ELEG4701

Intelligent Interactive Robot Practice

Introduction to Linux

Jiewen Lai
Research Assistant Professor
EE, CUHK
jiewen.lai@cuhk.edu.hk

Outline

- Linux Overview
- How to install Ubuntu on Virtual Machine (VM)
- Linux Interaction
- File System

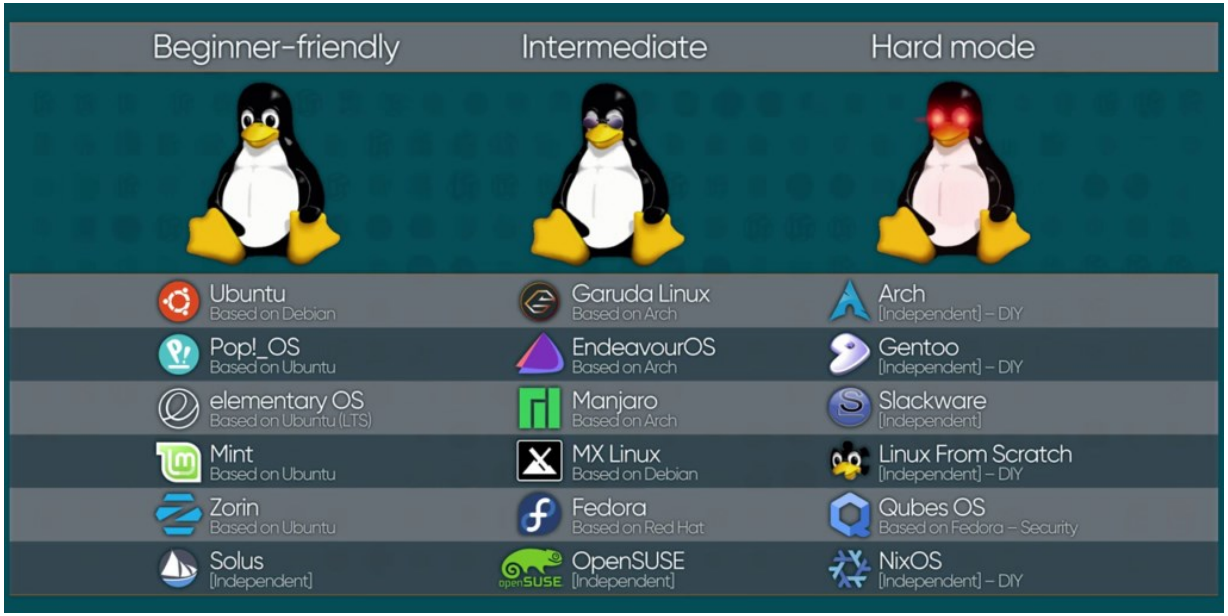
Linux

What, Who, When, Where, and Why

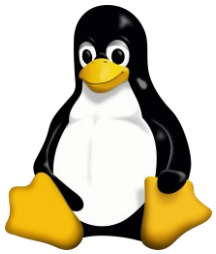
Linux Overview

What is Linux?

- Unix-like computer **operating system** assembled under the model of free and open-source software development and distribution
- These operating systems share the **Linux kernel**
- Comes in several “distributions” to serve different purposes

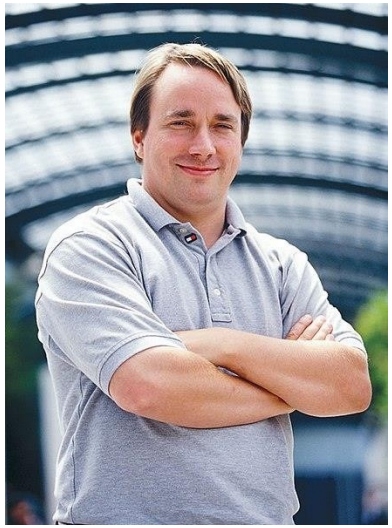


Three Major Operating Systems

Initial Release		Advantages	Disadvantages
1985		• Security • **Support for commercial software** • Affordable • Easy upgrades • Battery life	• Crashing • Costs • Mystery features
2001		• File system types (like Windows) • Fast • Security (It's a member of the UNIX family of OS) • Multi-user • Easy installation	• Limited game creation • Expensive • Limited modification
1991		• Multitasking • Open source • Supports desktop environments • Secure and high performance • Ideal for businesses	• Not user-friendly • Long installation • Poor graphics

Linux Overview

Who made Linux?



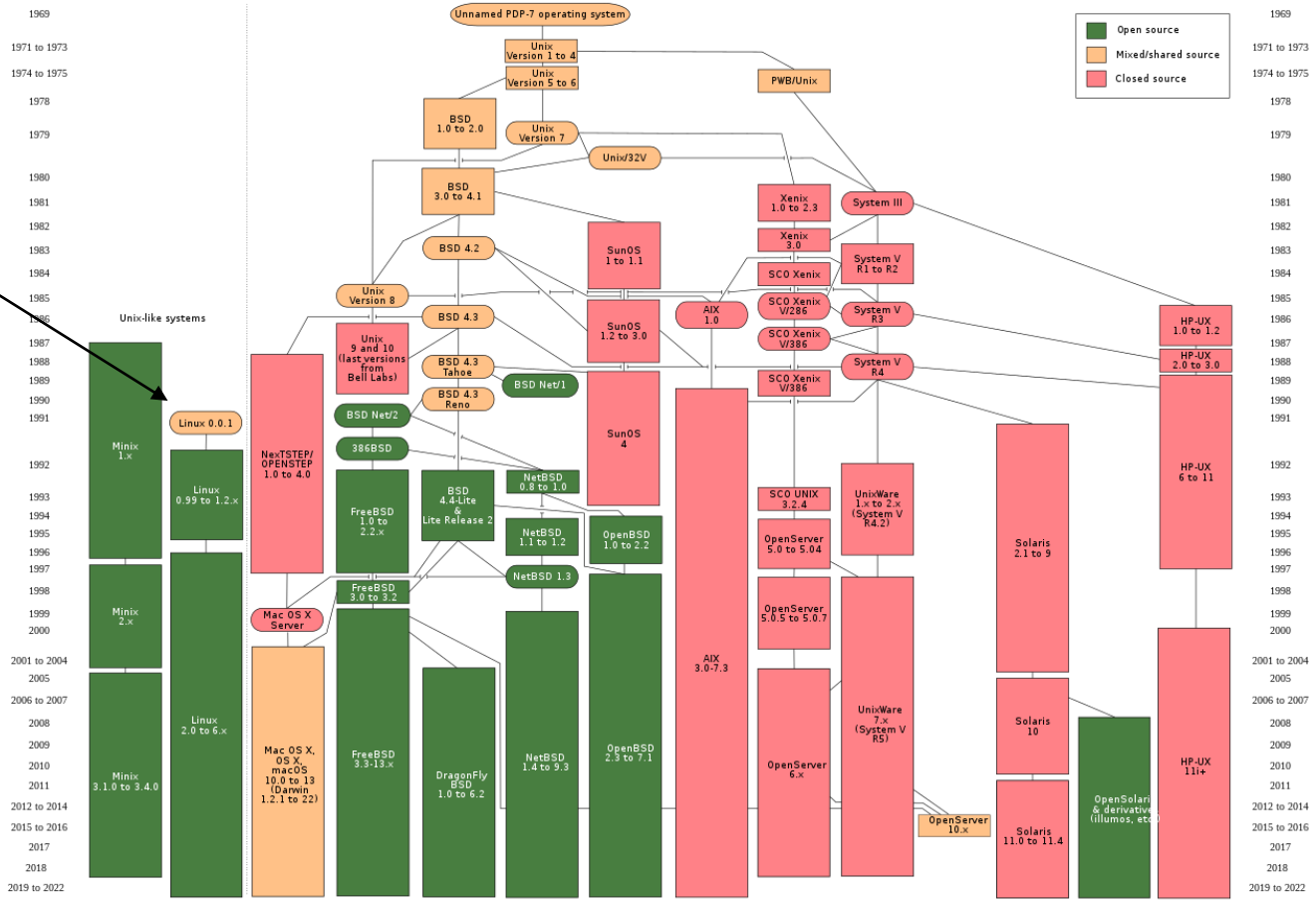
Linux is an O/S core originally written by **Linus Torvalds**. Now, almost 10,000 developers, including major technology companies like INTEL and IBM.

A set of programs written by **Richard Stallman** and others. They are the GNU utilities.

Linux Overview

When did Linux start?

~1991



Linux Overview

Where is Linux?

- **Internet**
  - 67% of the world's web servers run Linux (*2016)
- **Research / High-Performance Computing**
  - Google, Amazon, NASA, etc., 100% of the World's Top 500 super-computers run Linux
- **Modern Smartphones and devices**
  - Android phones
  - Amazon Kindle
  - Smart TVs/ Devices
  - Most Vending Machines

Linux Overview

Why Linux?

- Free and open-source
- Powerful for research
- Personal for desktops and phones
- Universal
- Community (and business) driven

How to install Ubuntu on a Virtual Machines

Ubuntu

Currently supported releases

Version	Code name	Release date	General support until	Security support (ESM) until
14.04 LTS	Trusty Tahr	2014-04-17[95]	2019-04-25[95]	2024-04
16.04 LTS	Xenial Xerus[96]	2016-04-21[97]	2021-04-30[98]	2026-04
18.04 LTS	Bionic Beaver	2018-04-26[99]	2023-05-31[100]	2028-04
20.04 LTS	Focal Fossa	2020-04-23[101]	2025-05-29[102]	2030-04
22.04 LTS	Jammy Jellyfish[103]	2022-04-21[104]	2027-06-01	2032-04
23.04	Lunar Lobster	2023-04-20	2024-01-25	unavailable
23.10	Mantic Minotaur	2023-10-12	**2024-07-11**	unavailable
24.04 LTS	Noble Numbat	2024-04-25[105]	2029-05-31	2034-04-25

Legend: Old version | Older version, still maintained | **Latest version** | Future release

- **Ubuntu is a Linux distribution** based on **Debian** and composed mostly of **free and open-source software**
- LTS: Long-term support (released every 2 years)
- We will use **20.04.06 LTS**.

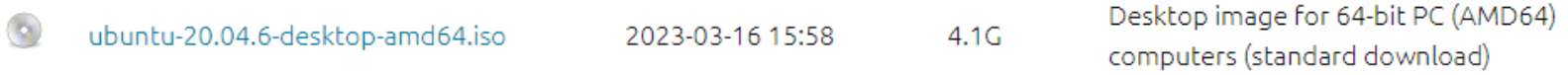
Installing Ubuntu on VM

Download **Virtual Machine**: VMWare Workstation Player 17 (540 MB)

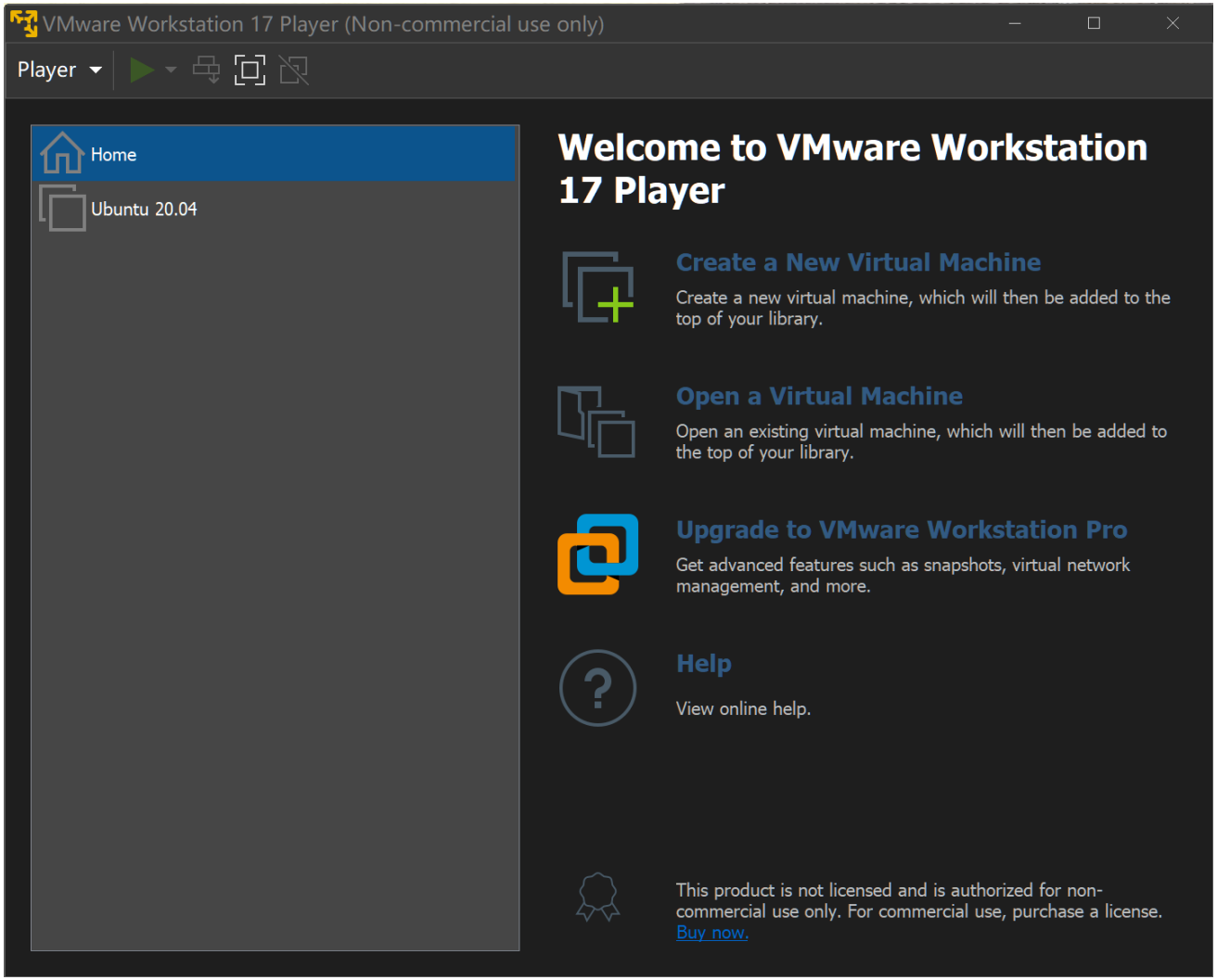
- https://www.vmware.com/hk/products/workstation-player/workstation-player-evaluation.html

Download **Ubuntu 20.04.06 LTS**, desktop version

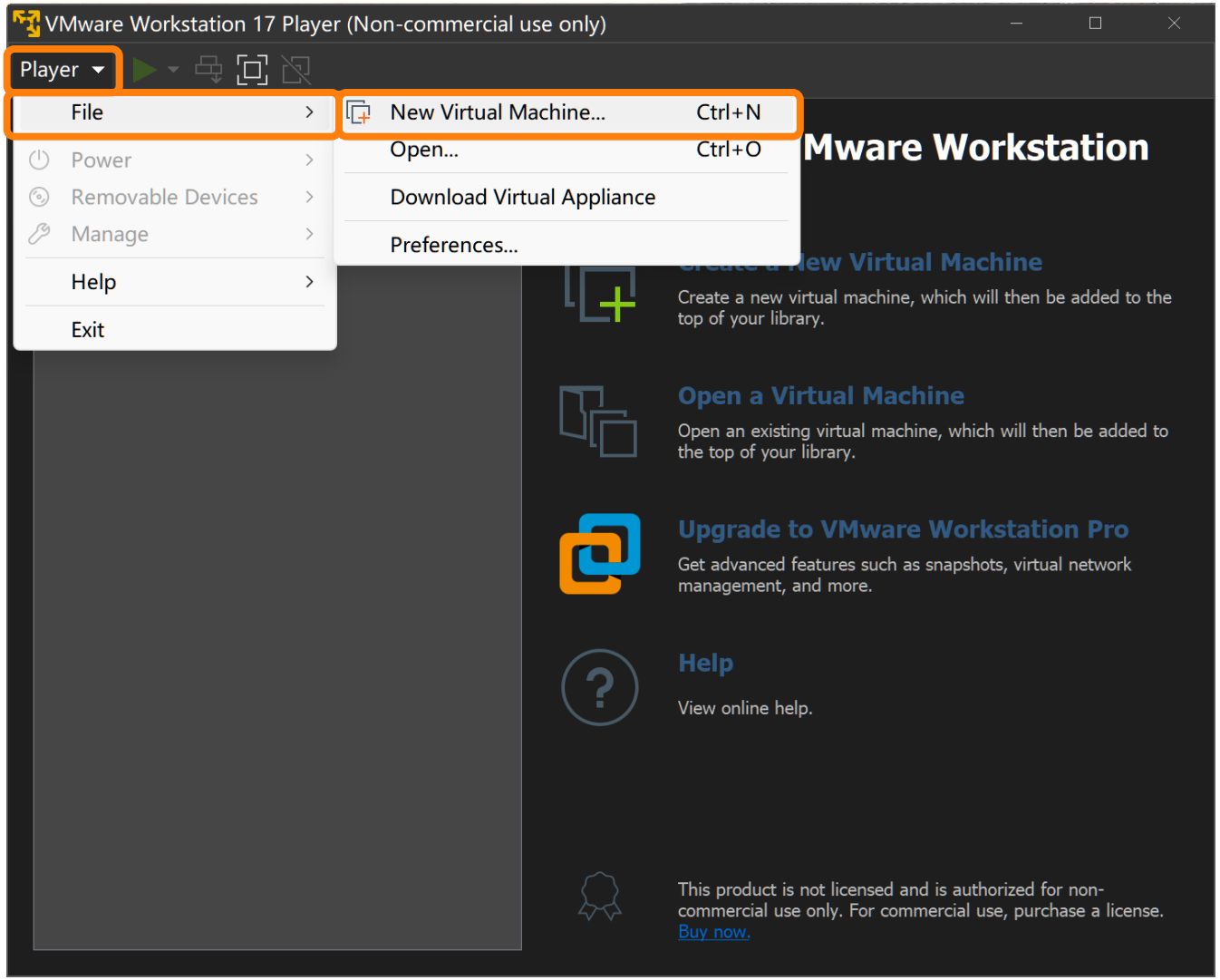
- https://releases.ubuntu.com/focal/



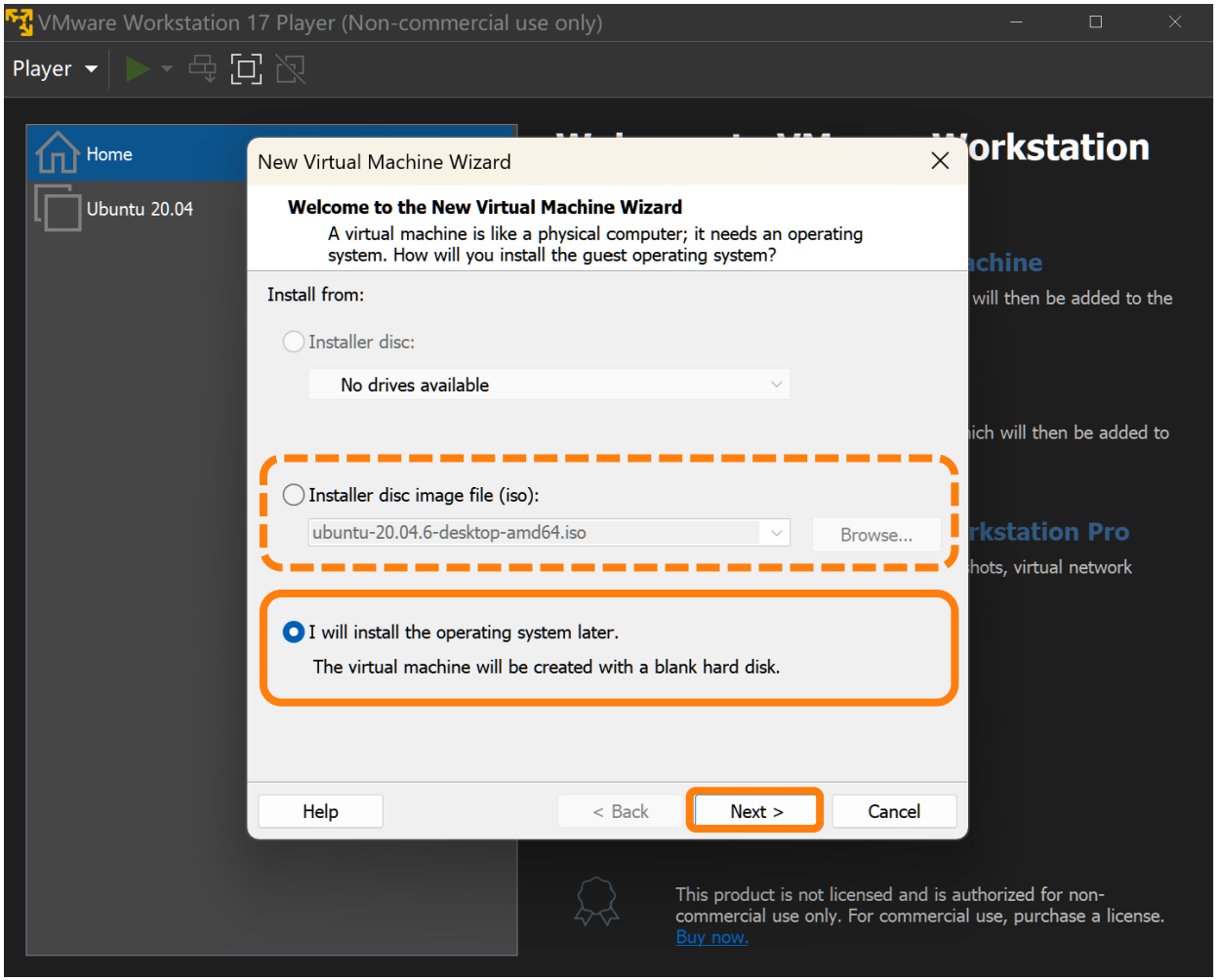
VMware Workstation Interface

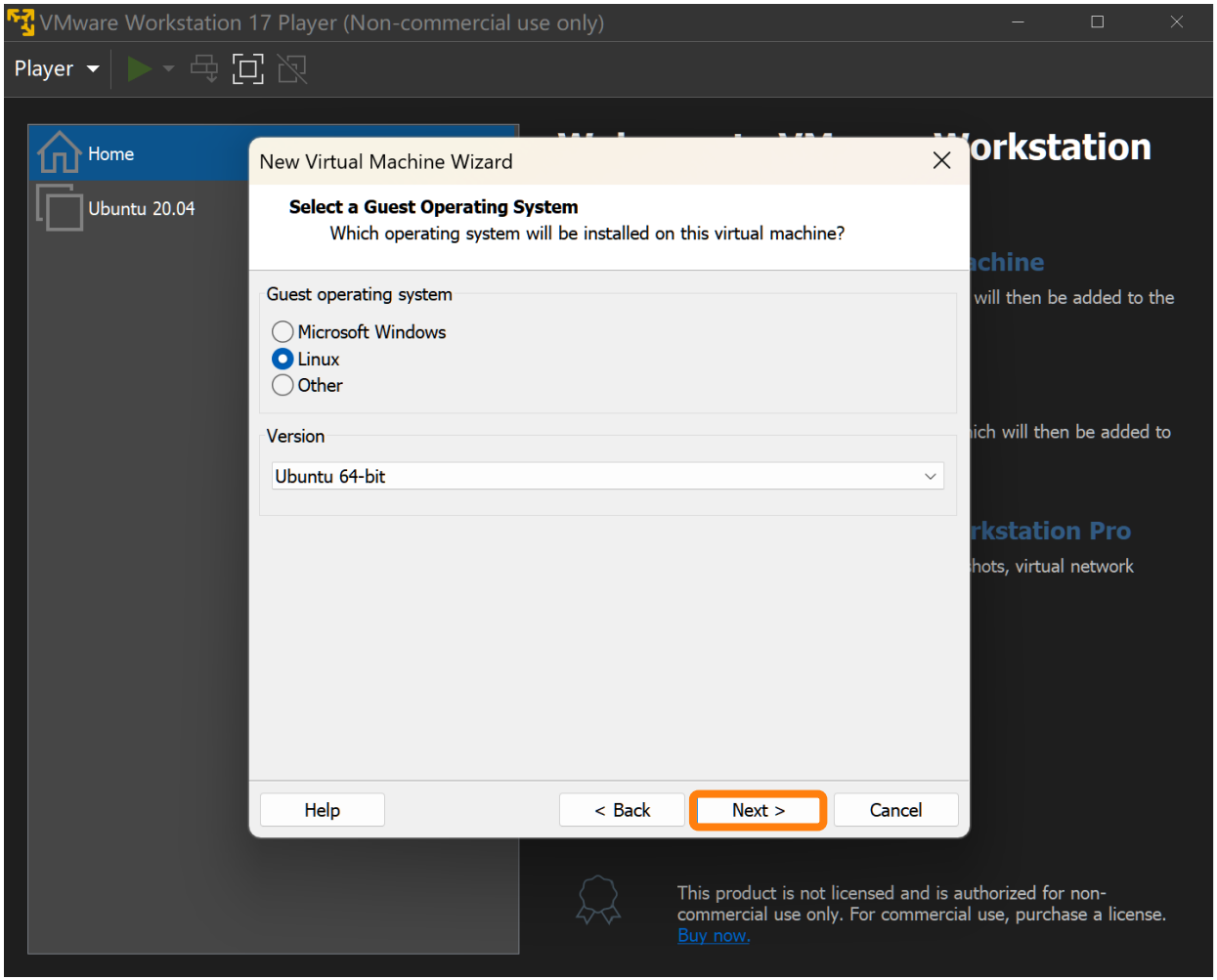


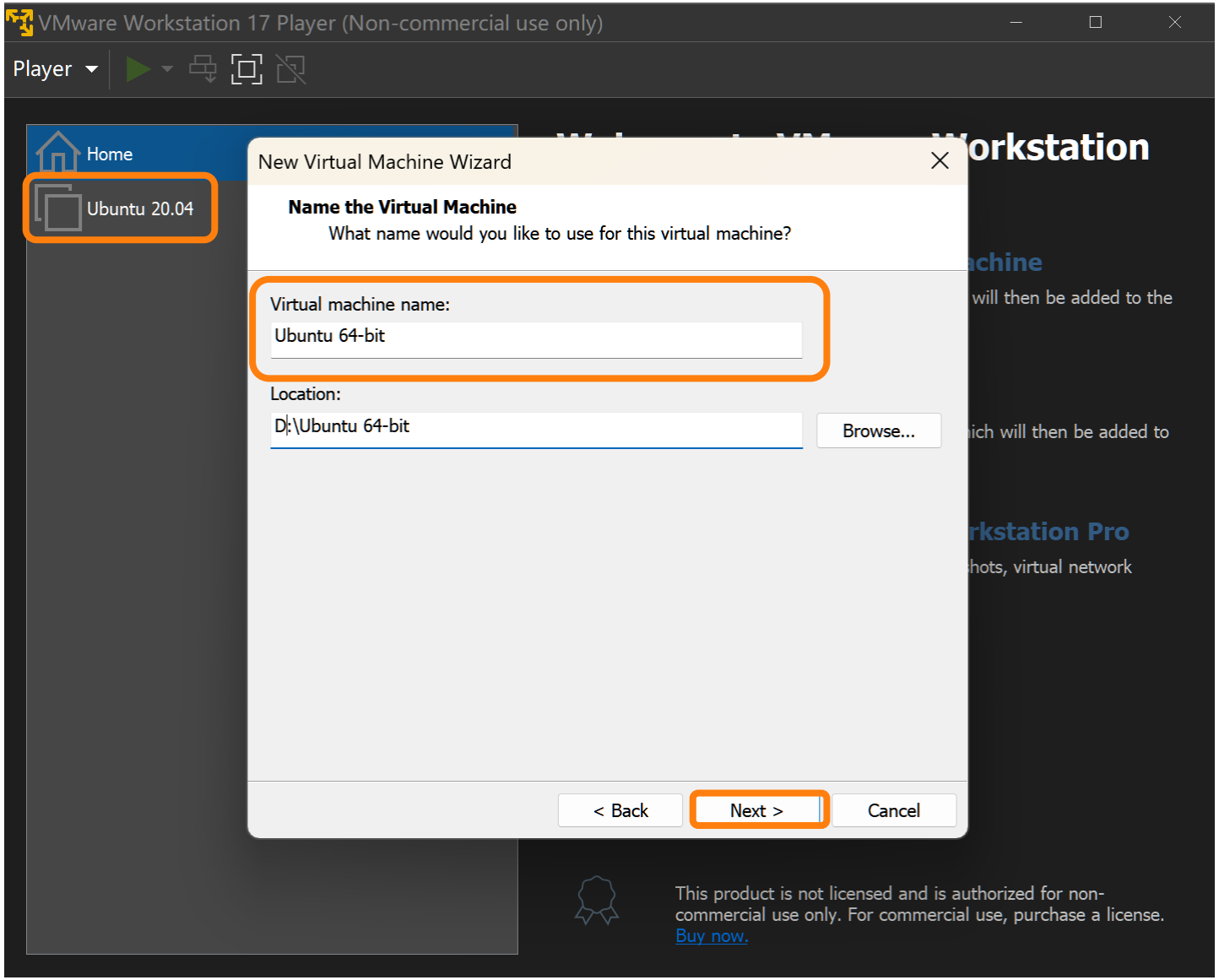
Create New VM

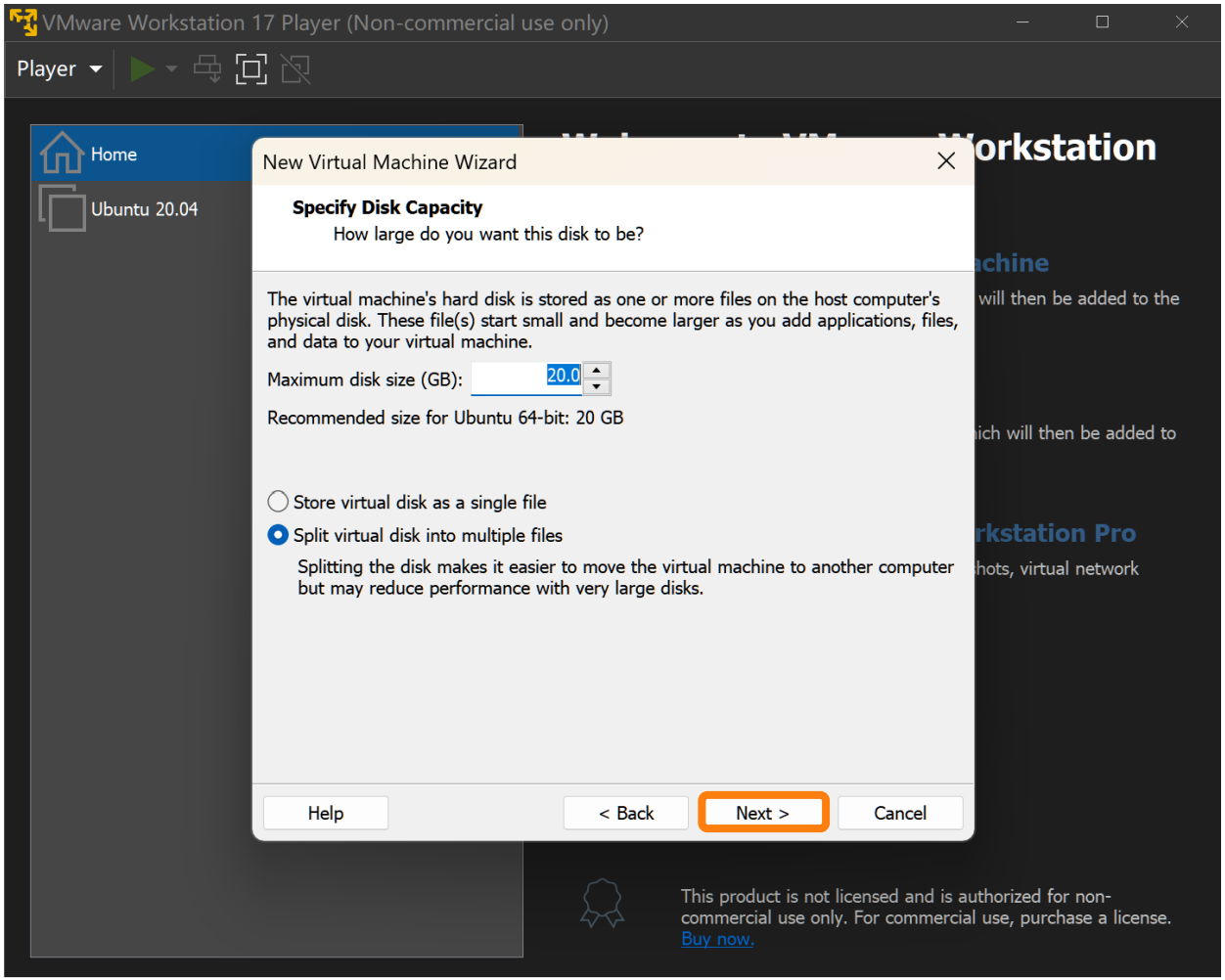


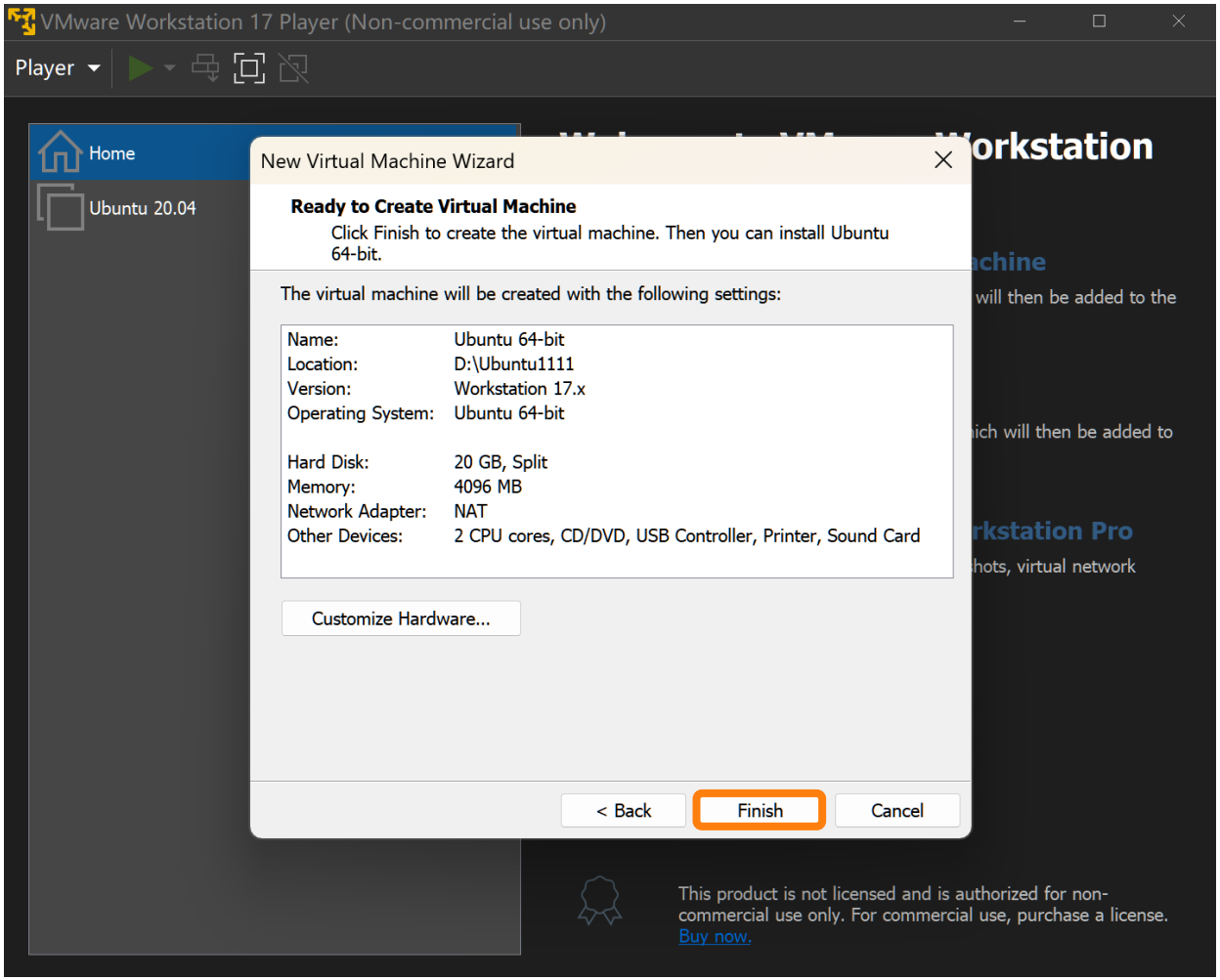
Install Ubuntu with ISO file / later



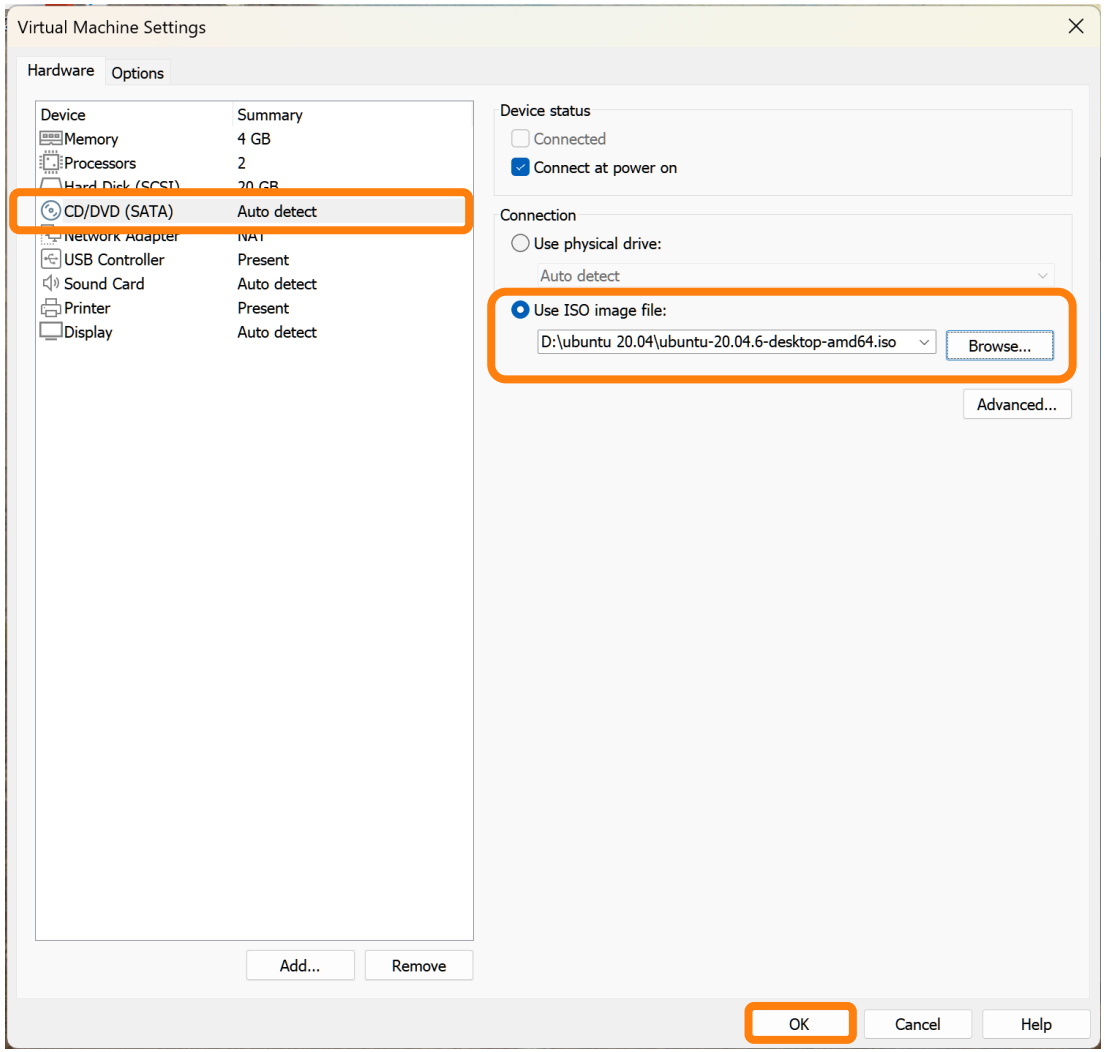

VMware Workstation 17 Player (Non-commercial use only)
Player
Home
Ubuntu 20.04
New Virtual Machine Wizard
Select a Guest Operating System
Which operating system will be installed on this virtual machine?
Guest operating system
Microsoft Windows
Linux
Other
Version
Ubuntu 64-bit
Help
< Back
Next >
Cancel
Workstation
This product is not licensed and is authorized for non-commercial use only. For commercial use, purchase a license.
Buy now.


VMware Workstation 17 Player (Non-commercial use only)
Player
Home
Ubuntu 20.04
New Virtual Machine Wizard
Name the Virtual Machine
What name would you like to use for this virtual machine?
Virtual machine name:
Ubuntu 64-bit
Location:
D:\Ubuntu 64-bit
Browse...
< Back
Next >
Cancel
Workstation
This product is not licensed and is authorized for non-commercial use only. For commercial use, purchase a license.
Buy now.


VMware Workstation 17 Player (Non-commercial use only)
Player
Home
Ubuntu 20.04
New Virtual Machine Wizard
Specify Disk Capacity
How large do you want this disk to be?
The virtual machine's hard disk is stored as one or more files on the host computer's physical disk. These file(s) start small and become larger as you add applications, files, and data to your virtual machine.
Maximum disk size (GB): 20.0
Recommended size for Ubuntu 64-bit: 20 GB
Store virtual disk as a single file
Split virtual disk into multiple files
Splitting the disk makes it easier to move the virtual machine to another computer but may reduce performance with very large disks.
Help
< Back
Next >
Cancel
This product is not licensed and is authorized for non-commercial use only. For commercial use, purchase a license.
Buy now.

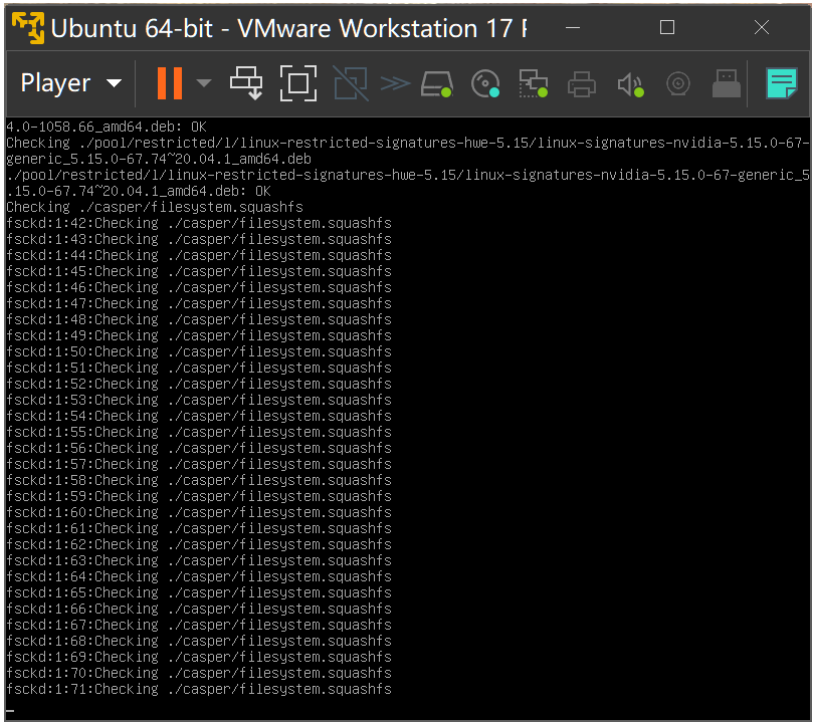

VMware Workstation 17 Player (Non-commercial use only)
Player
Home
Ubuntu 20.04
New Virtual Machine Wizard
Ready to Create Virtual Machine
Click Finish to create the virtual machine. Then you can install Ubuntu 64-bit.
The virtual machine will be created with the following settings:
Name: Ubuntu 64-bit
Location: D:\Ubuntu1111
Version: Workstation 17.x
Operating System: Ubuntu 64-bit
Hard Disk: 20 GB, Split
Memory: 4096 MB
Network Adapter: NAT
Other Devices: 2 CPU cores, CD/DVD, USB Controller, Printer, Sound Card
Customize Hardware...
< Back
Finish
Cancel
This product is not licensed and is authorized for non-commercial use only. For commercial use, purchase a license.
Buy now.

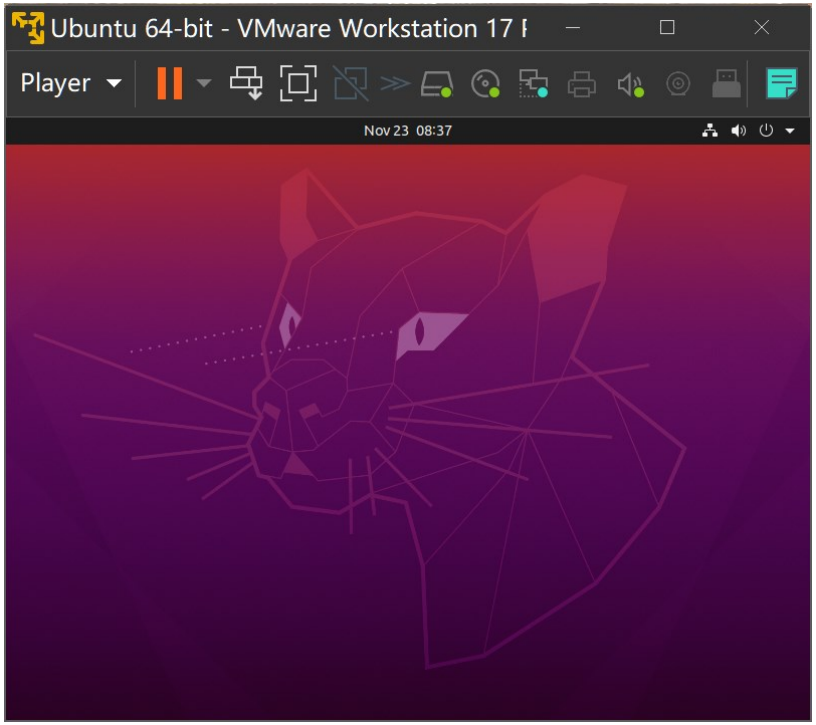
Edit VM Setting -> ISO image file

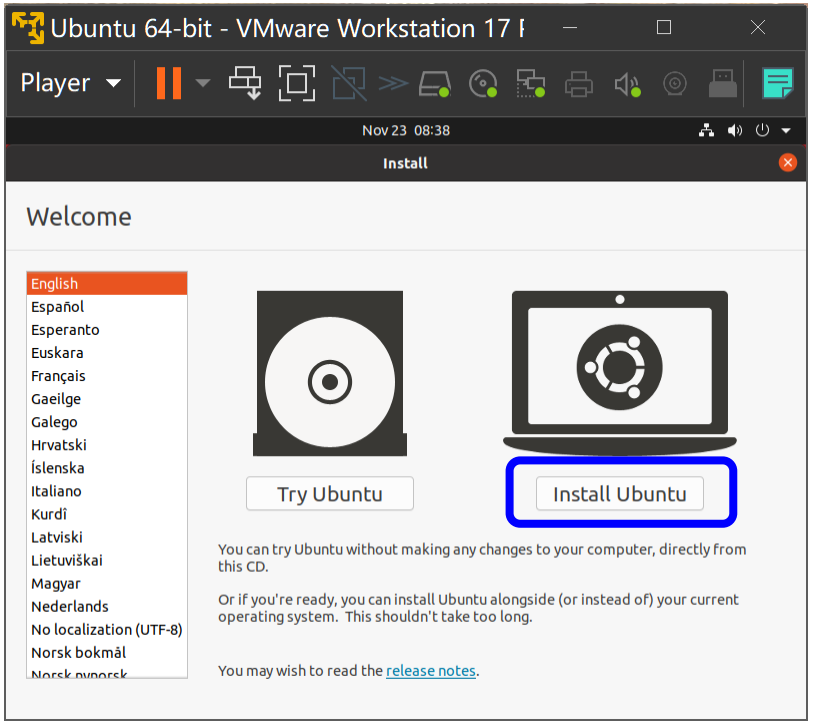


Click Play

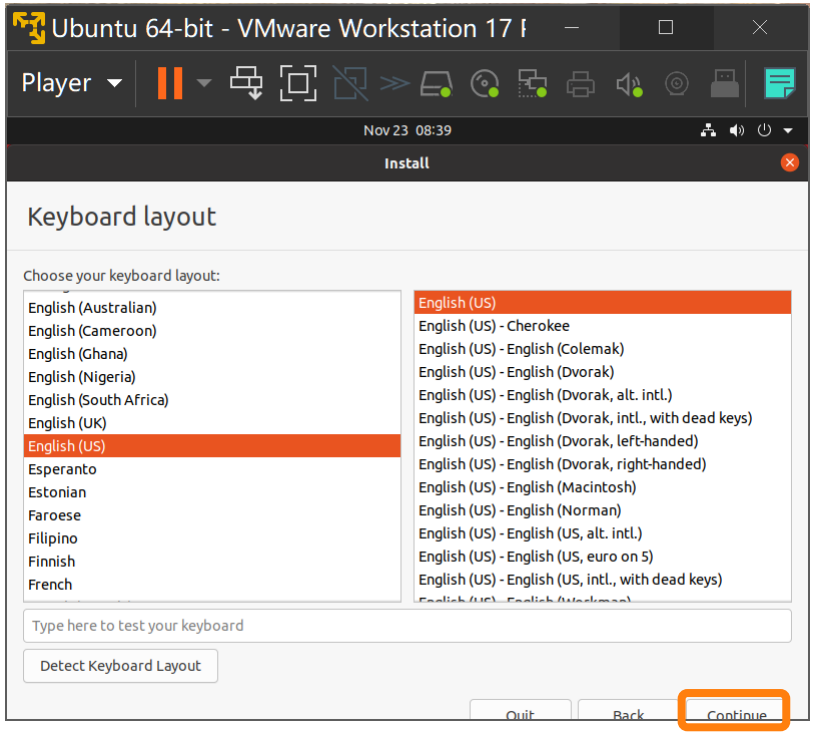
- Click **Play** then launch the OS installation



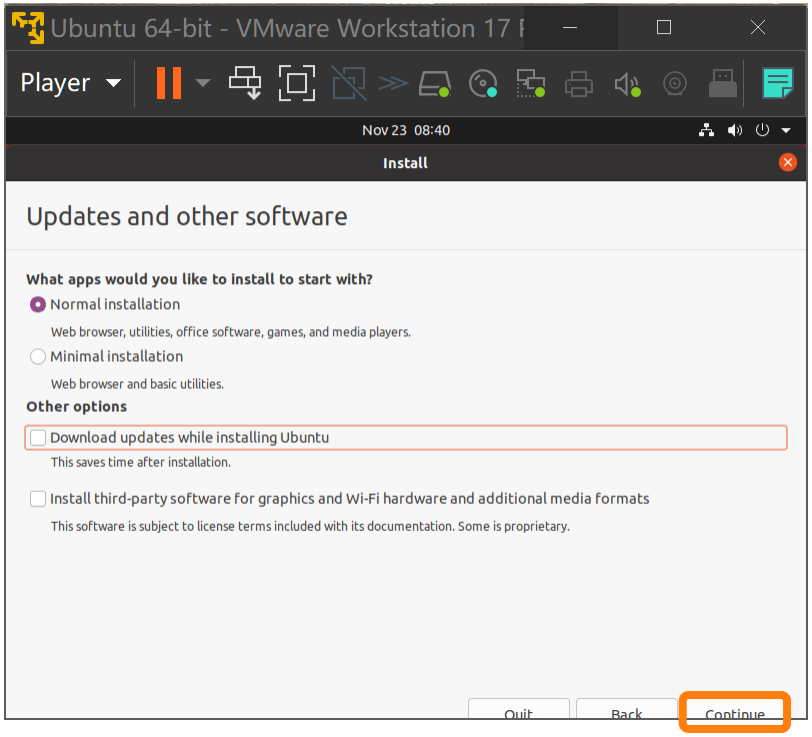




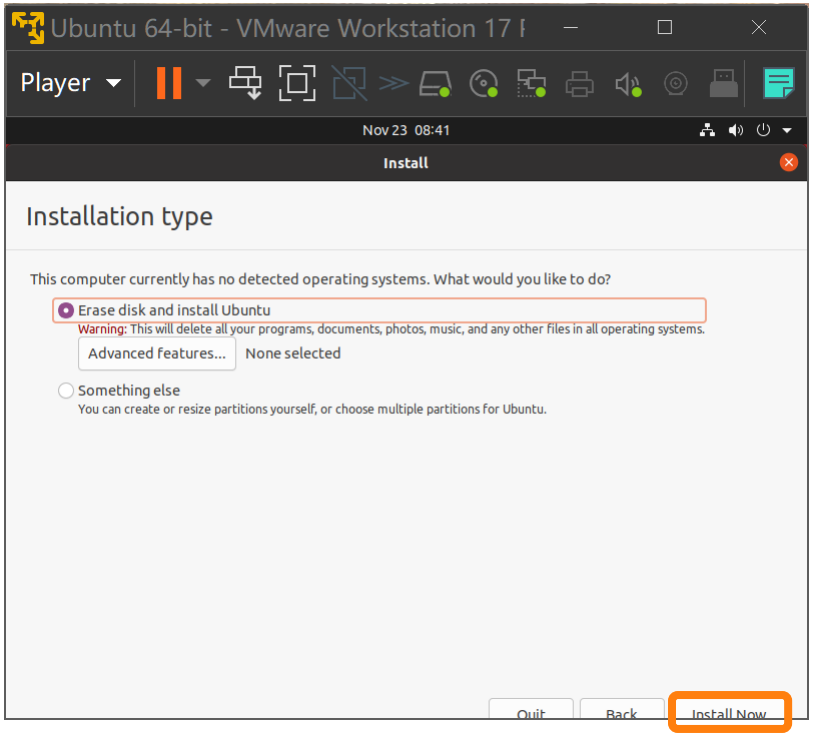
Install Ubuntu



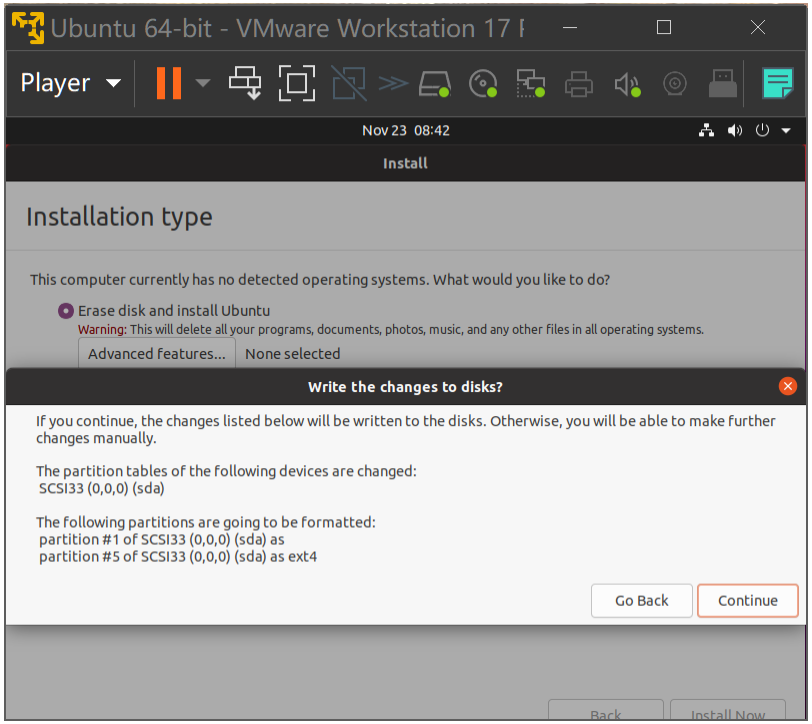
Keyboard setting

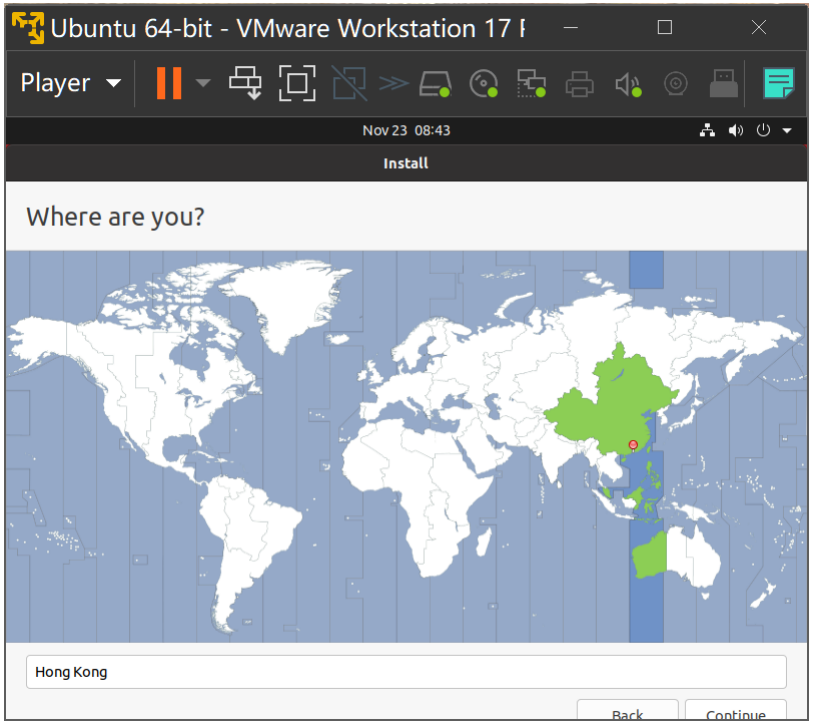


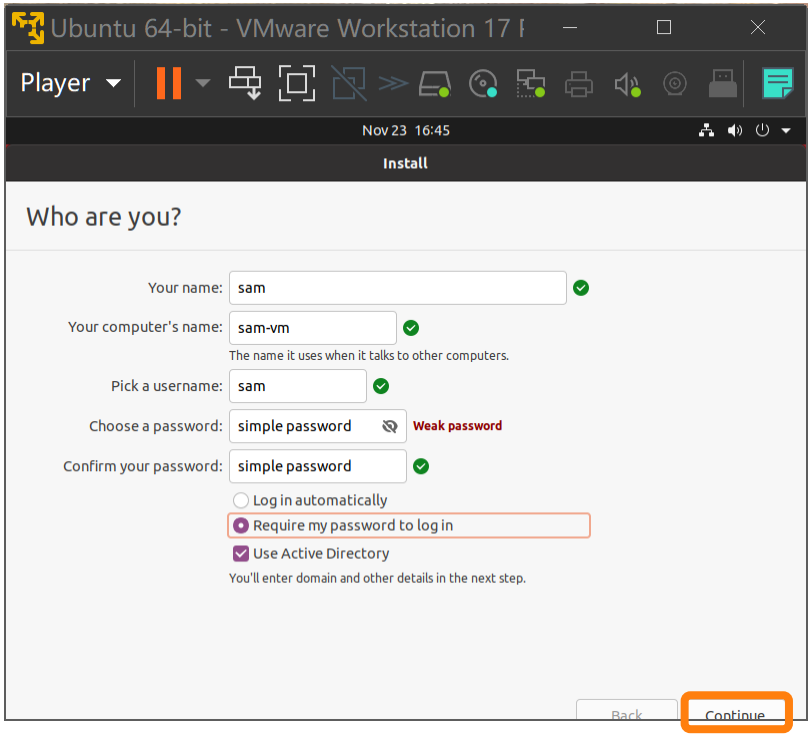
Disable the updates option

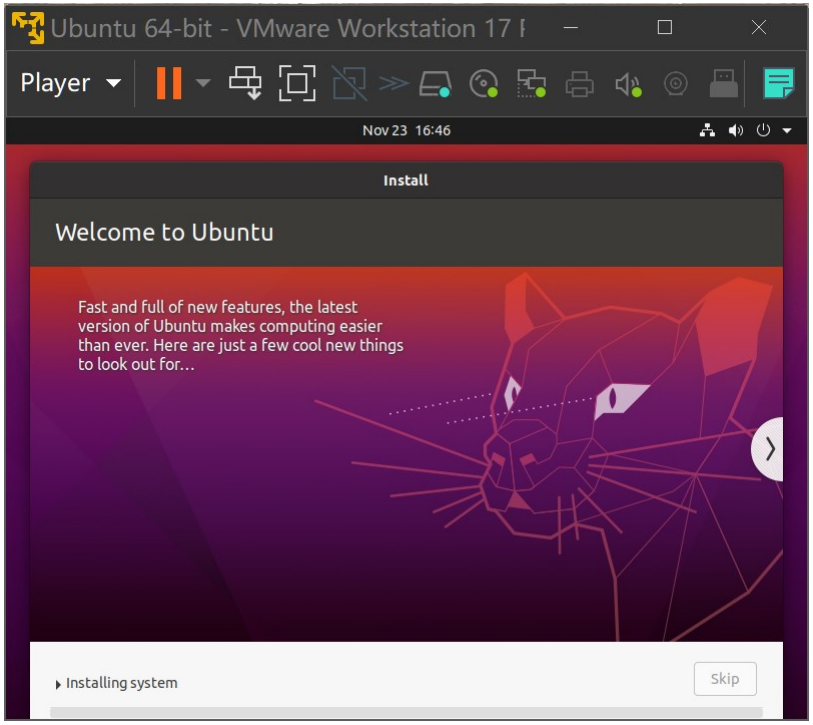


**It will not really erase your disk, because you are using a VM


Ubuntu 64-bit - VMware Workstation 17 F
Player
Nov 23 08:42
Install
Installation type
This computer currently has no detected operating systems. What would you like to do?
Erase disk and install Ubuntu
Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.
Advanced features...
None selected
Write the changes to disks?
If you continue, the changes listed below will be written to the disks. Otherwise, you will be able to make further changes manually.
The partition tables of the following devices are changed:
SCSI33 (0,0,0) (sda)
The following partitions are going to be formatted:
partition #1 of SCSI33 (0,0,0) (sda) as
partition #5 of SCSI33 (0,0,0) (sda) as ext4
Go Back
Continue
Back
Install Now

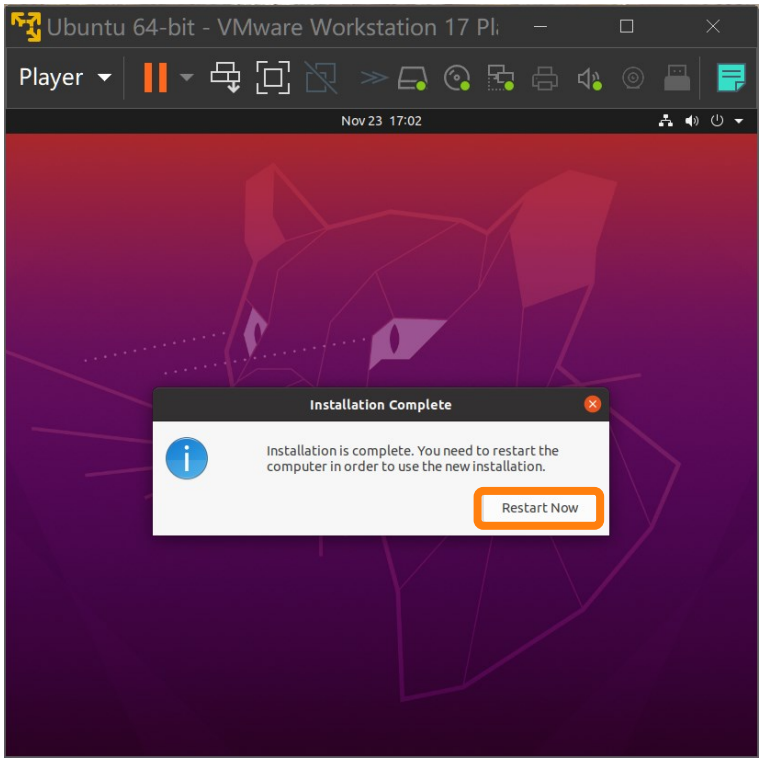

Ubuntu 64-bit - VMware Workstation 17 F
Player
Nov 23 08:43
Install
Where are you?
Hong Kong
Back
Continue

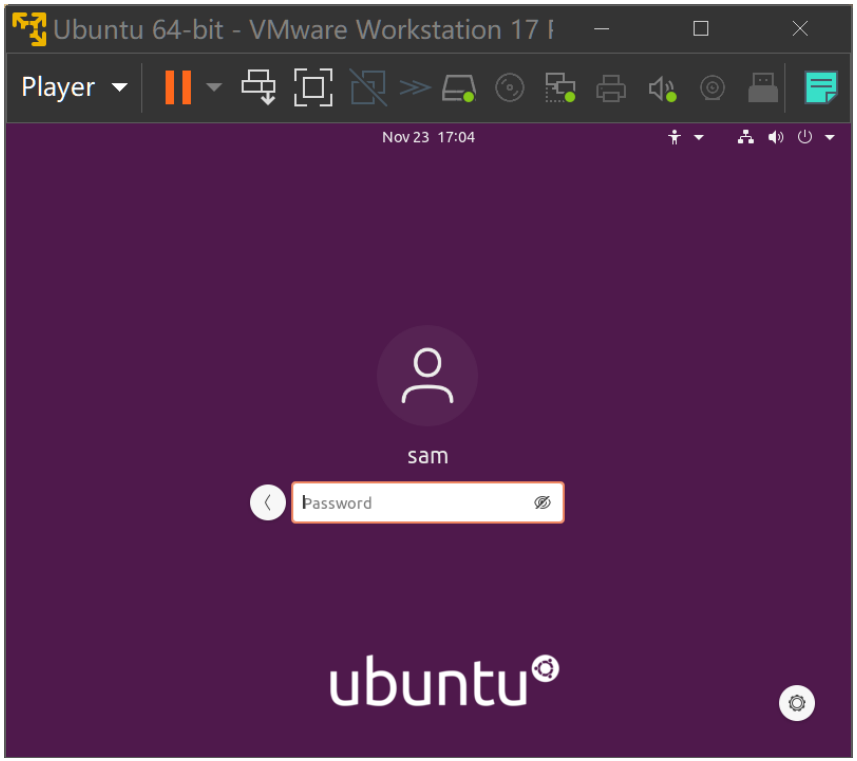


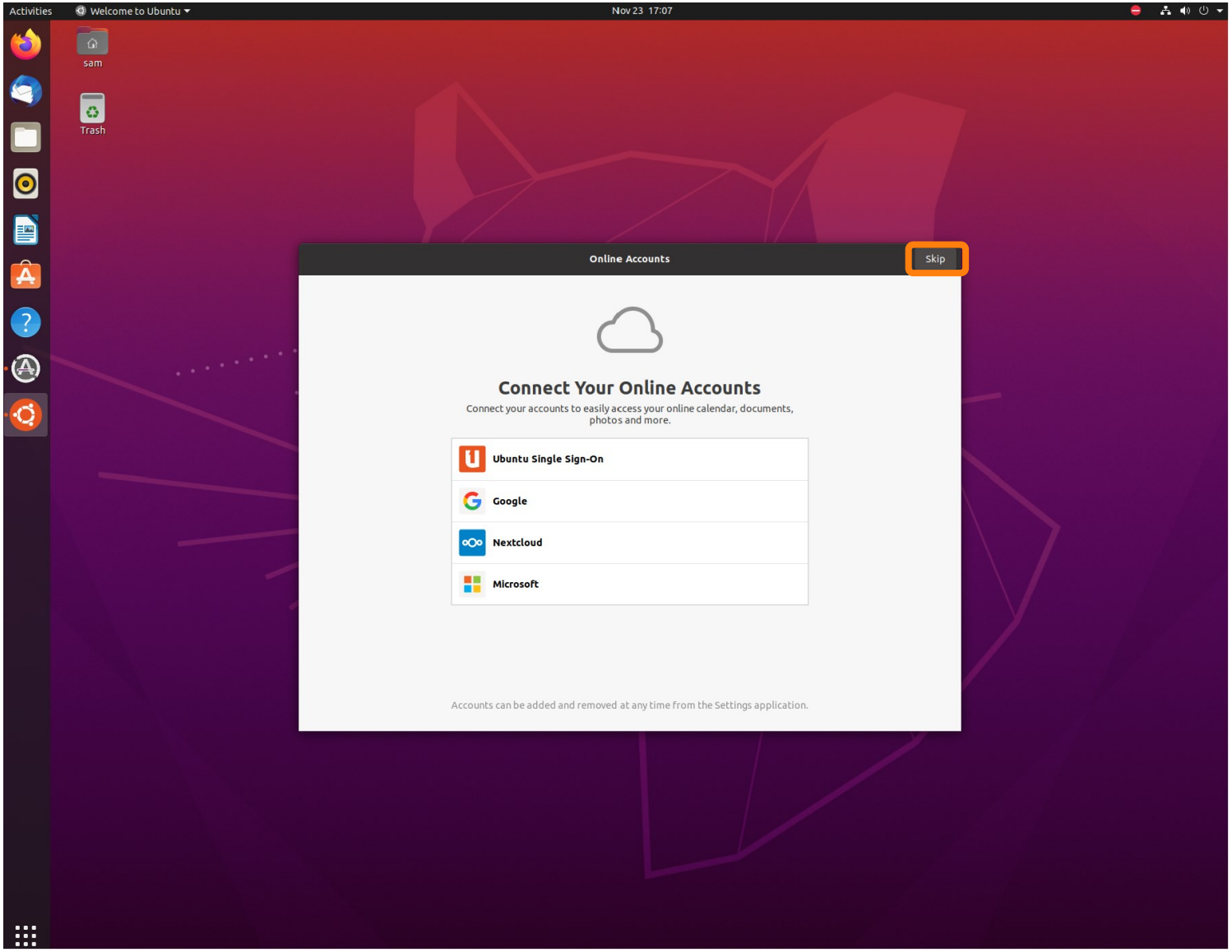


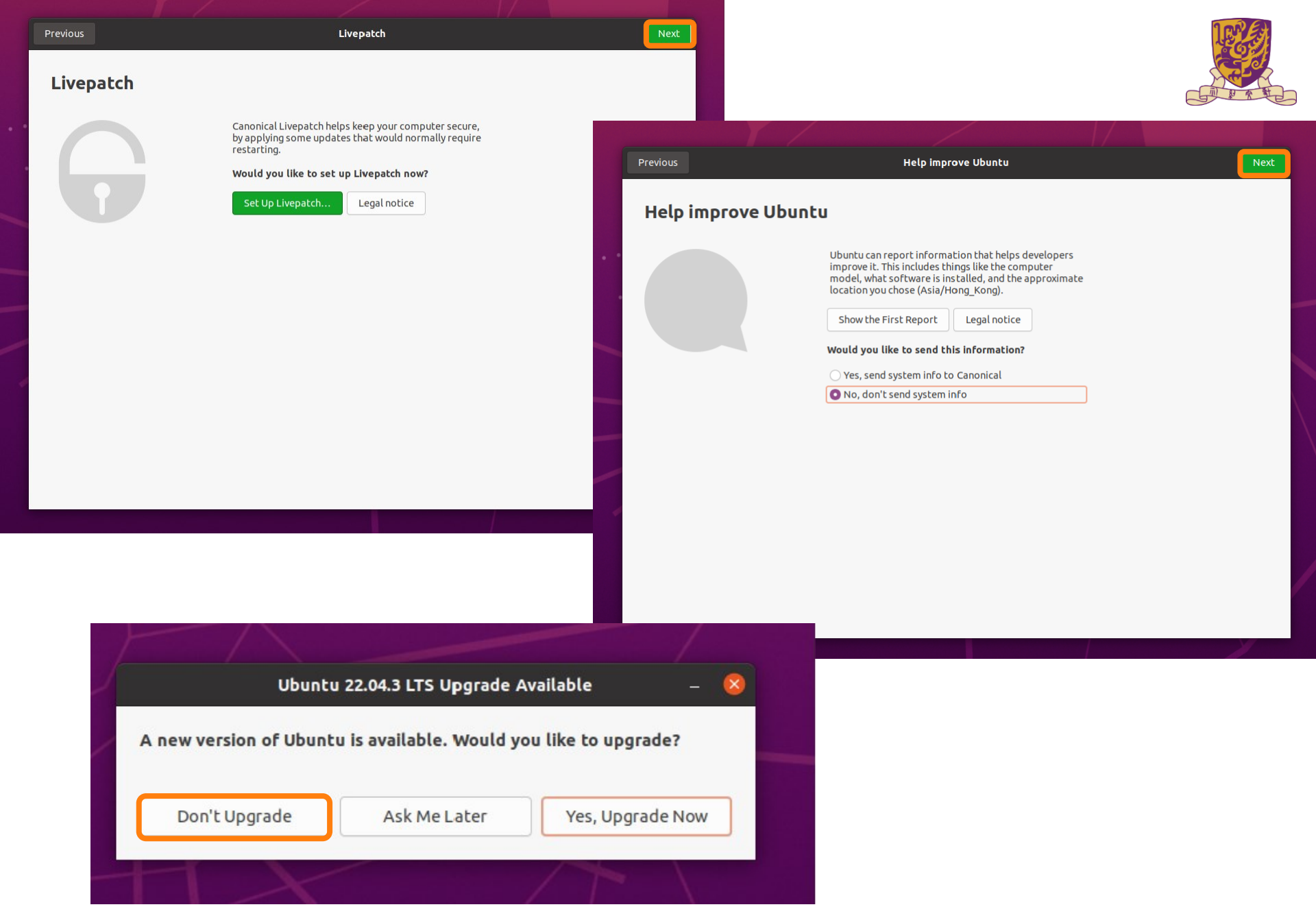
Password is something you will often use in the prompt – so make it short

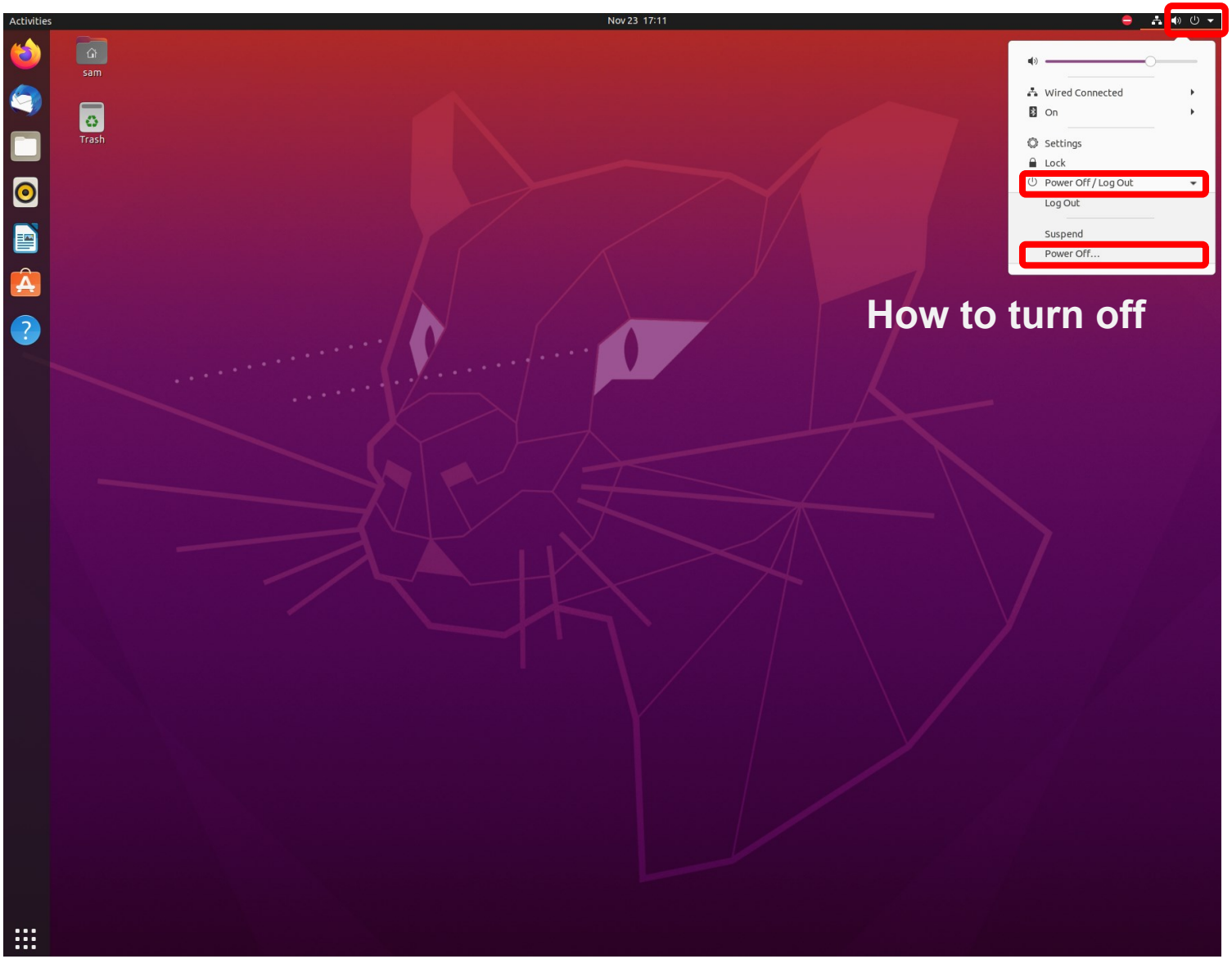
Installation launched
Takes 10-30 minutes


Ubuntu 64-bit - VMware Workstation 17 Pl
Player
Nov 23 17:02
Installation Complete
Installation is complete. You need to restart the computer in order to use the new installation.
Restart Now


Ubuntu 64-bit - VMware Workstation 17 I
Player
Nov 23 17:04
sam
Password
ubuntu


Activities
Welcome to Ubuntu
Nov 23 17:07
sam
Trash
Online Accounts
Skip
Connect Your Online Accounts
Connect your accounts to easily access your online calendar, documents, photos and more.
Ubuntu Single Sign-On
Google
Nextcloud
Microsoft
Accounts can be added and removed at any time from the Settings application.


Previous
Livepatch
Next
Livepatch
Canonical Livepatch helps keep your computer secure, by applying some updates that would normally require restarting.
Would you like to set up Livepatch now?
Set Up Livepatch...
Legal notice
Previous
Help improve Ubuntu
Next
Help improve Ubuntu
Ubuntu can report information that helps developers improve it. This includes things like the computer model, what software is installed, and the approximate location you chose (Asia/Hong_Kong).
Show the First Report
Legal notice
Would you like to send this information?
Yes, send system info to Canonical
No, don't send system info
Ubuntu 22.04.3 LTS Upgrade Available
A new version of Ubuntu is available. Would you like to upgrade?
Don't Upgrade
Ask Me Later
Yes, Upgrade Now


Activities
Nov 23 17:11
sam
Trash
Wired Connected
On
Settings
Lock
Power Off / Log Out
Log Out
Suspend
Power Off...
How to turn off

Now, you may follow the steps to install:

- **VM**
- **Ubuntu**

Account: **ELEG4701**
Password: **robot**

* You can also install one on your own laptop

Download **Virtual Machine**: VMWare Workstation Player 17 (540 MB)

- https://www.vmware.com/hk/products/workstation-player/workstation-player-evaluation.html

Download **Ubuntu 20.04.06 LTS**, desktop version

- https://releases.ubuntu.com/focal/

TA will check whether you have successfully installed Ubuntu

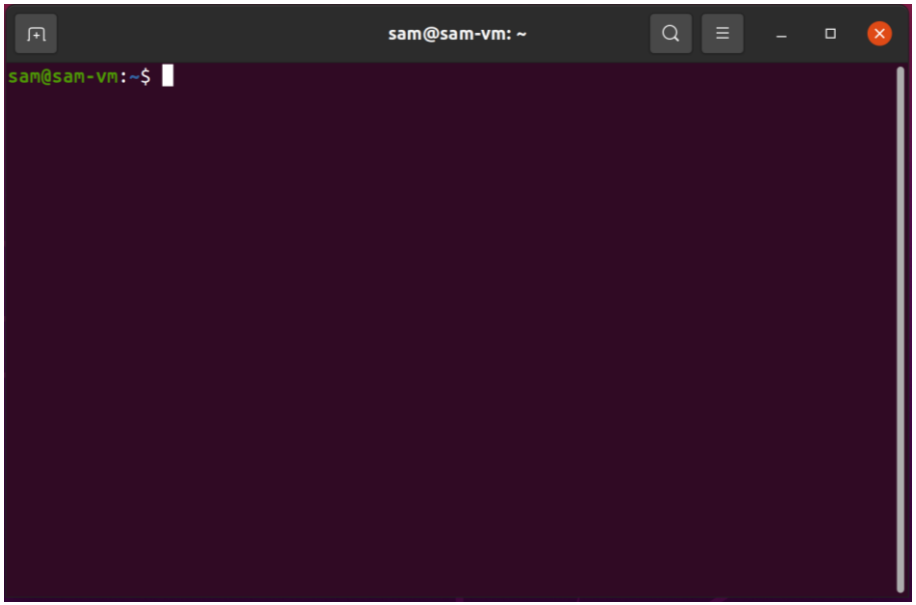
Linux Interaction

Prompts & Commands

Linux Interaction

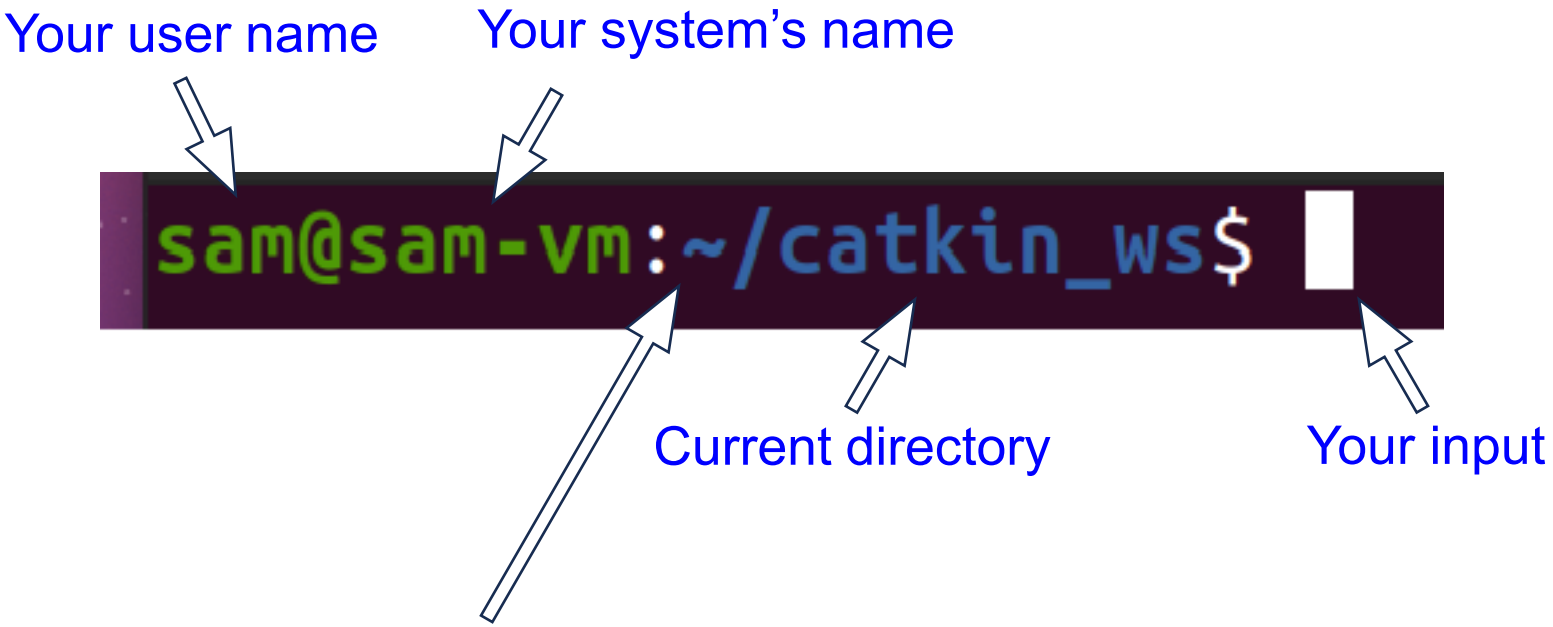
Terminal

- Press **Ctrl + Alt + T** at the same time, the terminal will come out
- Can also call terminal using GUI: Show Applications (like the "START" in Windows) – Terminal



Linux Interaction

Prompt



In Linux, the tilde sign "~" is a shorthand for your home directory

Linux Interaction

Linux: Command Basics

```
[username@scc1 ~]$ command --option argument
```

- **Command**: Command/program that does one thing
- **Options**: Change the way a command does that one thing
  - Short form: Single-dash and one letter e.g. **`ls -a`**
  - Long form: Double-dash and a word e.g. **`ls --all`**
- **Argument**: Provides the input/output that the command interacts with.

For more information about any command, use **`man`** or **`info`** (e.g. "**`man ls`**")

Linux Interaction

Commands: Hands-On Options

- Commands have three parts; command, options and arguments/parameters.

  Example: cal –j 3 1999. “cal” is the command, “-j” is an option (or switch), “3” and “1999” are arguments/parameters.

```
[username@scc1 ~]$ cal -j 3 1999
```

- What is the nature of the prompt?
- What was the system’s response to the command?

Linux Interaction

SYNOPSIS

cal [options] [[[day] month] year]

DESCRIPTION

cal displays a simple calendar. If no arguments are specified, the current month is displayed.

OPTIONS

-1, --one Display single month output. (This is the default.)

-3, --three Display prev/current/next month output.

-s, --sunday Display Sunday as the first day of the week.

-m, --monday Display Monday as the first day of the week.

-j, --julian Display Julian dates (days one-based, numbered from January 1).

-y, --year Display a calendar for the current year.

-V, --version Display version information and exit.

-h, --help Display help screen and exit.

```
sam@sam-vm:~$ cal 12 1993
   December 1993
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

sam@sam-vm:~$ cal -j 12 1993
       December 1993
 Su  Mo  Tu  We  Th  Fr  Sa
            335 336 337 338
339 340 341 342 343 344 345
346 347 348 349 350 351 352
353 354 355 356 357 358 359
360 361 362 363 364 365
```

https://www.linux.org/docs/man1/cal.html#:~:text=%2Dj%2C%20%2D%2Djulian%20Display%20Julian,%2C%20numbered%20from%20January%201).

Linux Interaction

Command History and Command Line Editing

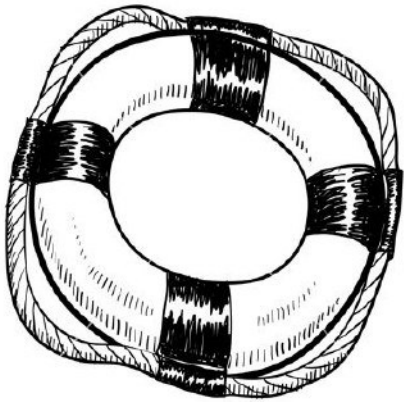
- Try the `history` command
- Choose from the command history using the up ↑ and down ↓ arrows
- To redo your last command, try `!!`
- To go further back in the command history try `!`, then the number as shown by history (e.g., `!132`). Or, !ls, for example, to match the most recent 'ls' command.
- What do the left ← and right → arrow do on the command line?
- Try the `<Del>` and `<Backspace>` keys

Linux Interaction

Help with Commands

- Type
  - `date --help`
  - `man date`
  - `info date`
- BASH built-ins
  - A little different from other commands
  - Just type the command **‘help’**
  - Or **‘man bash’**

```
BASH(1)                    General Commands Manual                    BASH(1)

NAME
       bash - GNU Bourne-Again SHell

SYNOPSIS
       bash [options] [command_string | file]

COPYRIGHT
       Bash is Copyright (C) 1989-2018 by the Free Software Foundation, Inc.

DESCRIPTION
       Bash  is  an  sh-compatible  command language interpreter that executes
       commands read from the standard input or from a file.  Bash also incor-
       porates useful features from the Korn and C shells (ksh and csh).

       Bash  is  intended  to  be a conformant implementation of the Shell and
       Utilities portion  of  the  IEEE  POSIX  specification  (IEEE  Standard
       1003.1).  Bash can be configured to be POSIX-conformant by default.

OPTIONS
       All of the single-character shell options documented in the description
       of the set builtin command, including -o, can be used as  options  when
 Manual page bash(1) line 1 (press h for help or q to quit)
```



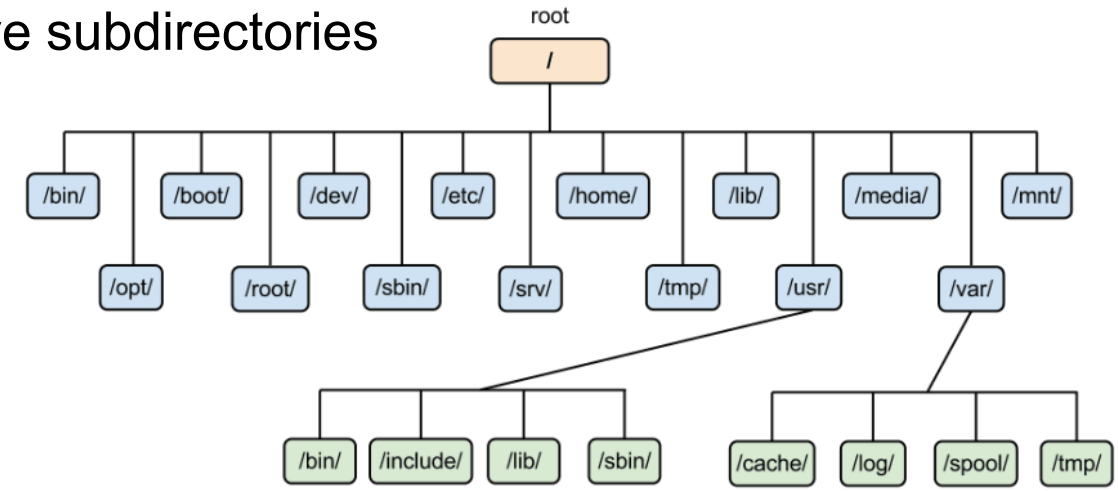
Yes, you can always Google it.

File System

File System

The Linux File system

- The structure resembles an upside-down tree
- Directories (a.k.a. folders) are collections of files and other directories
- Every directory has a parent except for the root directory
- Many directories have subdirectories



File System

Navigating the File System

- Essential navigation commands:
  - **`pwd`** print current directory
  - **`ls`** list files
  - **`cd`** change directory

File System

Navigating the File System

We use path names to refer to files and directories in the Linux file system.

- There are TWO types of pathnames:
  - **Absolute** – The full path to a directory or file; begins with /
  - **Relative** – A partial path that is relative to the current working directory; does not begin with /

File System

Navigating the File System

Special characters interpreted by the shell for filename expansion:

- `~` your home directory (e.g., /cuhk/eleg4701/LT1)
- `.` Current directory
- `..` Parent directory (previous level)
- `*` wildcard matching any filename
- `?` Wildcard matching any character
- `TAB` Try to complete (partially typed) filename

File System

Navigating the File System

Examples:

- **`cd /usr/local`** Change directory to **`usr/local`**
- **`cd ~`** Change to home directory (could just type **`cd`**)
- **`pwd`** Print working (current) directory
- **`cd ..`** Change directory to the “parent” directory
- **`cd -`** Return to the previous dir
- **`cd /`** Change directory to the “root”
- **`ls -d pro*`** Listing of only the directories starting with “pro”

File System

The `ls` command

Useful options for the `ls` command:

- **`ls -a`** List all files, including hidden files beginning with a “.”
- **`ls -ld *`** List details about a directory and not its contents
- **`ls -F`** Put an indicator character at the end of each name
- **`ls -l`** Simple long listing
- **`ls -lR`** Recursive long listing
- **`ls -lh`** Give human-readable file size
- **`ls -lS`** Sort files by file size
- **`ls -lt`** Sort files by modification times (very useful!)

File System

Some Useful File Commands

• `cp [file1] [file2]`	copy file
• `mkdir [name]`	make directory
• `rmdir [name]`	remove (empty) directory
• `mv [file] [destination]`	move file to destination
• `rm [file]`	remove file (-r for recursive)
• `file [file]`	identify file type
• `less [file]`	display files content one screen at a time
• `head –n N [file]`	display first N lines
• `tail –n N [file]`	display last N lines
• `ln –s [file] [new]`	create symbolic link
• `cat [file] [file2…]`	concatenate, display file(s)
• `tac [file] [file2…]`	display file in reverse order
• `touch [file]`	create a file without any content
• `od [file]`	octal dump: display contents in hexadecimal., octal, ASCII

File System

Manipulating files and directories

Examples:

- `cd` # same as `cd ~`
- `mkdir test`
- `cd test`
- `echo 'Hello World' > myfile.txt`
- `echo 'Goodbye' >> myfile.txt`
- `Less myfile.txt`
- `mkdir subdir1/subdir2` # Fails. Why?
- `mkdir -p subdir1/subdir2` # Succeeds
- `mv myfile.txt subdir1/subdir2`
- `cd ..`
- `rmdir test`
- `rm -rf test` # Succeeds

File System

Symbolic links

Sometimes it is helpful to be able to access a file from multiple locations within the hierarchy.

On a Windows system, we might create a “shortcut.” On a Linux system, we can create a symbolic link:

- `mkdir foo` # make foo directory
- `touch foo/bar` # create an empty file
- `ln -s foo/bar .` # create link in current dir.

Try the following tasks!

1. Use the command line to create a folder called **cakin_ws** in your home directory
2. Print the calendar of March of 17XX (XX = the last 2 digits of your SID), name 17XX.txt
3. Export this calendar as a text file to the **catkin_ws** folder
4. Write a simple Python code that can print this calendar by reading the txt file
5. Use the command line to run this py file

When you are done, ask the TA to check

(Learning how to google is important in programming)

More reading

- Augustine Abaris, Research Computing Services, Information Services & Technology, Boston University: https://www.bu.edu/tech/files/2018/05/2018-Summer-Tutorial-Intro-to-Linux.pdf