

Template Week 5 – Operating Systems

Student number: 591658

Assignment 5.1: Unix-like

a) Find out what the difference is between UNIX and unix-like operating systems?

UNIX is an operating system (OS) originally developed at Bell Labs. It is trademarked.

Unix-like are OS that share many characteristics with the early UNIX system. These OS may be official UNIX systems or UNIX clones. Official UNIX systems have a direct source code lineage from the original UNIX, while UNIX clones behave like UNIX but don't contain source code from that program.

Examples of official UNIX systems: AIX (developed by IBM), HP-UX (developed by HP), IRIX (developed by Silicon Graphics), Solaris (developed by Sun Microsystems)

Examples of UNIX clones: BSDs (i.e., FreeBSD, NetBSD, OpenBSD and Darwin), Linux, MINIX, QNX and Cygwin

(The Linux Information Project, n.d.)

b) Study the image above named UNIX timeline. Find out who Ken Thompson, Dennis Ritchie, Bill Joy, Richard Stallman, and Linus Torvalds are and what they have contributed to the development of UNIX or unix-like systems and to IT in general. TIP! English-language sources often contain more detailed information about these individuals.

Ken Thompson and Dennis Ritchie co-created the original UNIX operating system in 1969 and developed C language. UNIX's design becomes the foundation for most operating systems (Linux, macOS and Android) (Computer History Museum, n.d.a).

Bill Joy is key figure in developing the 1984 UNIX version with TCP/IP networking protocols- backbone of modern Internet. He co-founded Sun Microsystems and inspired the development of Java language (University of Michigan Department of Electrical Engineering and Computer Science, 2016).

Richard Stallman founded the free software movement and the GNU project. He is also the main author of the GNU General Public License, the most widely used free software license (Free Software Foundation, 2016).

Linus Torvalds creates the Linux kernel and leads the development of the popular open-sourced Linux operating system (Computer History Museum, n.d.b).

c) What is the philosophy of the GNU movement?

GNU movement believes that a program's user should be free to copy and change that program without its developers' interference. They advocate for software users' four freedoms: (0) to run the program, (1) to study and change the program in source code form, (2) to redistribute exact copies, and (3) to distribute modified versions (Free Software Foundation, Inc., n.d.).

- d) Does Ubuntu as a Linux operating system conform to the philosophy of the GNU movement? Please explain your answer.**

Ubuntu used open-sourced Linux kernel, so Ubuntu is fundamentally built upon free software principles. However, Ubuntu's parent company, Canonical, includes non-free components in some distribution so Ubuntu doesn't completely adhere to the philosophy of GNU movement (Free Software Foundation, 2025).

- e) Find out what is the Windows Subsystem for Linux?**

Windows Subsystem for Linux (WSL) is a feature of Windows that lets users run a Linux environment on their Windows devices, without the need to install virtual machine (Microsoft, 2025).

- f) Find out, which operating system family belongs to Android, iOS and ChromeOS?**

They belong to Unix-like operating systems.

Android and ChromeOS are based on Linux, while iOS belongs to the Unix-like (macOS/Darwin) family.

Assignment 5.2: Supercomputers and gameconsoles

- a) Research on this site what supercomputers are used for and write a short summary of it:

<https://www.computerhistory.org/timeline/search/?q=Supercomputer>

Supercomputers are used for complex, large-scale calculations in weather forecasting and climate research. They simulate experiments that might be too costly, expensive or dangerous to conduct in reality. A supercomputer consists of thousands of small computers called nodes (Argonne National Laboratory, n.d.).

- b) IBM is a company that has already built a number of supercomputers. One of them is IBM's Roadrunner. The CPU developed for this supercomputer was further developed at a later stage as the CPU for the PlayStation 3 console. Find out what a **PlayStation 3 cluster** is and what it was used for?

A PlayStation 3 (PS3) cluster is a supercomputer built by linking many PS3 consoles together via cables. It delivers supercomputer-level performance at a fraction of the cost of a traditional supercomputer and consumes less energy.

One example is the Condor Cluster, made of 1,760 PS3 consoles. US Air Force uses it for radar enhancement, pattern recognition, satellite image processing, and AI research (Zyga, 2010).

- c) You can build a supercomputer by putting a few computers together in a cluster. Here's what Oracle did with a collection of Raspberry Pi's, for example:

<https://blogs.oracle.com/developers/post/building-the-worlds-largest-raspberry-pi-cluster>

What specific operating system is running on this cluster?

Oracle Linux for ARM

- d) Does Oracle's Raspberry Pi supercomputer appear in the list of the 500 fastest supercomputers in the world? Make a logical decision for this, without going through the entire list.

<https://www.top500.org/lists/top500/list/2023/06/>

My guess: Oracle's Raspberry Pi supercomputer is not in the list of the 500 fastest supercomputers in the world. It is a small-scale project for demonstration, so it is unlikely that it can compete with multi-million dollar high-end supercomputers used for intensive tasks around the world.

- e) What CPU architecture is used for the PlayStation 5 and Xbox Series X?

AMD Zen 2

What operating systems run on these consoles?

PlayStation 5: customized OS based on FreeBSD (a Unix-like OS)

Xbox Series X: Xbox OS, a customized OS based on Windows

What conclusion can you draw from the answer to the previous question?

Besides general-purpose computer market, tech companies can create customized OS that targets specific sectors, such as gaming and healthcare. Those OS are built on a specific architecture (Unix-

like or Window), can address specialized requirements and strengthen company's presence in diversified fields. Controlling the operating system can be a brilliant business strategy to lock customers in an ecosystem.

Assignment 5.3: Working with Windows

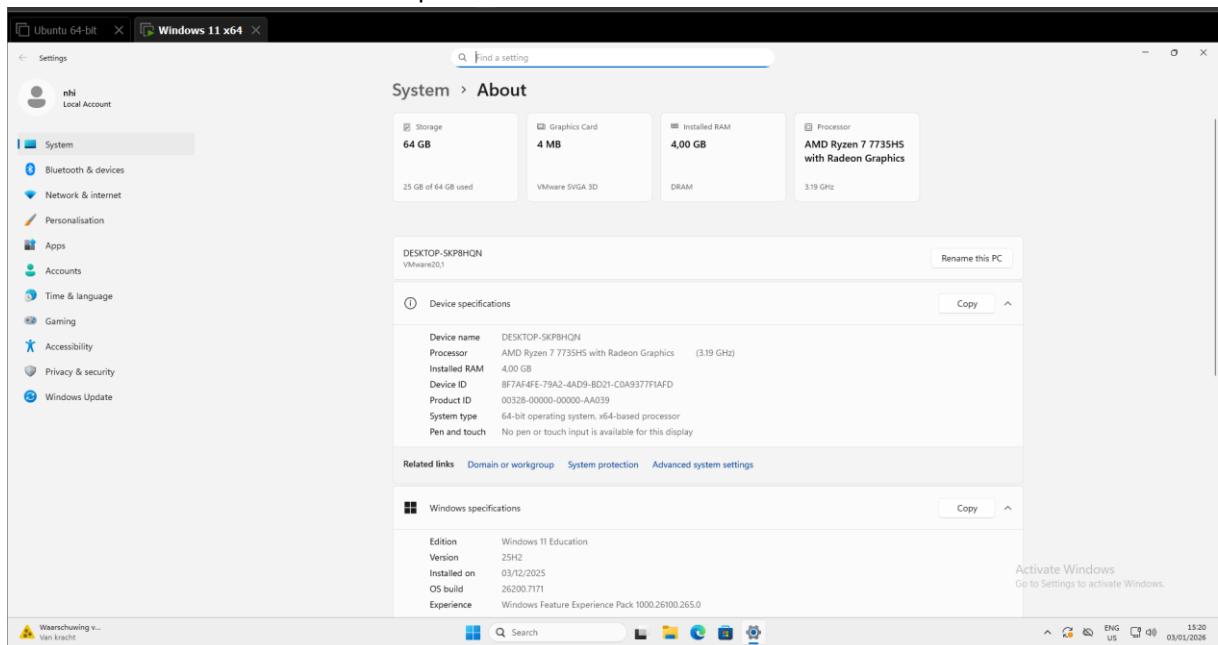
Take relevant screenshots of the assignments below

- Practice for about 10 minutes with the  keyboard shortcuts combinations, skip the general shortcuts in this exercise. Take a look at which screens are opened.
- The file explorer can be opened with  + E, Which key combination could you also use?

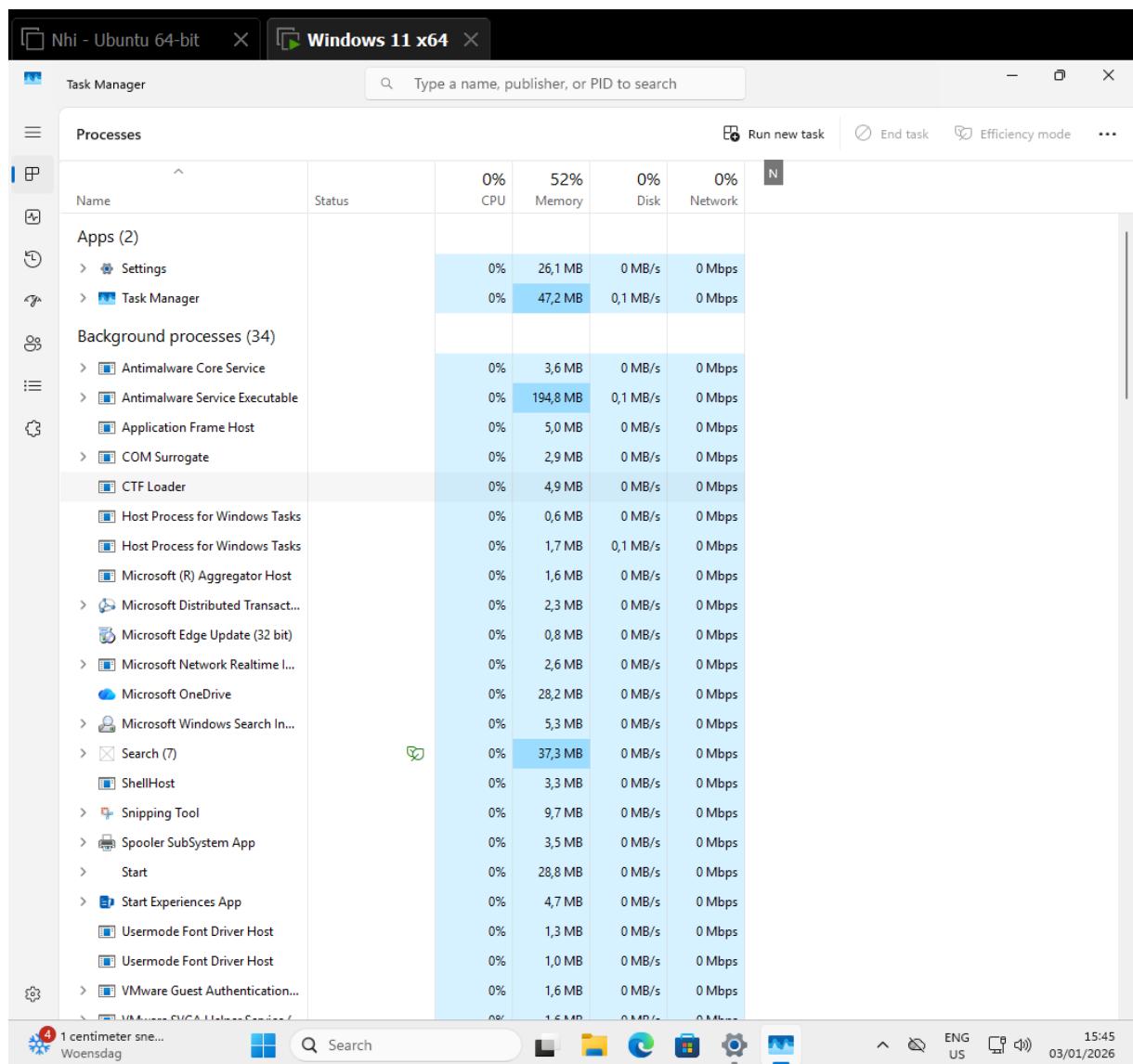
Windows logo key + R, then type explorer and press Enter.

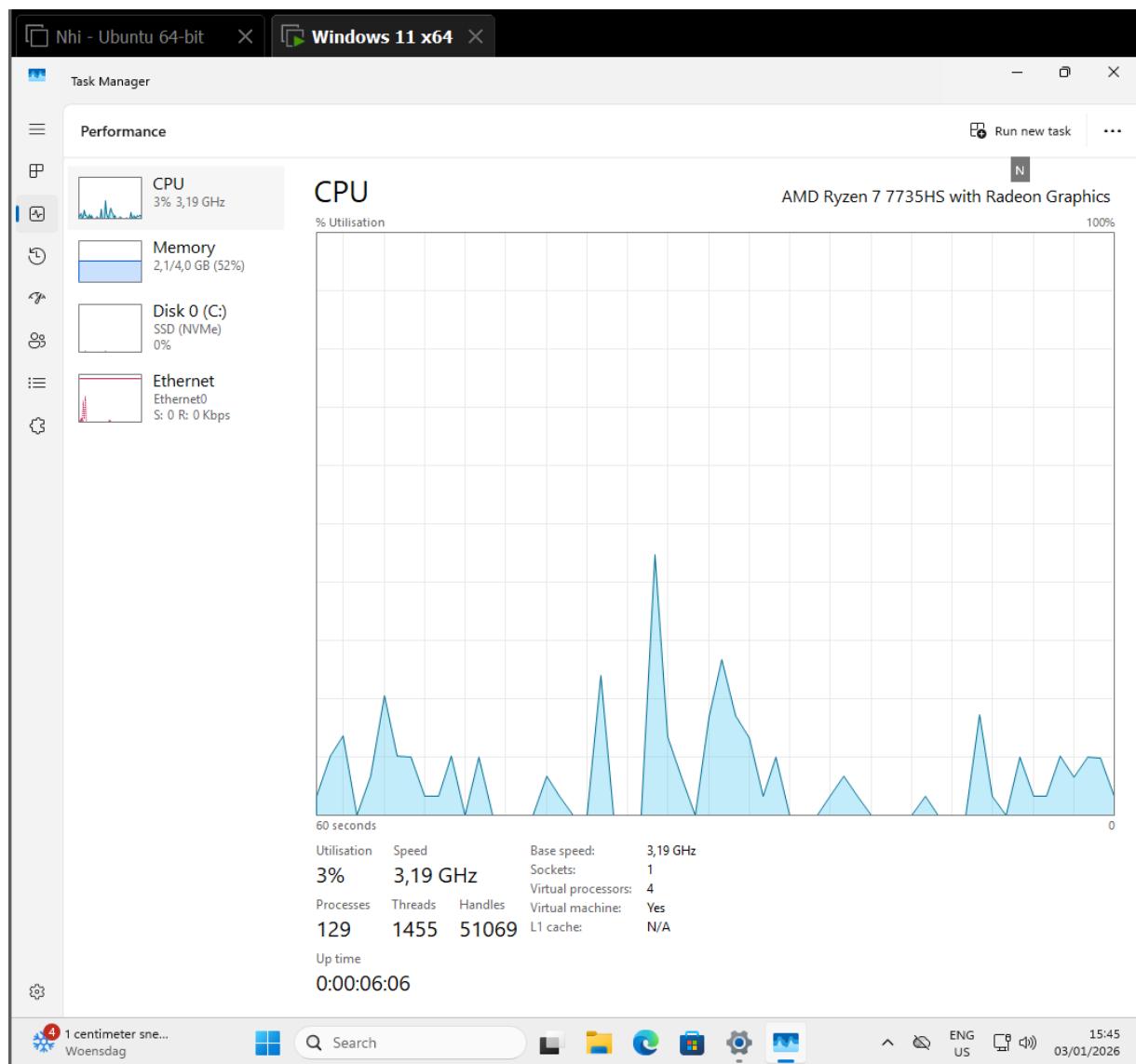
Windows logo key + X, then use the down arrow keys to select "File Explorer" from the Quick Link menu and press Enter.

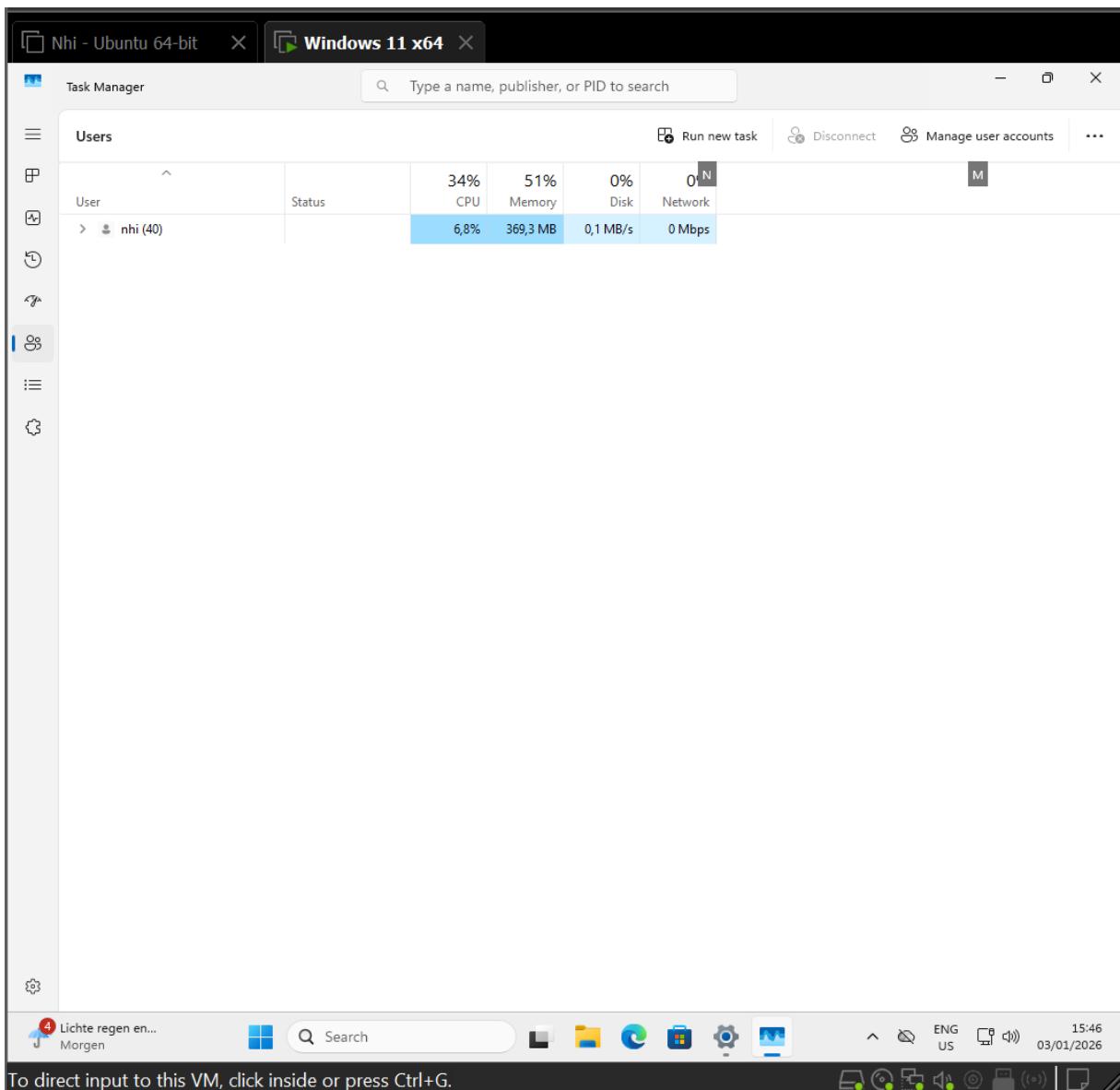
- Open the system properties with a  key combination, take a screenshot of the open screen. Paste this screenshot into this template.



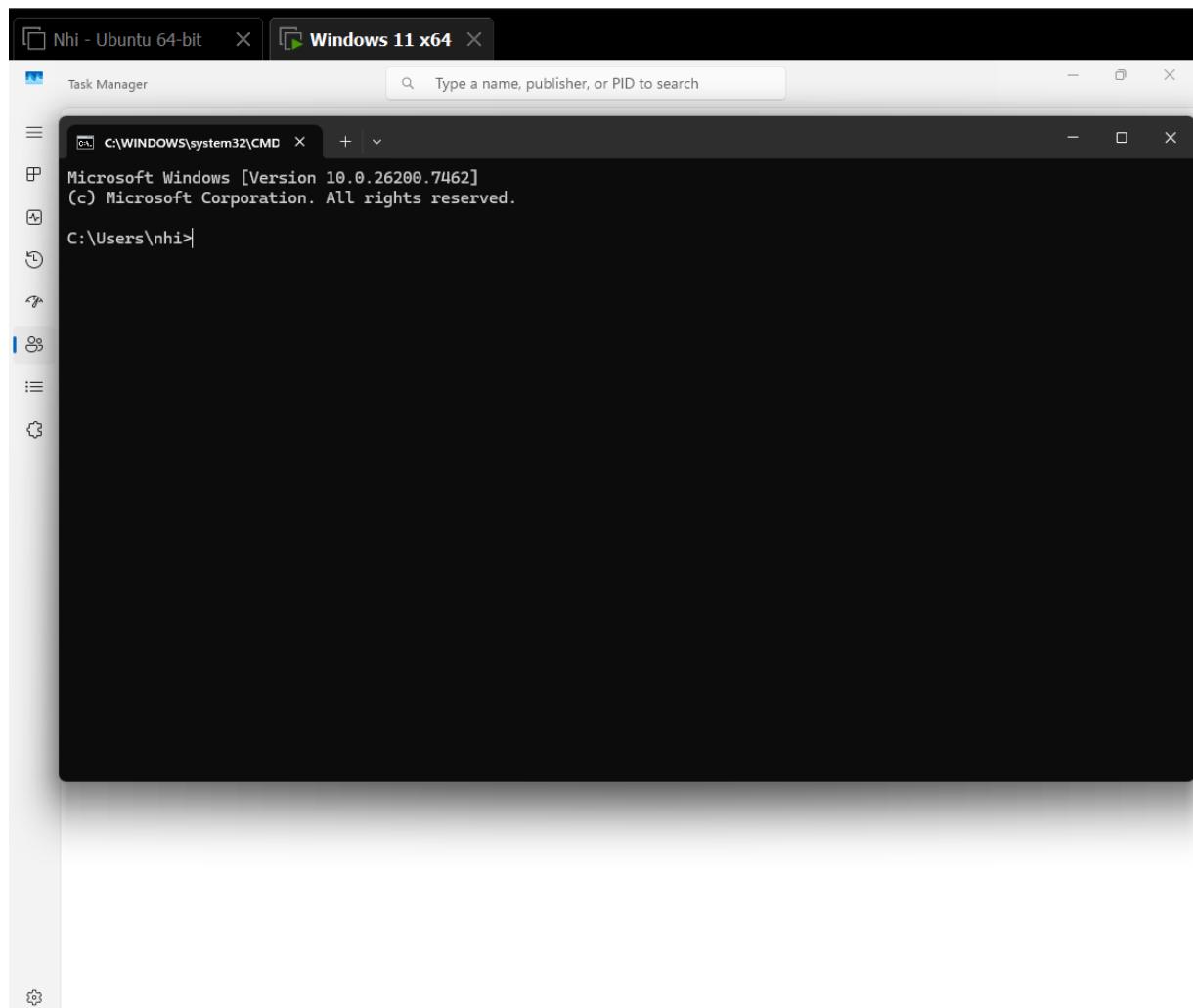
- Open task manager with a key combination. Take screenshots of the tabs: processes (shows active processes), performance, and users. Place these three screenshots in this template.







- e) If you're giving a PowerPoint presentation and you connect your laptop to a projector, Windows can use the projector as a second screen. For example, you may have Outlook open on your first screen that you don't show over the projector, while the PowerPoint presentation is displayed on the projector, or the second screen. Which key combination should you use for this?
- Window key + P to open the Project menu, then select the Extend option
- f) If you leave the classroom for a while and you leave your laptop behind, it is wise to lock the screen. Your Apps will continue to run in the background. So, for example, if you're waiting for a download that takes a while, lock the screen and get a cup of coffee. Which key combination do you use for this?
- Window key +L
- g) Open the Run screen with a key combination. On this screen, type CMD and press <enter>. Take a screenshot of this result and paste it into this template.



Working in the File Explorer

Relevant screenshots **copy** command:

Nhi - Ubuntu 64-bit X Windows 11 x64 X

C:\Windows\System32\cmd.e X + ▾

```
Microsoft Windows [Version 10.0.26200.7462]
(c) Microsoft Corporation. All rights reserved.

C:\SAXION> copy Wave.png HBOICT\YEAR1\QUARTILE1\Intro to Programming
The syntax of the command is incorrect.

C:\SAXION> copy Wave.png "HBOICT\YEAR1\QUARTILE1\Intro to Programming"
1 file(s) copied.

C:\SAXION> copy
C:\SAXION>copy "C:\SAXION\Plug.png" "C:\SAXION\HBOICT\YEAR1\QUARTILE1\Intro to Infrastructure"
1 file(s) copied.

C:\SAXION> copy Tumble.png "C:\SAXION\HBOICT\YEAR1\QUARTILE1\Synergy"
1 file(s) copied.
```

Relevant screenshots tree command:

C:\Windows\System32\cmd.e X + ▾

```
C:\SAXION>tree
Folder PATH listing
Volume serial number is B0C5-236C
C:.

HBOICT
└── YEAR1
    ├── QUARTILE1
    │   ├── Intro to Infrastructure
    │   ├── Intro to Programming
    │   └── Synergy
    ├── QUARTILE2
    │   ├── Database
    │   ├── IT Fundamentals
    │   └── IT's in the Game
    ├── QUARTILE3
    └── QUARTILE4

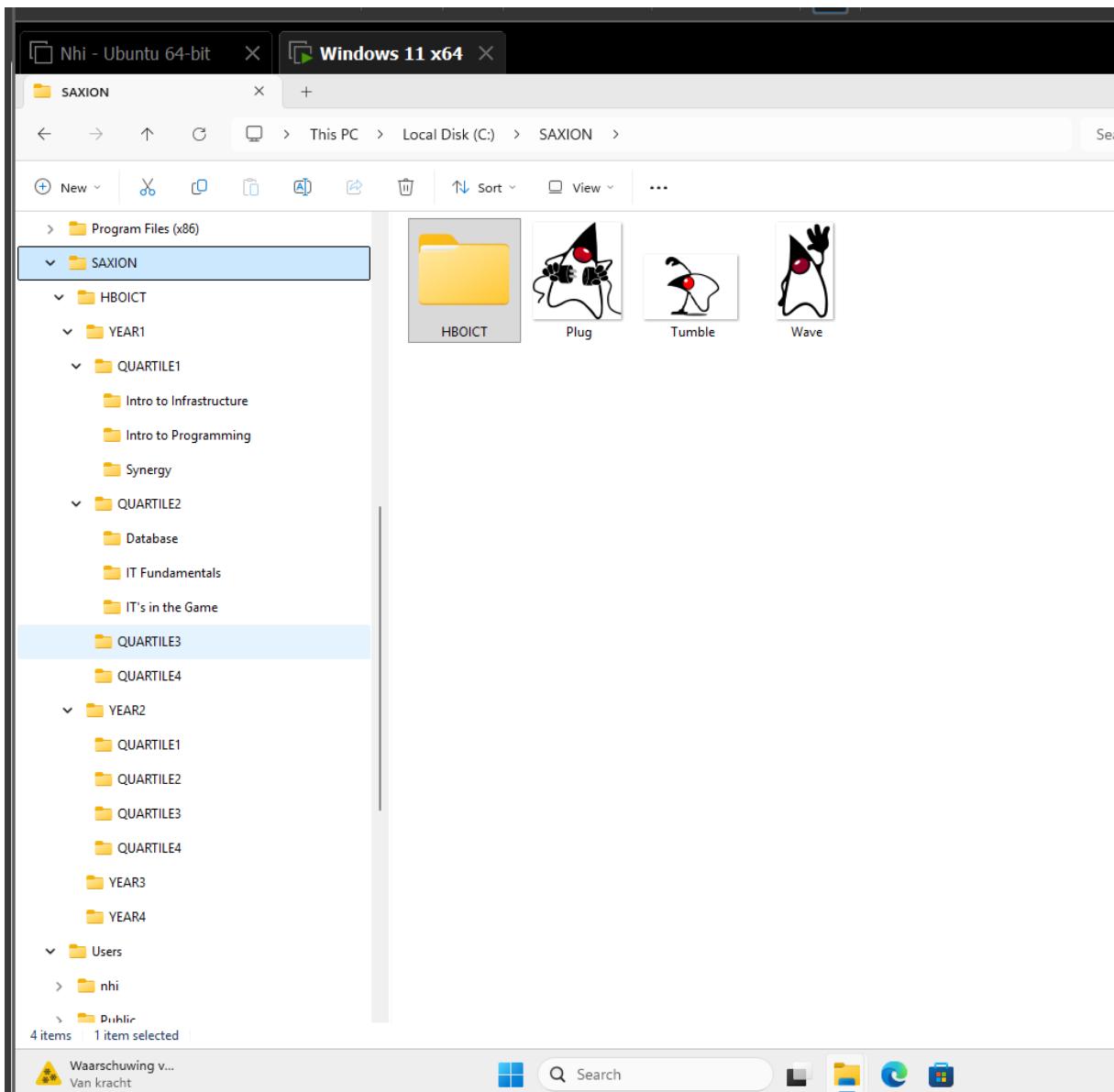
    └── YEAR2
        ├── QUARTILE1
        ├── QUARTILE2
        ├── QUARTILE3
        └── QUARTILE4

        └── YEAR3
            ├── QUARTILE1
            ├── QUARTILE2
            ├── QUARTILE3
            └── QUARTILE4

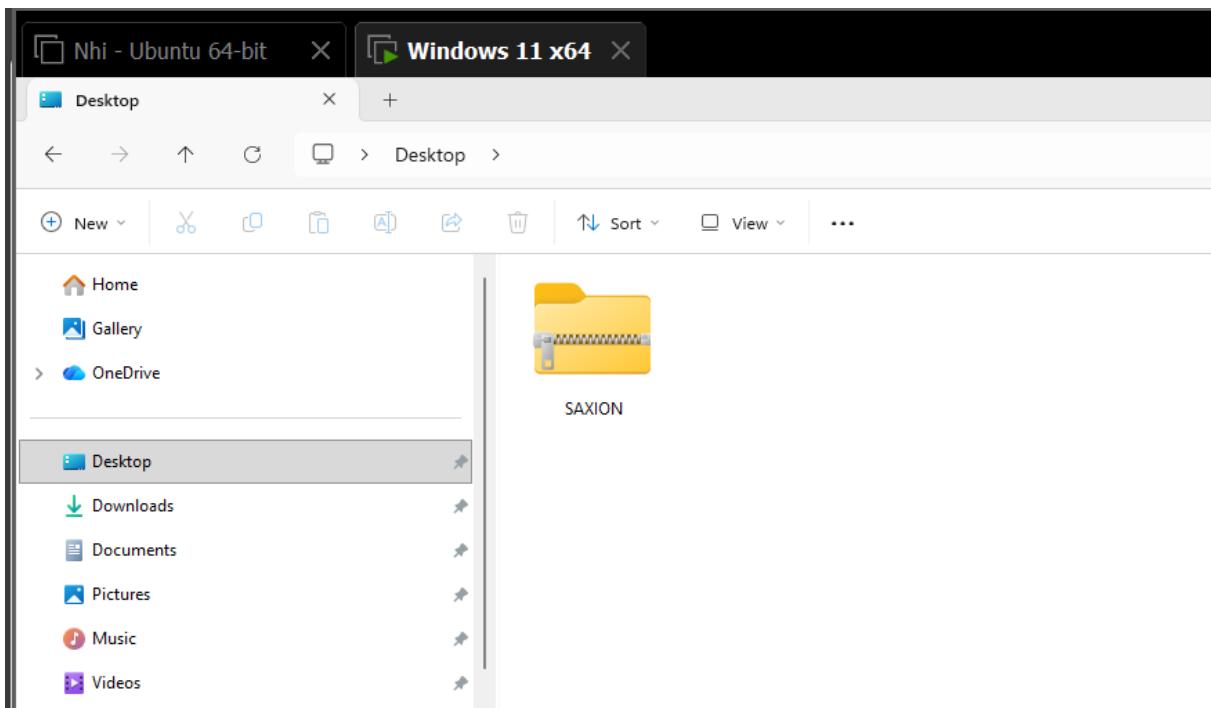
        └── YEAR4
            ├── QUARTILE1
            ├── QUARTILE2
            ├── QUARTILE3
            └── QUARTILE4

C:\SAXION> echo %username%
nhi
```

Relevant screenshots in the file explorer of the folder c:\Saxion + created zip file.



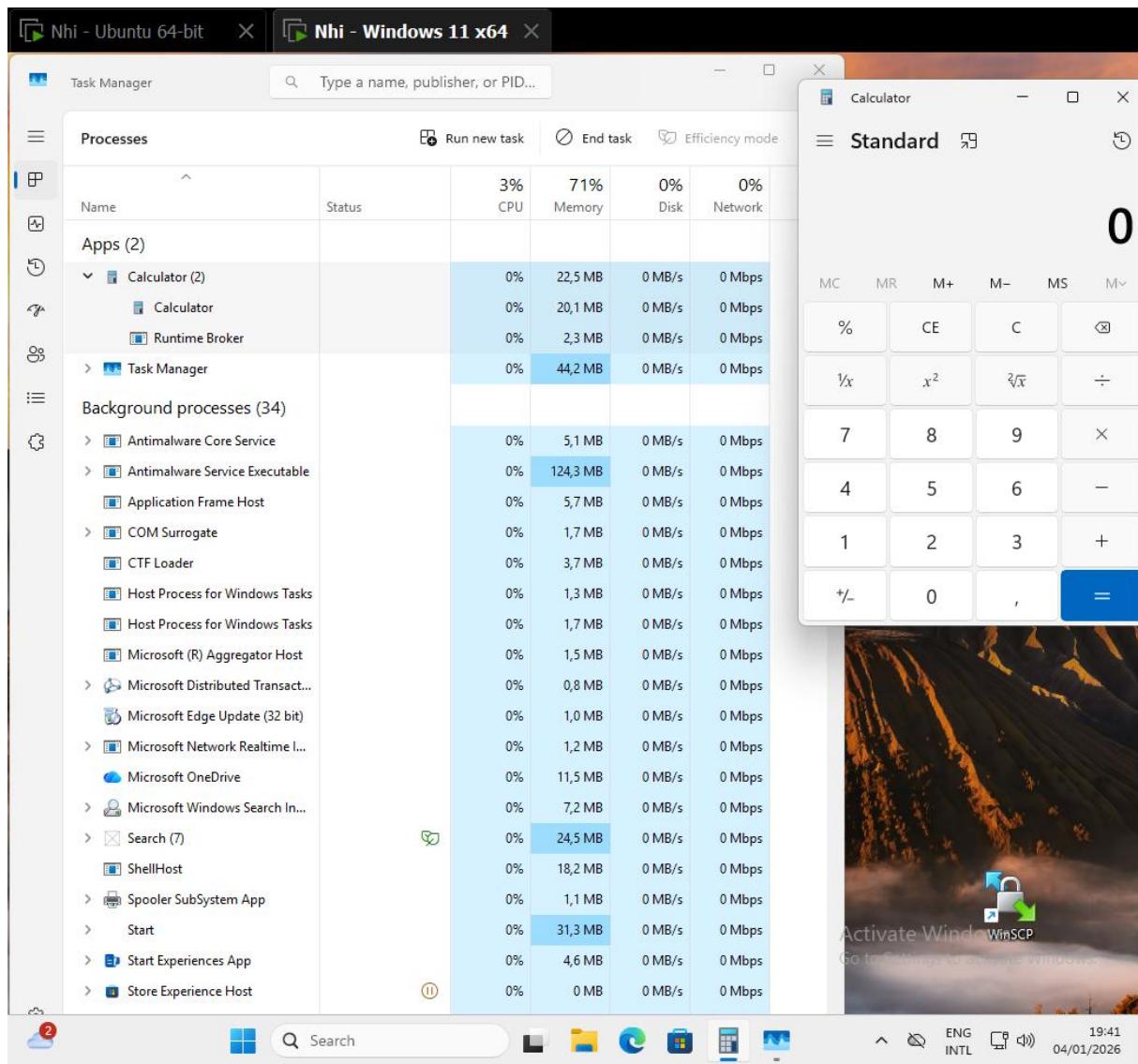
The 'Copy to → Compressed folder' option was not available, and creating ZIP files was blocked in C:\, so I used 'Send to → Compressed (zipped) folder' and create the zip file in my Desktop.



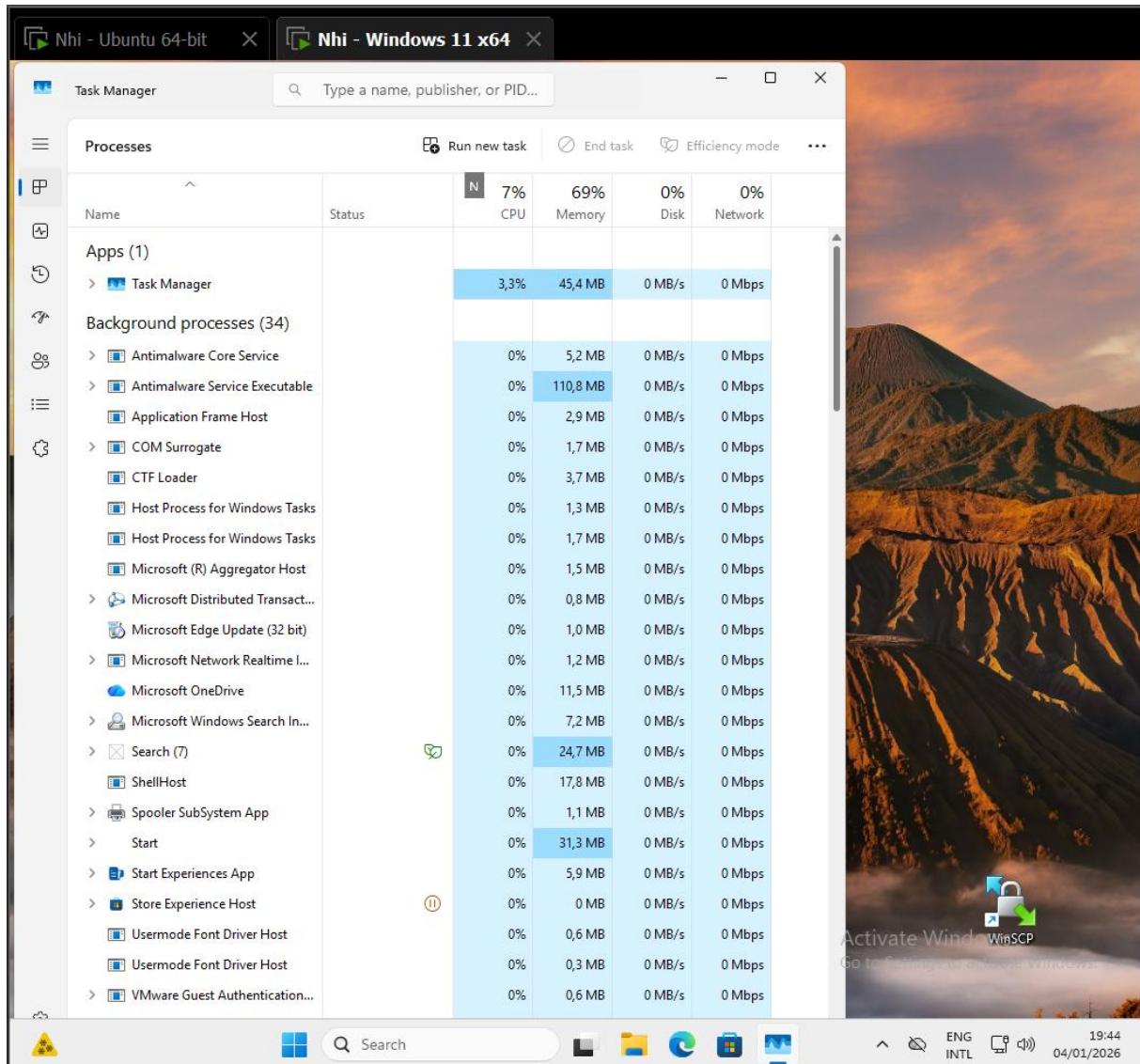
Terminating Processes

Relevant Screenshots Task Manager Window:

Open Task Manager while Calculator program is running



Choose calculator app, click End task to end the application



Install Software

a) Show that you have installed Firefox via winget in the command prompt.

```
Nhi - Ubuntu 64-bit X Windows 11 x64 X
Select Administrator: Command Prompt
Ablaze.Floorp      Ablaze.Floorp          12.9.2... Tag: firefox-fo... winget
Floorp 12 Daylight Ablaze.Floorp.Daylight 138.0... Tag: firefox-fo... winget
r3dfox             EclipseCommunity.r3dfox   146.0   Tag: firefox-fo... winget
Pale Moon          MoonchildProductions.PaleM... 33.9.1  Tag: firefox-fo... winget
Ghostery Private Browser Ghostery.GhosteryDawn 2024.8... Tag: firefoxfork winget
ffsend             TimVisee.ffsend        0.2.76  Tag: firefox-se... winget

C:\Windows\System32>winget install -e --id Mozilla.Firefox
Found Mozilla Firefox (en-US) [Mozilla.Firefox] Version 146.0.1
This application is licensed to you by its owner.
Microsoft is not responsible for, nor does it grant any licenses to, third-party packages.
Downloading https://download-installer.cdn.mozilla.net/pub/firefox/releases/146.0.1/win64/en-US/Firefox%20Setup%20146.0.1.exe
[██████████] 82.3 MB / 82.3 MB
Successfully verified installer hash
Starting package install...
Successfully installed

C:\Windows\System32>
```

b) Explain in your own words what exactly the above command does, explain the -e and --id options used as well. Use this site:

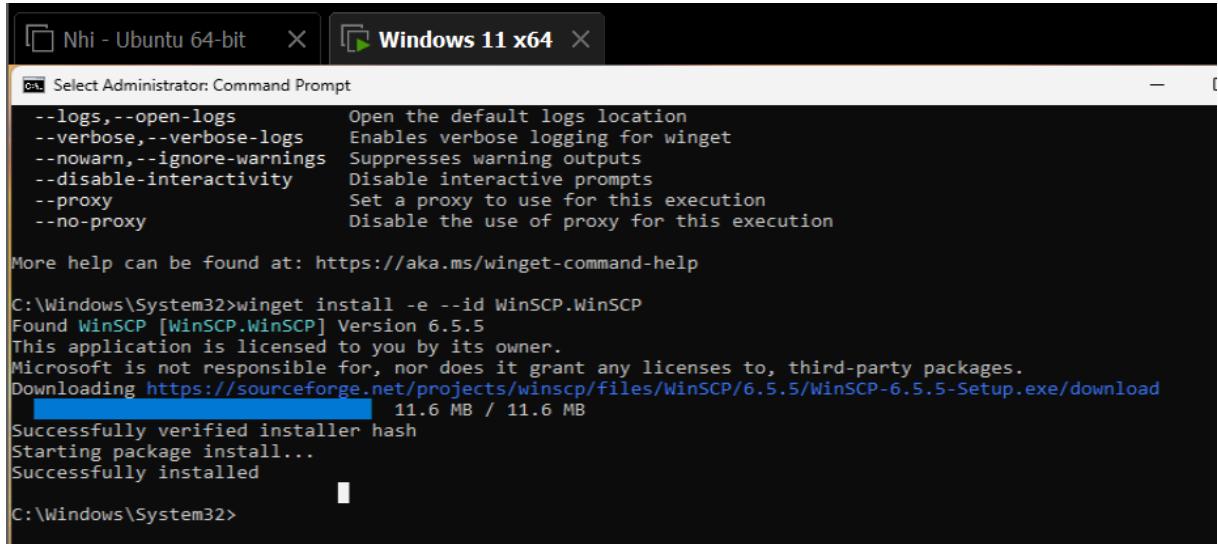
<https://learn.microsoft.com/en-us/windows/package-manager/winget/install>

The command winget install -e --id Mozilla.Firefox uses the Windows Package Manager (WinGet) to install Mozilla.Firefox.

The query arguments -e and --id ensure that only the **exact** match with the unique **ID** Mozilla.Firefox is installed.

c) Relevant screenshots that the following software is installed with winget:

- WinSCP



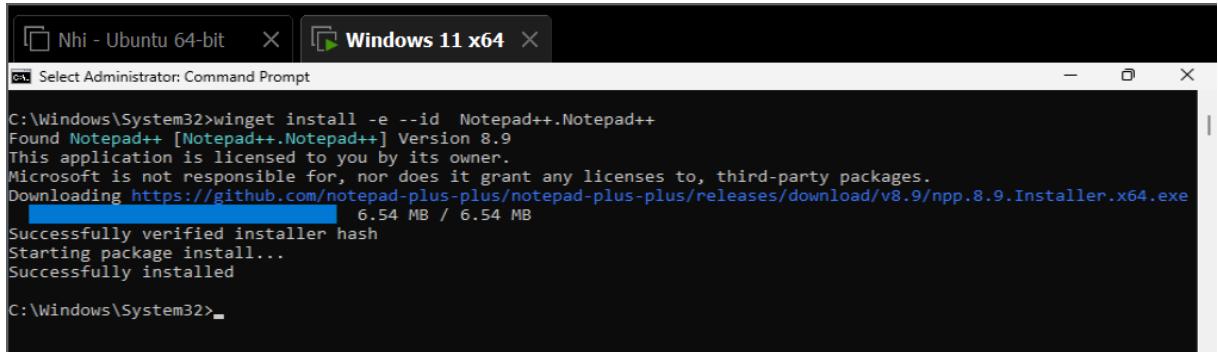
```
Nhi - Ubuntu 64-bit X Windows 11 x64 X
Select Administrator: Command Prompt
--logs,--open-logs      Open the default logs location
--verbose,--verbose-logs Enables verbose logging for winget
--nowarn,--ignore-warnings Suppresses warning outputs
--disable-interactivity Disable interactive prompts
--proxy                 Set a proxy to use for this execution
--no-proxy              Disable the use of proxy for this execution

More help can be found at: https://aka.ms/winget-command-help

C:\Windows\System32>winget install -e --id WinSCP.WinSCP
Found WinSCP [WinSCP.WinSCP] Version 6.5.5
This application is licensed to you by its owner.
Microsoft is not responsible for, nor does it grant any licenses to, third-party packages.
Downloading https://sourceforge.net/projects/winscp/files/WinSCP/6.5.5/WinSCP-6.5.5-Setup.exe/download
[Progress Bar] 11.6 MB / 11.6 MB
Successfully verified installer hash
Starting package install...
Successfully installed

C:\Windows\System32>
```

- Notepad++



```
Nhi - Ubuntu 64-bit X Windows 11 x64 X
Select Administrator: Command Prompt
C:\Windows\System32>winget install -e --id Notepad++.Notepad++
Found Notepad++ [Notepad++.Notepad++] Version 8.9
This application is licensed to you by its owner.
Microsoft is not responsible for, nor does it grant any licenses to, third-party packages.
Downloading https://github.com/notepad-plus-plus/notepad-plus-plus/releases/download/v8.9/npp.8.9.Installer.x64.exe
[Progress Bar] 6.54 MB / 6.54 MB
Successfully verified installer hash
Starting package install...
Successfully installed

C:\Windows\System32>
```

- 7zip

The screenshot shows a Windows Command Prompt window titled "Windows 11 x64". The command "winget search 7Zip" is run, displaying a list of packages. The output is as follows:

```
C:\Windows\System32>winget search 7Zip
Name           Id          Version      Match      Source
7-Zip          7zip.7zip    25.01       Moniker: 7zip winget
Advanced Archive Password Recovery Elcomsoft.ArchivePassword 4.66.266.6965 Tag: 7zip winget
NanaZip        M2Team.NanaZip 5.0.1263.0 Tag: 7zip winget
NanaZip Preview M2Team.NanaZip.Preview 6.0.1461.0 Tag: 7zip winget
7-Zip ZS       mcmilk.7zip-zstd 25.01 ZS v1.5.7 R2 Tag: 7zip winget
7-Zip Alpha (exe) 7zip.7zip.Alpha.exe 24.01      winget
7-Zip Alpha (msi) 7zip.7zip.Alpha.msi 24.01.00.0 winget
7zr            7zip.7zr      25.01       winget
QNapi          QNapi.QNapi   0.2.3       Tag: p7zip winget

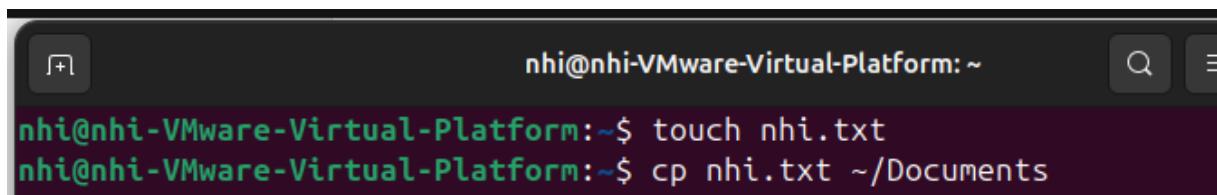
C:\Windows\System32>winget install -e --id 7zip.7zip
Found 7-Zip [7zip.7zip] Version 25.01
This application is licensed to you by its owner.
Microsoft is not responsible for, nor does it grant any licenses to, third-party packages.
Downloading https://7-zip.org/a/7z2501-x64.exe
[██████████] 1.56 MB / 1.56 MB
Successfully verified installer hash
Starting package install...
Successfully installed

C:\Windows\System32>
```

Assignment 5.4: Working with Linux

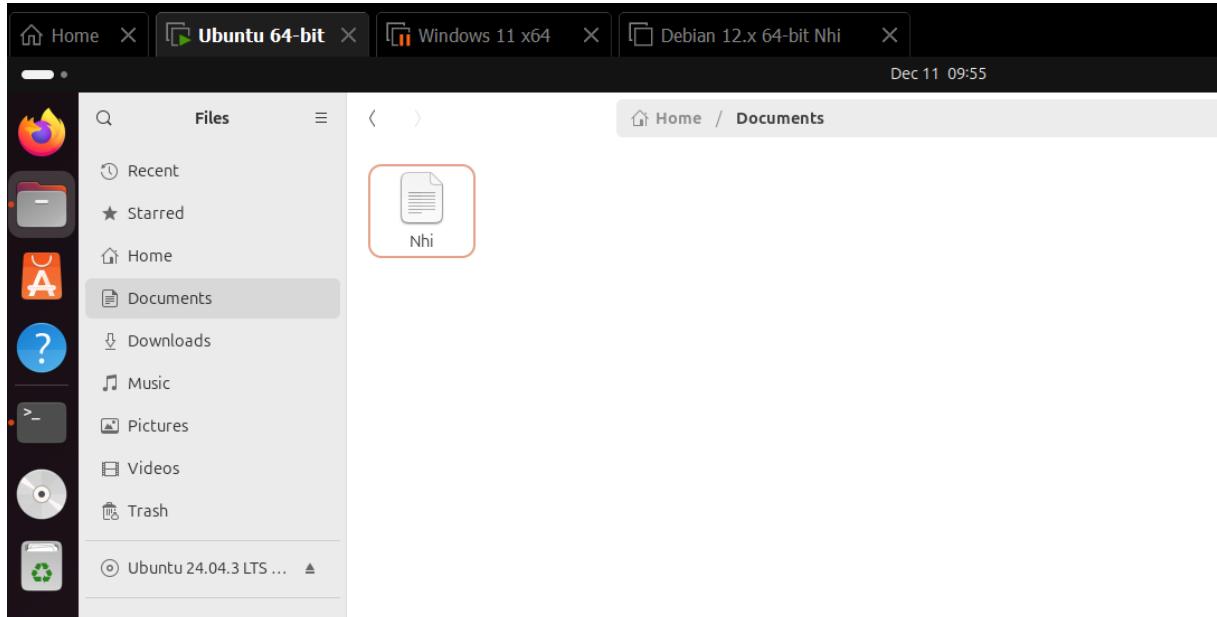
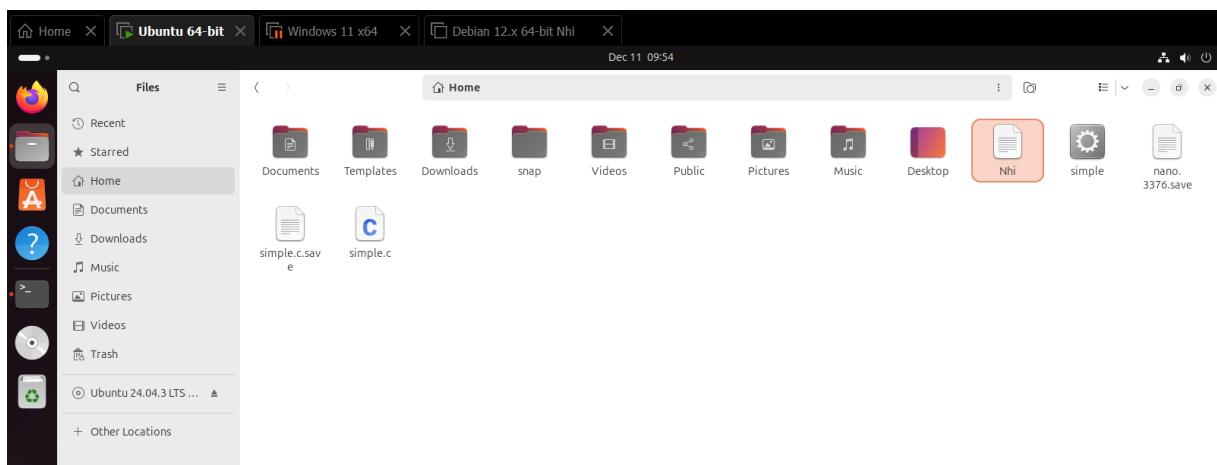
Relevant screenshots + motivation

Create test file and copy it to ~/Documents



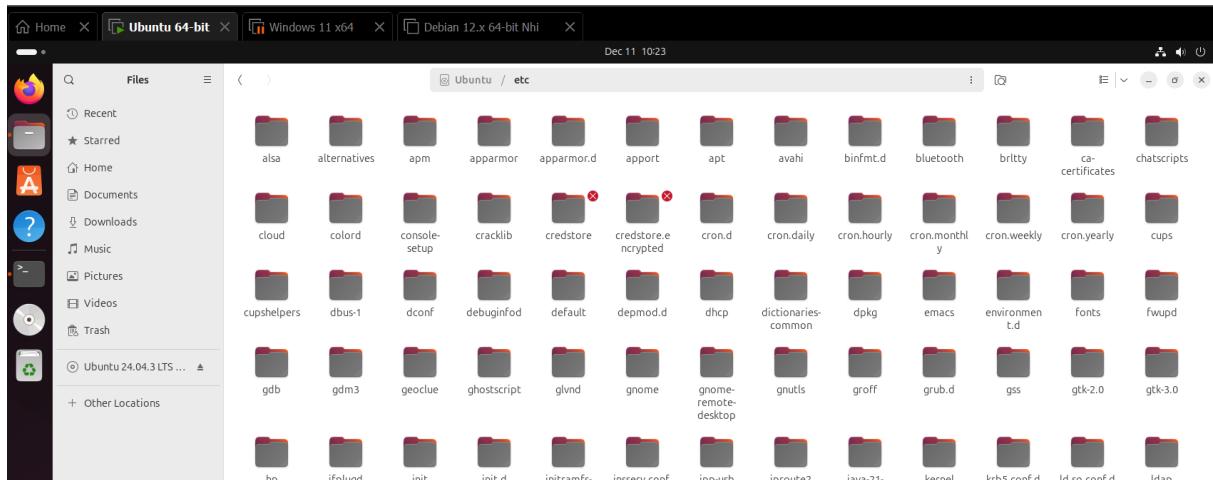
```
nhi@nhi-Virtual-Platform:~$ touch nhi.txt
nhi@nhi-Virtual-Platform:~$ cp nhi.txt ~/Documents
```

Copy the file from Home to Documents directory in file explorer



Navigating the file structure

- Type /etc in address bar to navigate to the etc directory in the file explorer



- Type `cd /etc` to go to etc directory in the terminal

```
nhi@nhi-VMware-Virtual-Platform:~/Documents$ cd /etc  
nhi@nhi-VMware-Virtual-Platform:/etc$ █
```

- `cd~` to get back to home directory in the terminal

A screenshot of a Linux desktop environment, likely elementary OS. The top bar shows four windows: 'Home' (closed), 'Ubuntu 64-bit' (active), 'Windows 11 x64' (closed), and 'Debian 1'. The date and time 'Dec 11 10:58' are displayed. Below the bar, the desktop background is visible with icons for a browser (Firefox) and a file manager (Nautilus). A terminal window is open in the foreground, showing a command-line session:
nhi@nhi-VMware-Virtual-Platform:~\$ cd ~
nhi@nhi-VMware-Virtual-Platform:~\$

- Name one significant difference in Linux's file structure when comparing it to Windows.

Linux has only one unified directory tree starting at / (root), while Windows have many drives letters like C:\, D:\

- What is the /etc directory usually used for?

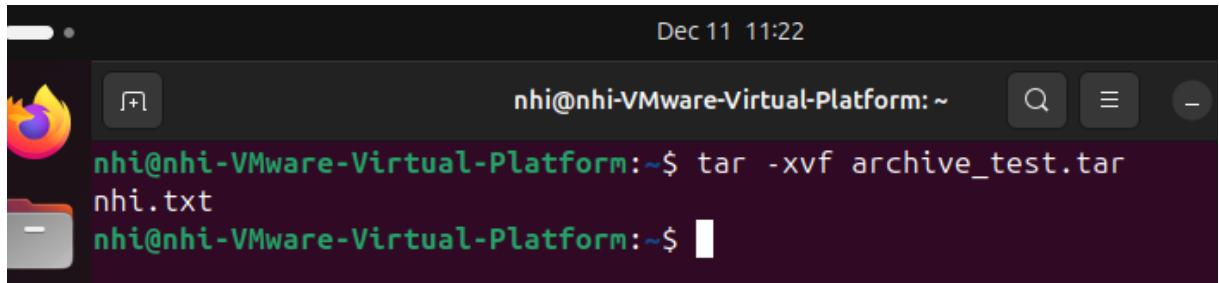
The /etc directory stores essential system configuration files that define system behavior, user access, boot settings, network rules, and service management (GeeksforGeeks, 2025)

- Compress files

- o Which command in the terminal would you use to compress a text file into a tar archive?

```
nhi@nhi-VMware-Virtual-Platform:~$ tar cvf nhiarchive.tar nhi.txt
```

- o With which command in the terminal would you be able to extract a tar file?



- o Compress a text file in a tar archive and compress it with gzip.

```
nhi@nhi-VMware-Virtual-Platform:~$ tar -cvf nhitest.tar nhi.txt
```

```
nhi@nhi-VMware-Virtual-Platform:~$ ls
```

Desktop	nano.10394.save	nhitest.tar	simple	Templates
---------	-----------------	--------------------	--------	-----------

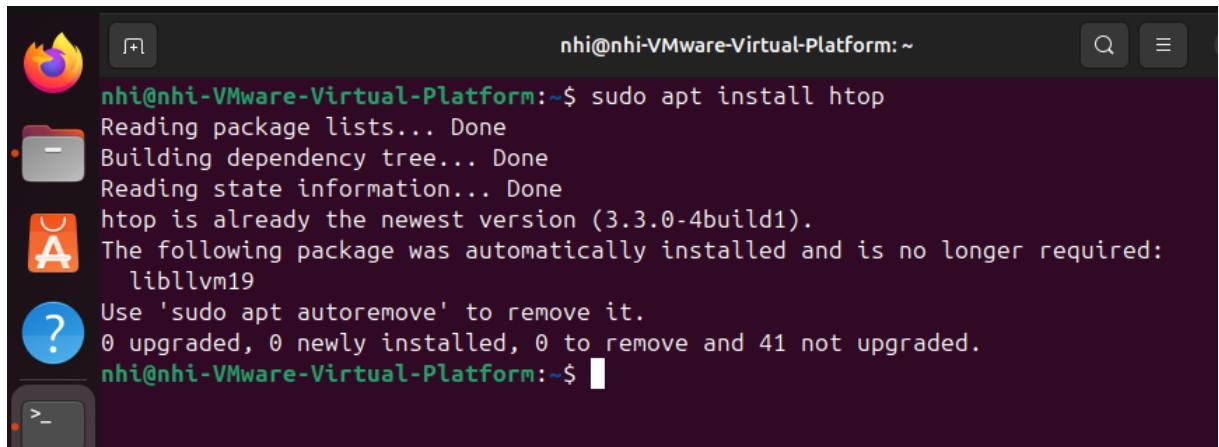

```
nhi@nhi-VMware-Virtual-Platform:~$ gzip nhitest.tar
```

```
nhi@nhi-VMware-Virtual-Platform:~$ ls
```

Desktop	nano.10394.save	nhitest.tar.gz	simple	Templates
---------	-----------------	-----------------------	--------	-----------

- View processes

- o Install the application **htop** via a terminal command

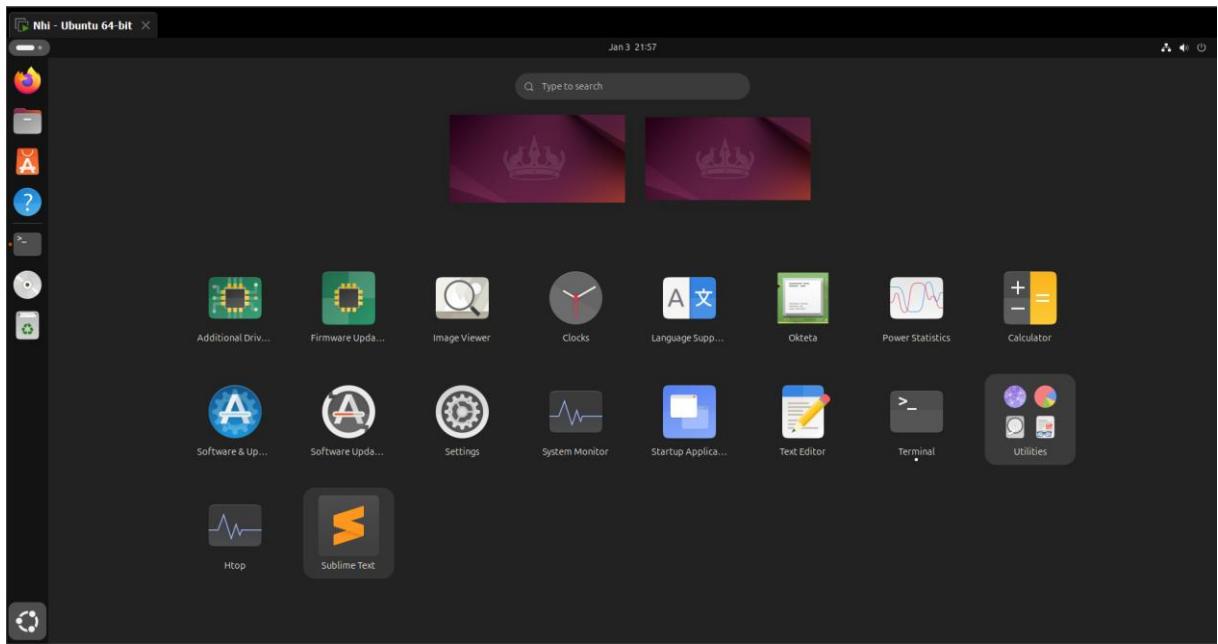


- o Launch the htop application. Explain what this application shows.

htop is an interactive interface showing all running processes, along with CPU, memory, and swap usage. It is equivalent of Window Task Manager in Ubuntu.

- Install Software

- o Software can be installed via the terminal in Ubuntu as we just did in the previous assignment, but it can also be installed in Ubuntu via the Software center. Find and install the **Sublime Text application** on your Ubuntu VM



- o Using a terminal command, install the **neofetch application**. What does this application show when you launch it?

It displays my computer's system information (OS, kernel, CPU, GPU, RAM, etc.) next to a logo of my OS in ASCII

Install neofetch

```
nhi@nhi-VMware-Virtual-Platform:~$ sudo apt install neofetch
[sudo] password for nhi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
neofetch is already the newest version (7.1.0-4).
The following package was automatically installed and is no longer required:
  libl LLVM19
Use 'sudo apt autoremove' to remove it.
0 upgraded, 0 newly installed, 0 to remove and 41 not upgraded.
nhi@nhi-VMware-Virtual-Platform:~$
```

Run neofetch:

```

nhi@nhi-VMware-Virtual-Platform:~$ cat logo
.-/+oossssoo+/-.
`:+ssssssssssssssssssssss+:
-+ssssssssssssssssssssyssss+-+
.oaaaaaaaaaaaaaaaadMMMNyssso.
/aaaaaaaaaaaaahdmNNmmyNMMMHssssss/
+ssssssssshmydMMMMMMMNdddyssssssss+-
/sssssssshNMMMyhyyyyhmNMMNHssssssss/
.ssssssssdMMMNhsssssssssshNMMMdssssssss.
+sssshhhyNMMNyssssssssssssyNMMMyssssssss+-
ossyNMMMNyMMhsssssssssssshmmhssssssso
ossyNMMMNyMMhsssssssssssshmmhssssssso
+sssshhhyNMMNyssssssssssssyNMMMyssssssss+-
.ssssssssdMMMNhsssssssssshNMMMdssssssss.
/sssssssshNMMMyhyyyyhdNMMNHssssssss/
+sssssssssdmydMMMMMMMNdddyssssssss+-
/aaaaaaaaaaaaahdmNNNMyNMMMHssssssss/
.oaaaaaaaaaaaaaaaadMMMNyssso.
-+ssssssssssssssssyyssss+-+
`:+ssssssssssssssssssss+:
.-/+oossssoo+/-.

nhi@nhi-VMware-Virtual-Platform:~$
```

nhi@nhi-VMware-Virtual-Platform:~

OS: Ubuntu 24.04.3 LTS x86_64
Host: VMware Virtual Platform None
Kernel: 6.14.0-37-generic
Uptime: 1 hour, 28 mins
Packages: 1826 (dpkg), 12 (snap)
Shell: bash 5.2.21
Resolution: 930x954
DE: GNOME 46.0
WM: Mutter
WM Theme: Adwaita
Theme: Yaru [GTK2/3]
Icons: Yaru [GTK2/3]
Terminal: gnome-terminal
CPU: AMD Ryzen 7 7735HS with Radeon
GPU: 00:0f.0 VMware SVGA II Adapter
Memory: 1105MiB / 3867MiB

Assignment 5.5: Users and permissions on Linux

Relevant screenshots + motivation

Create hello.sh file

```
nhi@nhi-VMware-Virtual-Platform:~$ nano hello.sh
```

Add content to hello.sh file, save and exit

```
GNU nano 7.2                                     hello.sh
#!/bin/bash
echo Hello Nhi, 591658 !
```

Create directory hello

```
nhi@nhi-VMware-Virtual-Platform:~$ mkdir hello
```

Move hello.sh into ~/hello

```
nhi@nhi-VMware-Virtual-Platform:~$ mv hello.sh ~/hello
```

Make the file executable only for the logged-in user but give other groups read-only permission

```
nhi@nhi-VMware-Virtual-Platform:~/hello$ chmod 744 hello.sh
```

Run i./hello.sh

```
nhi@nhi-VMware-Virtual-Platform:~/hello$ ./hello.sh
Hello Nhi, 591658 !
```

Assignment 5.6: View the contents of files

Relevant screenshots + motivation

How many lines does the file have? 12304 lines

```
nhi@nhi-VMware-Virtual-Platform:~/Downloads$ wc -l sherlock.txt  
12304 sherlock.txt
```

How many words? 107560 words

```
nhi@nhi-VMware-Virtual-Platform:~/Downloads$ wc -w sherlock.txt  
107560 sherlock.txt
```

And how many characters? 593 837 characters

```
nhi@nhi-VMware-Virtual-Platform:~/Downloads$ wc -m sherlock.txt  
593837 sherlock.txt
```

- On which lines is the word "kingdom" in the file? **TIP!** grep -n

Line 490 and line 1124

```
nhi@nhi-VMware-Virtual-Platform:~/Downloads$ grep -n "kingdom" sherlock.txt  
490:"I tell you that I would give one of the provinces of my kingdom to  
1124:And that was how a great scandal threatened to affect the kingdom of  
nhi@nhi-VMware-Virtual-Platform:~/Downloads$
```

- Use the head and/or tail commands to see the 20 words above and below the word "kingdom" on the screen

Line 490 has the word "kingdom".

20 line after =>490+20= line 510

Command head – n 510 sherlock to take first 510 lines

From line 510, tail command cuts 41 lines before it to get both 20 lines before and after line 490

```
nhi@nhi-VMware-Virtual-Platform:~/Downloads$ head -n 510 sherlock.txt | tail -n  
41
```

Assignment 5.7: Digital forensics

Relevant screenshots + motivation

EXIF

- Identify phone brand/type:

Phone moto g(6) play, Motorola branch

Run exif to find out details of the picture. These details include which device was used to take the picture, as well as the GPS of the location.

```

nhi@nhi-Virtual-Platform:~/Assignment$ exif oldcar.jpg
EXIF tags in 'oldcar.jpg' ('Motorola' byte order):
-----
Tag          |Value
-----
Manufacturer |motorola
Model        |moto g(6) play
X-Resolution |72
Y-Resolution |72
Resolution Unit |Inch
Software     |aljeter-user 9 PPPS29.55-35-18-7 6a0d0 release-keys
Date and Time |2020:11:07 15:08:57
YCbCr Positioning |Centered

```

- Are there GPS coordinates known? Yes

Latitude = 53° 11' 39.6794" N

Longitude = 6° 32' 12.9018" E

```

GPS Tag Version      |2.2.0.0
North or South Latit|N
Latitude            |53, 11, 39.6794
East or West Longitu|E
Longitude           | 6, 32, 12.9018
Altitude Reference  |Sea level
Altitude            |42.066
GPS Time (Atomic Clo|14:08:57.00
Geodetic Survey Data|WGS-84
Name of GPS Processi|ASCII
GPS Date            |2020:11:07
Interoperability Ind|R98
Interoperability Ver|0100
-----
EXIF data contains a thumbnail (59453 bytes).
nhi@nhi-Virtual-Platform:~/Assignment$ 

```

Google maps shows this is in Groningen city

Filename extensions

mv to rename the file to oldcar and run command: file oldcar.

Ubuntu still considers it jpg file after the extension jpg is removed.

```

nhi@nhi-Virtual-Platform:~/Assignment$ mv oldcar.jpg oldcar
nhi@nhi-Virtual-Platform:~/Assignment$ file oldcar
oldcar: JPEG image data, JFIF standard 1.01, aspect ratio, density 1x1, segment length 16,
  Exif Standard: [TIFF image data, big-endian, direntries=10, manufacturer=motorola, model=
  moto g(6) play, xresolution=160, yresolution=168, resolutionunit=2, software=aljeter-user
  9 PPPS29.55-35-18-7 6a0d0 release-keys, datetime=2020:11:07 15:08:57, GPS-Data], baseline,
  precision 8, 4160x3120, components 3

```

BASE64

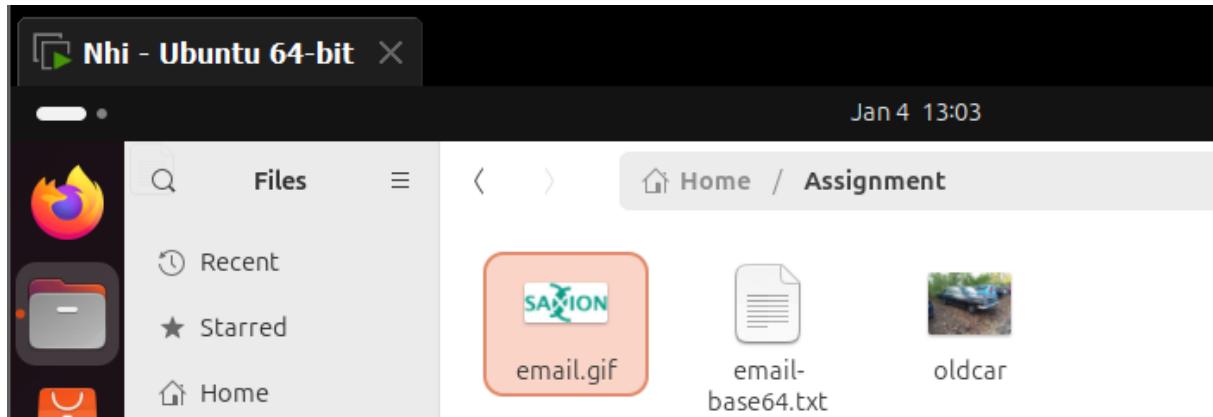
Decode the BASE64 String from email-base64.txt, and save the output as a binary gif file.

base64 -d decodes the string

> email.gif sends the output to a new file(email.gif) instead of the terminal in Linux

file email.gif checks the file type

```
nhi@nhi-VMware-Virtual-Platform:~/Assignment$ base64 -d email-base64.txt > email.gif  
nhi@nhi-VMware-Virtual-Platform:~/Assignment$ file email.gif  
email.gif: GIF image data, version 89a, 108 x 52
```



Assignment 5.8: Steganography

Relevant screenshots + motivation

Use steghide extract to extract the message, then use cat to read the message file

```
nhi@nhi-VMware-Virtual-Platform:~/Assignment$ steghide extract -sf apple2.jpg  
Enter passphrase:  
wrote extracted data to "message.txt".  
nhi@nhi-VMware-Virtual-Platform:~/Assignment$ cat message.txt  
Hello class.  
You have almost completed Week 5.
```

Assignment 5.9: Capture disk images

Make relevant screenshots + motivation:

- Proof that the Debian 13 server stored a back-up image of the Ubuntu 24.04 Desktop VM.
- Proof that you can restore the back-up image into an empty VM.

Documentation of steps

o Screenshots or terminal logs showing:

- Debian server setup

```
nhi@omv:~$ sudo apt update  
Hit:1 http://deb.debian.org/debian trixie InRelease  
Hit:2 http://deb.debian.org/debian trixie-updates InRelease  
Hit:3 http://security.debian.org/debian-security trixie-security InRelease  
1 package can be upgraded. Run 'apt list --upgradable' to see it.  
nhi@omv:~$ _
```

```
nhi@omv:~$ sudo apt install openssh-server -y  
openssh-server is already the newest version (1:10.0p1-7).  
Summary:  
Upgrading: 0, Installing: 0, Removing: 0, Not Upgrading: 1
```

```
nhi@omv:~$ sudo systemctl enable --now ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
nhi@omv:~$
```

Ip a to find Debian server's IP

```
nhi@omv:~$ sudo mkdir -p /srv/images
nhi@omv:~$ sudo chown $USER:$USER /srv/images
nhi@omv:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host noprefixroute
            valid_lft forever preferred_lft forever
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:0c:29:39:7d:61 brd ff:ff:ff:ff:ff:ff
        altname enp2s1
        altname enx000c29397d61
        inet 192.168.151.128/24 brd 192.168.151.255 scope global dynamic noprefixroute ens33
            valid_lft 1000sec preferred_lft 805sec
        inet6 fe80::f59:93ff:6b4a:e288/64 scope link
            valid_lft forever preferred_lft forever
nhi@omv:~$
```

Test SSH connectivity from Windows VM

The screenshot shows a Windows terminal window titled "nhi@omv: ~". The window displays the following text:

```
Microsoft Windows [Version 10.0.26200.7462]
(c) Microsoft Corporation. All rights reserved.

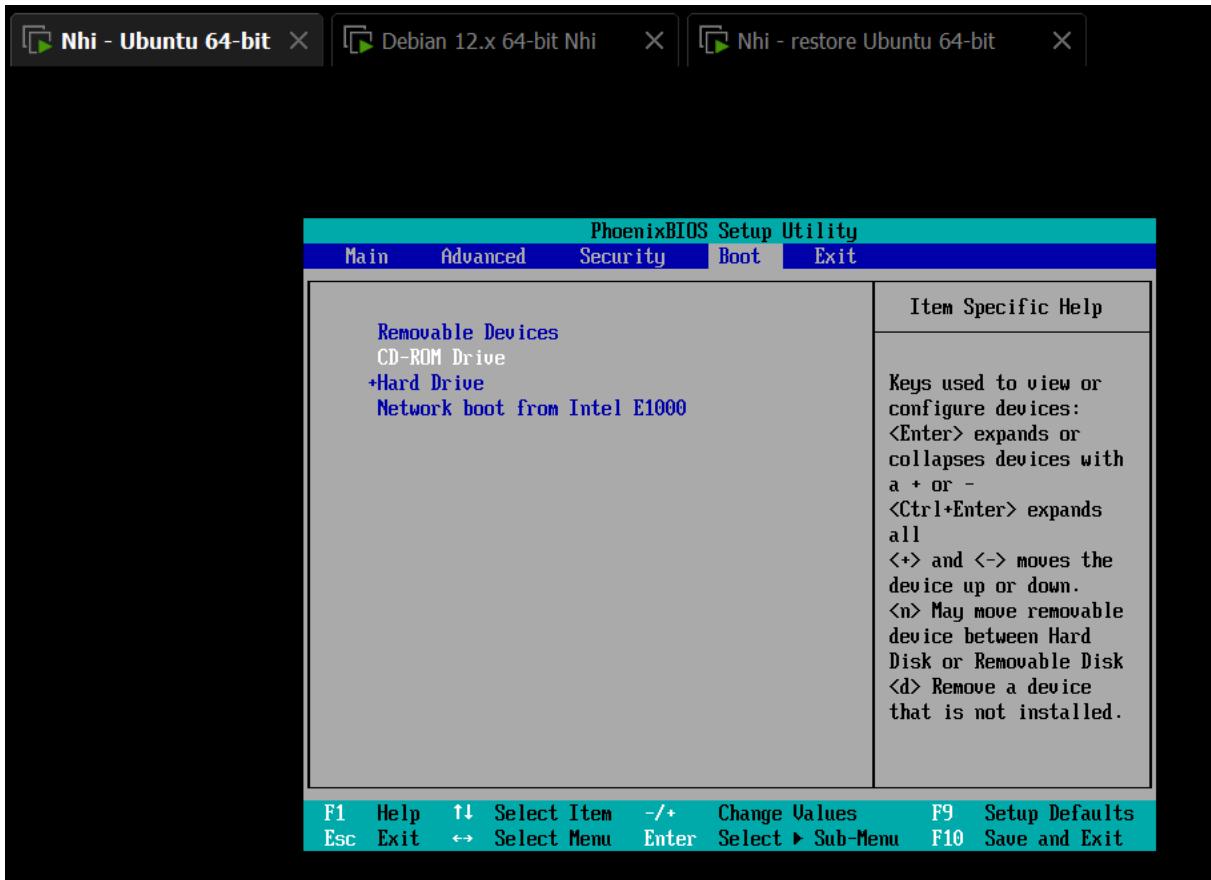
C:\Users\nhi> ssh nhi@192.168.151.128
The authenticity of host '192.168.151.128 (192.168.151.128)' can't be established.
ED25519 key fingerprint is SHA256:teECNWsPPNVcV48lWBG8dfpRD4ru8icvb2+tUvX3LGY.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.151.128' (ED25519) to the list of known hosts.
nhi@192.168.151.128's password:
Linux omv 6.12.57+deb13-amd64 #1 SMP PREEMPT_DYNAMIC Debian 6.12.57-1 (2025-11-05) x86_64

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.
nhi@omv:~$
```

Capture the Ubuntu 24.04 VM

Select Power on to Firmware to set that VM doesn't automatically use virtual hard disk when powered on.



Lsblk to check the name of the full disk.

```
ubuntu@ubuntu:~$ lsblk
NAME      MAJ:MIN RM    SIZE RO TYPE MOUNTPOINTS
loop0      7:0     0  1.7G  1 loop /rofs
loop1      7:1     0 523.3M  1 loop
loop2      7:2     0 925.9M  1 loop
loop3      7:3     0     4K  1 loop /snap/bare/5
loop4      7:4     0  73.9M  1 loop /snap/core22/2045
loop5      7:5     0 245.1M  1 loop /snap/firefox/6565
loop6      7:6     0  91.7M  1 loop /snap/gtk-common-themes/1535
loop7      7:7     0 11.1M  1 loop /snap/firmware-updater/167
loop8      7:8     0   516M  1 loop /snap/gnome-42-2204/202
loop9      7:9     0 10.8M  1 loop /snap/snap-store/1270
loop10     7:10    0  49.3M  1 loop /snap/snapd/24792
loop11     7:11    0   210M  1 loop /snap/thunderbird/769
loop12     7:12    0 112.6M  1 loop /snap/ubuntu-desktop-bootstrap/413
loop13     7:13    0   576K  1 loop /snap/snapd-desktop-integration/315
sr0       11:0    1   5.9G  0 rom  /cdrom
nvme0n1   259:0   0   64G  0 disk
└─nvme0n1p1 259:1   0     1M  0 part
└─nvme0n1p2 259:2   0   64G  0 part
```

- Disk capture

```

ubuntu@ubuntu:~$ sudo dd if=/dev/nvme0n1 bs=4M status=progress |gzip| ssh nhi@192.168.151.128 "cat > /srv/images/ubuntu2404_vm.img.gz"
The authenticity of host '192.168.151.128 (192.168.151.128)' can't be established.
ED25519 key fingerprint is SHA256:teECNWsPPNVcV48lWBG8dfpRD4ru8icvb2+tUvX3LGY.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.151.128' (ED25519) to the list of known hosts.
nhi@192.168.151.128's password:
68648173568 bytes (69 GB, 64 GiB) copied, 1175 s, 58.4 MB/s
16384+0 records in
16384+0 records out
68719476736 bytes (69 GB, 64 GiB) copied, 1176.79 s, 58.4 MB/s
ubuntu@ubuntu: ~$ 

```

- Image storage

Ls /srv/images in Debian VM to confirm that the image is captured.

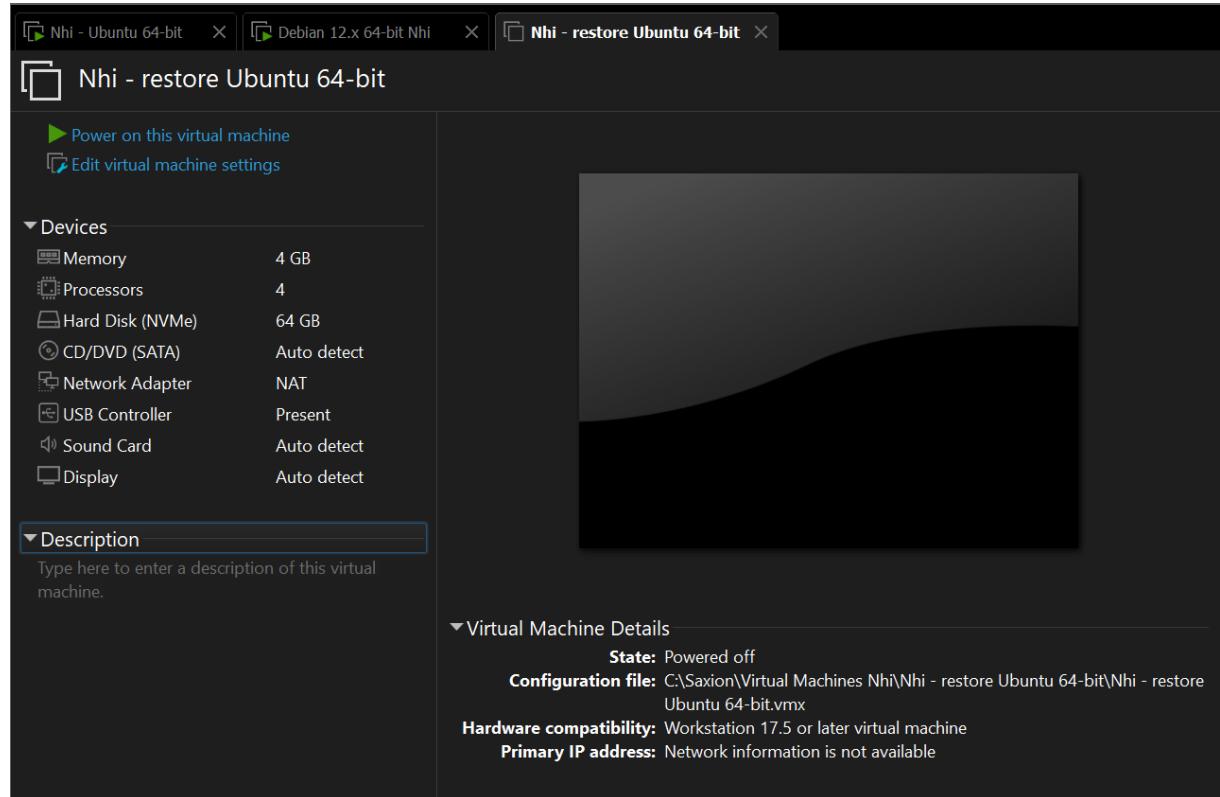
```

nhi@omv:~$ ls /srv/images
ubuntu2404_vm.img.gz
nhi@omv:~$ 

```

- Restore process

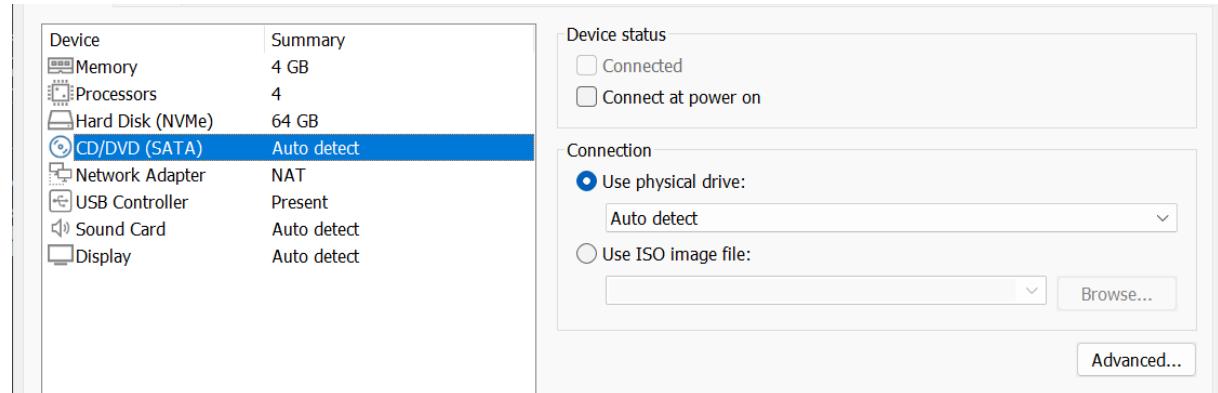
Create a new blank VM with similar setting as the original



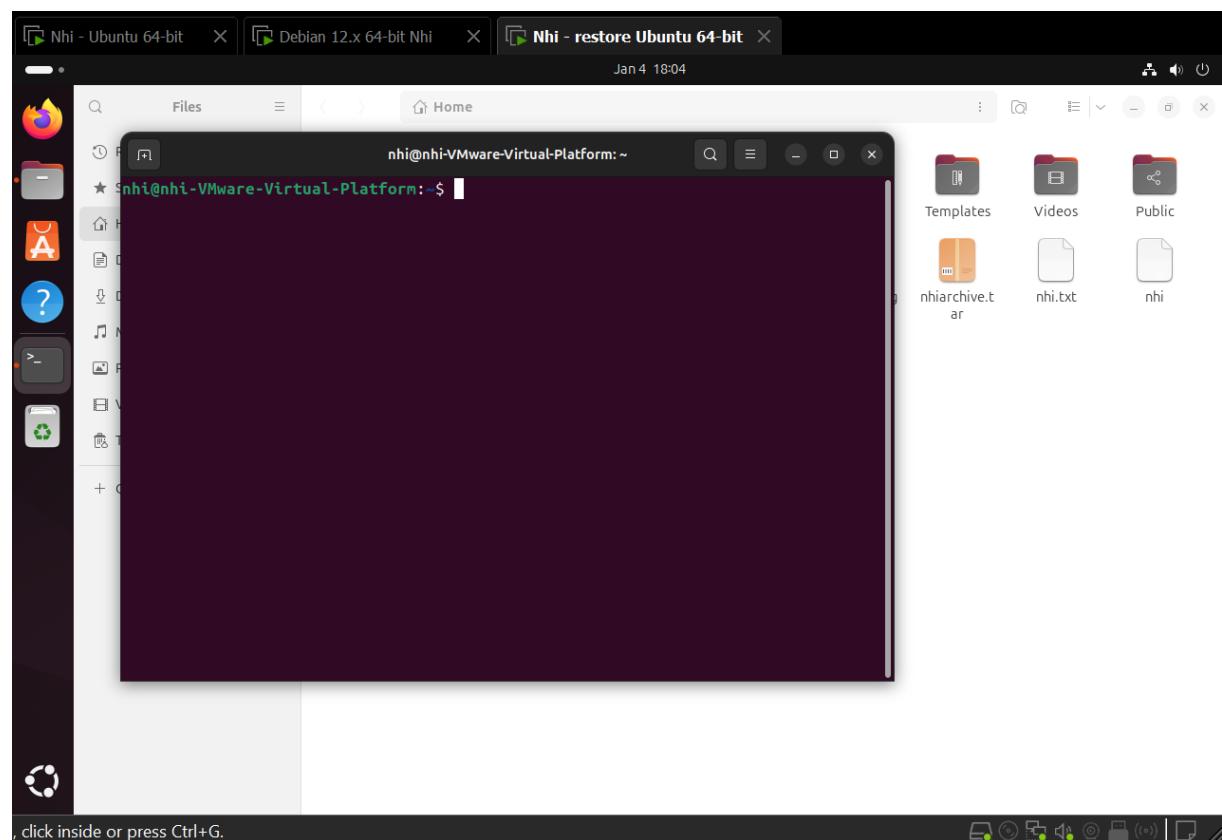
Restore the captured image in the blank VM while in live environment.

```
ubuntu@ubuntu:~$ ssh nhi@192.168.151.128 "cat /srv/images/ubuntu2404_vm.img.gz" | gzip -d| sudo dd of=/dev/nvme0n1 bs=4M status=progress
The authenticity of host '192.168.151.128 (192.168.151.128)' can't be established.
ED25519 key fingerprint is SHA256:teECNWsPPNVcV48lWBG8dfpRD4ru8icvb2+tUvX3LGY.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.151.128' (ED25519) to the list of known hosts.
nhi@192.168.151.128's password:
68692115456 bytes (69 GB, 64 GiB) copied, 706 s, 97.3 MB/s
0+2035577 records in
0+2035577 records out
68719476736 bytes (69 GB, 64 GiB) copied, 708.305 s, 97.0 MB/s
ubuntu@ubuntu:~$
```

Update VM Setting to remove Ubuntu ISO and boot from virtual hard drive.



o A screenshot of the successfully booted restored VM with logged-in user.



REFERENCES

- Argonne National Laboratory. (n.d.). *Supercomputing*. U.S. Department of Energy. <https://www.anl.gov/science-101/supercomputing>
- Computer History Museum. (n.d.). *Ken Thompson*. <https://computerhistory.org/profile/ken-thompson/>
- Computer History Museum. (n.d.). *Linus Torvalds*. <https://computerhistory.org/profile/linus-torvalds/>
- Free Software Foundation. (2025, April 24). *Explaining why we don't endorse other systems*. GNU Project. <https://www.gnu.org/distros/common-distros.en.html>
- Free Software Foundation, Inc. (n.d.). *Philosophy of the GNU Project*. Retrieved January 3, 2026, from <https://www.gnu.org/philosophy/philosophy.en.html>
- Free Software Foundation. (2016, August 10). *Staff and board*. Free Software Foundation. <https://www.fsf.org/about/staff-and-board/>
- GeeksforGeeks. (2025, October 25). Linux directory structure. <https://www.geeksforgeeks.org/linux-unix/linux-directory-structure/>
- Microsoft. (2025, May 21). *What is the Windows Subsystem for Linux?* Microsoft Learn. <https://learn.microsoft.com/en-us/windows/wsl/about>
- The Linux Information Project. (n.d.). *Unix-like definition*. Retrieved January 3, 2026, from <https://www.linfo.org/unix-like.html>
- University of Michigan Department of Electrical Engineering and Computer Science. (2016, April 12). *Bill Joy*. University of Michigan. <https://ece.engin.umich.edu/stories/bill-joy>
- Zyga, L. (2010, December 2). *US Air Force connects 1,760 PlayStation 3's to build supercomputer*. Phys.org. <https://www.phys.org/news/2010-12-air-playstation-3s-supercomputer.html>

Ready? Save this file and export it as a pdf file with the name: **week5.pdf**