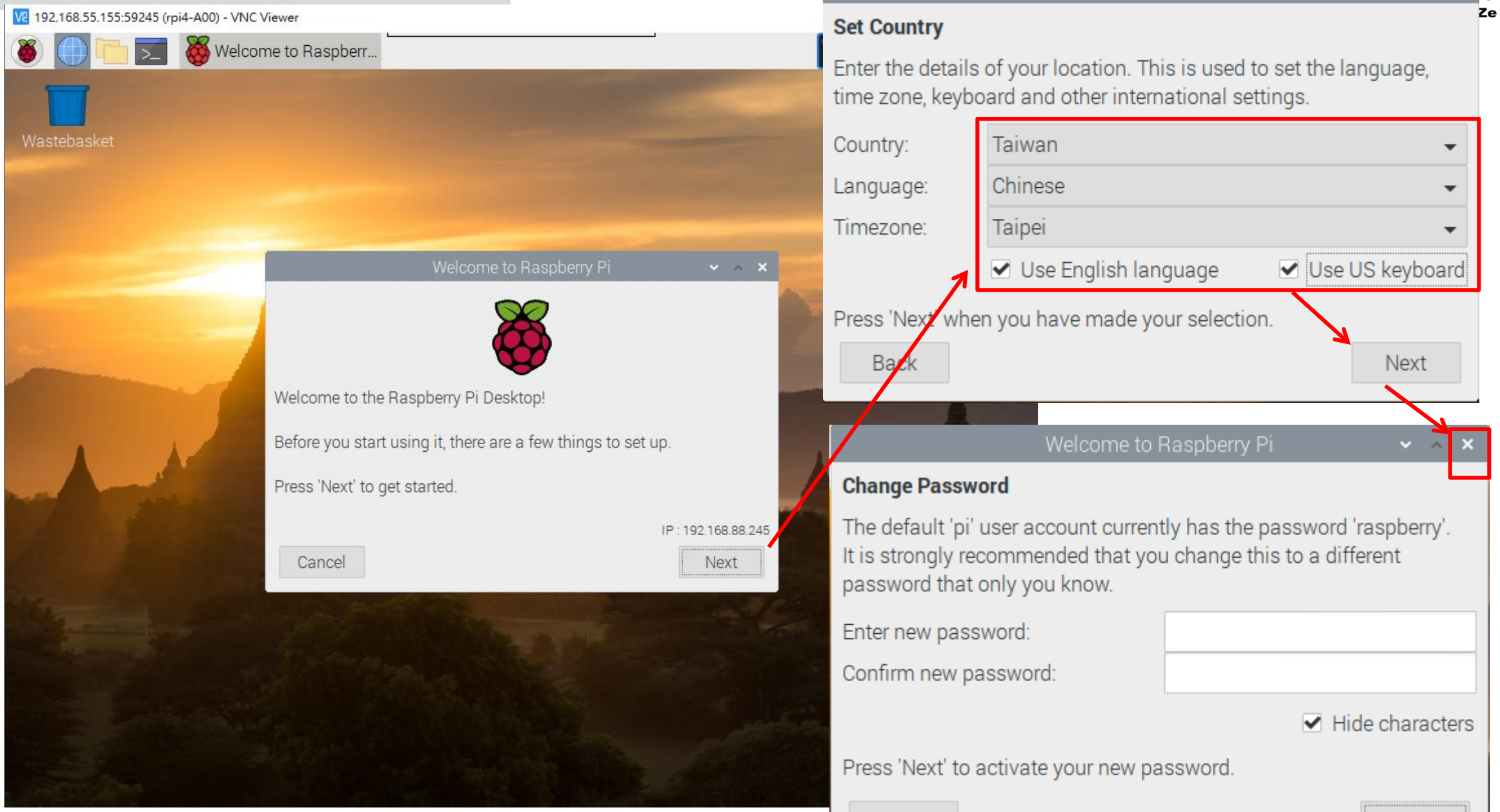
VNC Viewer

- Launch “VNC Viewer”

- The default port of VNC is 5900.
- But, your RPi is under NAT of a router.
- Set your VNC port to a number 59xxx where xxx is the last byte of your IP.
- Ex: If your IP is 192.168.88.249, then your VNC port is 59249.

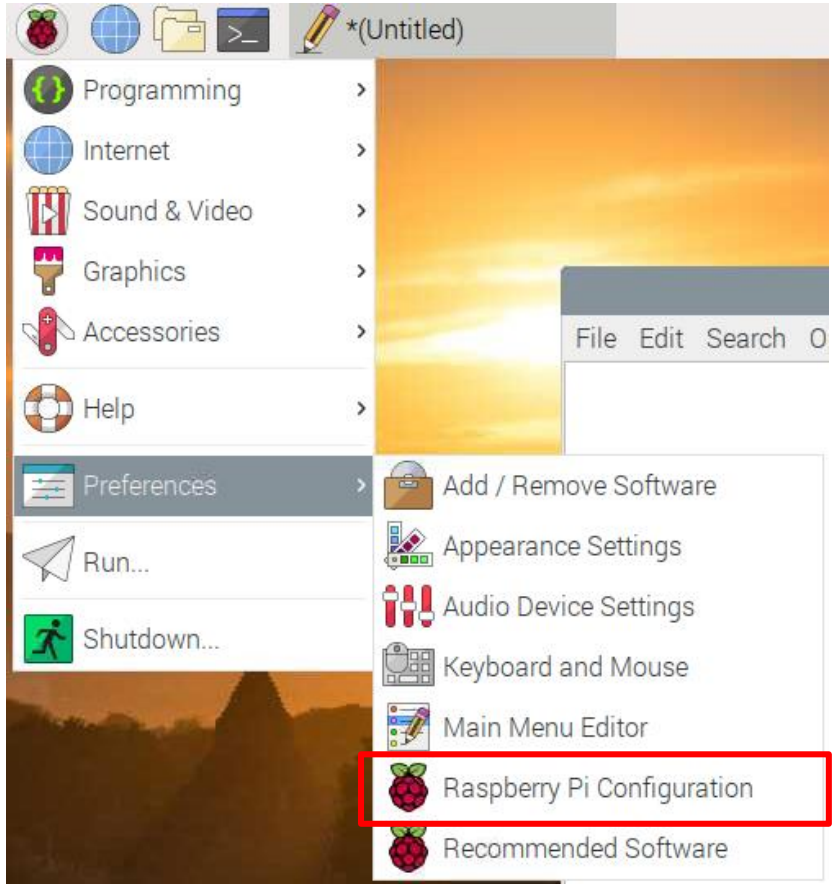


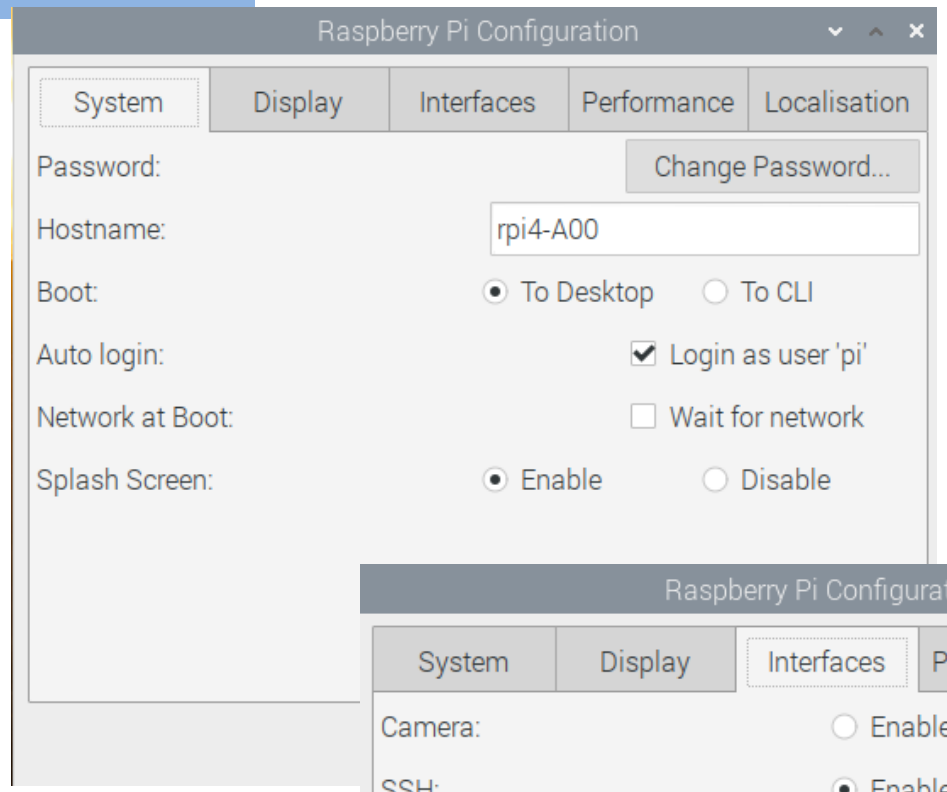

VNC Viewer
File View Help
140.138.145.158:59249
Enter
Identity Check
VNC Server not recognized
VNC Viewer has no record of connecting to this VNC Server, so its identity cannot be checked.
VNC Server: 192.168.55.155::59245
Catchphrase: Madonna regard field. Baboon volume sto
Signature: 28-3d-a5-d4-b3-88-48-be
Are you sure you want to connect? You won't be warned a
again.
Continue
Stop
Authentication
Enter the credentials expected by VNC Server running on the remote computer.
Note these are not your RealVNC account credentials.
VNC Server: 192.168.55.155::59245
Username: pi
Password:
Remember password
Catchphrase: Madonna regard field. Baboon volume storm.
Signature: 28-3d-a5-d4-b3-88-48-be
OK
Cancel

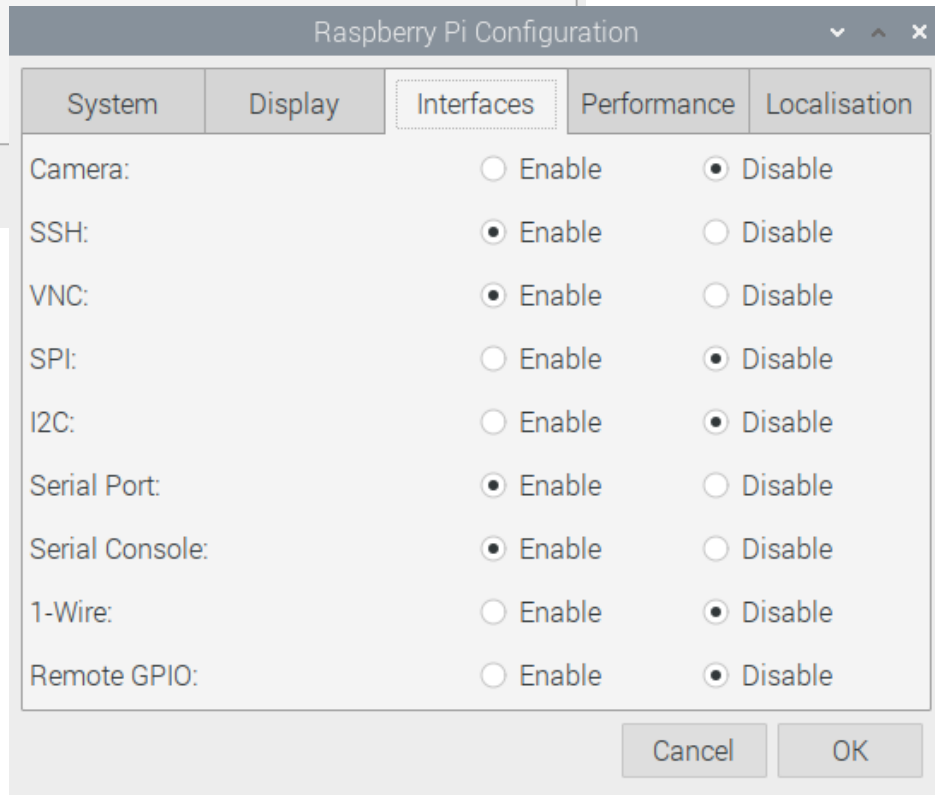

192.168.55.155:59245 (rpi4-A00) - VNC Viewer
Welcome to Raspberr...
Wastebasket
Welcome to Raspberry Pi
Welcome to the Raspberry Pi Desktop!
Before you start using it, there are a few things to set up.
Press 'Next' to get started.
IP : 192.168.88.245
Cancel
Next
Welcome to Raspberry Pi
Set Country
Enter the details of your location. This is used to set the language, time zone, keyboard and other international settings.
Country:
Taiwan
Language:
Chinese
Timezone:
Taipei
Use English language
Use US keyboard
Press 'Next' when you have made your selection.
Back
Next
Welcome to Raspberry Pi
Change Password
The default 'pi' user account currently has the password 'raspberry'. It is strongly recommended that you change this to a different password that only you know.
Enter new password:
Confirm new password:
Hide characters
Press 'Next' to activate your new password.
Back
Next

RPi GUI

- RPi configurations

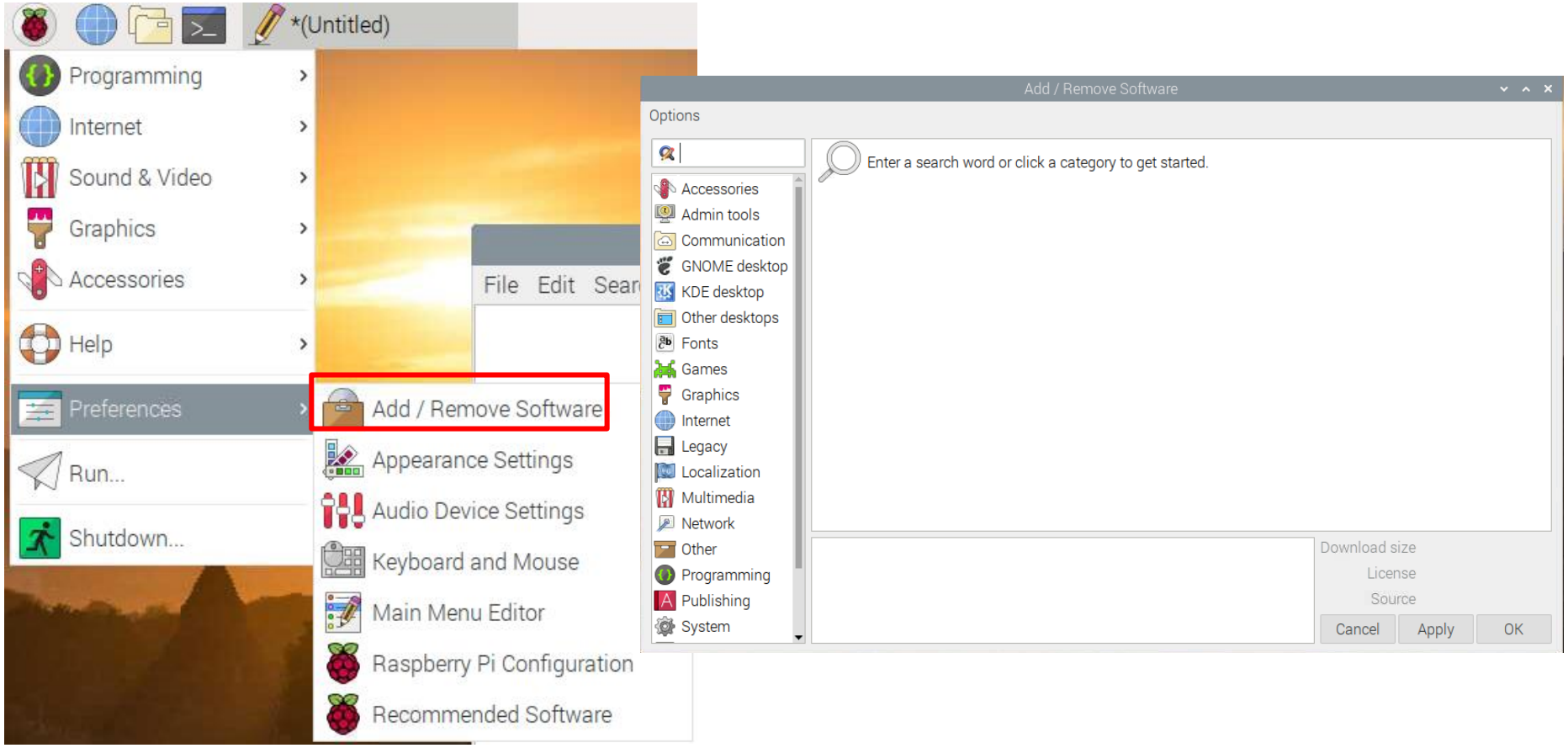






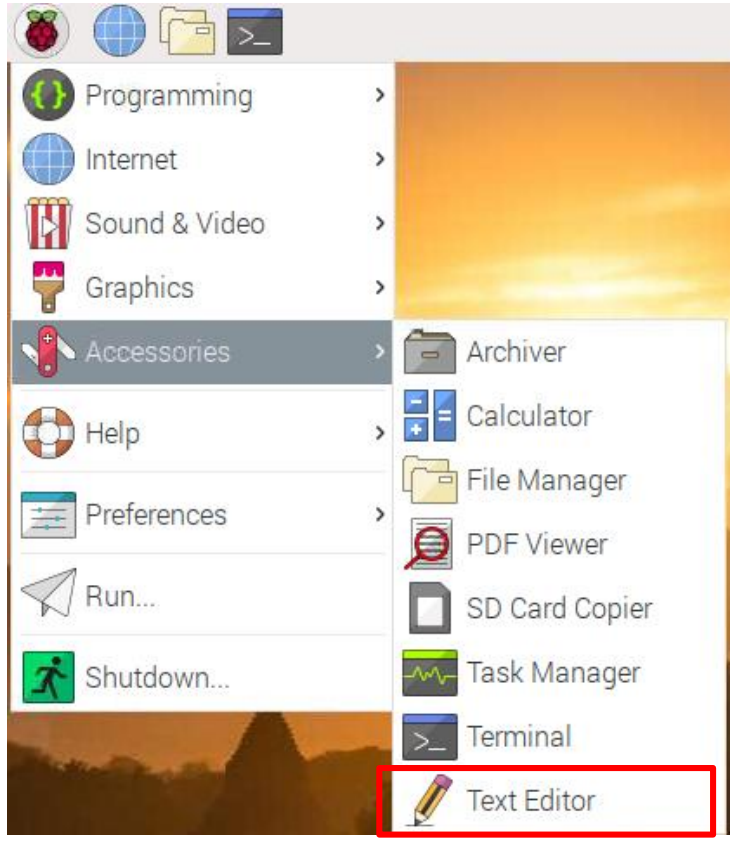
RPi GUI

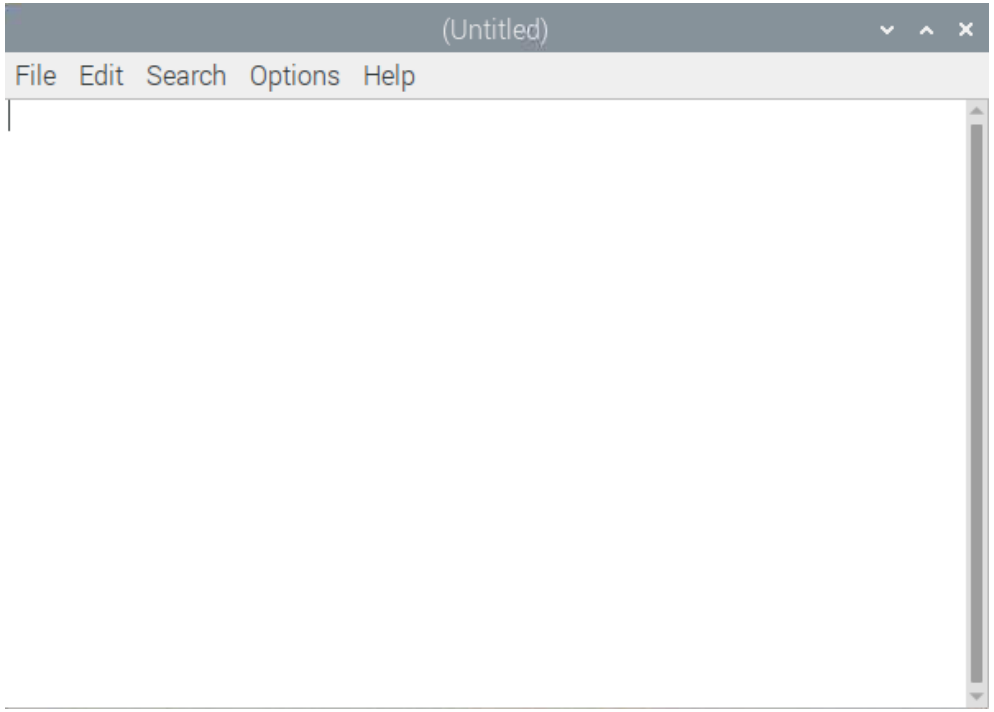
- RPi package manager



RPi GUI

- Accessories



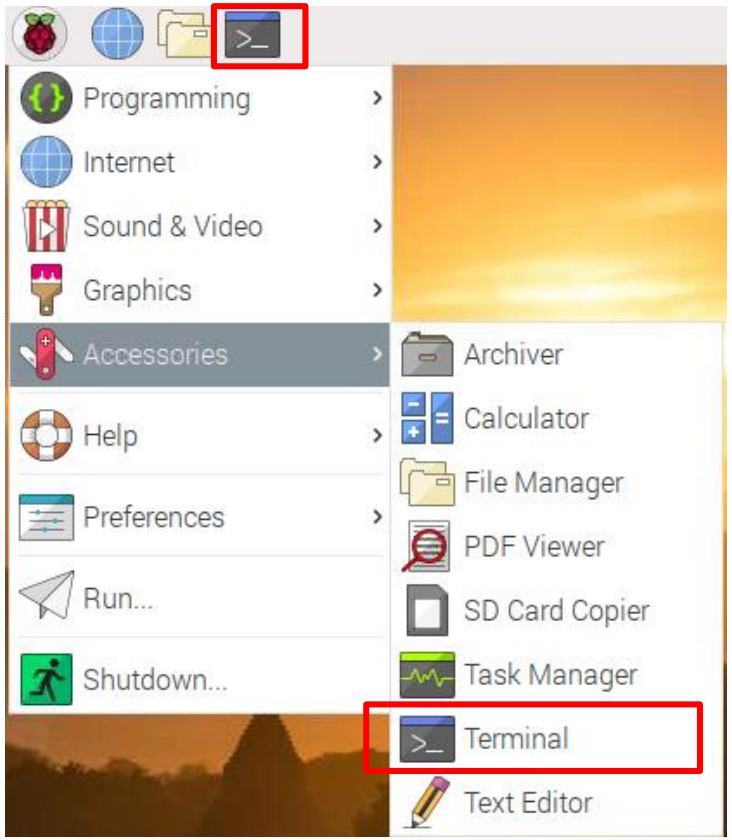


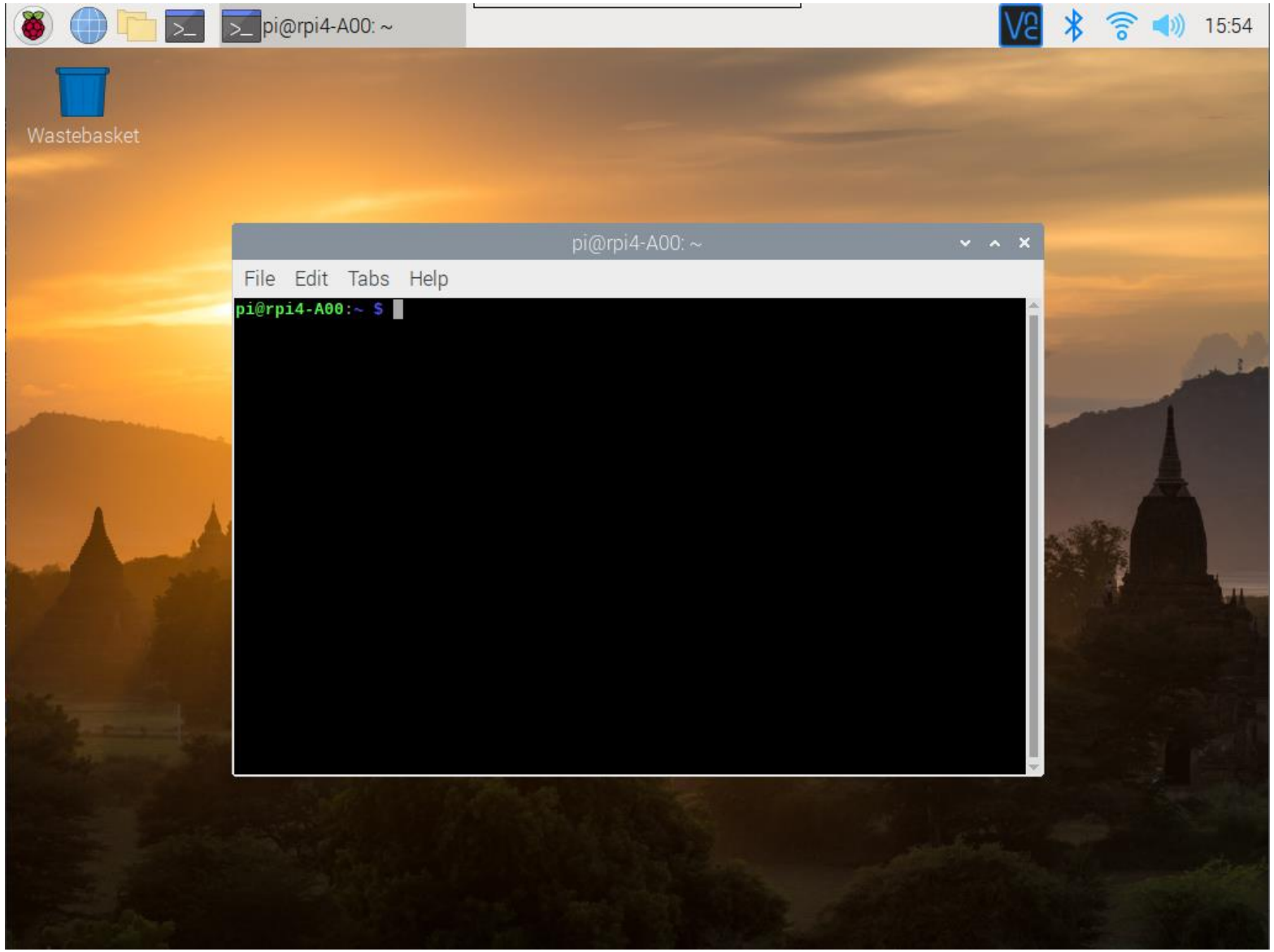
RPi GUI

- Browser

RPi GUI

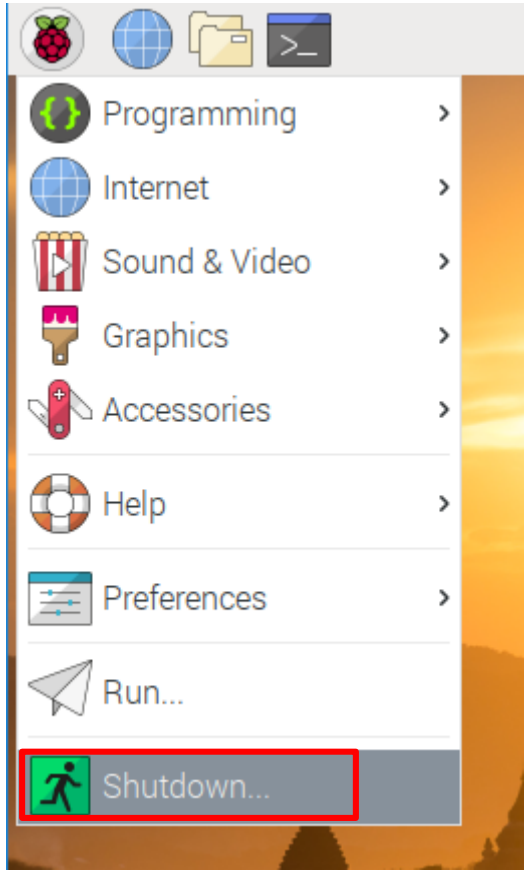
- Terminal

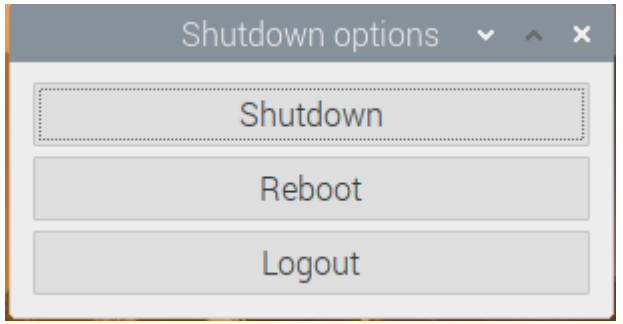




RPi GUI

- Shutdown or reboot RPi





Lab 2-4

- Check GUI of RPi by VNC viewer.
- No demonstration.

Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

Command Prompt

- You can access RPi through command prompt via
  - TTL-USB cable
  - Ethernet cable
  - Wi-Fi
- The network traffic of using remote shell is fewer than that of using remote desktop.

Basic Commands

- Basic commands of linux-based system
- ls: display files under the current directory
  - Use --help to see options

```
pi@rpi4-A00:~ $ ls
Bookshelf  Documents  Music      Public     Videos
Desktop    Downloads  Pictures   Templates
```

- pwd: display the current directory

```
pi@rpi4-A00:~ $ pwd
/home/pi
```

- cd: change directory to the specified path

```
pi@rpi4-A00:~ $ cd ..
pi@rpi4-A00:/home $ cd ~
pi@rpi4-A00:~ $ cd /
pi@rpi4-A00:/ $ cd /home/pi
pi@rpi4-A00:~ $
```

Basic Commands

- mkdir: make a directory with the specified name

```
pi@rpi4-A00:~ $ mkdir test
pi@rpi4-A00:~ $ ls
Bookshelf  Documents  Music      Public     Videos
Desktop    Downloads  Pictures   Templates  test
```

- rmdir: remove an empty directory

```
pi@rpi4-A00:~ $ rmdir test
pi@rpi4-A00:~ $ ls
Bookshelf  Documents  Music      Public     Videos
Desktop    Downloads  Pictures   Templates
```

Basic Commands

- rm: remove the specified files

```
pi@rpi-embedded:~ $ ls
Desktop    Downloads  master.zip  Pictures  Templates  thinclient_drives
Documents  MagPi      Music       Public    test.txt   Videos
```

```
pi@rpi-embedded:~ $ rm test.txt
pi@rpi-embedded:~ $ ls
Desktop    Downloads  master.zip  Pictures  Templates          Videos
Documents  MagPi      Music       Public    thinclient_drives
```

- rm -r-f

```
pi@rpi-embedded:~ $ rm --help
Usage: rm [OPTION]... [FILE]...
Remove (unlink) the FILE(s).

  -f, --force           ignore nonexistent files and arguments, never prompt
  -i                    prompt before every removal
  -I                    prompt once before removing more than three files, or
                          when removing recursively; less intrusive than -i,
                          while still giving protection against most mistakes
      --interactive[=WHEN]  prompt according to WHEN: never, once (-I), or
                          always (-i); without WHEN, prompt always
      --one-file-system  when removing a hierarchy recursively, skip any
                          directory that is on a file system different from
                          that of the corresponding command line argument
      --no-preserve-root  do not treat '/' specially
      --preserve-root[=all]  do not remove '/' (default);
                              with 'all', reject any command line argument
                              on a separate device from its parent
  -r, -R, --recursive   remove directories and their contents recursively
  -d, --dir             remove empty directories
  -v, --verbose         explain what is being done
      --help     display this help and exit
      --version  output version information and exit
```

Basic Commands

- cp: copy files to a specified directory or other name

```
pi@rpi-embedded:~ $ ls
Desktop    MagPi       Pictures   test              Videos
Documents  master.zip  Public     test.txt
Downloads  Music       Templates  thinclient_drives
```

```
pi@rpi-embedded:~ $ cp test.txt test/
pi@rpi-embedded:~ $ ls test/
test.txt
```

  - Copy file with a new name.

```
pi@rpi-embedded:~ $ cp test.txt test2.txt
pi@rpi-embedded:~ $ ls
Desktop    MagPi       Pictures   test       thinclient_drives
Documents  master.zip  Public     test2.txt  Videos
Downloads  Music       Templates  test.txt
```

  - Copy file to a directory with a new name.

```
pi@rpi-embedded:~ $ cp test.txt test/test2.txt
pi@rpi-embedded:~ $ ls test/
test2.txt  test.txt
```

Basic Commands

- mv: move files or directories to the specified path or rename a file

```
pi@rpi-embedded:~ $ ls
Desktop    MagPi       Pictures   test       thinclient_drives
Documents  master.zip  Public     test2.txt  Videos
Downloads  Music       Templates  test.txt
pi@rpi-embedded:~ $ mv test.txt test2.txt test/
pi@rpi-embedded:~ $ ls
Desktop    Downloads  master.zip  Pictures   Templates  thinclient_drives
Documents  MagPi      Music       Public     test       Videos
pi@rpi-embedded:~ $ cd test
pi@rpi-embedded:~/test $ ls
test2.txt  test.txt
```

  - Rename a file

```
pi@rpi-embedded:~/test $ ls
test2.txt  test.txt
pi@rpi-embedded:~/test $ mv test.txt test3.txt
pi@rpi-embedded:~/test $ ls
test2.txt  test3.txt
```

Basic Commands

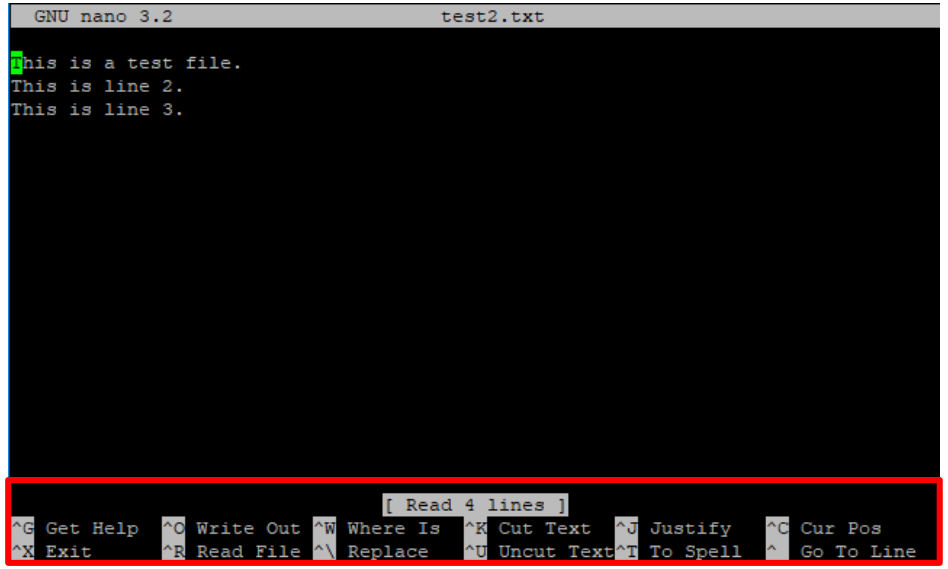
- cat: display the content of a specified file

```
pi@rpi-embedded:~/test $ ls
test2.txt  test3.txt
pi@rpi-embedded:~/test $ nano test2.txt
pi@rpi-embedded:~/test $ cat test2.txt
This is a test file.
This is line 2.
This is line 3.
```

  - In addition to show the content on the standard output, you can redirect the output.

Basic Commands

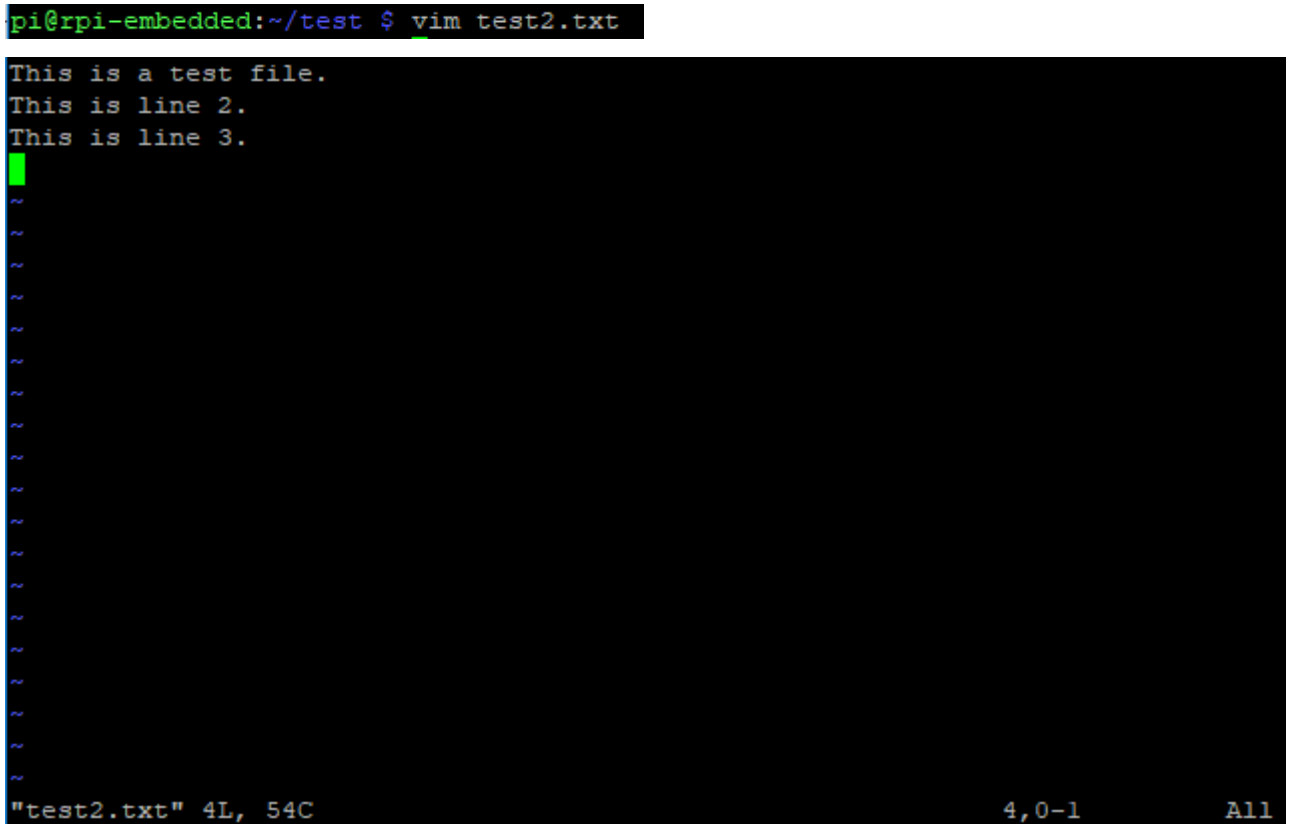
- nano: a lightweight editor



  - Syntax highlighting

Basic Commands

- vi / vim: a popular editor
  - It is not installed by default, you have to install it manually.
  - sudo apt-get install vim

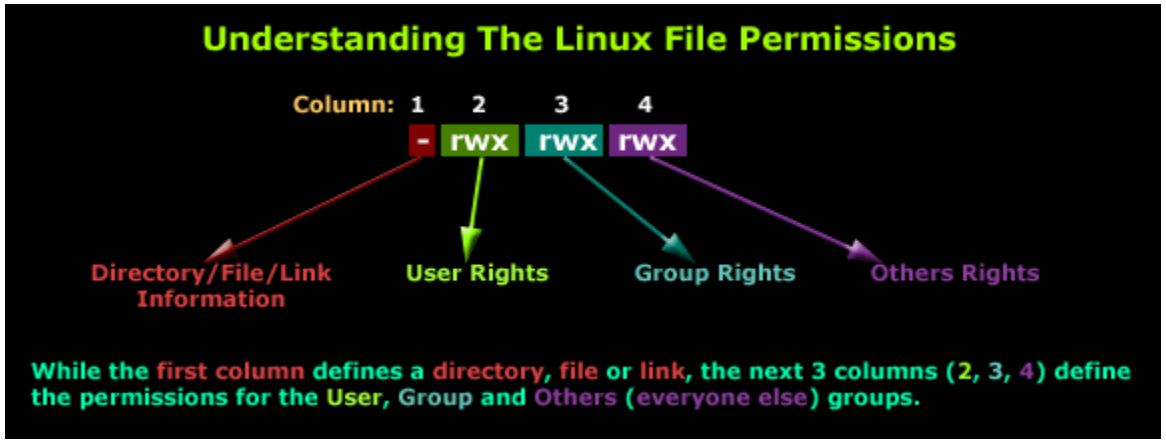


Basic Commands

- chmod: change the permissions of files or directories

```
pi@rpi-embedded:~/test $ ls -l
total 8
-rw-r--r-- 1 pi pi 54 Sep 26 15:23 test2.txt
-rw-r--r-- 1 pi pi  5 Sep 26 15:04 test3.txt
pi@rpi-embedded:~/test $ chmod g+w test2.txt
pi@rpi-embedded:~/test $ ls -l
total 8
-rw-rw-r-- 1 pi pi 54 Sep 26 15:23 test2.txt
-rw-r--r-- 1 pi pi  5 Sep 26 15:04 test3.txt
```

```
pi@rpi-embedded:~/test $ chmod 644 test2.txt
pi@rpi-embedded:~/test $ ls -l
total 8
-rw-r--r-- 1 pi pi 54 Sep 26 15:23 test2.txt
-rw-r--r-- 1 pi pi  5 Sep 26 15:04 test3.txt
```



Basic Commands

- sudo: get a higher priority for doing some commands

```
pi@rpi-embedded:~/test $ cat /etc/sudoers
cat: /etc/sudoers: Permission denied
pi@rpi-embedded:~/test $ sudo cat /etc/sudoers
#
# This file MUST be edited with the 'visudo' command as root.
#
# Please consider adding local content in /etc/sudoers.d/ instead of
# directly modifying this file.
#
# See the man page for details on how to write a sudoers file.
#
```

- shutdown: power off RPi
- Reboot
  - sudo reboot
  - sudo shutdown -r now

```
pi@rpi-embedded:~/test $ shutdown -h now
Failed to set wall message, ignoring: Interactive authentication required.
Failed to power off system via logind: Interactive authentication required.
Failed to open initctl fifo: Permission denied
Failed to talk to init daemon.
pi@rpi-embedded:~/test $ sudo shutdown -h now
```

Basic Commands

- history

```
pi@rpi-embedded:~/test $ history
    1  cd ~
    2  mkdir test
    3  cd test
    4  ls
    5  history
```

  - history #: list the last # commands.

```
pi@rpi-embedded:~/test $ history 4
    3  cd test
    4  ls
    5  history
    6  history 4
```

  - !#: do the # command.

```
pi@rpi-embedded:~/test $ history 4
    3  cd test
    4  ls
    5  history
    6  history 4
pi@rpi-embedded:~/test $ !4
ls
```

Basic Commands

- grep: search a set of contents for lines that match a regular expression.

```
pi@rpi-embedded:~/test $ cat test.txt
123
345
abc
def
pi@rpi-embedded:~/test $ grep 3 test.txt
123
345
pi@rpi-embedded:~/test $ grep ab test.txt
abc
```

- grep can work with other commands.

```
pi@rpi-embedded:~/test $ ls
test2.txt  test3.txt  test.txt
pi@rpi-embedded:~/test $ ls -l | grep test
-rw-r--r-- 1 pi pi 4 Sep 26 18:23 test2.txt
-rw-r--r-- 1 pi pi 4 Sep 26 18:23 test3.txt
-rw-r--r-- 1 pi pi 4 Sep 26 18:22 test.txt
pi@rpi-embedded:~/test $ ls -l | grep test3
-rw-r--r-- 1 pi pi 4 Sep 26 18:23 test3.txt
```

Basic Commands

- top: monitor the process execution and system information
  - Use “ctrl + c” to leave.

```
top - 16:04:16 up 11 min,  3 users,  load average: 0.00, 0.04, 0.05
Tasks: 135 total,   1 running, 134 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.2 sy,  0.0 ni, 99.8 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :    926.1 total,    568.6 free,    116.3 used,    241.2 buff/cache
MiB Swap:    100.0 total,    100.0 free,      0.0 used.    739.2 avail Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
  928 pi        20   0   10188   2924   2564 R   0.7   0.3   0:01.02 top
  221 root      20   0       0      0      0 I   0.3   0.0   0:00.53 kworker/u+
    1 root      20   0   33704   7900   6332 S   0.0   0.8   0:04.57 systemd
    2 root      20   0       0      0      0 S   0.0   0.0   0:00.00 kthreadd
    3 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 rcu_gp
    4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 rcu_par_gp
    7 root      20   0       0      0      0 I   0.0   0.0   0:00.63 kworker/u+
    8 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 mm_percpu+
    9 root      20   0       0      0      0 S   0.0   0.0   0:00.08 ksoftirqd+
   10 root      20   0       0      0      0 I   0.0   0.0   0:00.13 rcu_sched
   11 root      20   0       0      0      0 I   0.0   0.0   0:00.00 rcu_bh
   12 root      rt   0       0      0      0 S   0.0   0.0   0:00.03 migration+
   13 root      20   0       0      0      0 S   0.0   0.0   0:00.00 cpuhp/0
   14 root      20   0       0      0      0 S   0.0   0.0   0:00.00 cpuhp/1
   15 root      rt   0       0      0      0 S   0.0   0.0   0:00.02 migration+
   16 root      20   0       0      0      0 S   0.0   0.0   0:00.03 ksoftirqd+
   19 root      20   0       0      0      0 S   0.0   0.0   0:00.00 cpuhp/2
```

Basic Commands

- More commands
  - clear: clear the console.
  - unzip: decompression
  - tar: compression and decompression
  - tree: display the file structure of the current directory.
  - &: run the program in the background.
  - ps: show the program status.
  - df: show the disk information.
  - whereis: show the path to the program of a specified command.

Lab 2-5

- Create a file “rpi_intro.txt” under Pi’s home directory.
- Copy and paste the first paragraph of the wiki page into “rpi_intro.txt”.
  - https://en.wikipedia.org/wiki/Raspberry_Pi
- Create a folder called “iot” under Pi’s home directory.
- Copy “rpi_intro.txt” into “iot”.
- Change permission of “rpi_intro.txt” to be read-only (444).
- TA will check your results and the command history later.

Outline

- OS installation
- RPi environment settings
- Remote shell access
- Remote desktop
- Basic operations
- Programming on RPi

Python

- prime.py

```
# Program to check if a number is prime or not

# To take input from the user
num = int(input("Enter a number: "))

# define a flag variable
flag = False

# prime numbers are greater than 1
if num > 1:
    # check for factors
    for i in range(2, num):
        if (num % i) == 0:
            # if factor is found, set flag to True
            flag = True
            # break out of loop
            break

# check if flag is True
if flag:
    print(num, "is not a prime number")
else:
    print(num, "is a prime number")
```

Run Python Program

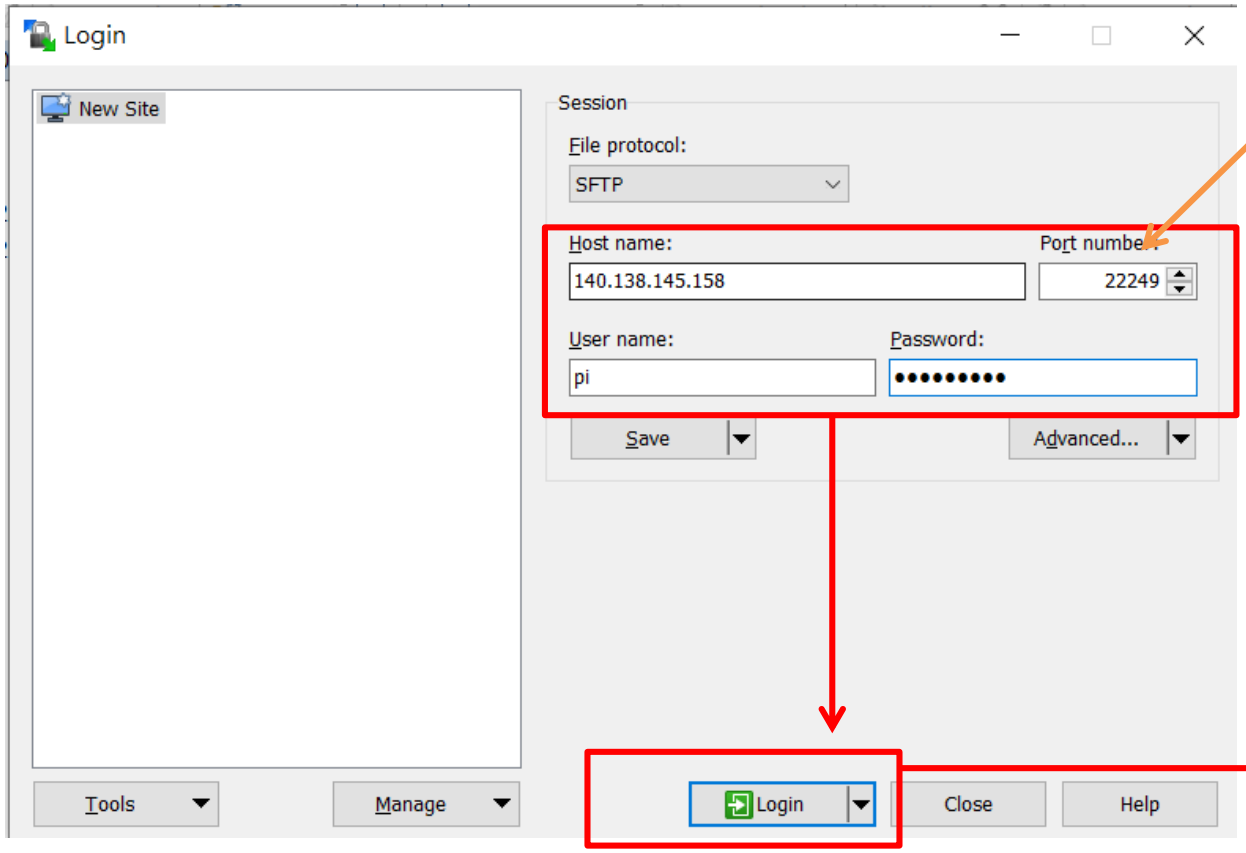
- Edit the program
  - Enter the program on RPi
  - Edit the program on your local machine and upload onto RPi.

$ python3 prime.py

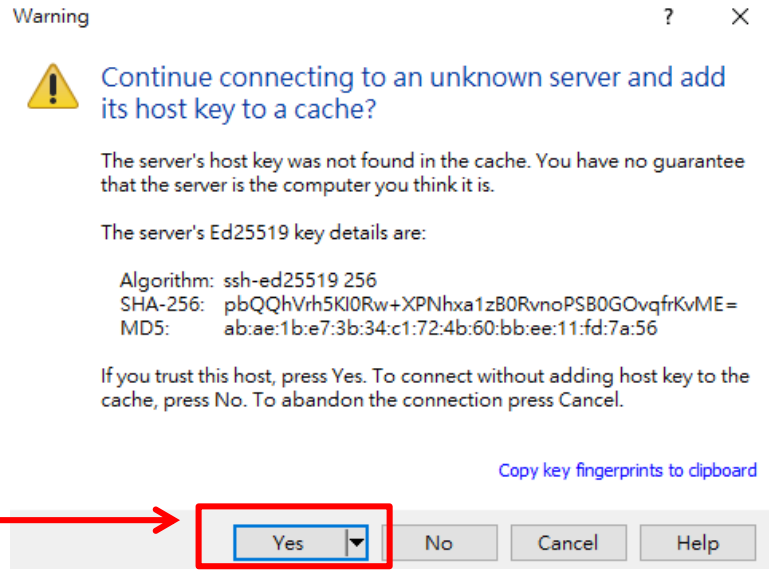
```
pi@rpi4-A00:~ $ python3 prime.py
Enter a number: 100
100 is not a prime number
pi@rpi4-A00:~ $ python3 prime.py
Enter a number: 101
101 is a prime number
```

SCP

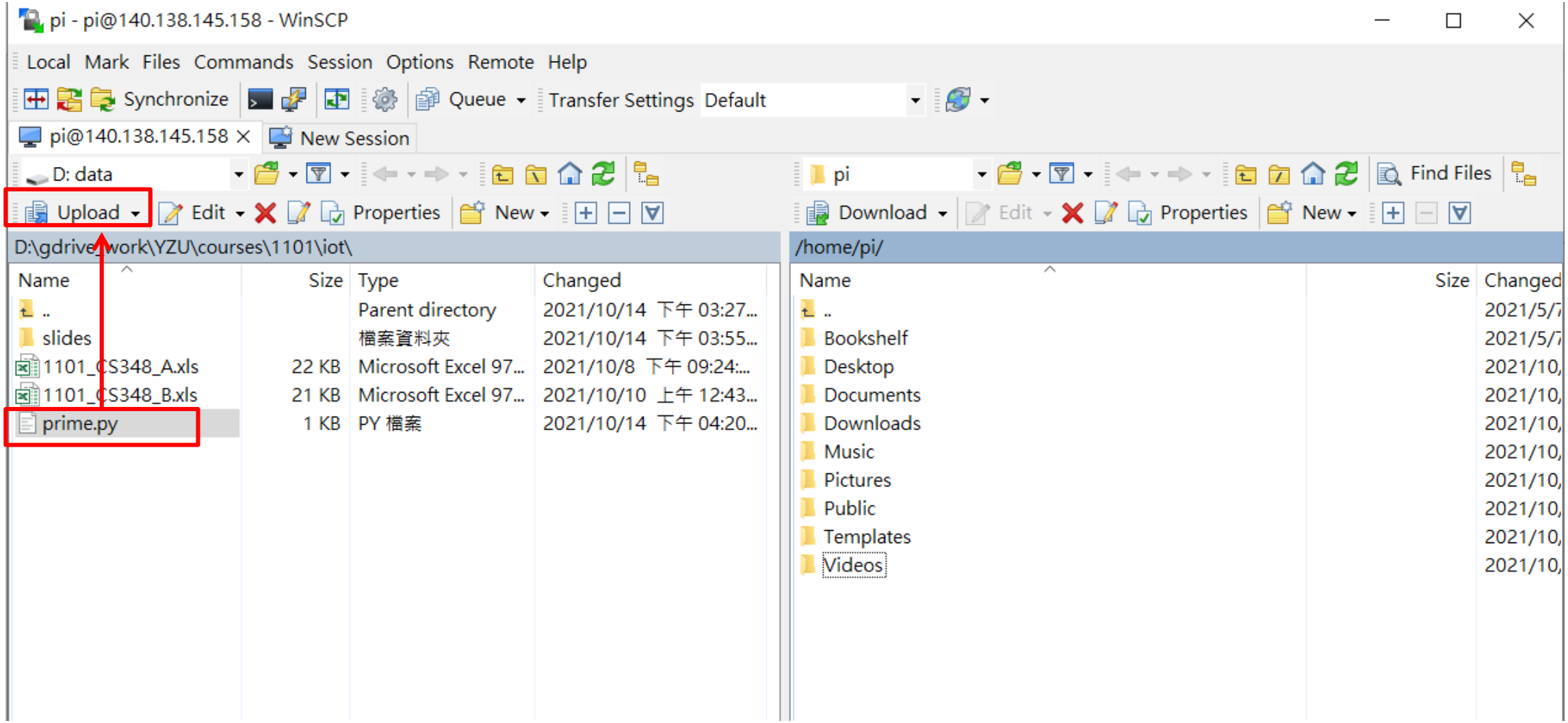
- Transfer the file to RPi by WinSCP.
- SCP (secure copy) is a command used for sending files over SSH.



Use the port number for Putty



SCP


pi - pi@140.138.145.158 - WinSCP
Local Mark Files Commands Session Options Remote Help
Synchronize
Queue
Transfer Settings Default
pi@140.138.145.158
New Session
D: data
Upload
Edit
Properties
New
pi
Find Files
Download
Edit
Properties
New
D:\gdrive_work\YZU\courses\1101\iot\
/home/pi/
Name Size Type Changed
.. Parent directory 2021/10/14 下午 03:27...
slides 檔案資料夾 2021/10/14 下午 03:55...
1101_CS348_A.xls 22 KB Microsoft Excel 97... 2021/10/8 下午 09:24:...
1101_CS348_B.xls 21 KB Microsoft Excel 97... 2021/10/10 上午 12:43...
prime.py 1 KB PY 檔案 2021/10/14 下午 04:20...
Name Size Changed
..
Bookshelf
Desktop
Documents
Downloads
Music
Pictures
Public
Templates
Videos

Labs

- Show TA that you can run python program by VNC Viewer.
- Upload something onto RPi by WinSCP.
- Show the history of Lab 2-5.