Template Week 5 – Operating Systems

Student number: 579864

Assignment 5.1: Unix-like

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

Originally written in assembly language, Unix was later rewritten in C, allowing it to be compiled for various processors. Today it's used on servers, and it has a strong presence on personal computers and smartphones thanks to Apple's macOS and iOS, both of which are based on Unix. Unix supports multiple users, multitasking, and a unified, hierarchical directory structure.

Unix-like systems are computer systems that behave similarly to UNIX, without necessarily meeting the Single UNIX Specification.

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 - is an American computer scientist who was a cowinner of the 1983 A.M. Turing Award, the highest honor in computer science. Thompson and the American computer scientist **Dennis M. Ritchie** were cited jointly for "their development of generic operating systems theory and specifically for the implementation of the UNIX operating system," which they collaborated on at Bell Laboratories.

Thompson had written an electronic game, *Space Travel*, for Multics, which he wanted to play at Bell Labs on an obsolete Digital Equipment Corporation (DEC) PDP-7 minicomputer. So he began developing a more flexible OS for the PDP-7. Within a few months, Thompson and Ritchie, who had joined him, had created UNIX, a new OS not completely tied to any particular computer hardware, as earlier systems had been.

In conjunction with the development of UNIX, Thompson, with some help from Ritchie, in 1970 created the B programming language. As they moved their system to a newer minicomputer, the PDP-11, in 1971, the shortcomings of B became apparent, and Ritchie extended the language over the next year to create the C programming language. C and its family of languages, including C++ and Java, remain among the most widely used programming languages. In 1973 Thompson and Ritchie rewrote UNIX in C.

Bill Joy is an American software developer, entrepreneur, and cofounder of the computer manufacturer Sun Microsystems. Joy devised a version of the UNIX operating system, Berkeley UNIX, that used the TCP/IP networking language, which placed UNIX servers at the forefront of the Internet revolution and the open-source movement. He also collaborated on both the Java programming language and the Jini networking system, which fostered connectability between the Internet and household appliances.

Richard Stallman is an American computer programmer and free-software advocate who founded (1985) the Free Software Foundation.

In 1983 Stallman began working in his personal time on his GNU Project, or GNU operating system. GNU was intended to be a free version of AT&T's UNIX, and the name GNU was created as a recursive acronym of GNU's not UNIX. One of the last of the "hackers," computer programmers who strongly believed in freely modifying and sharing computer code.

In 1985 Stallman created the nonprofit Free Software Foundation, which initially focused on supporting his GNU Project. In 1990 he was awarded a MacArthur fellowship, the so-called "genius award" that gives recipients a substantial financial stipend with no strings attached. The award helped free Stallman to write various utilities for the GNU Project, such as the GNU Emacs editor, GNU compiler, and GNU debugger, which would later be combined with the kernel developed by **Linus Torvalds**, a Finnish computer science student, to produce the GNU/Linux, or Linux, operating system in 1994.

Linus Torvalds (born December 28, 1969, Helsinki, Finland) is a Finnish computer scientist who was the principal force behind the development of the Linux operating system.

After buying a MS-DOS PC in 1996 he decided to create his own PC-based version of UNIX and developed Linux. In 1991 Torvalds posted a message on the Internet to alert other PC users to his new system, made the software available as a free download, and, as was a common practice among software developers at the time, released the source code, which meant that anyone with knowledge of computer programming could modify Linux to suit their own purposes. Because of their access to the source code, many programmers helped Torvalds retool and refine the software, and by 1994 Linux kernel (original code) version 1.0 had been released.

Operating Linux required a certain amount of technical acumen; it was not as easy to use as more popular operating systems, such as Windows, Apple's Mac OS, or IBM OS/2. However, Linux evolved into a remarkably reliable, efficient system that rarely crashed. Linux became popular in the late 1990s when competitors of Microsoft began taking the upstart OS seriously. Netscape Communications, Corel, Oracle, Intel, and other companies announced plans to support Linux as an inexpensive alternative to Windows.

c) What is the philosophy of the GNU movement?

GNU, a recursive acronym that stands for GNU's Not Unix, is a software project started in the 1980s, with a goal of creating a Unix-like operating system as free software, its supporters believed in freely modifying and sharing computer code. The GNU project and Linux are separate efforts, but they have become closely associated.

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

From gnu.org:

We're often asked why we don't endorse a particular system—usually a popular GNU/Linux distribution. The short answer to that question is that they ***don't follow the free system distribution***

***guidelines**. But since it isn't always obvious how a particular distro fails to follow the guidelines, this list gives more information about the problems of certain well-known nonfree system distros. (…)*

(…) Ubuntu maintains specific repositories of nonfree software, and Canonical expressly promotes and recommends nonfree software under the Ubuntu name in some of their distribution channels. Ubuntu offers the option to install only free packages, which means it also offers the option to install nonfree packages too. In addition, the version of Linux, the kernel, included in Ubuntu contains firmware blobs.

So FSF does not completely approve Ubuntu as a strict follower of the GNU philosophy as it violates some guidelines such as user privacy and inclusion of any non-free or proprietary software/drivers.

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

Windows Subsystem for Linux (WSL) is a component of Microsoft Windows that allows the use of a Linux environment from within Windows, foregoing the overhead of a virtual machine and being an alternative to dual booting. The WSL command-line interface tool is installed by default in Windows 11, but a distribution must be downloaded and installed through it before use. In Windows 10, WSL can be installed either by joining the Windows Insider program or manually via Microsoft Store or Winget.

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

Android uses a Unix-like OS (modified Linux kernel)

iOS is based on Unix, more specifically the Berkeley distribution (BSD)

ChromeOS is a Linux-based OS created by Google.

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

A supercomputer is a highly advanced computer designed to perform extremely fast calculations, often measured in floating-point operations per second (FLOPS).

These machines are used for complex tasks such as climate research, quantum mechanics, and simulations of physical phenomena. Supercomputers typically consist of thousands of processors working in parallel to achieve high performance.

They are essential for solving problems that are too large or complex for standard computers, enabling breakthroughs in science, engineering, and medicine.

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 cluster is a distributed high-performance computing system assembled from multiple Sony PlayStation 3 video game consoles interconnected via networking to operate as a supercomputer, harnessing the parallel processing capabilities of the consoles' Cell Broadband Engine processors for tasks like scientific simulations, image analysis, and data processing.

This approach leverages the console's hardware to create an affordable alternative to traditional supercomputers, with consoles serving as individual nodes linked via networking for distributed computation.

During 2009 and 2010, PlayStation 3 clusters experienced significant expansion, driven by increasing recognition of the Cell Broadband Engine's potential for high-performance computing at a fraction of traditional costs. A notable example was the U.S. Department of Defense's initiative to assemble the Condor Cluster at the Air Force Research Laboratory's Rome Research Site, involving the acquisition and integration of 1,760 PS3 units into a cohesive supercomputing system.[4] This project, funded with approximately $2.5 million, highlighted the scalability of PS3-based architectures for defense applications, leveraging the consoles' parallel processing capabilities.
By 2010, PS3 clusters reached their zenith, with the Condor Cluster achieving a peak performance of around 500 TFLOPS and ranking 33rd on the TOP500 list of the world's most powerful supercomputers, underscoring the Cell processor's viability in enterprise-grade systems.

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?

A 12-node Raspberry Pi cluster typically runs a **lightweight version of a Linux-based operating system – custom version of Oracle Linux 7**

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/

No, a Raspberry Pi cluster — even one assembled by Oracle — is built from low-power, low-performance ARM CPUs and maybe many nodes, but its total performance is nowhere near what's required to enter the TOP500. The entry point for the list is on the order of *teraflops* or *petaflops*, while Raspberry Pi based clusters typically achieve gigaflops at best (thousands of times smaller) — orders of magnitude too slow.

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

- PS5 CPU: x86-64-AMD Ryzen Zen 8 Cores / 16 Threads at 3.5GHz.
- Xbox series X CPU: custom 7 nm AMD SoC combining Zen 2 CPU and RDNA 2 GPU

What operating systems run on these consoles?

- PS5 OS: Orbis OS based on FreeBSD11 (Unix-like system)
- Xbox series x OS: Windows

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

Modern gaming consoles use PC-like CPUs **and** PC-derived operating systems so the are basically specialized gaming PCs unlike older versions of same consoles.

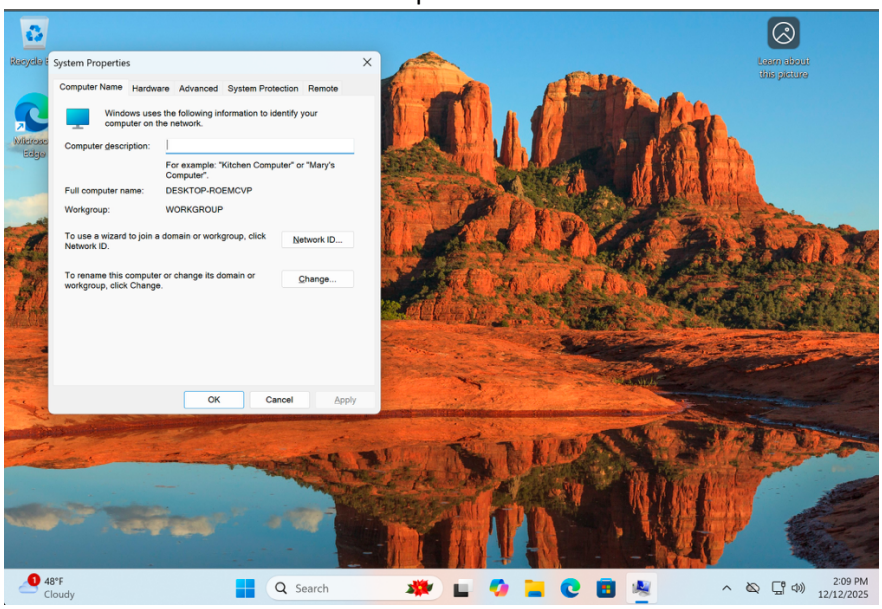
Assignment 5.3: Working with Windows

Take relevant screenshots of the assignments below

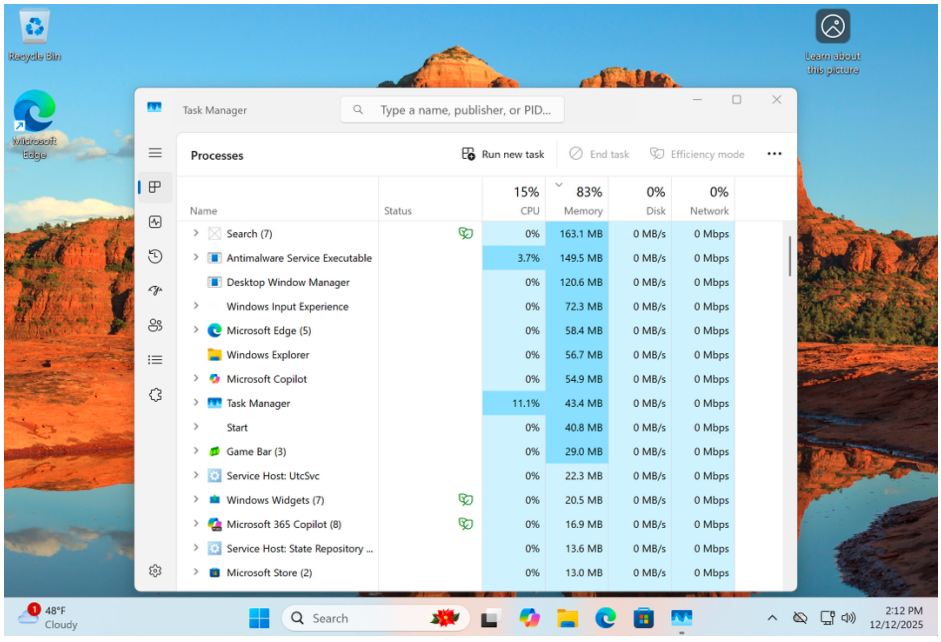
a) Practice for about 10 minutes with the ⊞ keyboard shortcuts combinations, skip the general shortcuts in this exercise. Take a look at which screens are opened.

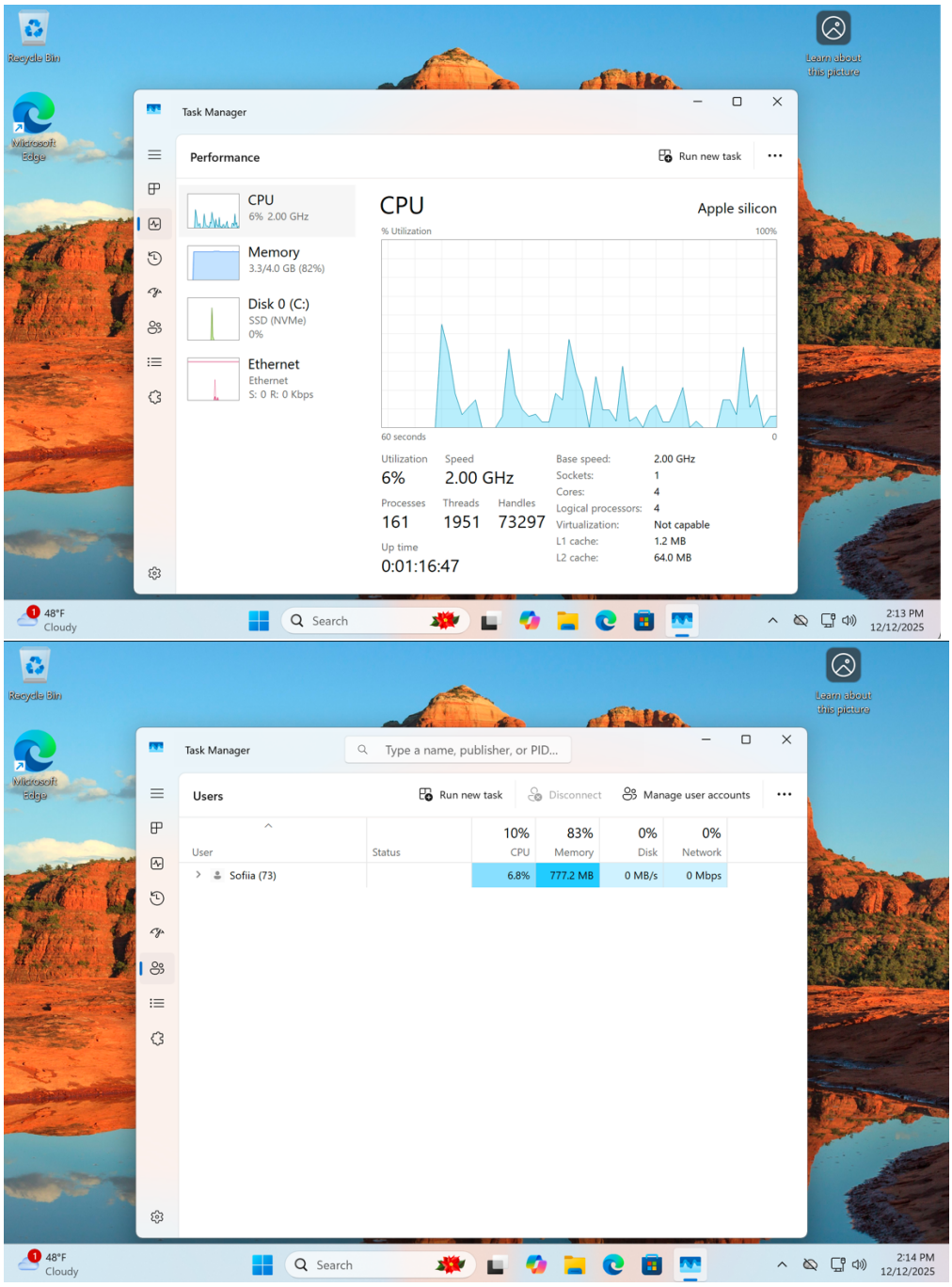
b) The file explorer can be opened with ⊞ + E, Which key combination could you also use? Ctrl+N to open new window or ⊞+X and select Explorer.

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



d) 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.





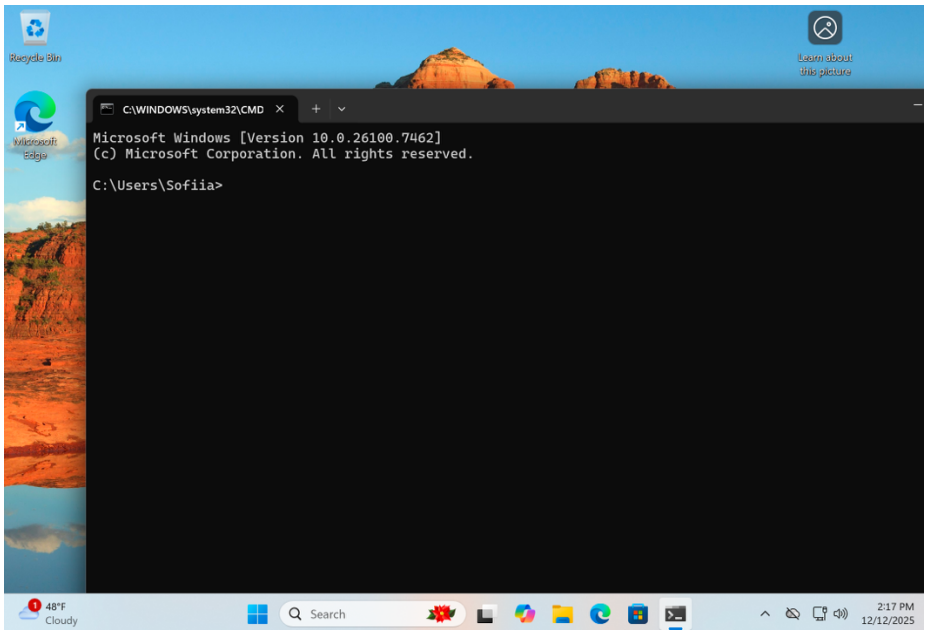
e) If you're giving a PowerPoint presentation and you connect your laptop to a projector, Windows can use the projector as a second screen. For example, you may have Outlook open on your first screen that you don't show over the projector, while the PowerPoint presentation is displayed on the projector, or the second screen. Which key combination should you use for this?

+ P to open presenter mode

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?

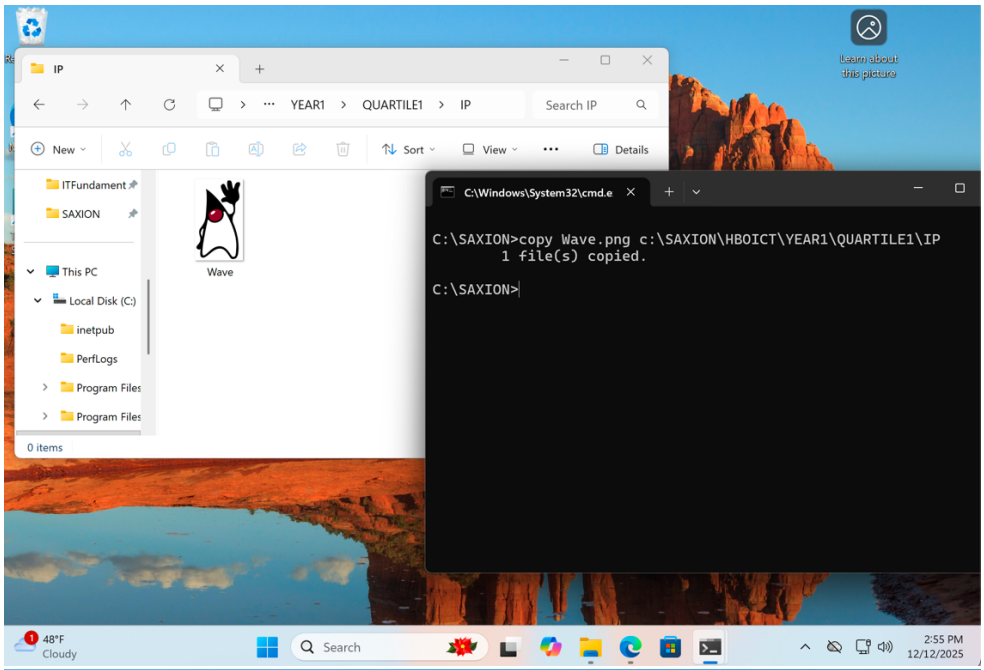
+ L

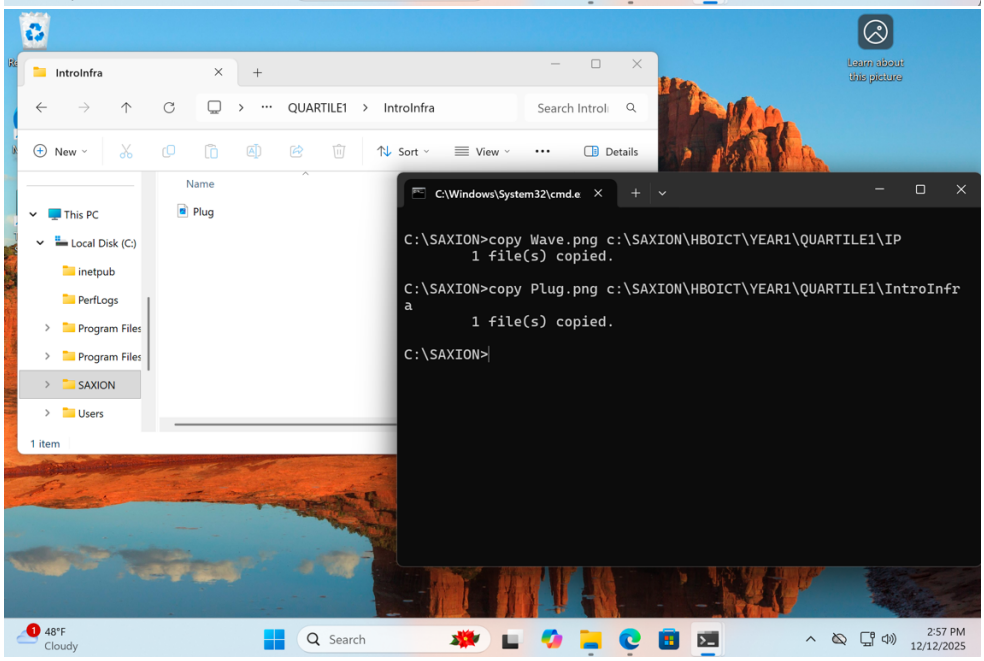
g) Open the Run screen with a key combination. On this screen, type CMD and press <enter>. Take a screenshot of this result and paste it into this template.

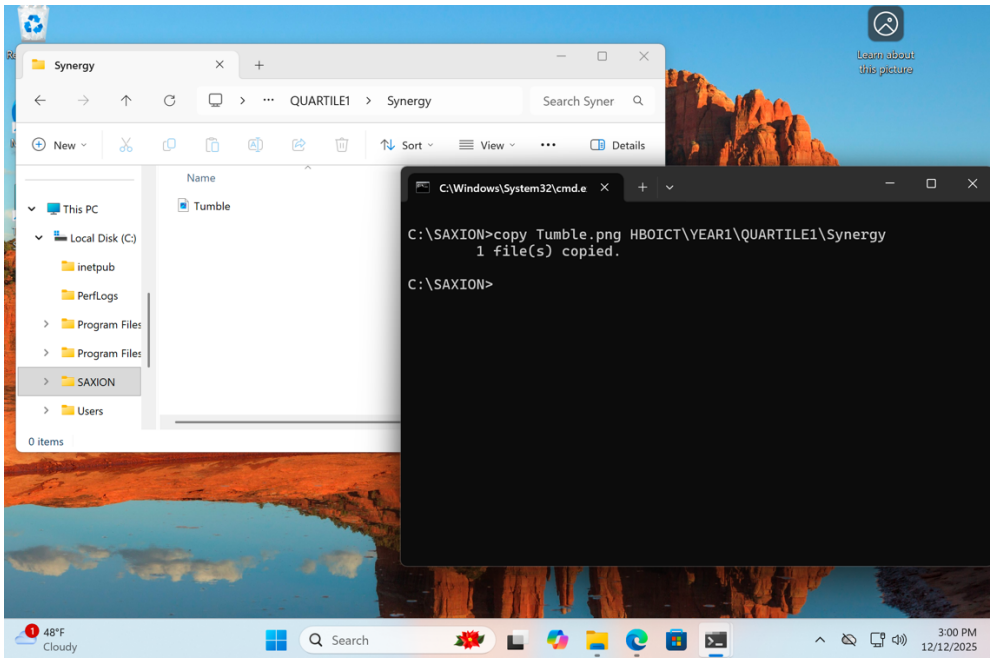


Working in the File Explorer

Relevant screenshots **copy** command:


IP
YEAR1 › QUARTILE1 › IP
Search IP
New
Sort
View
Details
ITFundament
SAXION
This PC
Local Disk (C:)
inetpub
PerfLogs
Program Files
Program Files
0 items
Wave
C:\Windows\System32\cmd.e
C:\SAXION>copy Wave.png c:\SAXION\HBOICT\YEAR1\QUARTILE1\IP
1 file(s) copied.
C:\SAXION>
Learn about this picture
48°F
Cloudy
Search
2:55 PM
12/12/2025


IntroInfra
QUARTILE1 › IntroInfra
Search Introl
New
Sort
View
Details
Name
Plug
This PC
Local Disk (C:)
inetpub
PerfLogs
Program Files
Program Files
SAXION
Users
1 item
C:\Windows\System32\cmd.e
C:\SAXION>copy Wave.png c:\SAXION\HBOICT\YEAR1\QUARTILE1\IP
1 file(s) copied.
C:\SAXION>copy Plug.png c:\SAXION\HBOICT\YEAR1\QUARTILE1\IntroInfra
1 file(s) copied.
C:\SAXION>
Learn about this picture
48°F
Cloudy
Search
2:57 PM
12/12/2025

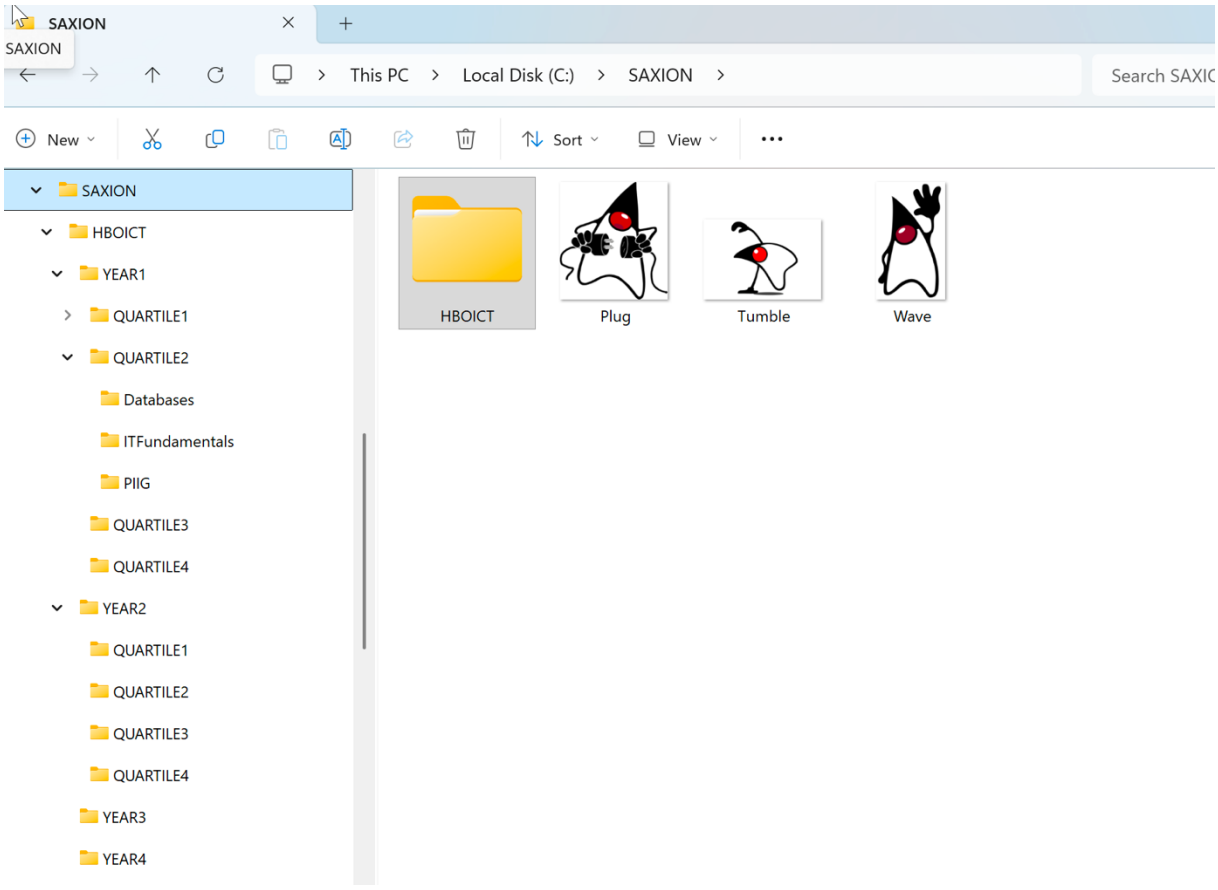


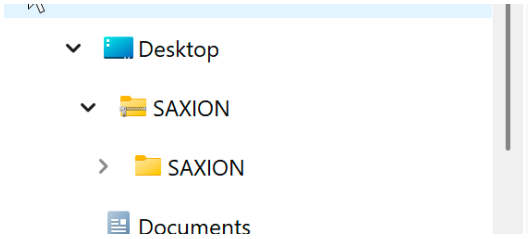
Relevant screenshots **tree** command:

```
C:\SAXION>tree
Folder PATH listing
Volume serial number is 00000222 8E57:A9DF
C:.
└───HBOICT
    ├───YEAR1
    │   ├───QUARTILE1
    │   │   ├───IntroInfra
    │   │   ├───IP
    │   │   └───Synergy
    │   ├───QUARTILE2
    │   │   ├───Databases
    │   │   ├───ITFundamentals
    │   │   └───PIIG
    │   ├───QUARTILE3
    │   └───QUARTILE4
    ├───YEAR2
    │   ├───QUARTILE1
    │   ├───QUARTILE2
    │   ├───QUARTILE3
    │   └───QUARTILE4
    ├───YEAR3
    └───YEAR4

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

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





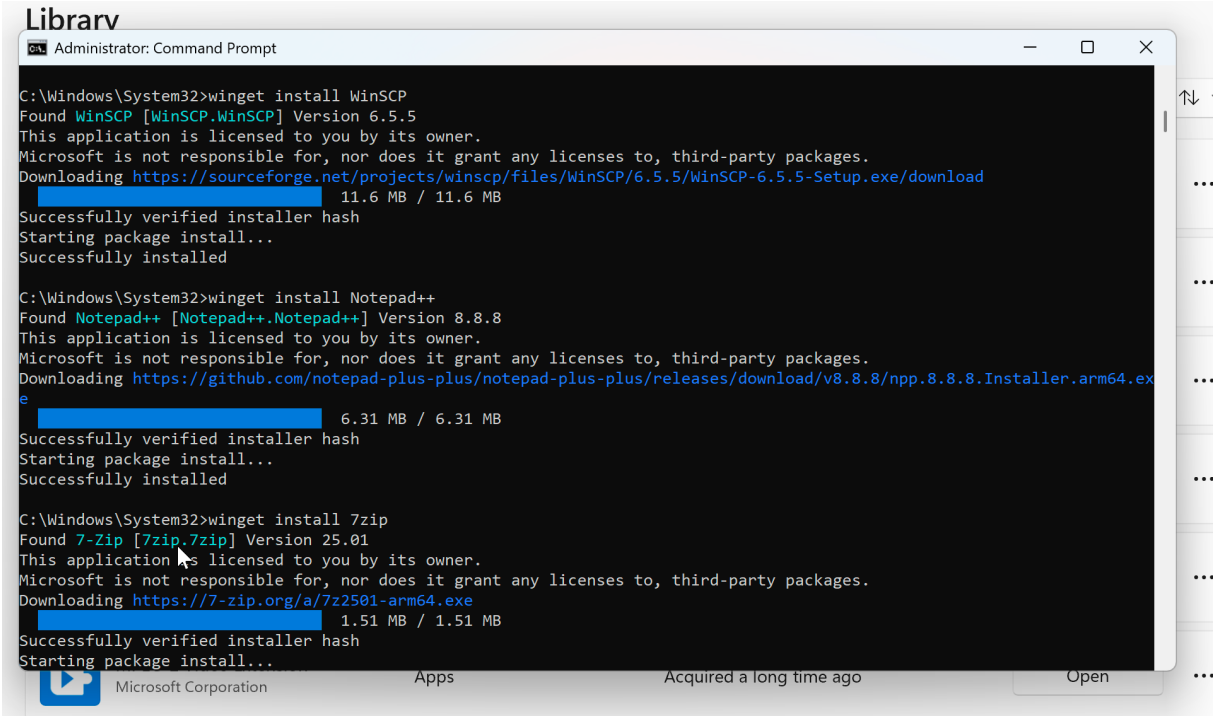
Terminating Processes

Relevant Screenshots Task Manager Window:

Install Software

Relevant screenshots that the following software is installed with winget:

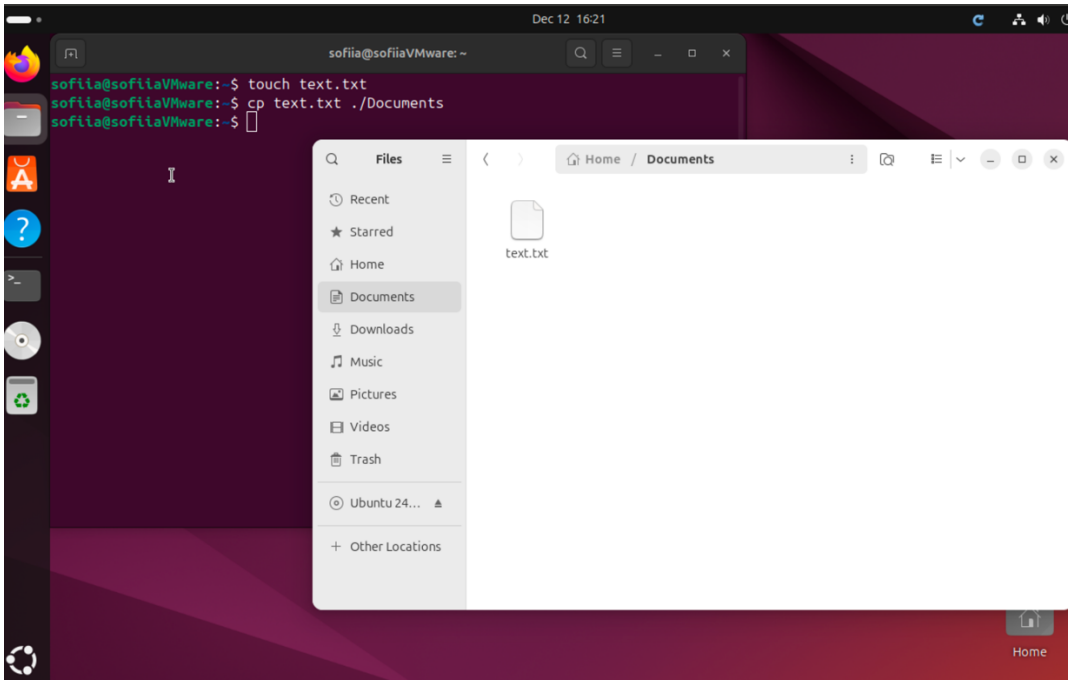
- WinSCP
- Notepad++
- 7zip


Library
Administrator: Command Prompt
C:\Windows\System32>winget install 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
11.6 MB / 11.6 MB
Successfully verified installer hash
Starting package install...
Successfully installed
C:\Windows\System32>winget install Notepad++
Found Notepad++ [Notepad++.Notepad++] Version 8.8.8
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/v8.8.8/npp.8.8.8.Installer.arm64.exe
6.31 MB / 6.31 MB
Successfully verified installer hash
Starting package install...
Successfully installed
C:\Windows\System32>winget install 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-arm64.exe
1.51 MB / 1.51 MB
Successfully verified installer hash
Starting package install...
Microsoft Corporation
Apps
Acquired a long time ago
Open

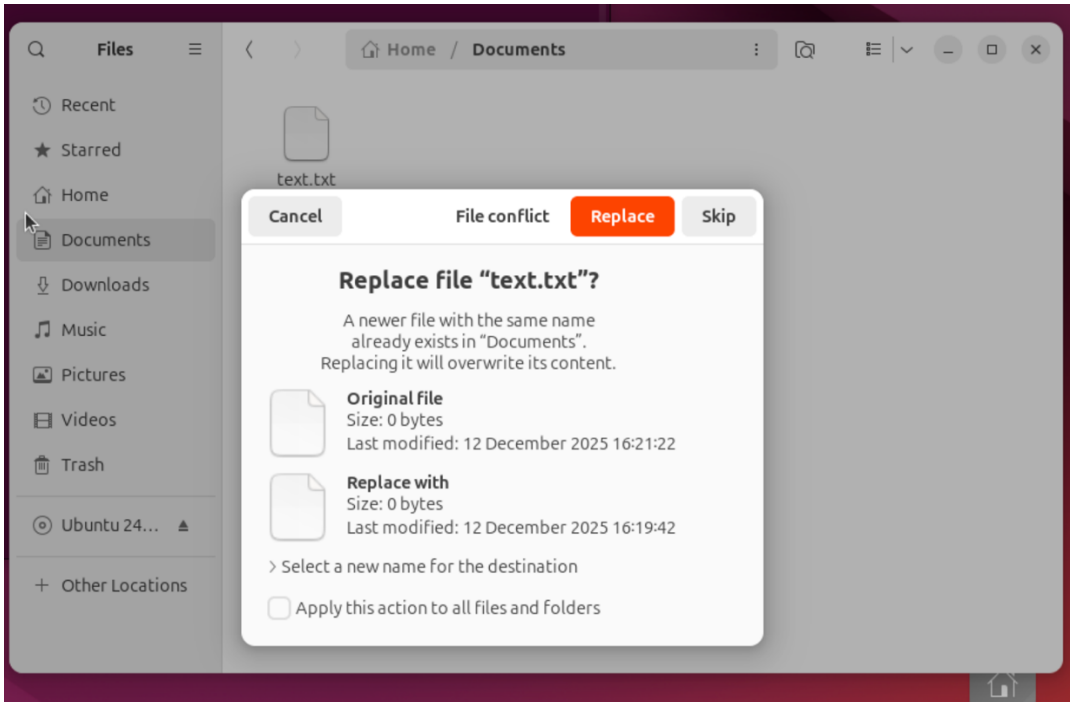
Assignment 5.4: Working with Linux

Relevant screenshots + motivation

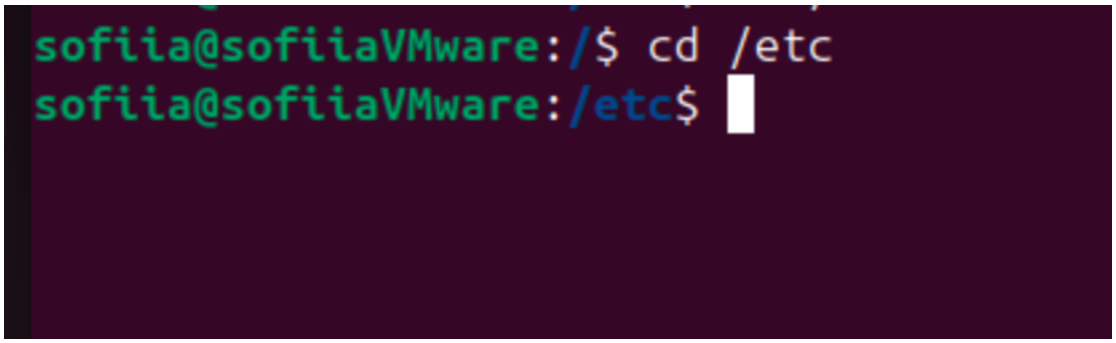
- **Copying files**
  o in terminal



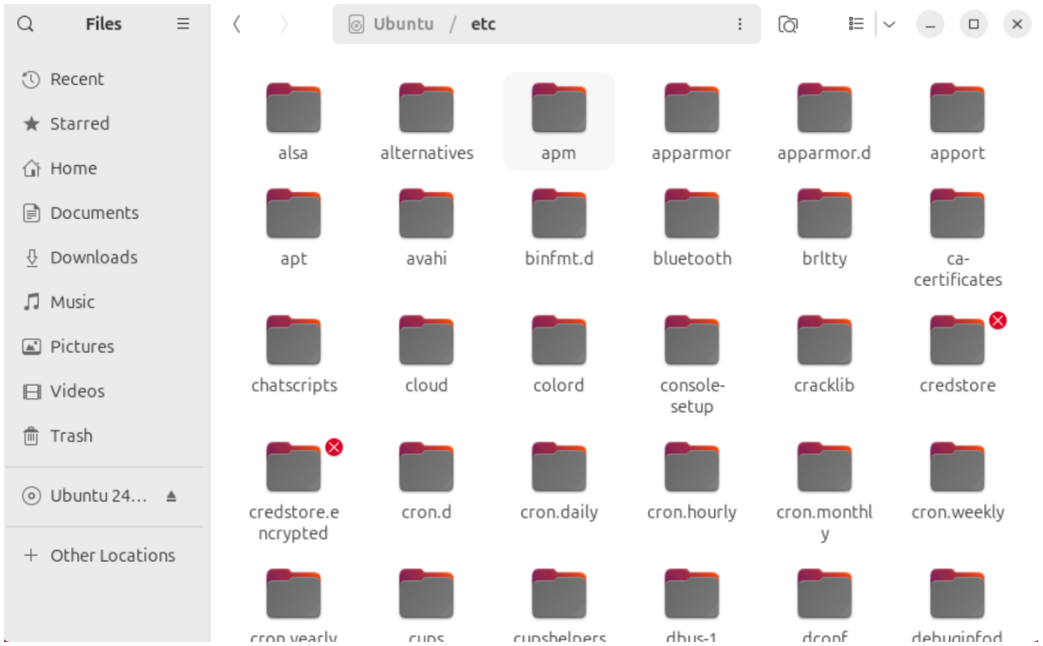
o In file explorer



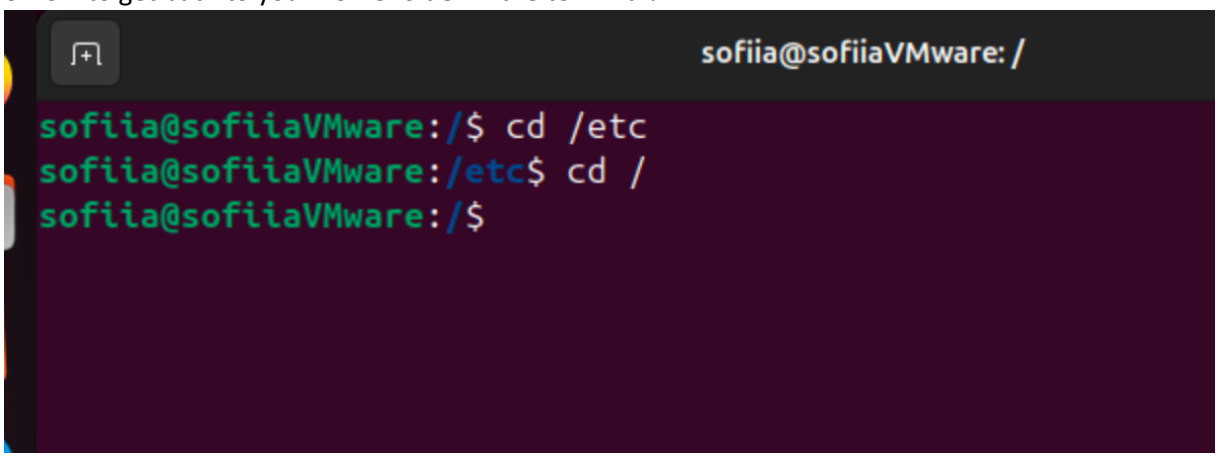
o Navigate to the /etc folder in the terminal



o Navigate to the /etc folder in the file explorer



o How to get back to your home folder in the terminal?



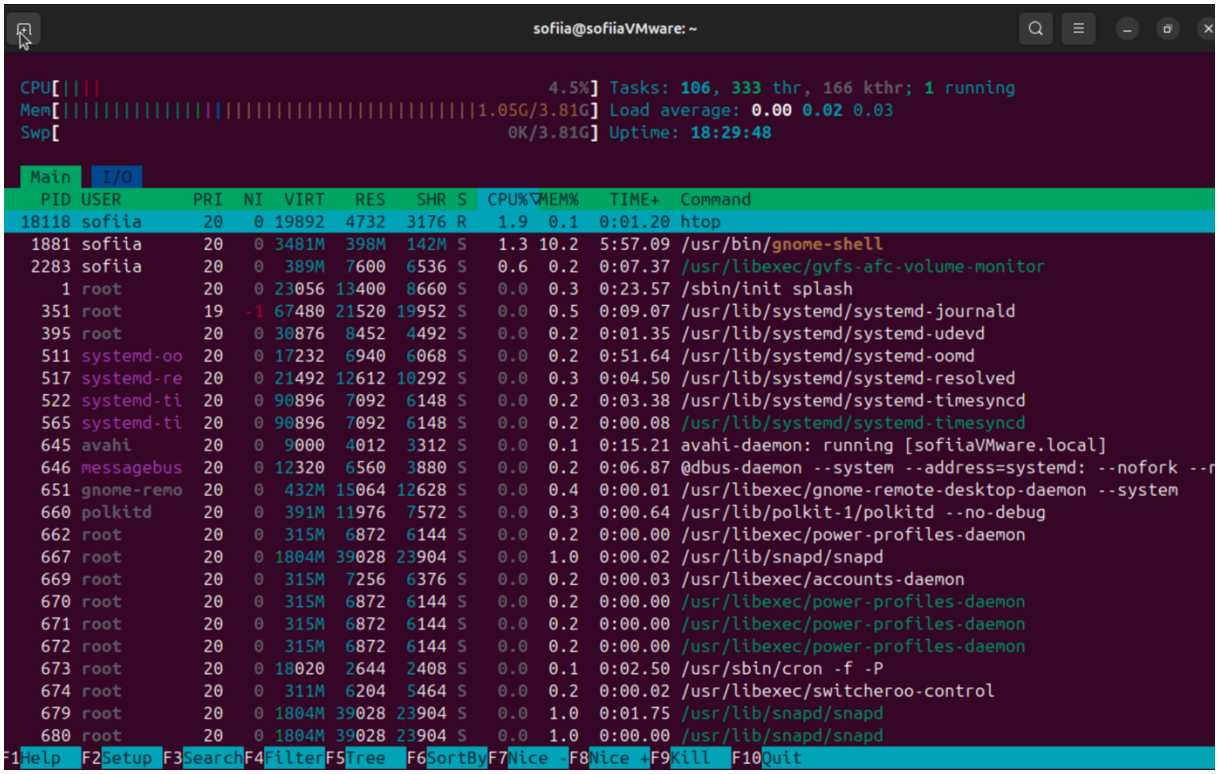
- **Compress files**

```
sofiia@sofiiaVMware:~$ touch text1.txt
sofiia@sofiiaVMware:~$ tar -cf archive.tar text1.txt
sofiia@sofiiaVMware:~$ tar -xvf archive.tar
text1.txt
sofiia@sofiiaVMware:~$
```

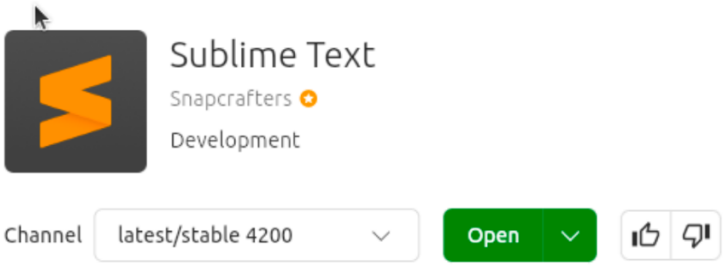
o Compress a text file in a tar archive and compress it with gzip.

```
sofiia@sofiiaVMware:~$ tar -zcf archive.tar.gz text1.txt
sofiia@sofiiaVMware:~$
```

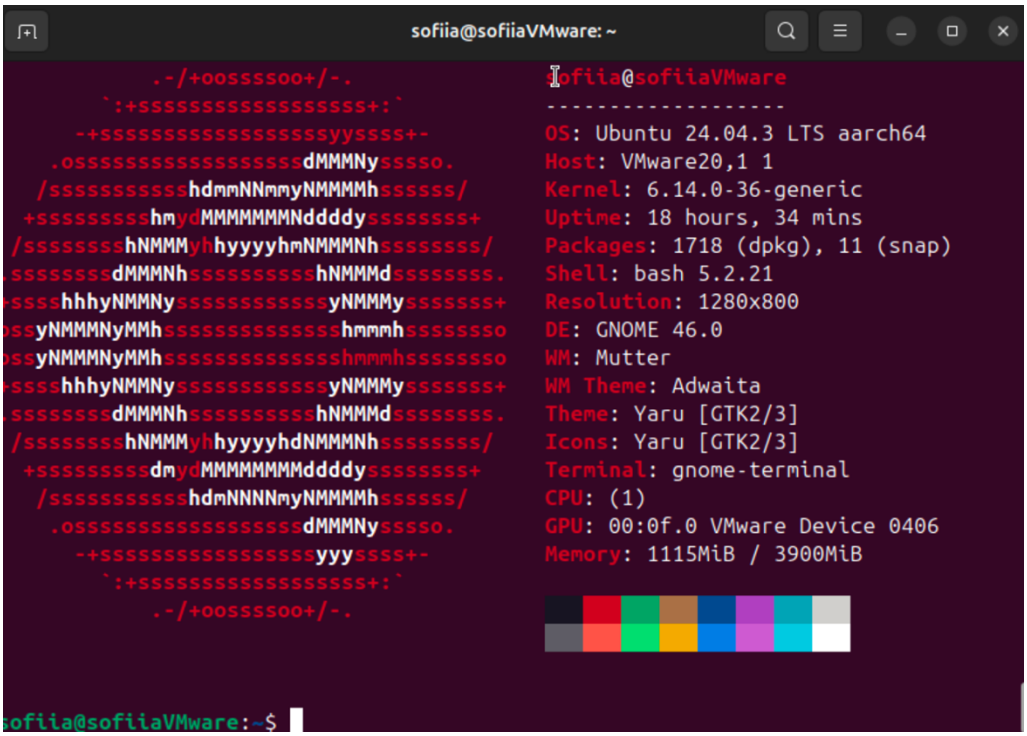
o Install the application htop via a terminal command
o Launch the htop application. Explain what this application shows.



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.



Assignment 5.5: Users and permissions on Linux

Relevant screenshots + motivation

Create a text file on your Linux VM with the following contents: #!/bin/bash echo Hello !

Save the file under the name hello.sh in a new directory ~/hello/

• Make the file executable with chmod.

• Try to run it with ./hello.sh

```
sofiia@sofiiaVMware:~$ mv /text.txt ~/hello/
mv: cannot stat '/text.txt': No such file or directory
sofiia@sofiiaVMware:~$ mv ~/text.txt ~/hello/
mv: cannot move '/home/sofiia/text.txt' to '/home/sofiia/hello/': Not a director
y
sofiia@sofiiaVMware:~$ mkdir ~/hello/
sofiia@sofiiaVMware:~$ mv ~/text.txt ~/hello/
sofiia@sofiiaVMware:~$ chmod
chmod: missing operand
Try 'chmod --help' for more information.
sofiia@sofiiaVMware:~$ chmod +x hello/text.txt
sofiia@sofiiaVMware:~$ mv text.txt /hello/hello.sh
mv: cannot stat 'text.txt': No such file or directory
sofiia@sofiiaVMware:~$ mv /hello text.txt /hello/hello.sh
mv: target '/hello/hello.sh': No such file or directory
sofiia@sofiiaVMware:~$ mv text.txt hello.sh
mv: cannot stat 'text.txt': No such file or directory
sofiia@sofiiaVMware:~$ mv ~/hello/text.txt ~/hello/hello.sh
sofiia@sofiiaVMware:~$ ls ~/hello
hello.sh
```

- Use the chmod command to make the file executable only for the logged-in user.

```
sofiia@sofiiaVMware:~$ chmod 744 ~/hello/hello.sh
```

Assignment 5.6: View the contents of files

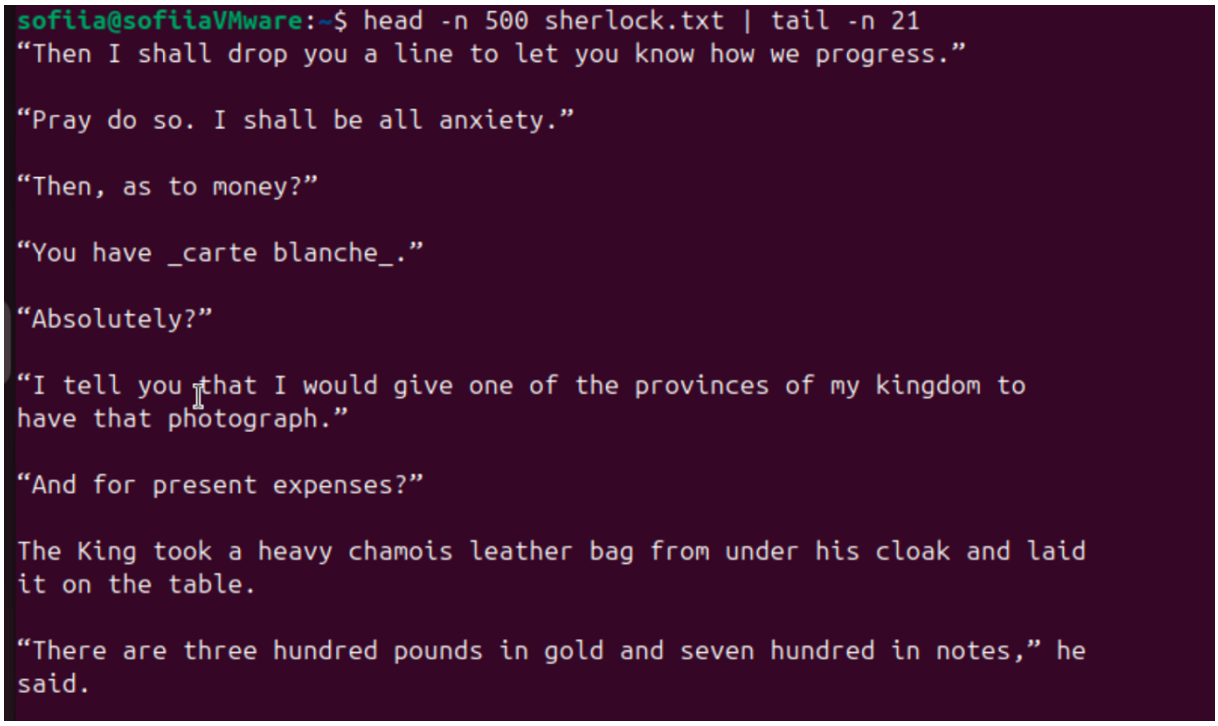
Relevant screenshots + motivation

• How many lines does the file have? How many words? And how many characters?

• On which lines is the word "kingdom" in the file?

```
sofiia@sofiiaVMware:~$ cat ~/sherlock.txt | wc
  12305  107560  595124
sofiia@sofiiaVMware:~$ 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
```

• Use the head and/or tail commands to see the 10 lines above and below the word "kingdom" on the screen.

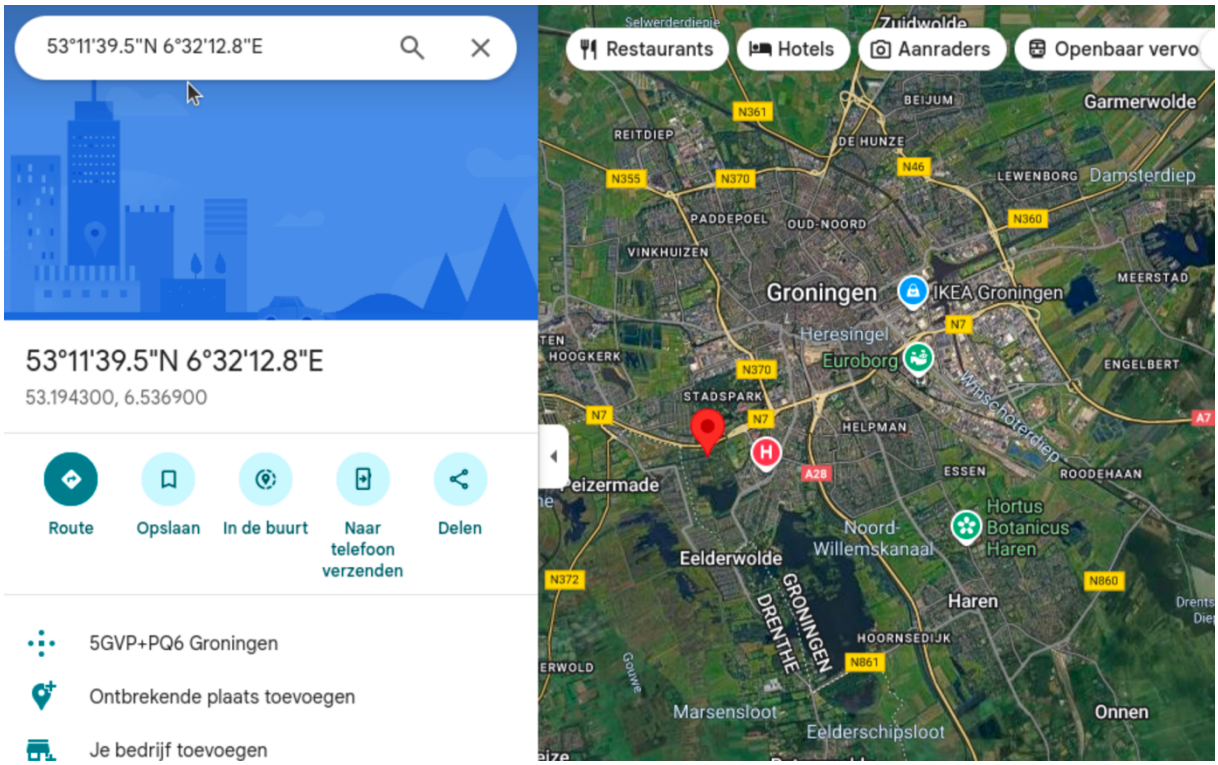


Assignment 5.7: Digital forensics

Relevant screenshots + motivation

```
sofiia@sofiiaVMware:~$ exiftool oldcar
ExifTool Version Number         : 12.76
File Name                       : oldcar
Directory                       : .
File Size                       : 2.4 MB
File Modification Date/Time     : 2025:12:16 22:38:41+01:00
File Access Date/Time           : 2025:12:16 22:40:13+01:00
File Inode Change Date/Time     : 2025:12:16 22:39:56+01:00
File Permissions                : -rw-rw-r--
File Type                       : JPEG
File Type Extension             : jpg
MIME Type                       : image/jpeg
JFIF Version                    : 1.01
Exif Byte Order                 : Big-endian (Motorola, MM)
Make                            : motorola
Camera Model Name               : moto g(6) play
X Resolution                    : 72
Y Resolution                    : 72
Resolution Unit                 : inches
Software                        : aljeter-user 9 PPPS29.55-35-18-7 6a0d0 release
-keys
Modify Date                     : 2020:11:07 15:08:57
Y Cb Cr Positioning             : Centered
Exposure Time                   : 1/33
F Number                        : 2.0
Exposure Program                : Program AE
ISO                             : 64
Exif Version                    : 0220
Date/Time Original              : 2020:11:07 15:08:57
Create Date                     : 2020:11:07 15:08:57
Components Configuration        : Y, Cb, Cr, -
Shutter Speed Value             : 1/33
```

```
Contrast                        : Normal
Saturation                      : Low
Sharpness                       : Soft
GPS Version ID                  : 2.2.0.0
GPS Latitude Ref                : North
GPS Longitude Ref               : East
GPS Altitude Ref                : Above Sea Level
GPS Time Stamp                  : 14:08:57
GPS Map Datum                   : WGS-84
GPS Processing Method           : ASCII
GPS Date Stamp                  : 2020:11:07
Compression                     : JPEG (old-style)
Thumbnail Offset                : 2862
Thumbnail Length                : 59453
Image Width                     : 4160
Image Height                    : 3120
Encoding Process                : Baseline DCT, Huffman coding
Bits Per Sample                 : 8
Color Components                : 3
Y Cb Cr Sub Sampling            : YCbCr4:2:0 (2 2)
Aperture                        : 2.0
Image Size                      : 4160x3120
Megapixels                      : 13.0
Shutter Speed                   : 1/33
Thumbnail Image                 : (Binary data 59453 bytes, use -b option to ext
ract)
GPS Altitude                    : 42 m Above Sea Level
GPS Date/Time                   : 2020:11:07 14:08:57Z
GPS Latitude                    : 53 deg 11' 39.68" N
GPS Longitude                   : 6 deg 32' 12.90" E
Focal Length                    : 3.5 mm
GPS Position                    : 53 deg 11' 39.68" N, 6 deg 32' 12.90" E
```



The picture was taken in Groningen

• Identify phone brand/type: motorola moto g(6) play

• Rename the file to oldcar. (So you've removed the file extension)

• In the terminal, type the command file oldcar.

• Does Ubuntu still consider it to be a jpg file?

```
sofiia@sofiiaVMware:~$ 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, manufactu
rer=motorola, model=moto g(6) play, xresolution=160, yresolution=168, resolution
unit=2, software=aljeter-user 9 PPPS29.55-35-18-7 6a0d0 release-keys, datetime=2
020:11:07 15:08:57, GPS-Data], baseline, precision 8, 4160x3120, components 3
sofiia@sofiiaVMware:~$
```

- Decode this BASE64 String, and save the output as a binary gif file. To do this, use the base64 command on the Ubuntu VM. Read the man pages of the base64 command on your Ubuntu VM and find out how to do this.

```
sofiia@sofiiaVMware:~$ nano email.txt
sofiia@sofiiaVMware:~$ -d email-base64 > base64.gif
-d: command not found
sofiia@sofiiaVMware:~$ base64 -d email-base64 > base64.gif
base64: email-base64: No such file or directory
sofiia@sofiiaVMware:~$ base64 -d ~/email-base64 > base64.gif
base64: /home/sofiia/email-base64: No such file or directory
sofiia@sofiiaVMware:~$ base64 -d ~/email-base64.txt > base64.gif
sofiia@sofiiaVMware:~$ file base64.gif
base64.gif: GIF image data, version 89a, 108 x 52
```

Assignment 5.8: Steganography

Relevant screenshots + motivation

Download the file: apple2.jpg from Brightspace, copy it to your Ubuntu VM. Hidden in this file is a text file with the password: apple2 Use the command line tool steghide --help to extract this text file.

```
sofiia@sofiiaVMware:~$ ls apple2.jpeg
apple2.jpeg
sofiia@sofiiaVMware:~$ steghide extract -sf apple2.jpeg
Enter passphrase:
wrote extracted data to "message.txt".
sofiia@sofiiaVMware:~$
```

```
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.

```
ubuntu@ubuntu:~$ sudo dd if=/dev/nvme0n1 bs=4M status=progress | gzip | ssh sofi
ia@192.168.176.133 "cat > /srv/images/ubuntu2404_vm.img.gz"~
The authenticity of host '192.168.176.133 (192.168.176.133)' can't be establishe
d.
ED25519 key fingerprint is SHA256:eDihMkJiZBe1xOr7FnQjhXRKL0sWBBdw4aM+TjThqVs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.176.133' (ED25519) to the list of known host
s.
sofiia@192.168.176.133's password:
12209618944 bytes (12 GB, 11 GiB) copied, 93 s, 131 MB/s^[
```

```
ubuntu@ubuntu:~$ sudo dd if=/dev/nvme0n1 bs=4M status=progress | gzip | ssh sofi
ia@192.168.176.133 "cat > /srv/images/ubuntu2404_vm.img.gz"~
The authenticity of host '192.168.176.133 (192.168.176.133)' can't be establishe
d.
ED25519 key fingerprint is SHA256:eDihMkJiZBe1xOr7FnQjhXRKL0sWBBdw4aM+TjThqVs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.176.133' (ED25519) to the list of known host
s.
sofiia@192.168.176.133's password:
68597841920 bytes (69 GB, 64 GiB) copied, 551 s, 124 MB/s
16384+0 records in
16384+0 records out
68719476736 bytes (69 GB, 64 GiB) copied, 551.611 s, 125 MB/s
ubuntu@ubuntu:~$
```

```
sofiia@ivanova:~$ ls -l /srv/images
total 4905548
-rw-rw-r-- 1 sofiia sofiia 5023273909 Dec 17 16:16 ubuntu2404_vm.img.gz~
sofiia@ivanova:~$
```

- Proof that you can restore the back-up image into an empty VM.

```
ubuntu@ubuntu:~$ ssh sofiia@192.168.176.133 "cat /srv/images/ubuntu2404_vm.img.gz~" | gzip -d | sudo dd of=/dev/nvme
bs=4M status=progress
The authenticity of host '192.168.176.133 (192.168.176.133)' can't be established.
ED25519 key fingerprint is SHA256:eDihMkJiZBe1xOr7FnQjhXRKL0sWBBdw4aM+TjThqVs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.176.133' (ED25519) to the list of known hosts.
sofiia@192.168.176.133's password:
4455432192 bytes (4.5 GB, 4.1 GiB) copied, 34 s, 131 MB/s
```

```
ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ ssh sofiia@192.168.176.133 "cat /srv/images/ubuntu2404_vm.img.gz~" | gzip -d | sudo dd of=/dev/nvme
bs=4M status=progress
The authenticity of host '192.168.176.133 (192.168.176.133)' can't be established.
ED25519 key fingerprint is SHA256:eDihMkJiZBe1xOr7FnQjhXRKL0sWBBdw4aM+TjThqVs.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.176.133' (ED25519) to the list of known hosts.
sofiia@192.168.176.133's password:
68715446272 bytes (69 GB, 64 GiB) copied, 361 s, 190 MB/s
0+2080208 records in
0+2080208 records out
68719476736 bytes (69 GB, 64 GiB) copied, 361.225 s, 190 MB/s
ubuntu@ubuntu:~$
```

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