

Template Week 5 – Operating Systems

Student number: 587707

Assignment 5.1: Unix-like

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

UNIX is a multitasking and multiuser operating system(OS) known for it's stable, secure and flexibility. Key features of the UNIX OS include multiuser system, multitasking capability, portability, hierarchical file system, security/permissions and shell and scripting support. UNIX is trademarked and has certain specifications.

Unix-like operating systems behave like a UNIX operating system, meaning they follow the UNIX design principles, but are not certified. Rather than to be trademarked and certified, they are often free/open source.

- 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. He is a co-creator of UNIX. He wrote the first UNIX kernel and created or helped design UNIX utilities. He's also created a programming language called B, co-designed the Go (Golang) programming language and wrote a famous paper called: 'Reflections on trusting trust'.

Dennis Ritchie,
Was an American computer scientist. He is a co-creator of UNIX, he refined process management, file systems, and system calls and application programming interfaces. He also created the C programming language and rewrote UNIX in C. This made UNIX portable. He also contributed to the B programming language, BCPL-inspired languages, helped define POSIX concepts and shaped the UNIX philosophy.

Bill Joy,
full name William Nelson Joy, is an American computer scientist and entrepreneur. He was the primary architect of BSD UNIX. BSD introduced virtual memory, fast file systems and advanced networking support. BSD UNIX included the TCP/IP networking stack, which helped drive the adoption of the internet. He wrote or co-created the visual editor, C shell, and parts of termcap, job control and process control tools. He is also co-founder of Sun Microsystems, thought leadership and ethics in technology.

Richard Stallman,
full name Richard Matthew Stallman, is an American programmer and activist. He is known as the founder of the Free Software Movement. Stallman believes that software should respect four essential freedoms: run the program for any purpose, study how it works, modify it and redistribute copies. This turned into a philosophy which most open-source ecosystems are built on. Stallman is the founder of the GNU project. It was designed to be UNIX-like, not UNIX

itself. GNU produced everything needed for an OS but the kernel. He wrote the GNU compiler collection, GNU debugger, GNU core utilities and Emacs (a text editor). He founded the Free Software Foundation (FSF) and GNU General Public Licence (GPL). He proved that the law can be used to protect openness, not restrict it.

Linus Torvalds, full name Linus Benedict Torvalds, is a Finnish-American software engineer. He created the Linux kernel, which follows the UNIX design principals. He invented a new model of global collaboration that runs Linux, Git and many more. Modern IT rests on Linux. He is the creator of Git. He influenced modern system engineering culture by this pragmatic mindset of prioritizing technical correctness over politeness, valuing working code over theory and rejecting unnecessary complexity.

To summarize all of the above:

If Thompson and Ritchie built UNIX,
and Bill Joy spread it,
Stallman made it free and
Torvalds wrote the kernel that made it all ubiquitous.

- c) What is the philosophy of the GNU movement?

Software should respect the freedom of its users.

- d) Does Ubuntu as a Linux operating system conform to the philosophy of the GNU movement?

Please explain your answer.

Yes it does mostly, but not completely.

Ubuntu is a Linux operating system based on GNU/Linux, so it uses many GNU tools and free software. Most of the software in Ubuntu can be freely used, studied, modified, and shared, which follows the ideas of the GNU movement.

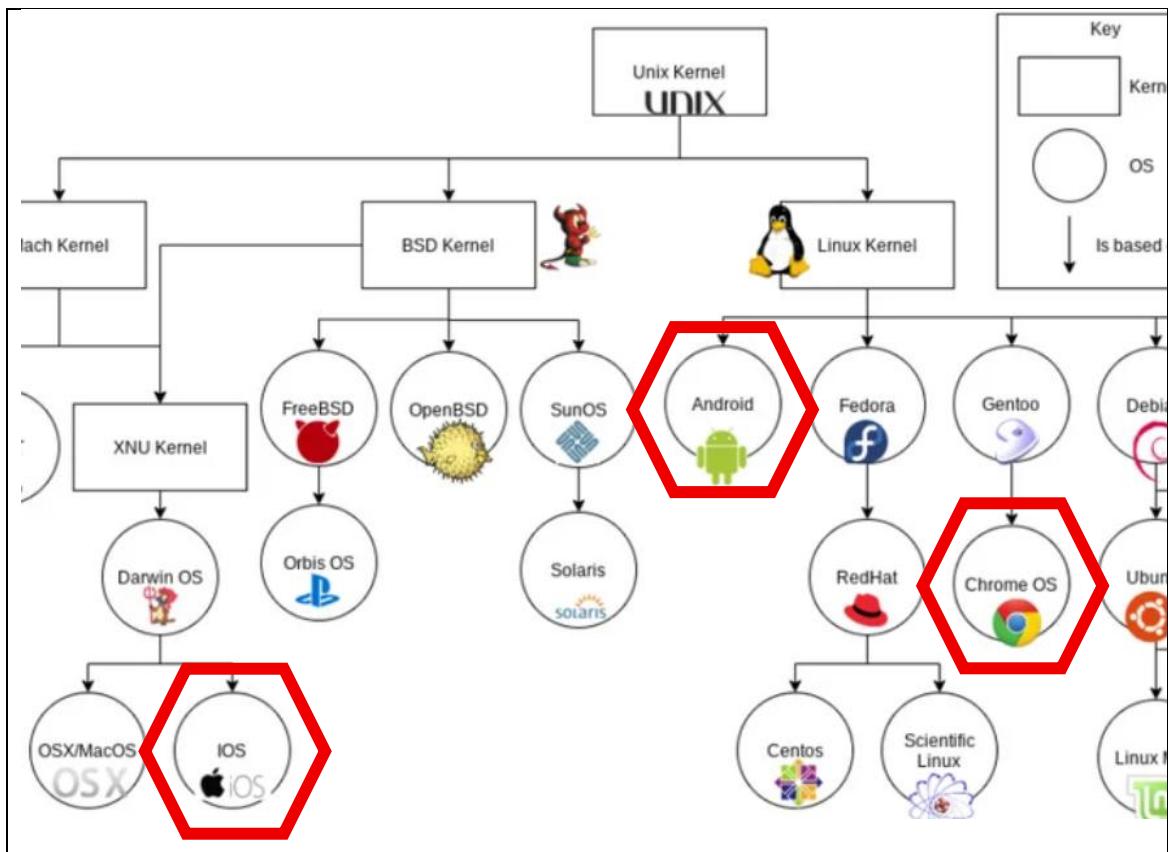
However, Ubuntu also allows proprietary (non-free) software, such as drivers and media codecs. This goes against the GNU philosophy, which believes all software should be completely free. GNU would argue 'If it's not free, it shouldn't be promoted at all.', but Ubuntu disagrees for usability reasons.

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

The Windows Subsystem for Linux (WSL) is a Microsoft feature that lets you run a full Linux environment, including command-line tools, utilities, and applications, directly on Windows without a virtual machine.

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

Android: Linux family
iOS: Unix family/BSD/XNU
ChromeOS: Linux 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 very fast computers used for scientific research and big calculations. The earliest supercomputers is the CDC 6600 (1964) and was introduced by Control Data Corporation. Made by Seymour Cray, it was the world's fastest computer of it's time. It was widely used for scientific computing tasks. After the CDC 6600, Seymour made another computer: The Cray-1 (1976). The C-shaped design helped reduce signal delays and achieve high processing speeds, making it great for scientific and research applications. The ASCI Red supercomputer was made in 1997 as part of the U.S. government's Accelerated Strategic Computing Initiative (ASCI). It was among the first computers to reach teraflop performance (trillions of calculations per second) and served important national research needs including simulation work after underground nuclear testing was banned. In 1998, a prototype supercomputer was built using Linux, consumer hardware and a high-speed, low-latency interconnection network. The design of this computer led to the development project "RoadRunner" (1999), the first Linux supercomputer for open use. This design became the predominant architecture for all major supercomputers in the world. To create global climate models, the Japanese government created the Earth Simulator(2002). It is a massively parallel, vector-based system. In 2004-2005 NASA got the Columbia supercomputer, second fastest in the world. Columbia was used in space vehicle analysis, including studying the Columbia disaster, but also in astrophysics, weather and ocean modeling. In 2009 the "RoadRunner" is the first computer to each a sustained performance of 1 petaflop (one thousand trillion floating point operations per second). It was used to model the decay of the US nuclear arsenal, analyze financial data, and render 3D medical images in real-time.

- 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?

An offshoot of the POWER XCell8i chip was used as the main processor in the Sony PlayStation 3 game console. A PlayStation 3 cluster is a supercomputer built by linking many PS3 consoles together, using their powerful Cell processors for affordable, high-performance scientific computing. It was used for tasks like radar enhancement, satellite image processing, artificial intelligence research, and astrophysical simulations by the U.S. government. It was also used by universities to simulate black hole collisions, gravitational waves, cryptography and general scientific modelling.

- 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/>

- e) No, Even if you combine over a 1024 Raspberry Pis, each individual board has very limited CPU performance compared to the high-end CPUs and GPUs used in Top500 systems.

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

The PlayStation 5 and the Xbox Series X both use a 64-bit x86-64 CPU architecture.

What operating systems run on these consoles?

The PlayStation 5: The FreeBSD 11, it is derived from Orbis OS, which is based on FreeBSD, an open-source Unix-like operating system.

The Xbox Series X: Xbox OS, based on the Windows NT kernel.

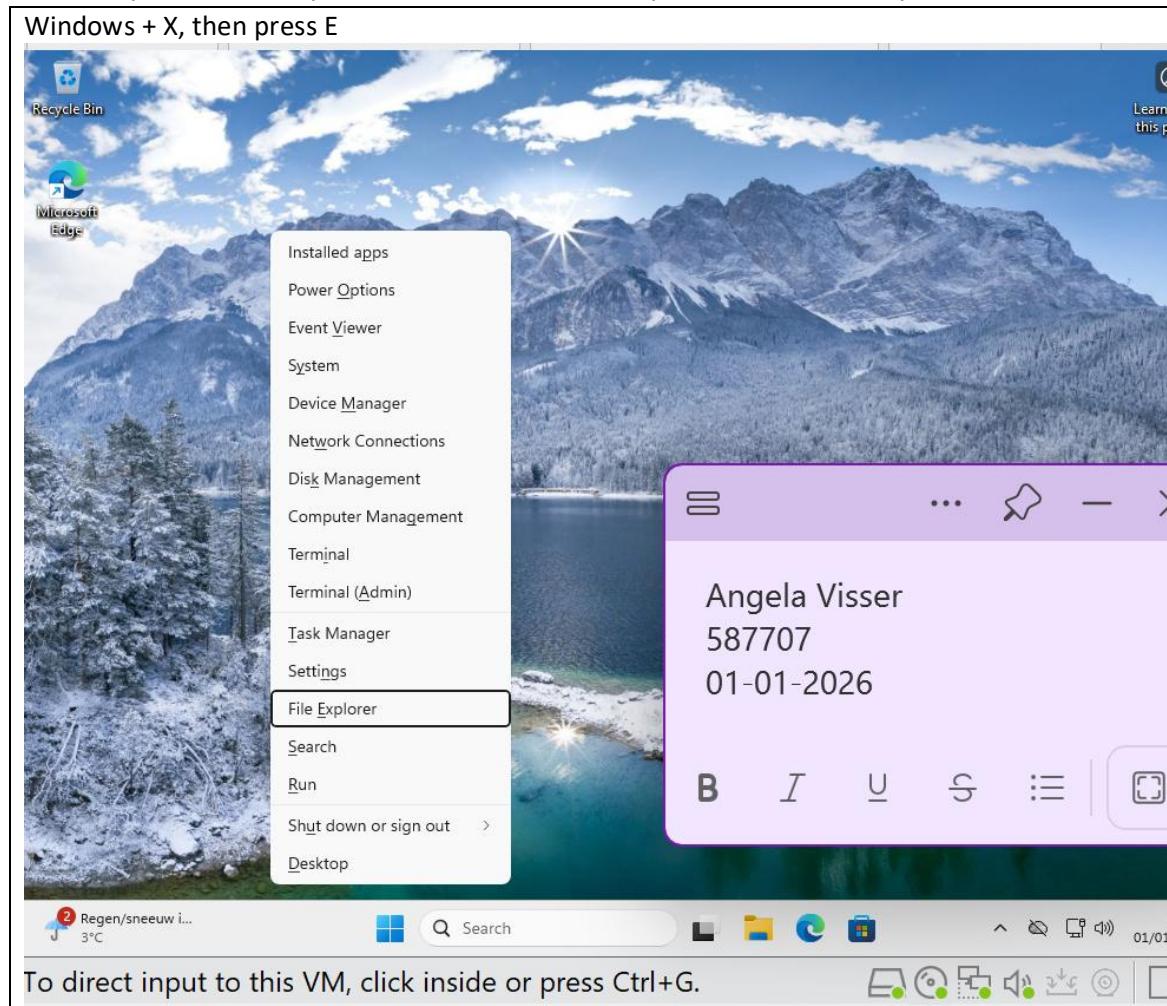
What conclusion can you draw from the answer to the previous question?

That these game consoles are technically very similar to PS's and that different devices don't need completely new OS's, but can build on existing OS's.

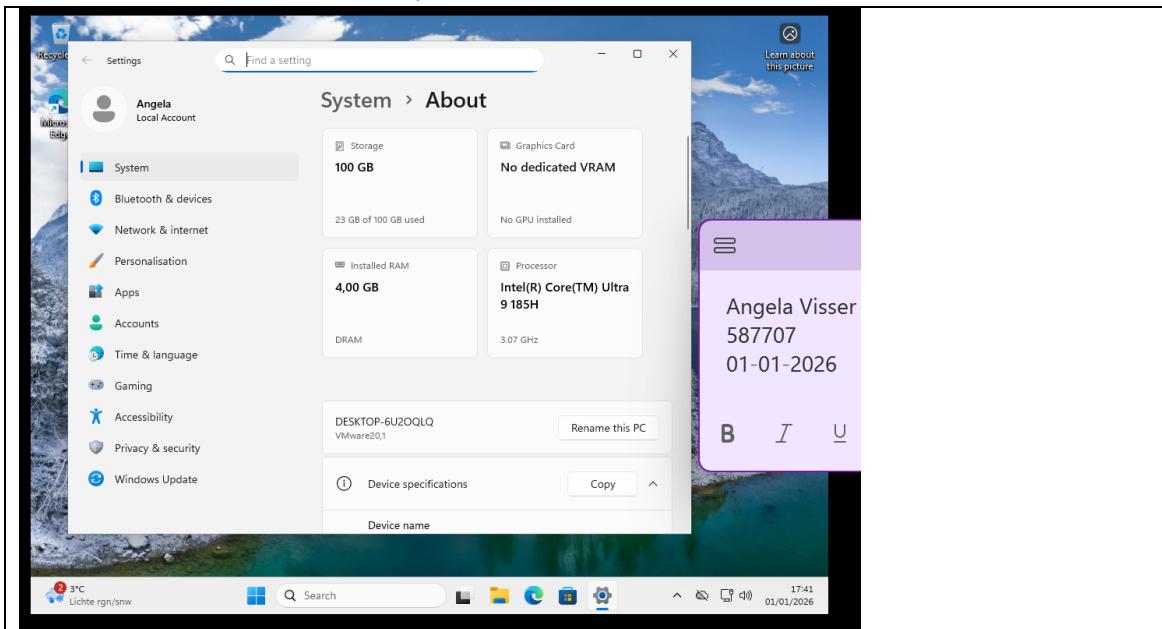
Assignment 5.3: Working with Windows

Take relevant screenshots of the assignments below

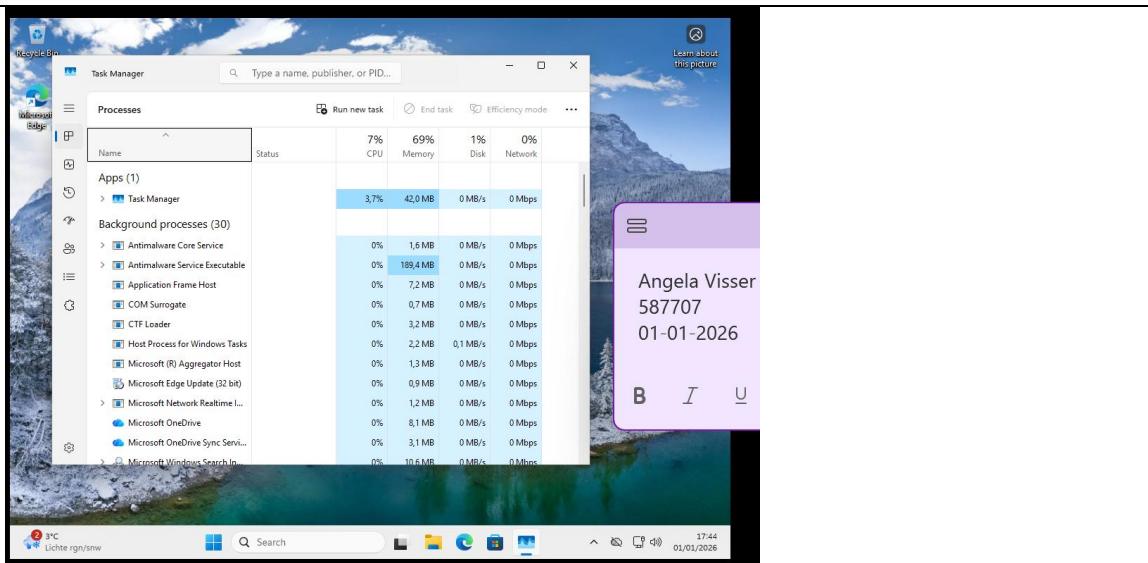
- Practice for about 10 minutes with the **Windows** keyboard shortcuts combinations, skip the general shortcuts in this exercise. Take a look at which screens are opened.
- The file explorer can be opened with **Windows + E**, Which key combination could you also use?



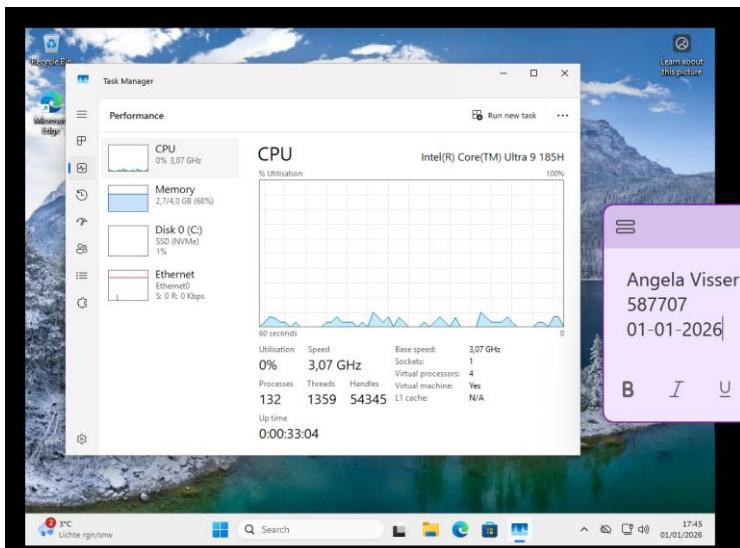
- c) Open the system properties with a **Windows** key combination, take a screenshot of the open screen. Paste this screenshot into this template.



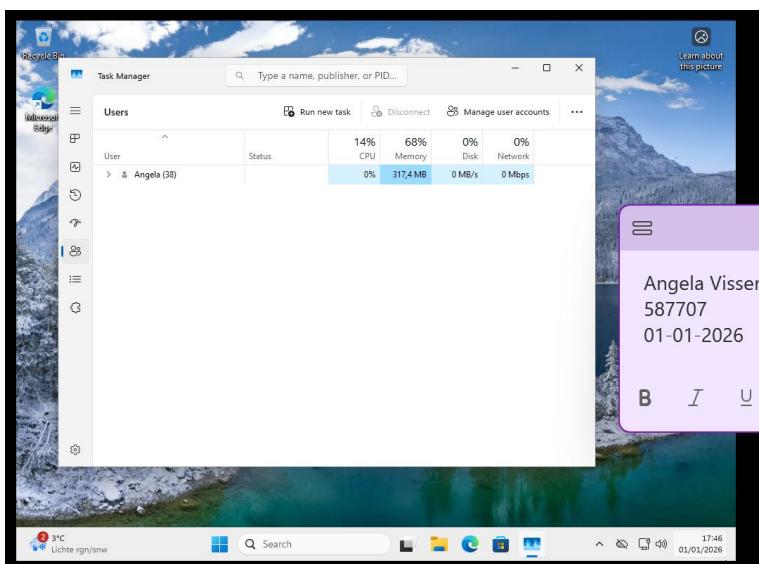
- d) Open task manager with a key combination. Take screenshots of the tabs: processes (shows active processes), performance, and users. Place these three screenshots in this template.



Figuur 1. Processes



Figuur 2. Performance



Figuur 3. Users

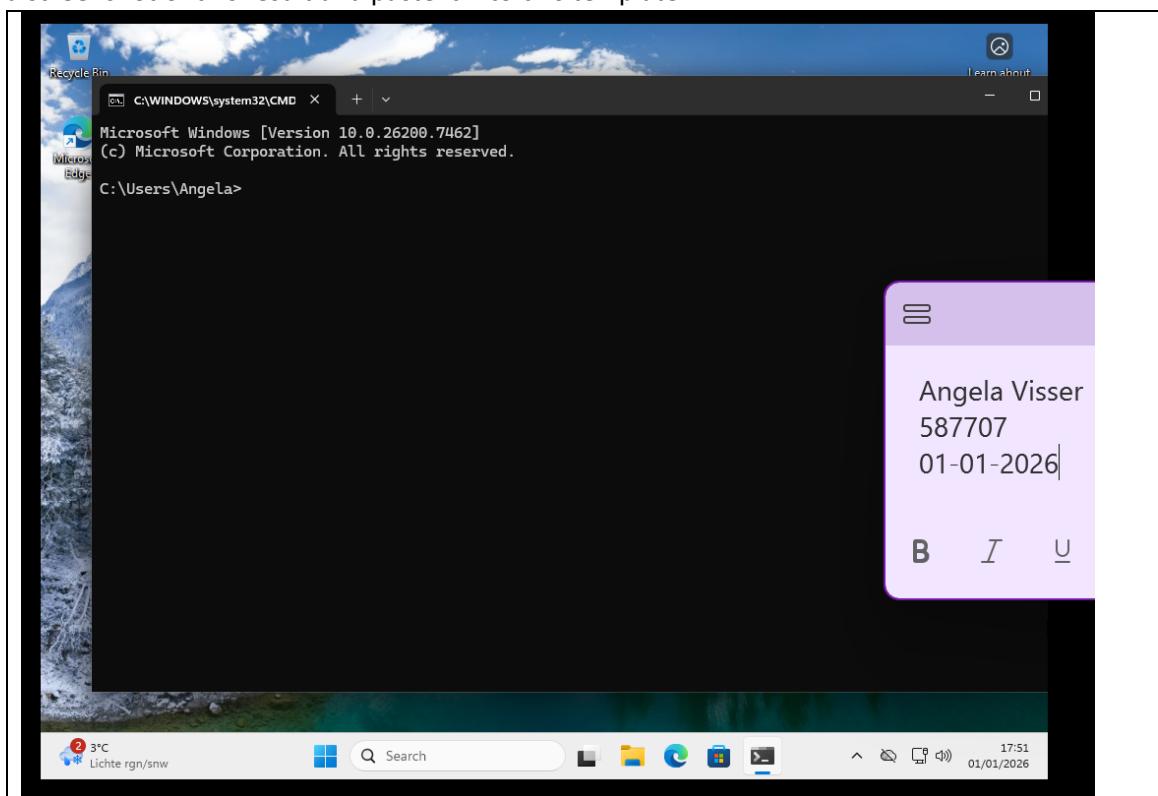
- e) If you're giving a PowerPoint presentation and you connect your laptop to a projector, Windows can use the projector as a second screen. For example, you may have Outlook open on your first screen that you don't show over the projector, while the PowerPoint presentation is displayed on the projector,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

Win + P

- 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?

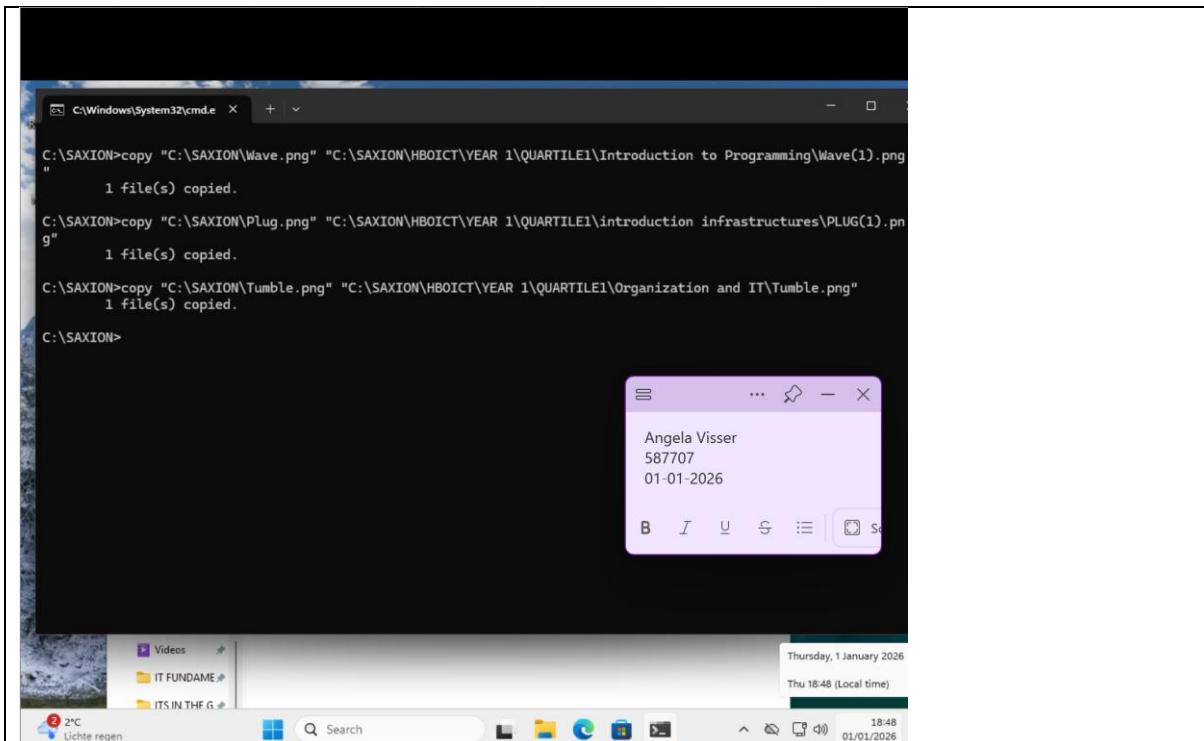
Win + L

- 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.

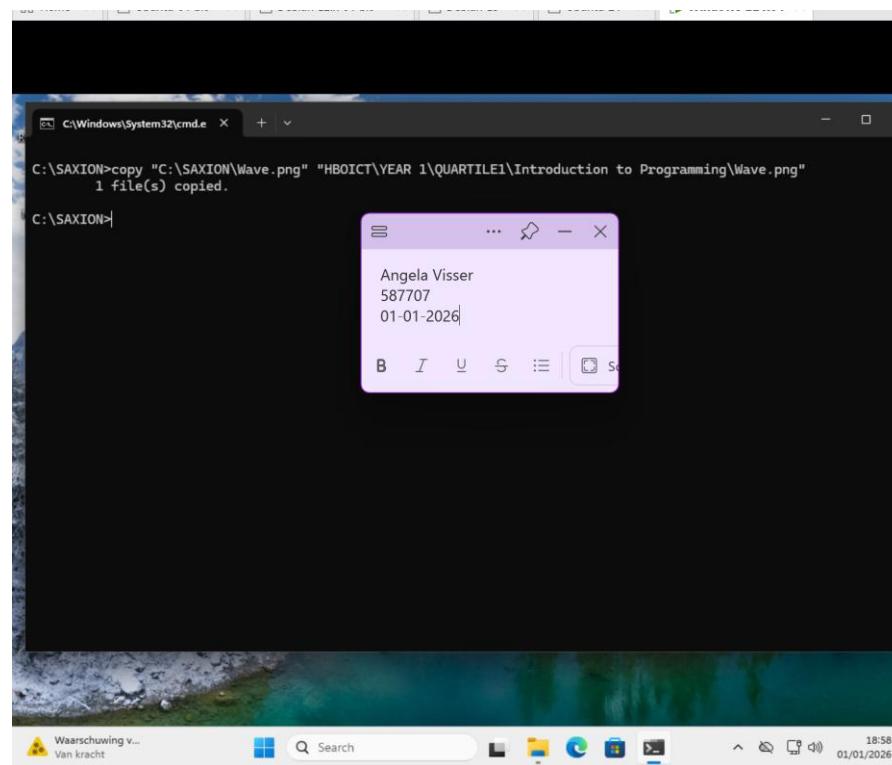


Working in the File Explorer

Relevant screenshots **copy** command:

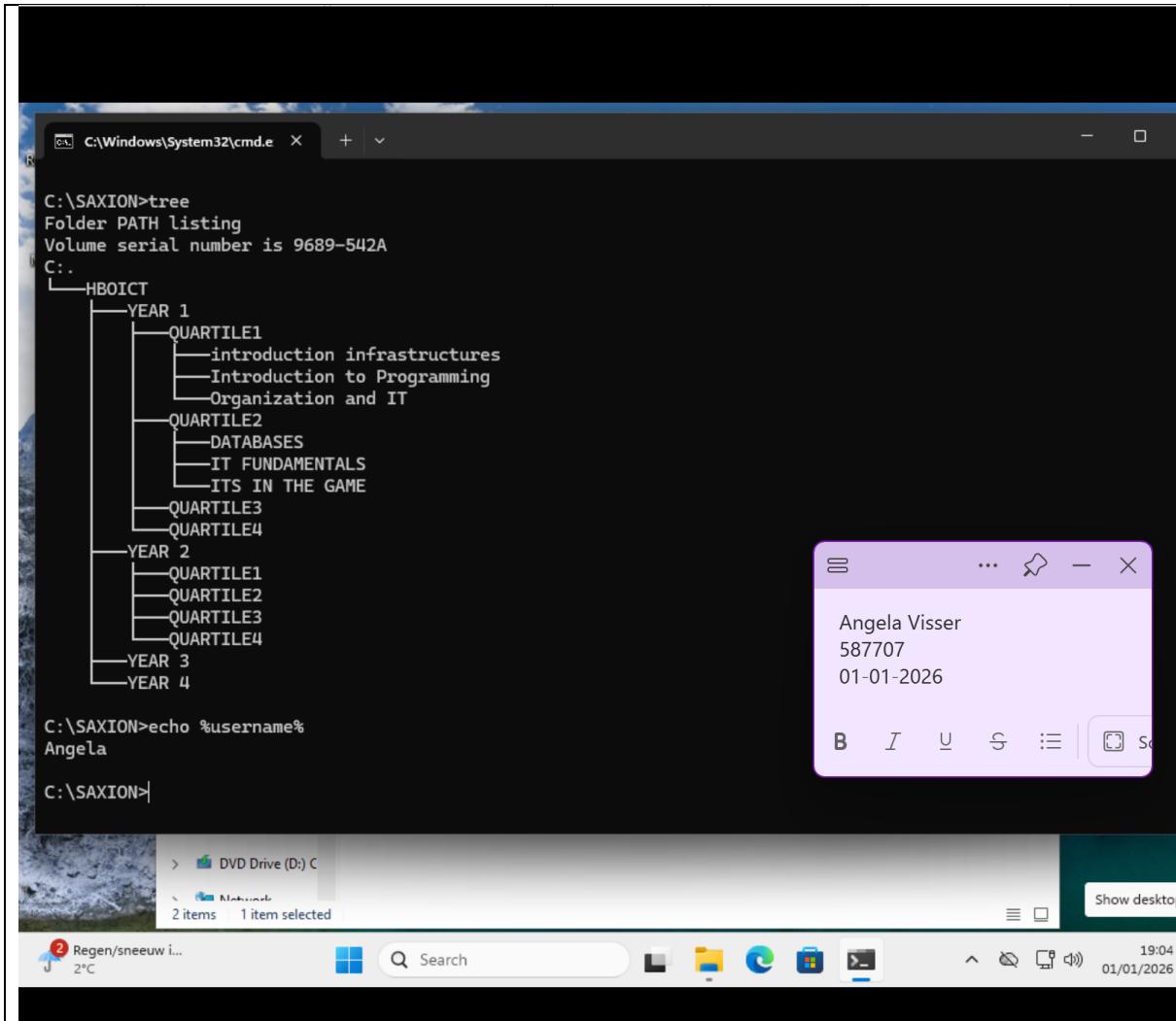


Figuur 4. Absolute path.

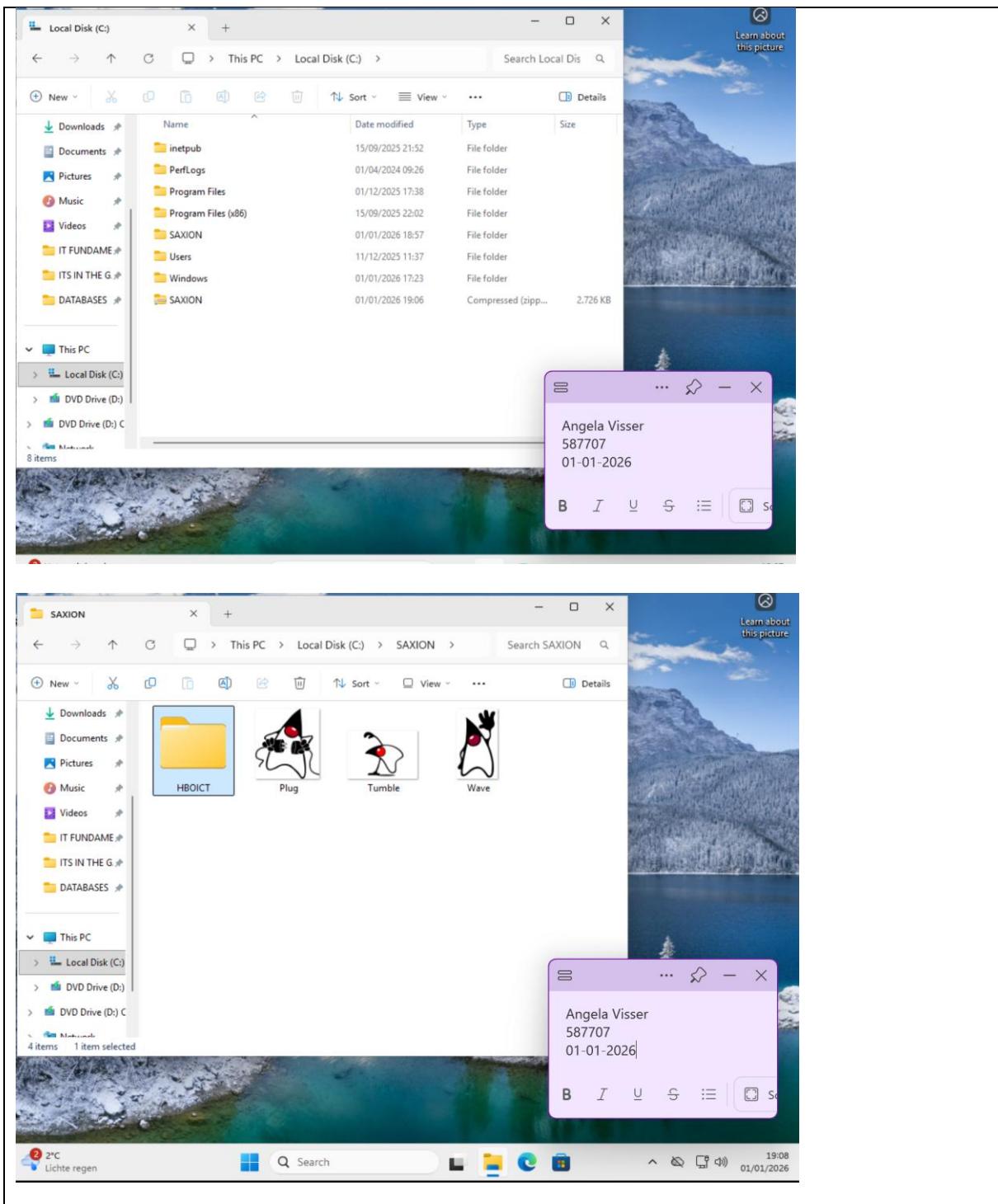


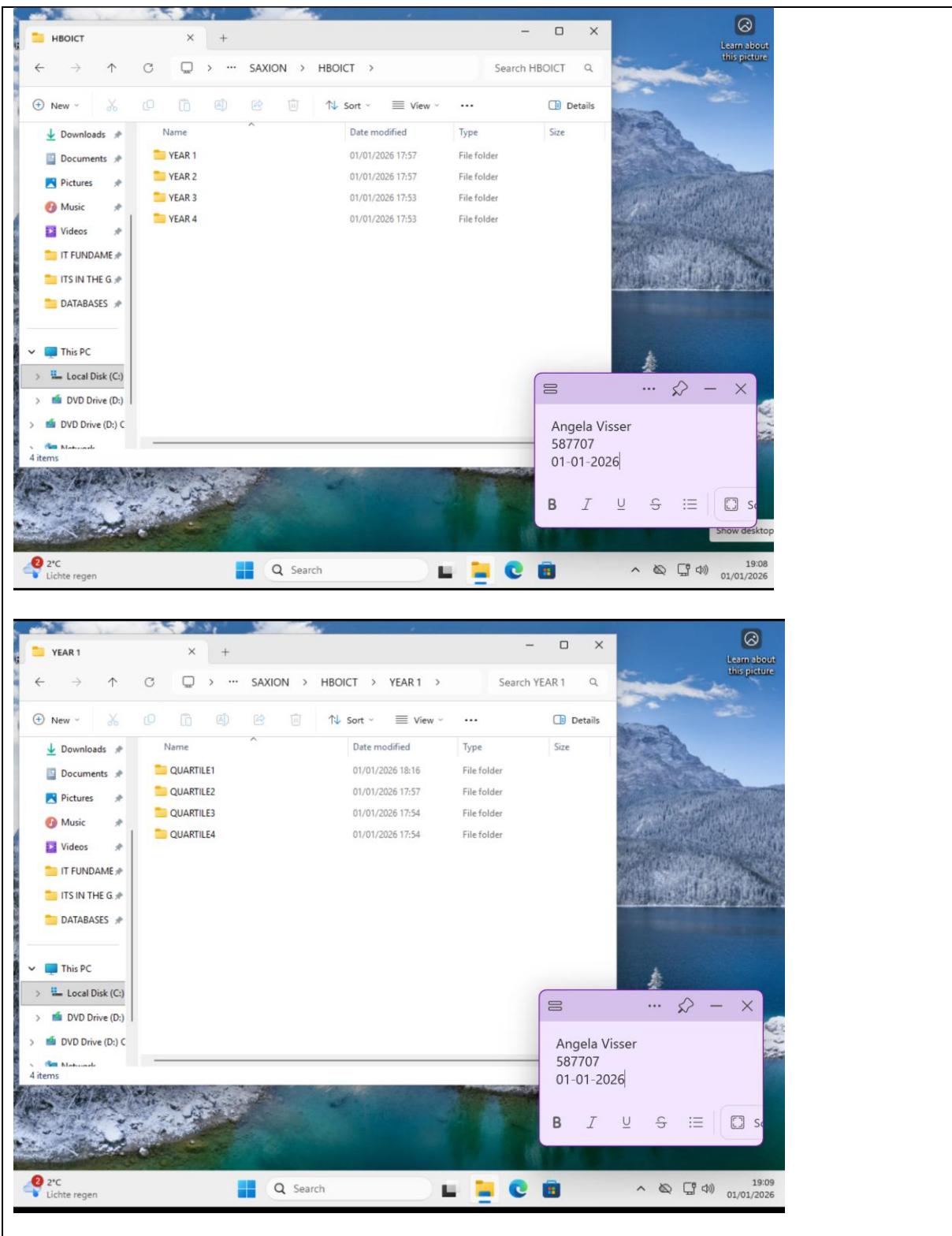
Figuur 5. Relative path.

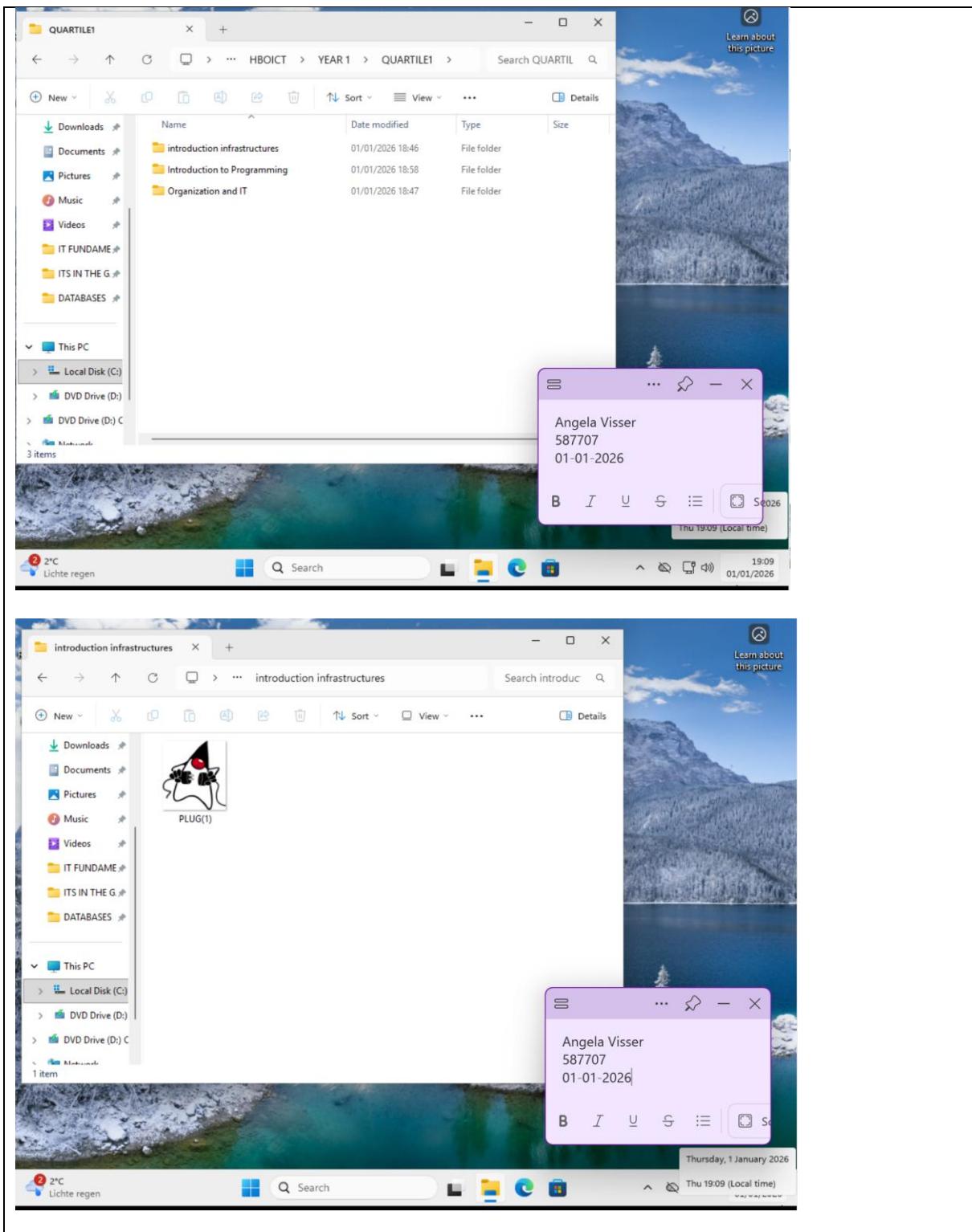
Relevant screenshots **tree** command:

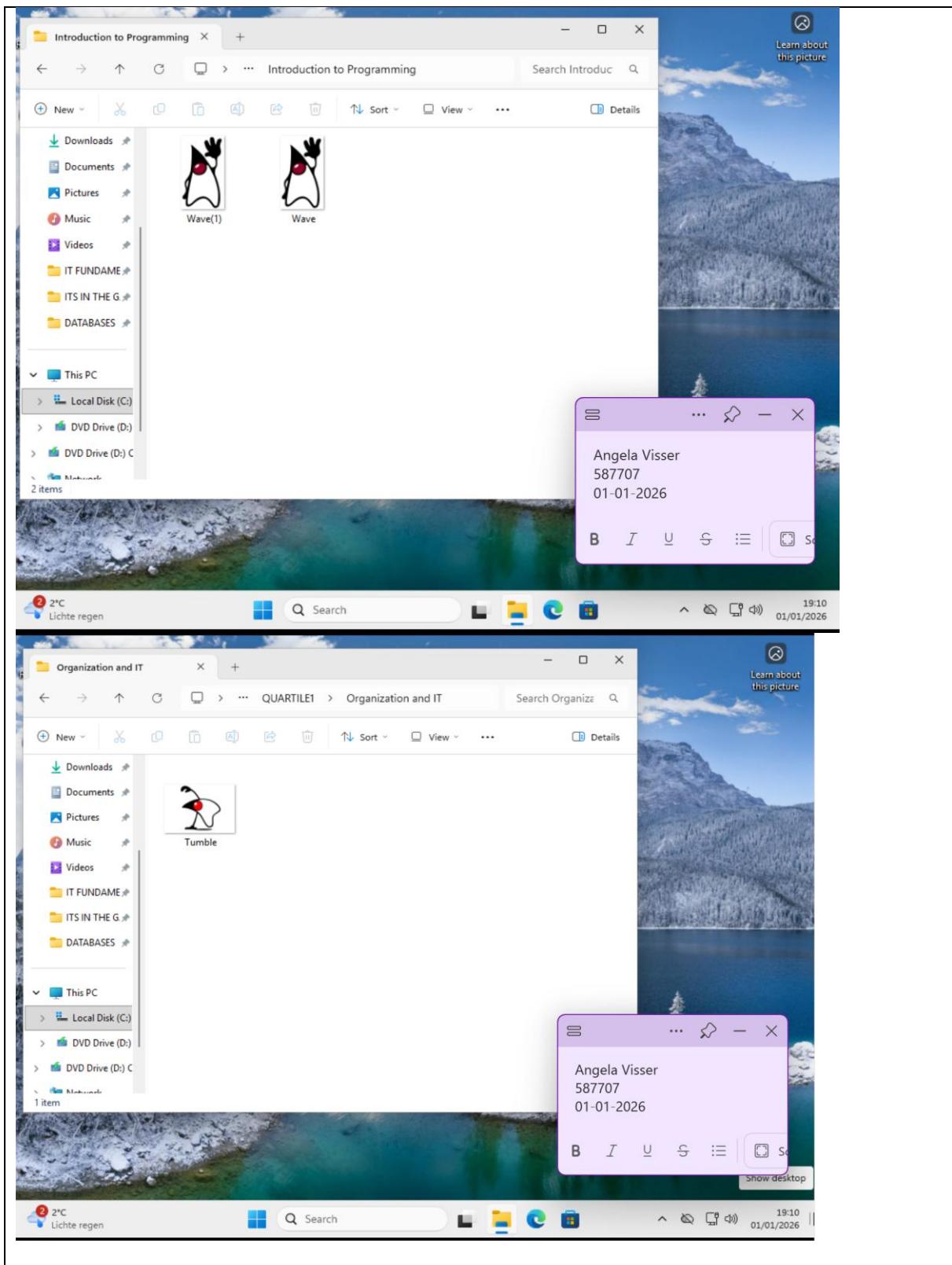


Relevant screenshots in the file explorer of the folder c:\Saxion + created zip file.



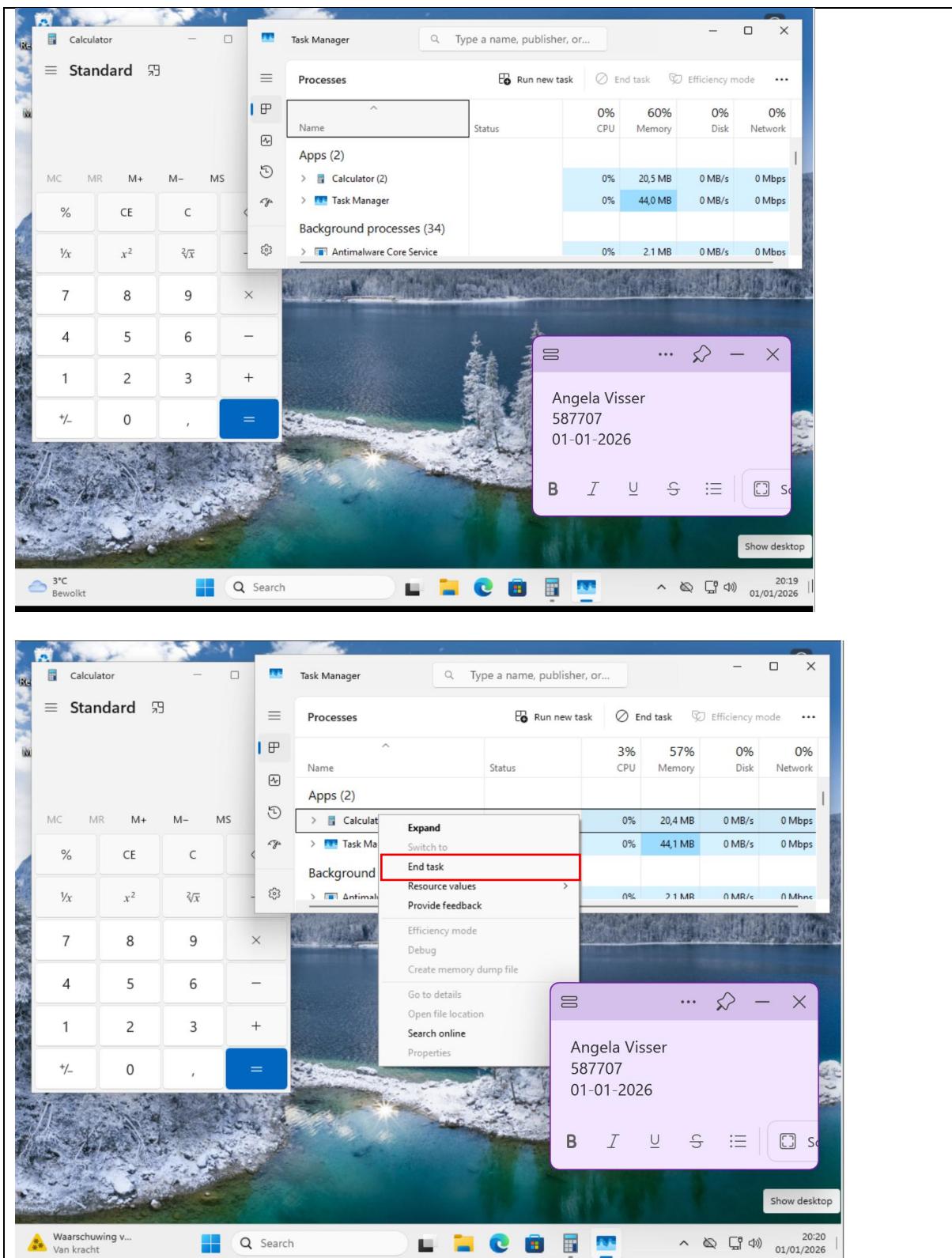






Terminating Processes

Relevant Screenshots Task Manager Window:



Install Software

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

Fire fox installation:

A screenshot of a Windows desktop. In the foreground, a Command Prompt window titled "Administrator: Command Prompt" is open. It shows the results of a "winget search Firefox" command. The output includes terms of service acceptance, a list of Mozilla Firefox variants with their IDs, versions, and sources, and a note about the msstore source requiring regional agreement. Below the Command Prompt is a taskbar with a weather widget showing "2 centimeter sne... Zondag" and a search bar. A small purple notification bubble from the taskbar displays the name "Angela Visser" and the date "01-01-2026".

```
--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 search Firefox
The `msstore` source requires that you view the following agreements before using.
Terms of Transaction: https://aka.ms/microsoft-store-terms-of-transaction
The source requires the current machine's 2-letter geographic region to be sent to the backend service to function properly (ex. "US").

Do you agree to all the source agreements terms?
[Y] Yes [N] No: y

Name                           Id          Version Match   Source
-----
Mozilla Firefox                9NZVDKPMR9RD    Unknown        msstore
Mozilla Firefox (en-US)         Mozilla.Firefox   146.0.1       Moniker: firefox winget
Mozilla Firefox (MSIX)          Mozilla.Firefox.MSIX 146.0.1       Moniker: firefox winget
Mozilla Firefox (ach)           Mozilla.Firefox.ach 146.0.1       Moniker: firefox winget
Mozilla Firefox (af)            Mozilla.Firefox.af 146.0.1       Moniker: firefox winget
Mozilla Firefox (an)            Mozilla.Firefox.an 146.0.1       Moniker: firefox winget
Mozilla Firefox (ar)            Mozilla.Firefox.ar 146.0.1       Moniker: firefox winget
Mozilla Firefox (ast)           Mozilla.Firefox.ast 146.0.1      Moniker: firefox winget
Mozilla Firefox (az)            Mozilla.Firefox.az 146.0.1       Moniker: firefox winget
Mozilla Firefox (be)            Mozilla.Firefox.be 146.0.1       Moniker: firefox winget
Mozilla Firefox (bg)            Mozilla.Firefox.bg 146.0.1       Moniker: firefox winget
Mozilla Firefox (bn)            Mozilla.Firefox.bn 146.0.1       Moniker: firefox winget
Mozilla Firefox (br)            Mozilla.Firefox.br 146.0.1       Moniker: firefox winget
Mozilla Firefox (bs)            Mozilla.Firefox.bs 146.0.1       Moniker: firefox winget
```

A screenshot of a Windows desktop. In the foreground, a Command Prompt window titled "Administrator: Command Prompt" is open. It shows the results of a "winget install -e --id Mozilla.Firefox" command. The output includes finding the Mozilla Firefox (en-US) package, its version (146.0.1), and the download progress of the installer (82.3 MB / 82.3 MB). Below the Command Prompt is a taskbar with a weather widget showing "Lichte regen Morgen" and a search bar. A small purple notification bubble from the taskbar displays the name "Angela Visser" and the date "01-01-2026".

```
Mozilla Firefox ESR (trs)      Mozilla.Firefox.ESR.trs  140.6.0      winget
Mozilla Firefox ESR (uk)        Mozilla.Firefox.ESR.uk   140.6.0      winget
Mozilla Firefox ESR (ur)        Mozilla.Firefox.ESR.ur   140.6.0      winget
Mozilla Firefox ESR (uz)        Mozilla.Firefox.ESR.uz   140.6.0      winget
Mozilla Firefox ESR (vi)        Mozilla.Firefox.ESR.vi   140.6.0      winget
Mozilla Firefox ESR (xh)        Mozilla.Firefox.ESR.xh   140.6.0      winget
Mozilla Firefox ESR (zh-CN)     Mozilla.Firefox.ESR.zh-CN 140.6.0      winget
Mozilla Firefox ESR (zh-TW)     Mozilla.Firefox.ESR.zh-TW 140.6.0      winget
Mozilla Firefox (MSIX) Night... Mozilla.Firefox.MSIX.Night... 148.25...      winget
Profile Switcher for Firefox... nulldev.ProfileSwitcherfor... 0.1.1      winget
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>winget search Firefox
Name                           Id          Version Match   Source
```

- 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>

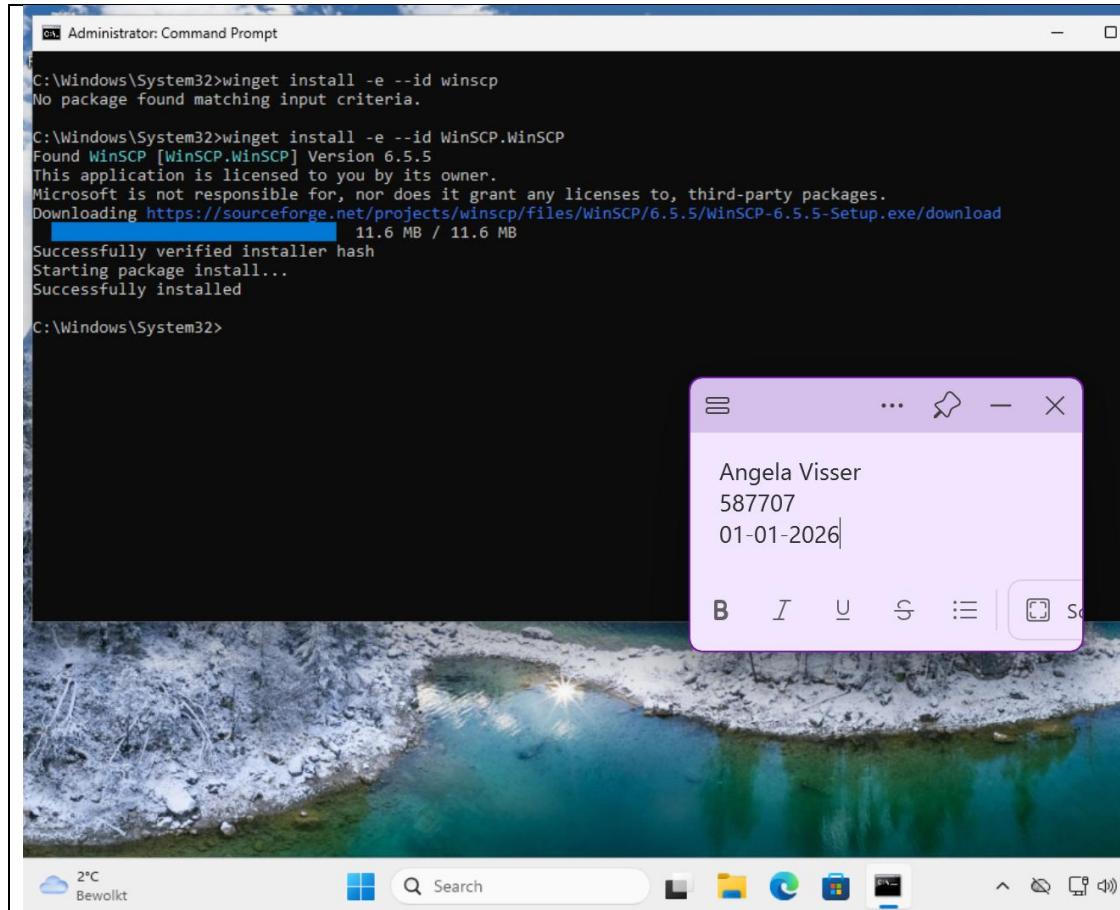
The command tells Winget to install a program. Because of -e and --id, you are guaranteed to install the official Firefox package, not another Mozilla-related or similar-named app.

-e: It tells Winget not to match partially or use substrings, it must match exactly as written, including checking case sensitivity.

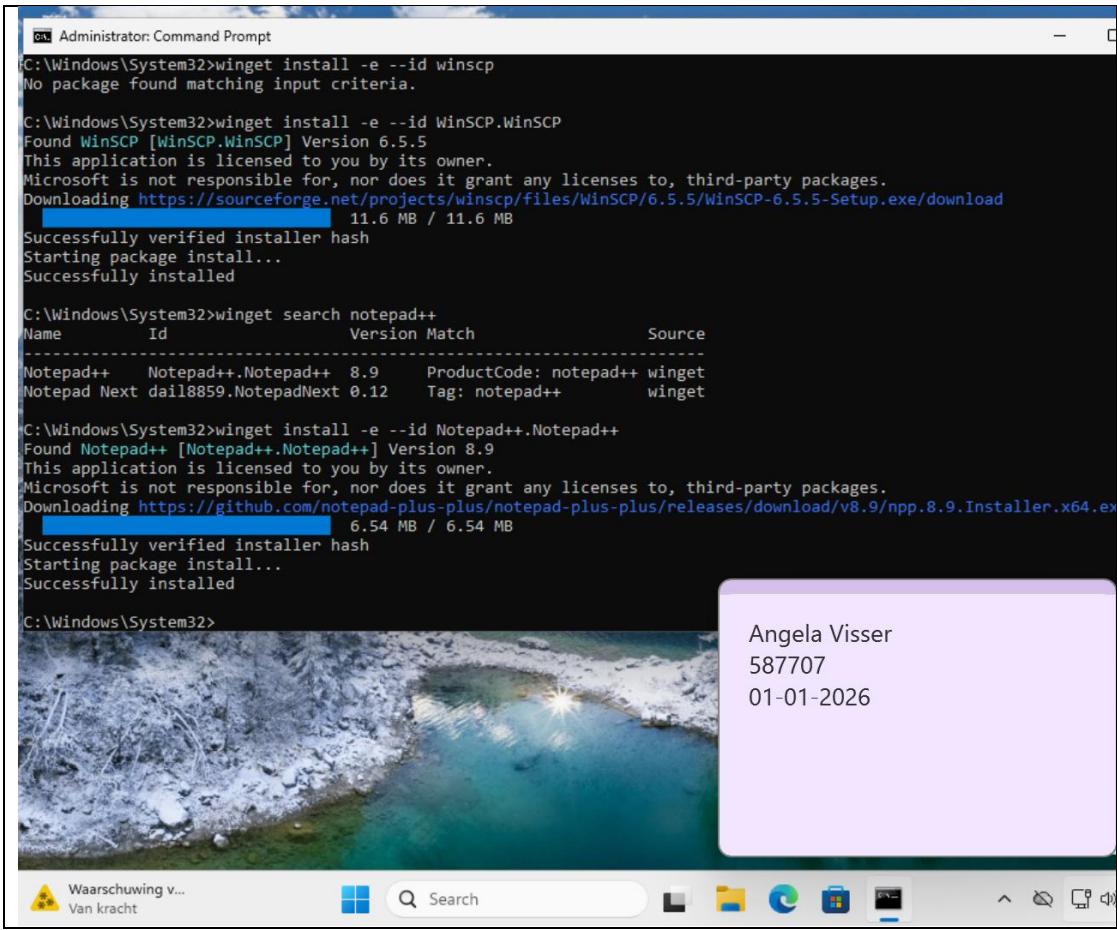
--id: Limiting the install to a specific application ID.

Relevant screenshots that the following software is installed with winget:

- WinSCP



- Notepad++



The screenshot shows a Windows Command Prompt window titled "Administrator: Command Prompt". The user has run several commands using winget:

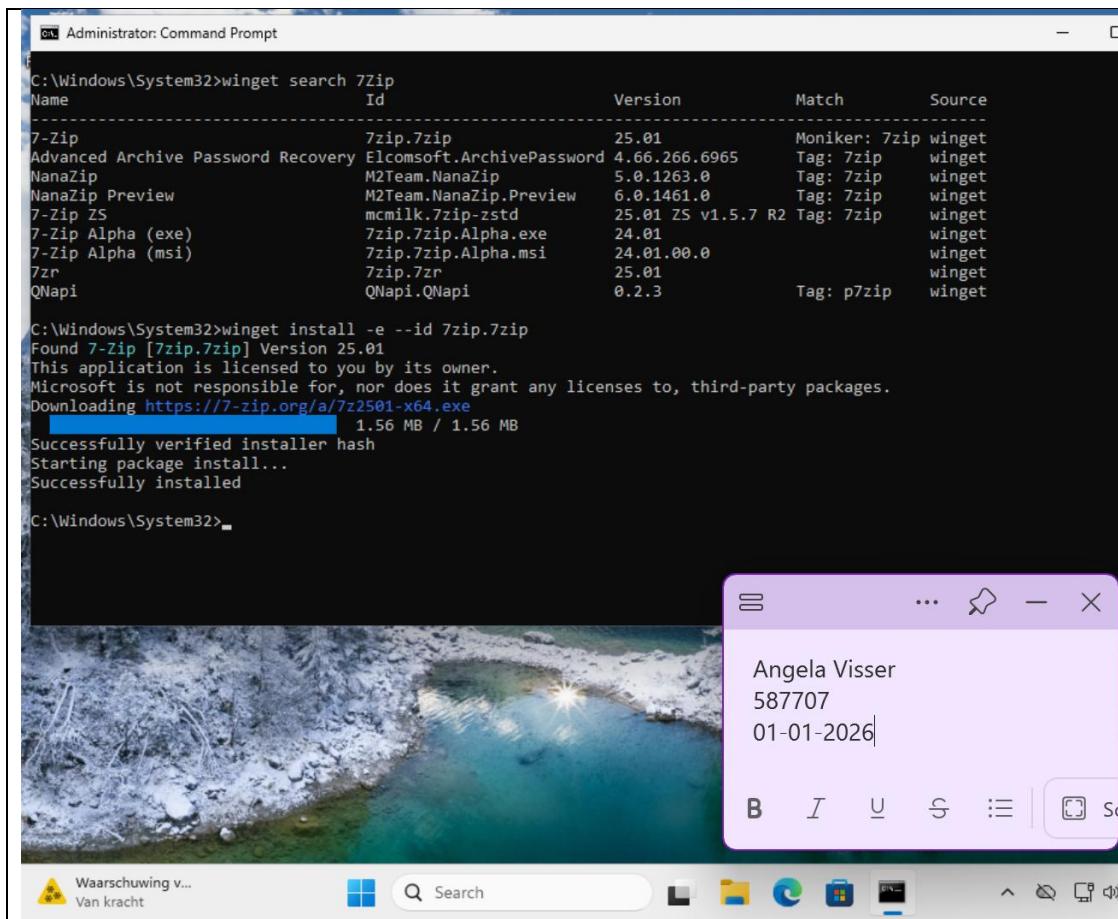
- First, they attempt to install WinSCP: `C:\Windows\System32>winget install -e --id winscp`. The output shows no package found matching the criteria.
- Next, they try to install WinSCP again: `C:\Windows\System32>winget install -e --id WinSCP.WinSCP`. This time, it finds the package, version 6.5.5, and starts the download from sourceforge.net. The progress bar shows 11.6 MB / 11.6 MB.
- After the download, it successfully verifies the installer hash and starts the package install. It is shown as "Successfully installed".
- Then, they search for Notepad++: `C:\Windows\System32>winget search notepad++`. The results table shows two entries:

Name	Id	Version	Match	Source
Notepad++	Notepad++.Notepad++	8.9	ProductCode: notepad++	winget
Notepad Next	dail8859.NotepadNext	0.12	Tag: notepad++	winget

- Finally, they install Notepad++: `C:\Windows\System32>winget install -e --id Notepad++.Notepad++`. It finds the package, version 8.9, and starts the download from github.com. The progress bar shows 6.54 MB / 6.54 MB.
- After the download, it successfully verifies the installer hash and starts the package install. It is shown as "Successfully installed".
- The command prompt ends with `C:\Windows\System32>`.

A small pink callout box in the bottom right corner contains the text: "Angela Visser", "587707", and "01-01-2026".

- 7zip



Assignment 5.4: Working with Linux

- Copying files

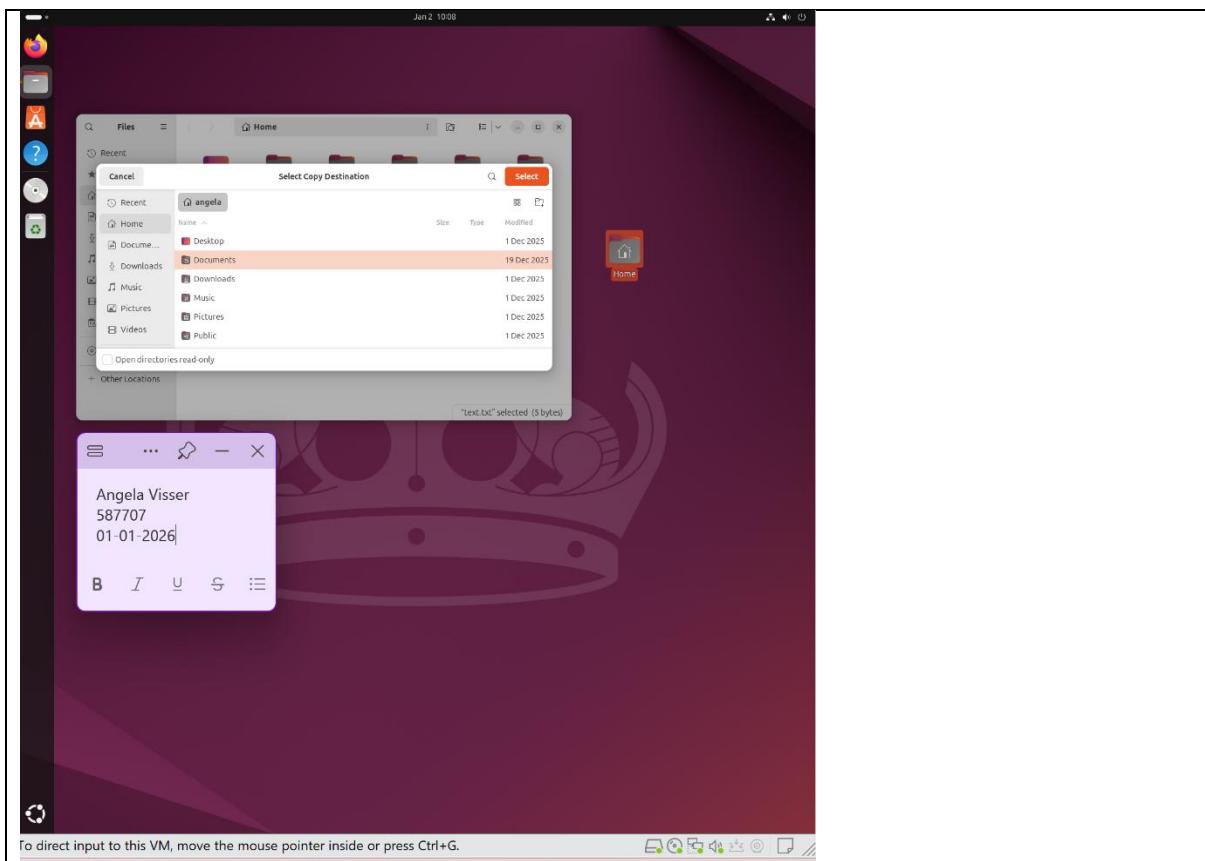


Figure 1. copy in file explorer

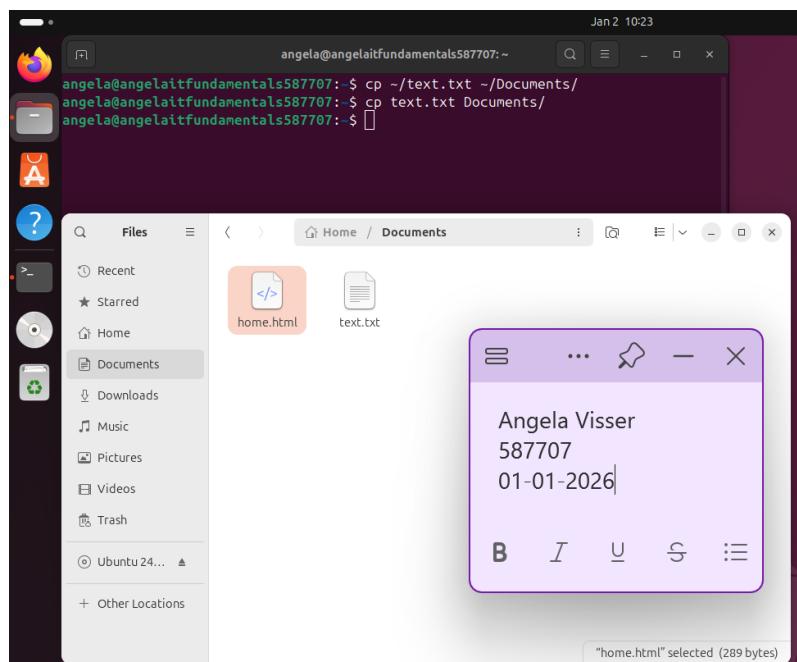


Figure 2. copy via terminal

- Navigating the file structure

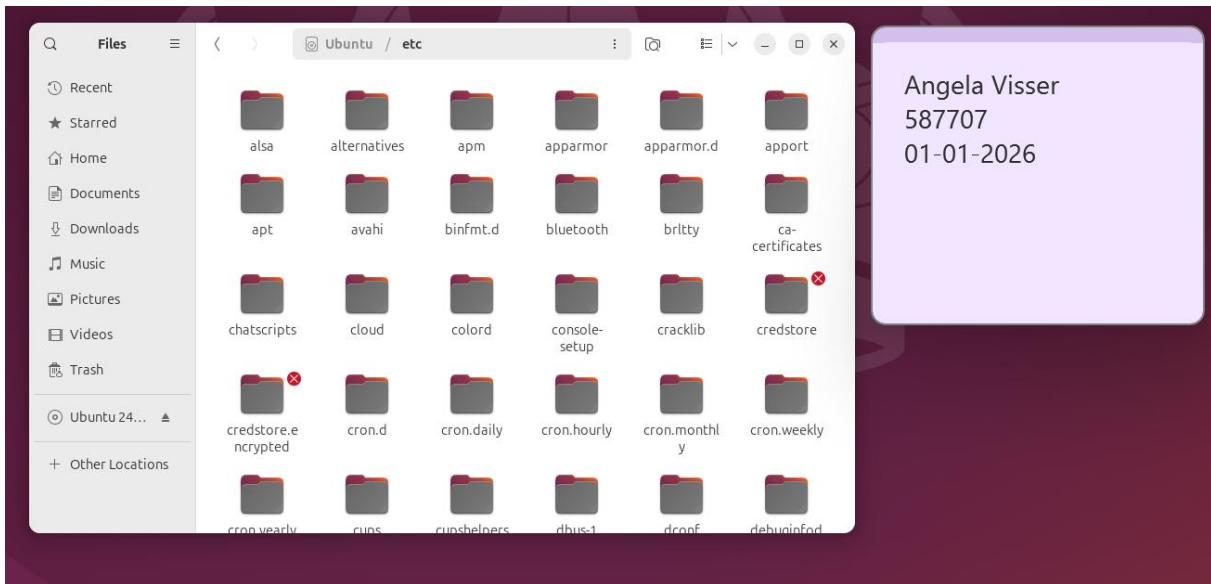


Figure 3. Navigate to the /etc folder in the file explorer (ctrl+L → type /etc)

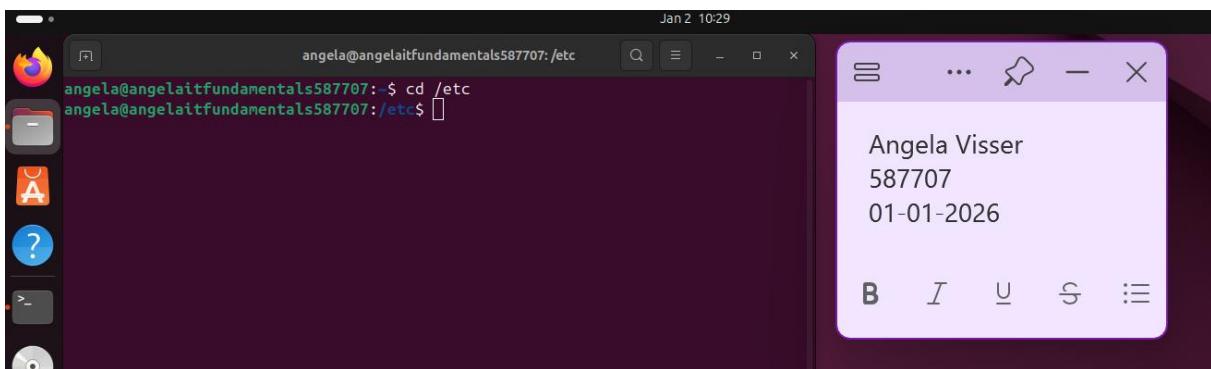


Figure 4. Navigate to the /etc folder in the terminal

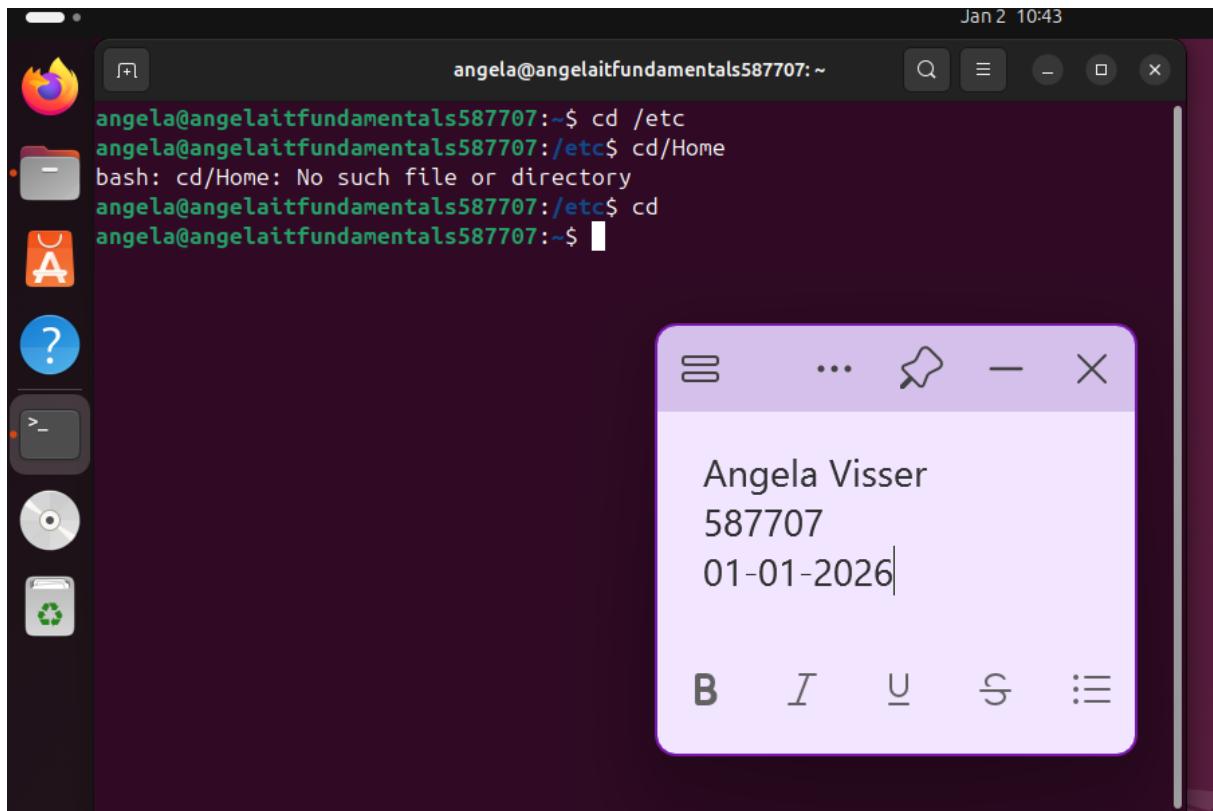


Figure 5. How to get back to your home folder in the terminal? Type cd in the command line

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

Linux uses a tree directory, so everything is back traceable to one root directory.
As for windows, each storage device has its own root. Named by different letters.

What is the /etc directory usually used for?

/etc directory is used for storing system-wide configuration files.

- Compress files

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

tar -cvf archive_name.tar file.txt
and to gzip : tar -czvf archive_name.tar.gz file.txt

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

tar -xvf archive_name.tar
and a gzip: tar -xzvf archive_name.tar.gz

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

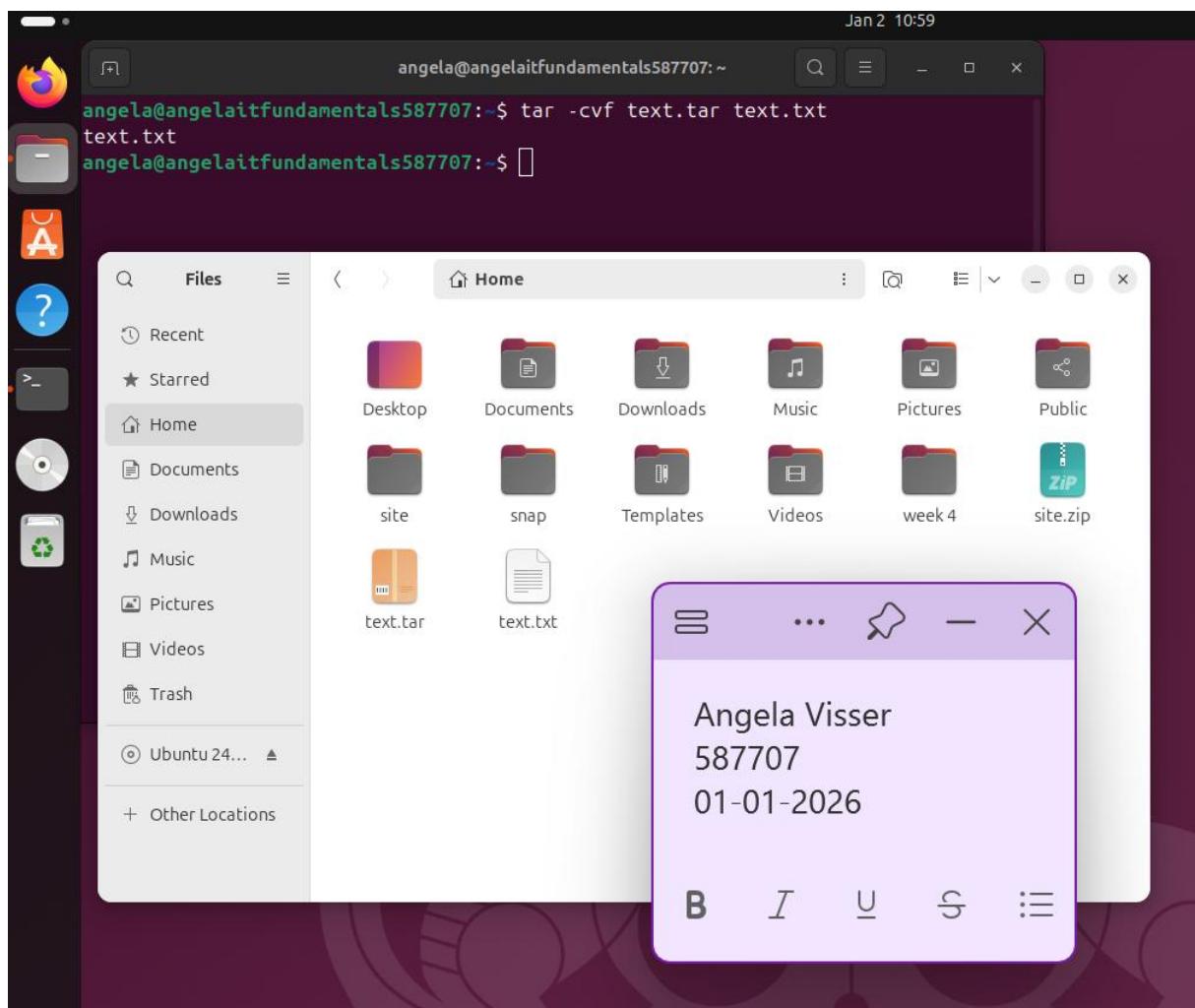


Figure 6. Compressed text.txt into tar archive text.tar

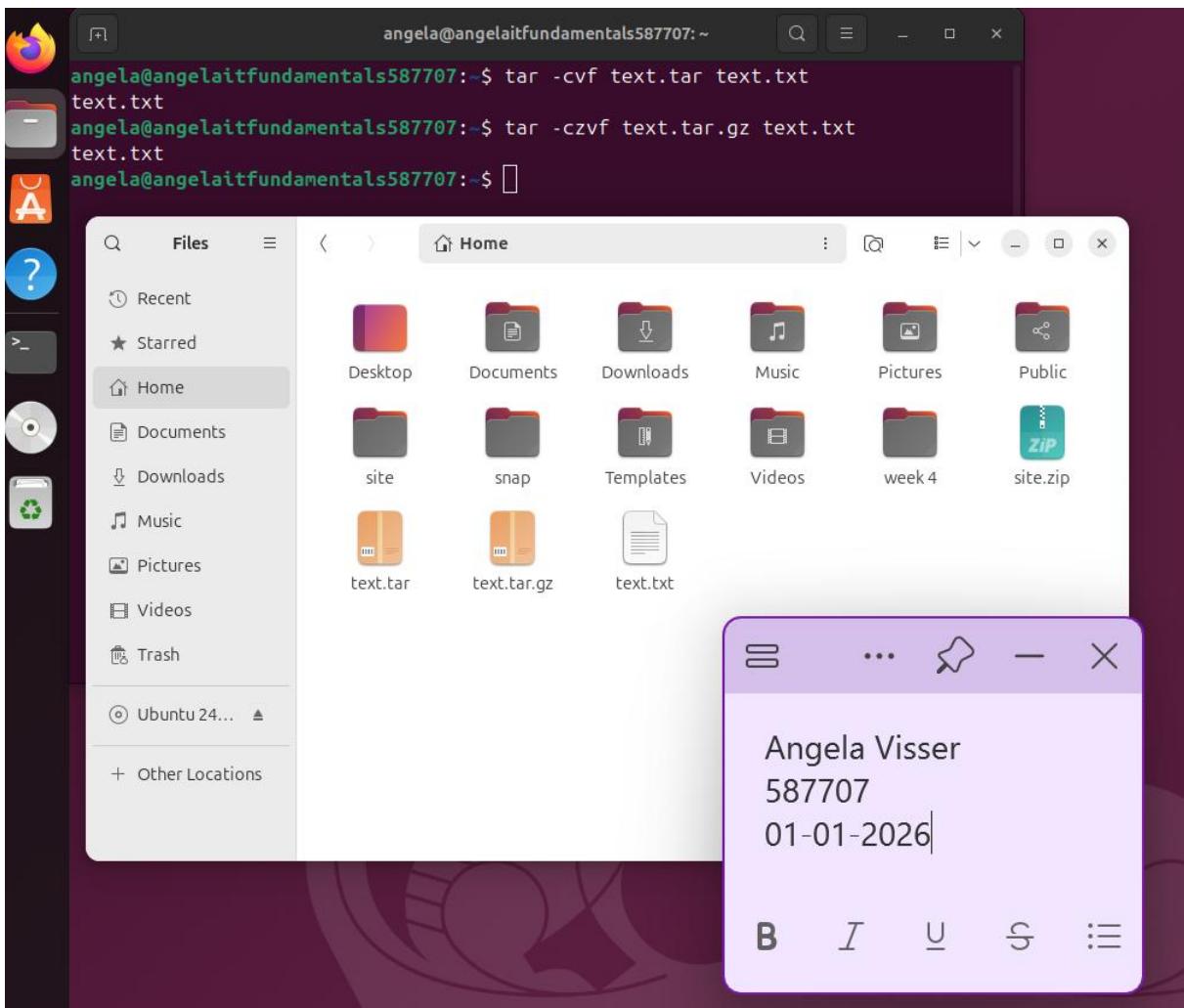


Figure 7. compressed to text.tar.gz

- View processes

Install the application htop via a terminal command.

```
sudo apt update  
sudo apt install htop
```

Launch the htop application. Explain what this application shows.

The terminal window displays system statistics and a list of running processes. The notification bubble shows user information: Angela Visser, ID 587707, dated 01-01-2026.

```

angela@angelaitfundamentals587707:~ 
0[|]          3.2%] Tasks: 117, 383 thr, 194 kthr; 1 runni
1[|]          0.6%] Load average: 0.15 0.10 0.15
2[|]          0.6%] Uptime: 01:16:31
3[|]          0.0%]
Mem[|||||||||||1.25G/3.78G]  OK[3.78G]
Swp[          0.0%]

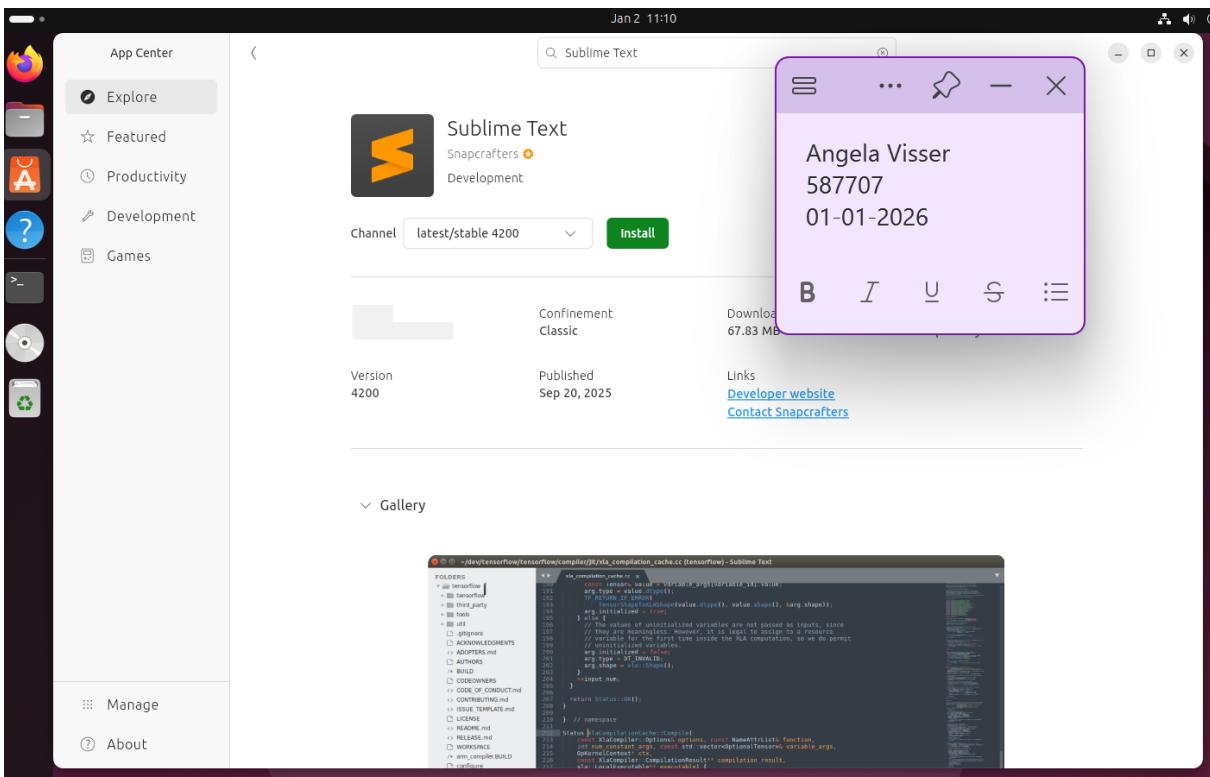
Main I/O
PID USER PRI NI VIRT RES SHR S CPU% MEM% TIME+ Command
5149 angela 20 0 11356 5820 3596 R 0.6 7.5 0:49.62 /usr/bin/gnom
1944 angela 20 0 4289M 291M 128M S 0.0 0.4 0:07.21 /sbin/init sp
381 root 19 -1 67240 18564 17028 S 0.0 0.5 0:01.03 /usr/lib/syst
419 root 20 0 221M 1716 1384 S 0.0 0.0 0:00.00 vmware-vmblc
420 root 20 0 221M 1716 1384 S 0.0 0.0 0:00.00 vmware-vmblc
421 root 20 0 221M 1716 1384 S 0.0 0.0 0:00.00 vmware-vmblc
445 root 20 0 32076 10188 5004 S 0.0 0.3 0:00.71 /usr/lib/syst
707 systemd-oo 20 0 17560 7632 6720 S 0.0 0.2 0:01.72 /usr/lib/syst
710 systemd-re 20 0 21580 13356 10988 S 0.0 0.3 0:00.33 /usr/lib/syst
712 systemd-ti 20 0 91048 7872 6892 S 0.0 0.2 0:00.15 /usr/lib/syst
722 root 20 0 56064 11916 10348 S 0.0 0.3 0:00.10 /usr/bin/VGAU
732 root 20 0 239M 9420 7956 S 0.0 0.2 0:16.59 /usr/bin/vmt
F1Help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice -F8Vice -F9Kill F10Quit

```

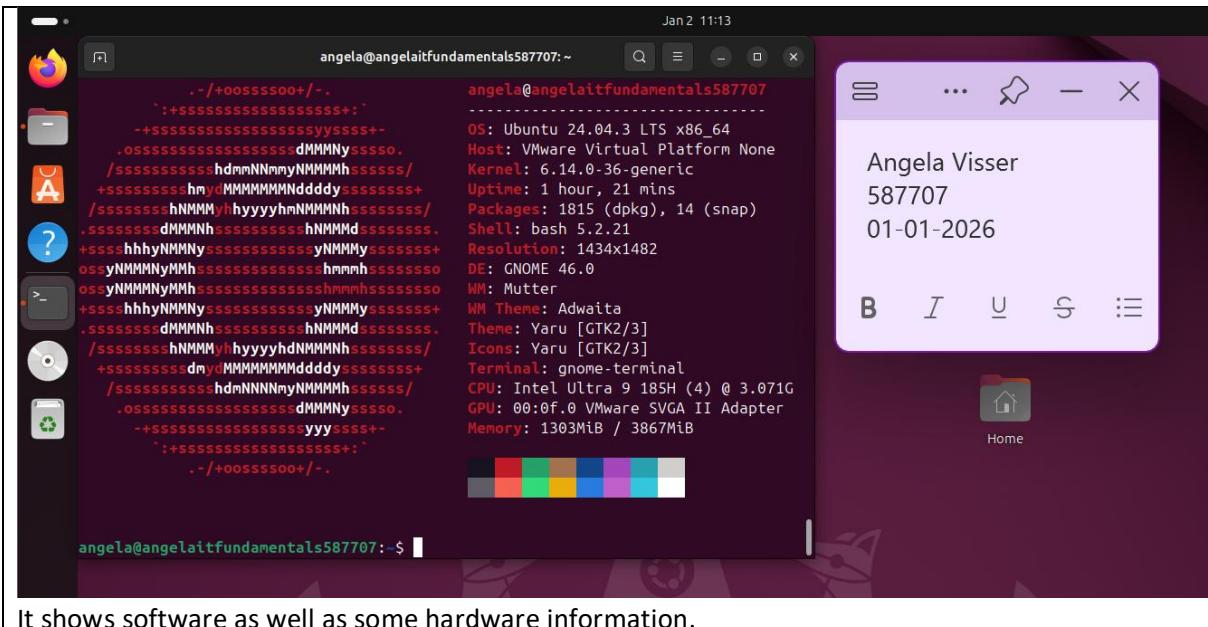
It shows the currently running processes.

- Install Software

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

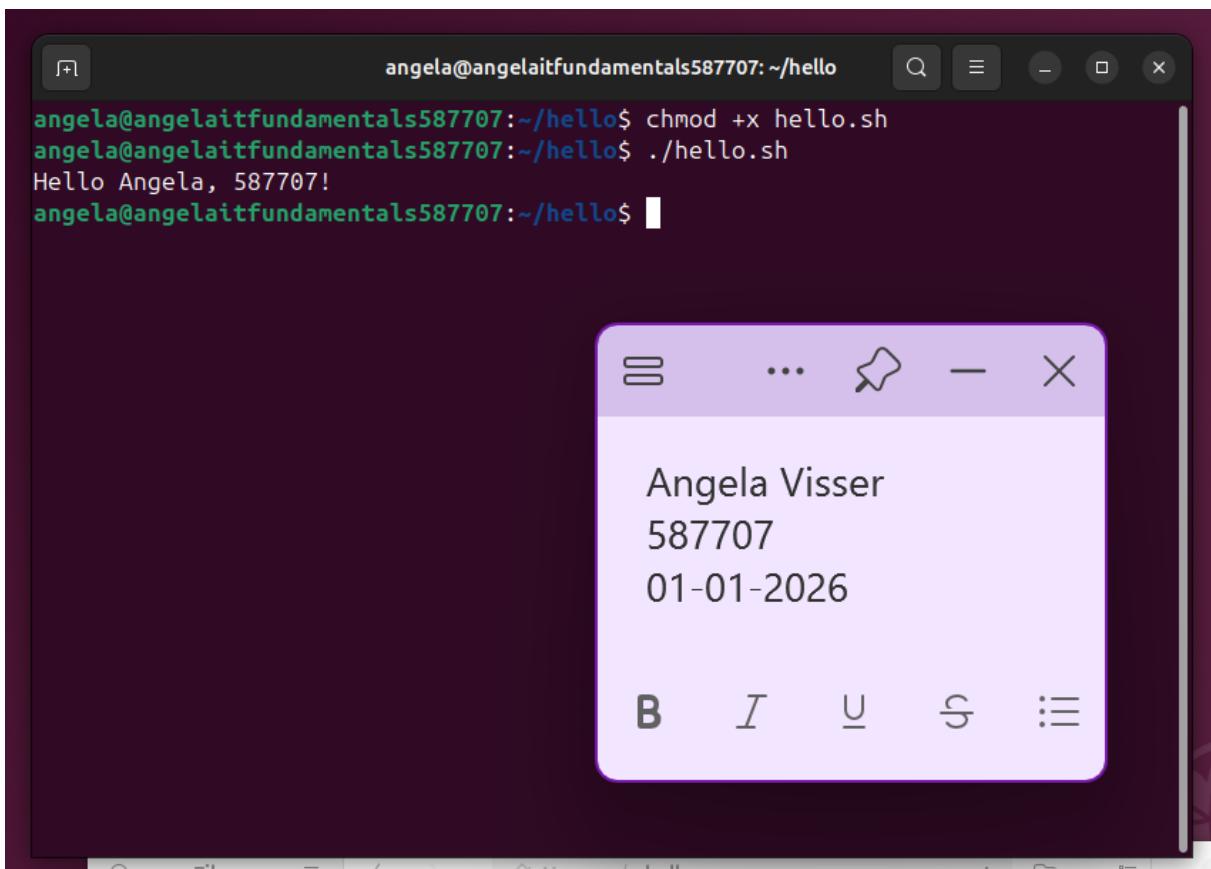


Using a terminal command, install the neofetch application. What does this application show when you launch it?



It shows software as well as some hardware information.

Assignment 5.5: Users and permissions on Linux



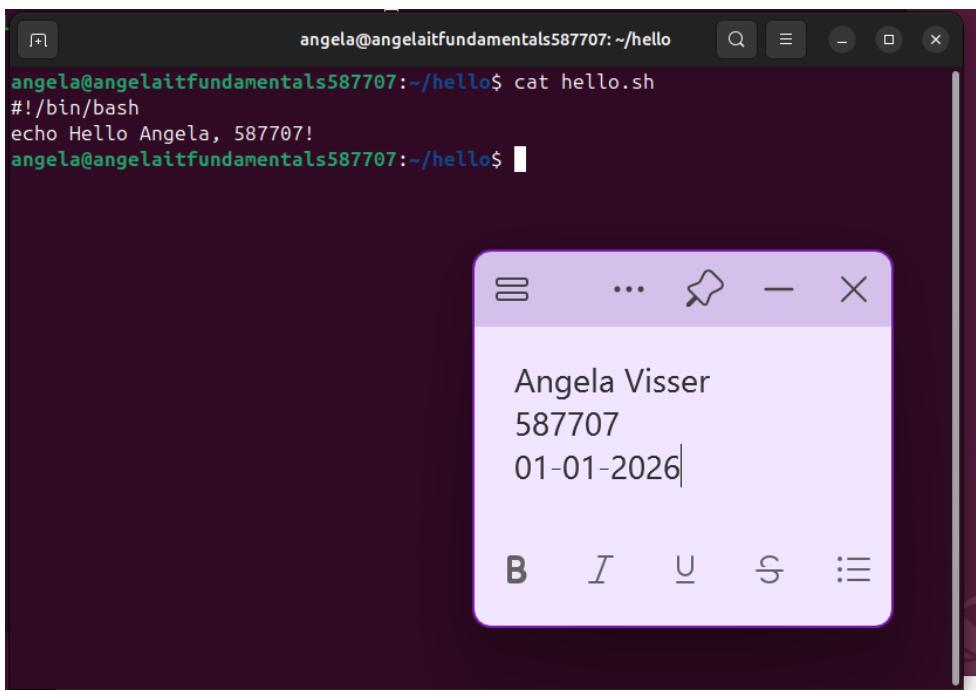
The screenshot shows a terminal window titled "angela@angelaitfundamentals587707: ~/hello". The user runs the command "chmod +x hello.sh" to make the script executable. Then, they run "./hello.sh", which outputs "Hello Angela, 587707!". Below the terminal is a small text editor window displaying the following text:

```
Angela Visser  
587707  
01-01-2026
```

The text editor has standard toolbar icons for bold, italic, underline, and alignment.

Figure 8. Made a textfile executable with chmod and executed it.

Assignment 5.6: View the contents of files



The screenshot shows a terminal window titled "angela@angelaitfundamentals587707: ~/hello". The user runs the command "cat hello.sh", which displays the contents of the file:

```
#!/bin/bash  
echo Hello Angela, 587707!
```

Below the terminal is a small text editor window displaying the same text as Figure 8:

```
Angela Visser  
587707  
01-01-2026
```

The text editor has standard toolbar icons for bold, italic, underline, and alignment.

Figure 9. cat shows the content of a file.

```
angela@angelaitfundamentals587707:~/hello$ cat hello.sh
#!/bin/bash
echo Hello Angela, 587707!
angela@angelaitfundamentals587707:~/hello$ wc hello.sh
2 5 39 hello.sh
angela@angelaitfundamentals587707:~/hello$
```

A screenshot of a terminal window titled "angela@angelaitfundamentals587707: ~/hello". It shows the command "cat hello.sh" being run, displaying the contents of the file "hello.sh" which contains a single line of text: "Hello Angela, 587707!". Then, the command "wc hello.sh" is run, showing the word count: 2 lines, 5 words, and 39 characters. The terminal has a dark background with light-colored text.

A screenshot of a file viewer window titled "angela@angelaitfundamentals587707: ~/hello". It displays the same text as the terminal: "Hello Angela, 587707!". Below the text are standard file viewer icons for bold, italic, underline, and copy.

Figure 10. *cat* shows the content of a file and *wc* (word count) counts the lines, words and characters depending on flags (*-l*, *-w*, *-c*).

```
angela@angelaitfundamentals587707:~/hello$
```

A screenshot of a terminal window titled "angela@angelaitfundamentals587707: ~/hello". It shows the command "less hello.sh" being run, which displays the file "hello.sh" page by page. The first few lines of the file are visible. Below the terminal is a file viewer window titled "angela@angelaitfundamentals587707: ~/hello". It displays the same text as the terminal: "Hello Angela, 587707!". Below the text are standard file viewer icons for bold, italic, underline, and copy.

Figure 11. *less* let's you view files page by page.

The screenshot shows a terminal window with a dark background. The terminal title is "angela@angelaitfundamentals587707: ~/hello". The user runs several commands:

- `cat hello.sh`: Displays the contents of the file:

```
#!/bin/bash
echo Hello Angela, 587707!
```

- `wc hello.sh`: Prints the word count:

```
2 5 39 hello.sh
```

- `tail hello.sh`: Prints the last 10 lines of the file:

```
#!/bin/bash
echo Hello Angela, 587707!
```

- `head hello.sh`: Prints the first 10 lines of the file:

```
#!/bin/bash
echo Hello Angela, 587707!
```

A small floating window is overlaid on the terminal, containing the following text:

Angela Visser
587707
01-01-2026

Below this text are five icons: bold, italic, underline, strikethrough, and a list icon.

Figure 12. `tail` shows, by default, the last 10 lines of a file. flags can change the defult to more lines (`-n 20`). `Head` does the same but for the first lines in a file.

```
angela@angelaitfundamentals587707:~/hello$ cat hello.sh
#!/bin/bash
echo Hello Angela, 587707!
angela@angelaitfundamentals587707:~/hello$ wc hello.sh
2 5 39 hello.sh
angela@angelaitfundamentals587707:~/hello$ tail hello.sh
#!/bin/bash
echo Hello Angela, 587707!
angela@angelaitfundamentals587707:~/hello$ head hello.sh
#!/bin/bash
echo Hello Angela, 587707!
angela@angelaitfundamentals587707:~/hello$ grep "Hello" hello.sh
echo Hello Angela, 587707!
angela@angelaitfundamentals587707:~/hello$
```

Angela Visser
587707
01-01-2026

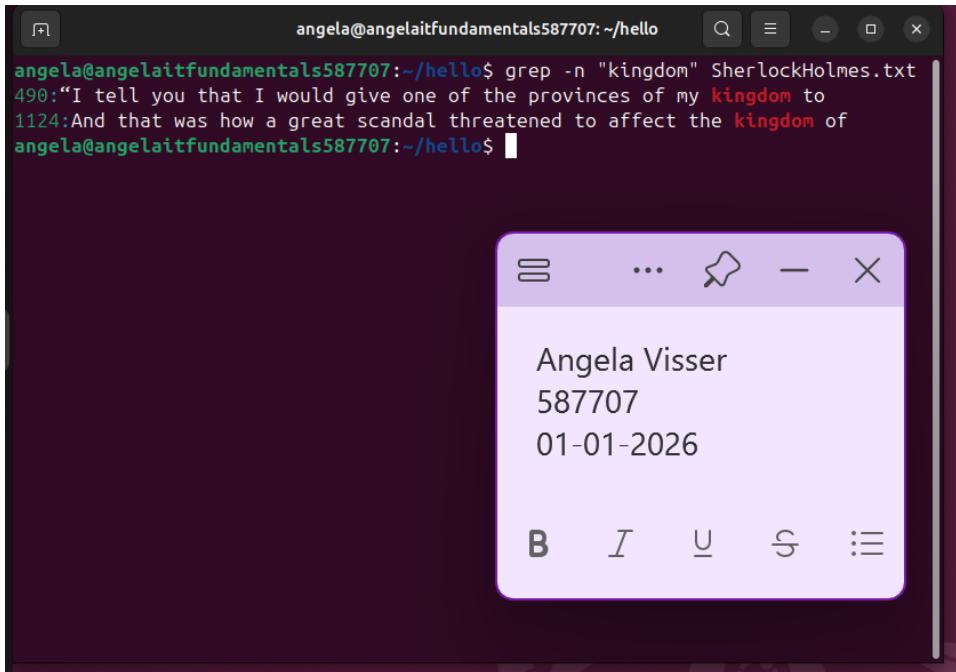
Figure 13. Grep shows all lines with a certain word in it. to make it case-insensitive, show line numbers or search recursively in directories flags can be added (-i, -n, -r).

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

```
angela@angelaitfundamentals587707:~/hello$ wc SherlockHolmes.txt
12303 107560 607425 SherlockHolmes.txt
angela@angelaitfundamentals587707:~/hello$
```

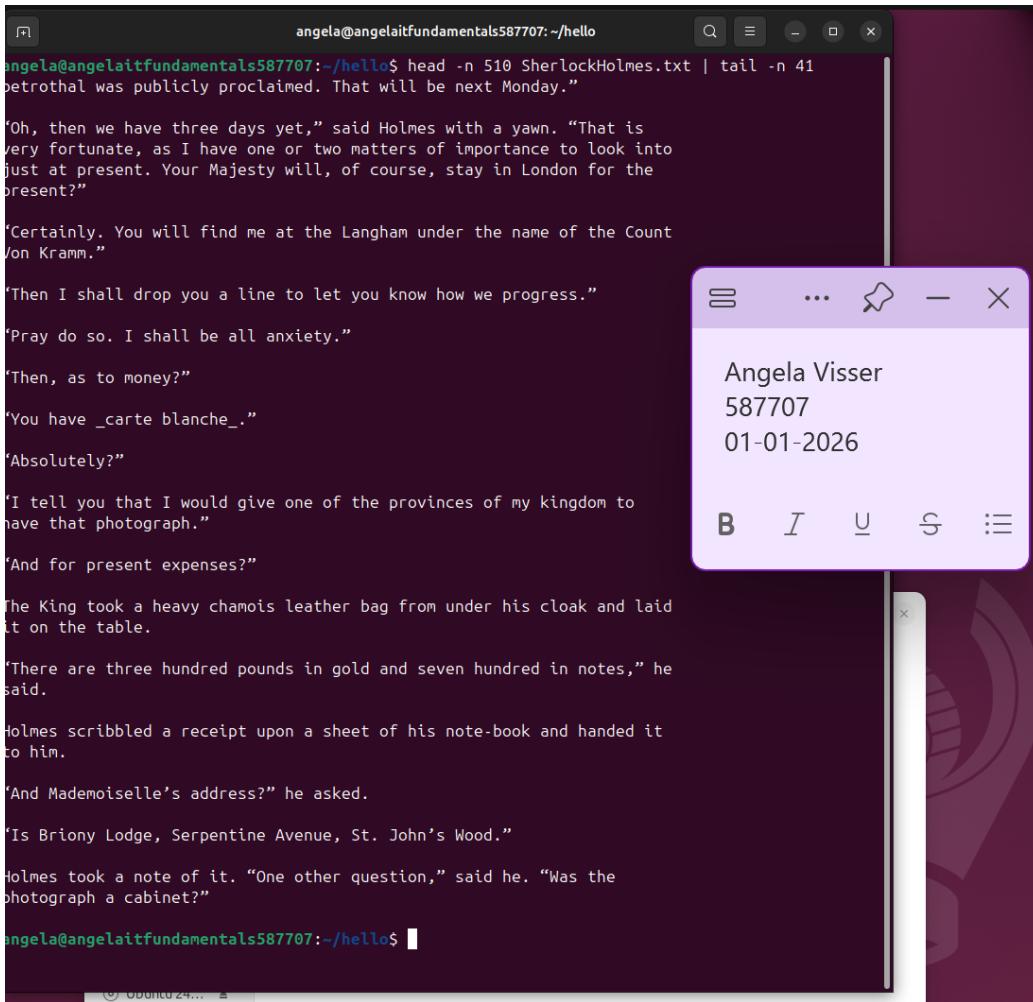
Angela Visser
587707
01-01-2026

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



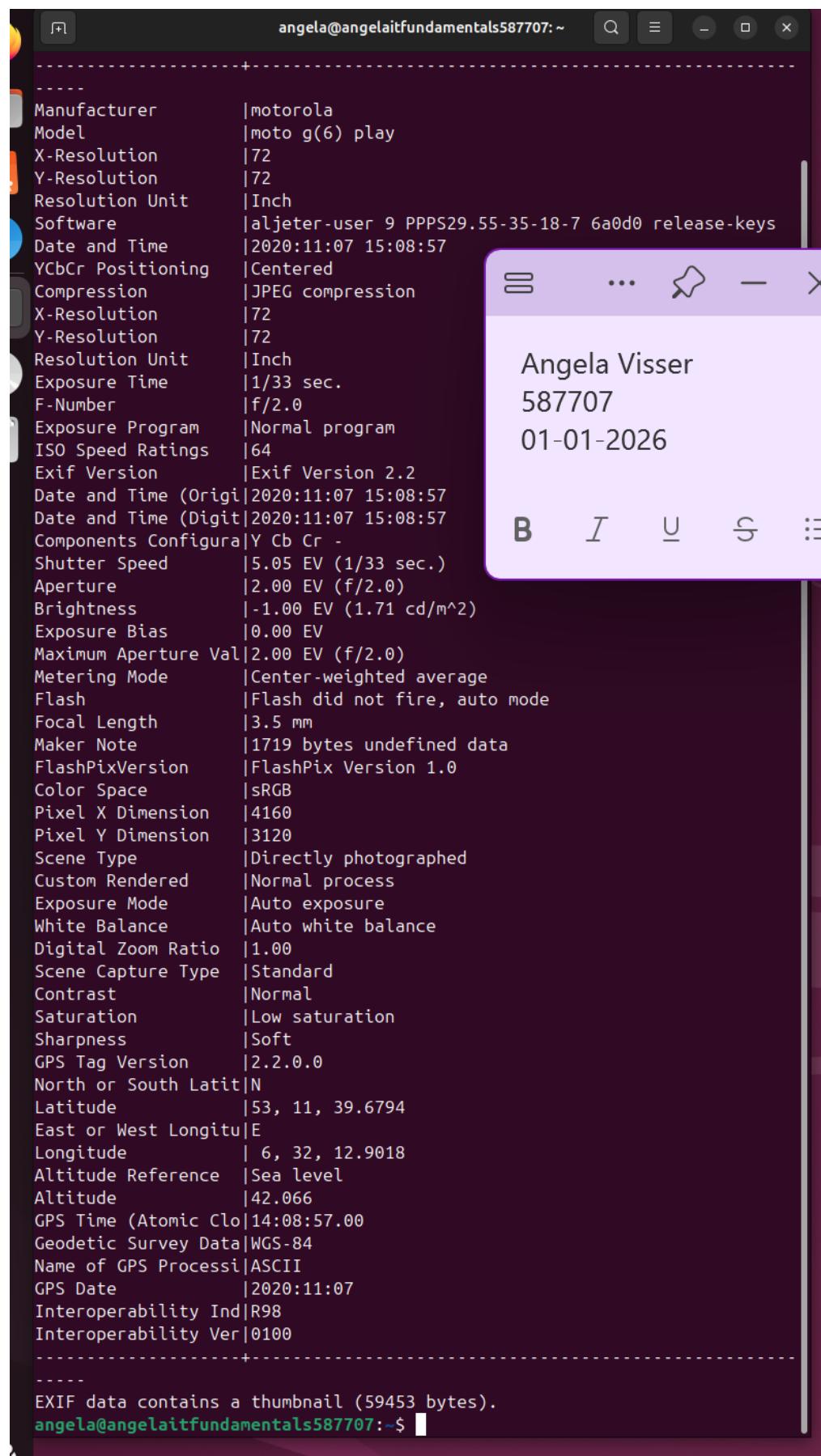
```
angela@angelaitfundamentals587707:~/hello$ grep -n "kingdom" SherlockHolmes.txt
490:"I tell you that I would give one of the provinces of my kingdom to
1124:And that was how a great scandal threatened to affect the kingdom of
angela@angelaitfundamentals587707:~/hello$
```

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



```
angela@angelaitfundamentals587707:~/hello$ head -n 510 SherlockHolmes.txt | tail -n 41
betrothal was publicly proclaimed. That will be next Monday."
'Oh, then we have three days yet," said Holmes with a yawn. "That is
very fortunate, as I have one or two matters of importance to look into
just at present. Your Majesty will, of course, stay in London for the
present?"'
'Certainly. You will find me at the Langham under the name of the Count
Jon Kramm.'"
'Then I shall drop you a line to let you know how we progress.'
'Pray do so. I shall be all anxiety.'
'Then, as to money?"'
>You have _carte blanche_."
'Absolutely?"'
'I tell you that I would give one of the provinces of my kingdom to
have that photograph.'"
'And for present expenses?"'
The King took a heavy chamois leather bag from under his cloak and laid
it on the table.
'There are three hundred pounds in gold and seven hundred in notes," he
said.
Holmes scribbled a receipt upon a sheet of his note-book and handed it
to him.
'And Mademoiselle's address?" he asked.
'Is Briony Lodge, Serpentine Avenue, St. John's Wood.'"
Holmes took a note of it. "One other question," said he. "Was the
photograph a cabinet?"'
angela@angelaitfundamentals587707:~/hello$
```

Assignment 5.7: Digital forensics



```
angela@angelaitfundamentals587707:~
```

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
Compression	JPEG compression
X-Resolution	72
Y-Resolution	72
Resolution Unit	Inch
Exposure Time	1/33 sec.
F-Number	f/2.0
Exposure Program	Normal program
ISO Speed Ratings	64
Exif Version	Exif Version 2.2
Date and Time (Original)	2020:11:07 15:08:57
Date and Time (Digitized)	2020:11:07 15:08:57
Components Configuration	Y Cb Cr -
Shutter Speed	5.05 EV (1/33 sec.)
Aperture	2.00 EV (f/2.0)
Brightness	-1.00 EV (1.71 cd/m^2)
Exposure Bias	0.00 EV
Maximum Aperture Value	2.00 EV (f/2.0)
Metering Mode	Center-weighted average
Flash	Flash did not fire, auto mode
Focal Length	3.5 mm
Maker Note	1719 bytes undefined data
FlashPixVersion	FlashPix Version 1.0
Color Space	sRGB
Pixel X Dimension	4160
Pixel Y Dimension	3120
Scene Type	Directly photographed
Custom Rendered	Normal process
Exposure Mode	Auto exposure
White Balance	Auto white balance
Digital Zoom Ratio	1.00
Scene Capture Type	Standard
Contrast	Normal
Saturation	Low saturation
Sharpness	Soft
GPS Tag Version	2.2.0.0
North or South Latitude	N
Latitude	53, 11, 39.6794
East or West Longitude	E
Longitude	6, 32, 12.9018
Altitude Reference	Sea level
Altitude	42.066
GPS Time (Atomic Clock)	14:08:57.00
Geodetic Survey Data	WGS-84
Name of GPS Processor	ASCII
GPS Date	2020:11:07
Interoperability Index	R98
Interoperability Version	0100

```
EXIF data contains a thumbnail (59453 bytes).
```

```
angela@angelaitfundamentals587707:~$
```

Angela Visser
587707
01-01-2026

EXIF

Identify phone brand/type

Motorola, moto g6 play

Are there GPS coordinates known? If yes: look up the location in Google maps and Streetview

53°11'39.7"N 6°32'12.9"E

In which city was this photo taken?

Groningen

Filename extensions

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

In the terminal, type the command **file oldcar**.

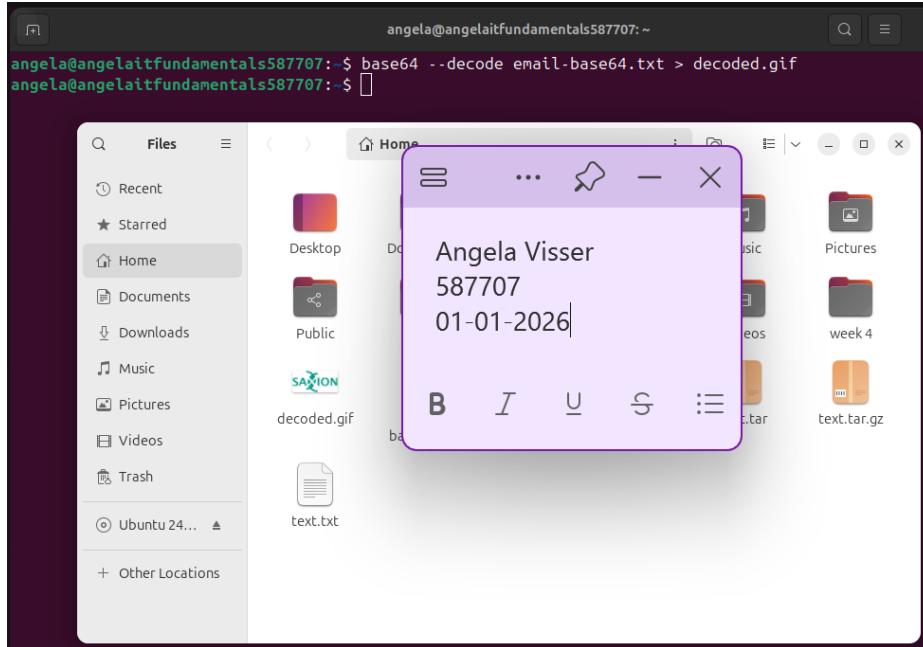
Does Ubuntu still consider it to be a jpg file?

```
Scene Capture Type |Standard
Contrast          |Normal
Saturation        |Low saturation
Sharpness         |Soft
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).
angela@angelaitfundamentals587707:~$ 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, datatime
=2020:11:07 15:08:57, GPS-Data], baseline, precision 8, 4160x3120, components 3
angela@angelaitfundamentals587707:~$
```

Yes.

BASE64

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. TIP! Figure out how to send output to a file instead of the screen on Linux.

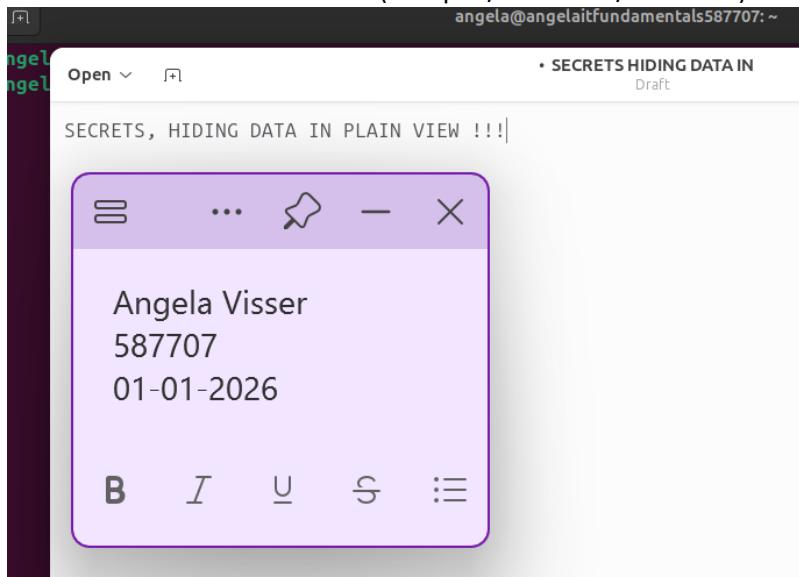


Assignment 5.8: Steganography

Select the blank line above.

Copy the selected line.

Paste the line into a text editor (notepad/texteditor/nano etc.)



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.

The terminal window shows the command `steghide extract -sf apple2.jpg` being run, followed by the prompt "Enter passphrase:". The output shows the extracted message: "Hello class. You have almost completed Week 5." A separate screenshot of a text editor window displays the extracted message: "Hello class. You have almost completed Week 5."

```
angela@angelaitfundamentals587707:~$ steghide extract -sf apple2.jpg
Enter passphrase:
wrote extracted data to "message.txt".
angela@angelaitfundamentals587707:~$ cat message.txt
Hello class.
You have almost completed Week 5.

angela@angelaitfundamentals587707:~$
```

Angela Visser
587707
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Assignment 5.9: Capture disk images

Make relevant screenshots + motivation:

Student must submit:

Documentation of steps Screenshots or terminal logs showing:

- Debian server setup

The terminal window shows the command `is /var/log` being run, followed by a list of log files. The output includes messages from the VMware Tools version 12.5.0 build 3427846, indicating the capture of a disk image named "apple2". The process involves various VMware tools plugins like vmsvc, vmtoolsd, and vix, and ends with a success message: "digen succeeded".

```
angela@ITF587707:~$ is /var/log
alternatives.log  btmp  installer  lastlog  README  vmware-network.1.log  vmware-network.log  vmware-vmwsvc-root.log  wtmp
boot.log  dkms.log  Journal  private  runit  vmware-network.2.log  vmware-vmwsvc-root.1.log  vmware-vmtoolsd-root.log  wtmp.db
[sudo] password for angela:
[2026-01-04T08:38:33.4822] [message] [vmsvc] [785] VMware Tools Version: 12.5.0.51152 (Build 3427846)
[2026-01-04T08:38:33.4822] [message] [vmsvc] [785] Guest OS details: architectures=X86; bitness=64; distroAddlVersion='13 (trixie)'; prettyName='Debian GNU/Linux 13 (trixie)'
[2026-01-04T08:38:33.4822] [message] [vmsvc] [785] kernelVersion='6.12.57+deb13-smd64'; distroName='Debian GNU/Linux 13 (trixie)'
[2026-01-04T08:38:33.4822] [message] [vmsvc] [785] Log caching is enabled with maxCacheEntries=4096.
[2026-01-04T08:38:33.4822] [message] [vmsvc] [785] Core dump limit set to -1
[2026-01-04T08:38:33.5842] [message] [vmtoolsd] [785] Plugin 'hgfsServer' initialized.
[2026-01-04T08:38:33.5842] [message] [vix] [785] Plugin 'vix' initialized.
[2026-01-04T08:38:33.5842] [message] [vmtoolsd] [785] Plugin 'vix' initialized.
[2026-01-04T08:38:33.5842] [message] [vmtoolsd] [785] Plugin 'apoptInfo' initialized.
[2026-01-04T08:38:33.5842] [message] [vmtoolsd] [785] Plugin 'componentMgr' initialized.
[2026-01-04T08:38:33.5842] [message] [vmtoolsd] [785] Plugin 'guestInfo' initialized.
[2026-01-04T08:38:33.5852] [message] [vmtoolsd] [785] Plugin 'powerops' initialized.
[2026-01-04T08:38:33.5852] [message] [vmtoolsd] [785] Plugin 'resolutionCommon' initialized.
[2026-01-04T08:38:33.5852] [message] [vmtoolsd] [785] resolutionCheckForKMS: System support available for resolutionKMS.
[2026-01-04T08:38:33.5852] [message] [vmtoolsd] [785] Plugin 'resolutionMS' initialized.
[2026-01-04T08:38:33.5852] [message] [vmtoolsd] [785] Plugin 'timeSync' initialized.
[2026-01-04T08:38:33.5892] [message] [vmtoolsd] [785] Plugin 'vmbackground' initialized.
[2026-01-04T08:38:33.5892] [message] [vix] [785] ToolsobernmentCtorReceiveVixCommand: command 62.
[2026-01-04T08:38:33.6062] [message] [vix] [785] ToolsobernmentCtorReceiveVixCommand: command 62, additionalError = 17
[2026-01-04T08:38:33.6062] [message] [vmsvc] [785] Executing script for state change 'OS_PowerOn'.
[2026-01-04T08:38:33.6062] [message] [powerops] [785] Executing script: '/etc/vmware-tools/poweron-vm-default'
[2026-01-04T08:38:33.6062] [message] [vmsvc] [785] Script exit code: 0, success = 1
[2026-01-04T09:02:11.6202] [warning] [guestinfo] [785] *** WARNING: GuestInfo collection interval longer than expected; actual=639 sec, expected=30 sec, ***
```

```

angela@ITF587707:~$ sudo apt update
Hit:1 http://security.debian.org/debian-security trixie-security InRelease
Hit:2 http://deb.debian.org/debian trixie InRelease
Hit:3 http://deb.debian.org/debian trixie-updates InRelease
1 package can be upgraded. Run 'apt list --upgradable' to see it.
angela@ITF587707:~$ sudo apt install openssh-server -y
openssh-server is already the newest version (1:10.0p1-7).
openssh-server set to manually installed.
Summary:
  Upgrading: 0, Installing: 0, Removing: 0, Not Upgrading: 1
angela@ITF587707:~$ 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
angela@ITF587707:~$ sudo mkdir -p /srv/images
mkdir: invalid option -- '/'
Try 'mkdir --help' for more information.
angela@ITF587707:~$ sudo mkdir -p /srv/images
angela@ITF587707:~$ sudo chown $USER:$USER /srv/images
angela@ITF587707:~$ 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: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:0c:29:4c:4a:86 brd ff:ff:ff:ff:ff:ff
        altname enp2s1
        altname enx000c294c4a86
        inet 192.168.139.134/24 brd 192.168.139.255 scope global dynamic noprefixroute ens33
            valid_lft 1136sec preferred_lft 911sec
        inet6 fe80::df0c:e019:fb37:6fa5/64 scope link
            valid_lft forever preferred_lft forever
angela@ITF587707:~$ _

```

Figure 14. prepare the debian 13 image server

```

angela@angelaitfundamentals587707:~$ ssh angela@192.168.139.134
The authenticity of host '192.168.139.134 (192.168.139.134)' can't be established.
ED25519 key fingerprint is SHA256:aDrrijgyNWXXetJdRNsZc7h2s+LSQ+KG6avoKOWLnDc.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.139.134' (ED25519) to the list of known hosts.
angela@192.168.139.134's password:
Linux ITF587707 6.12.57+deb13-amd64 #1 SMP PREEMPT_DYNAMIC Debian 6.12.57-1 (2025-11-05) x86_64

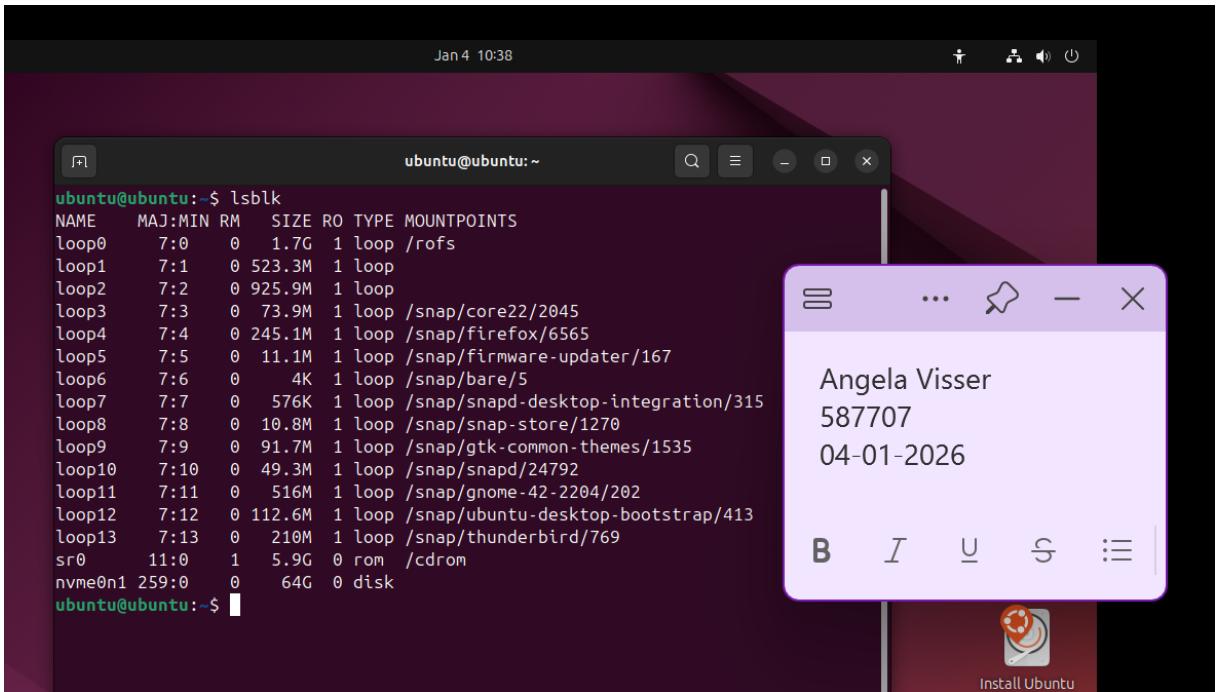
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
angela@ITF587707:~$ 

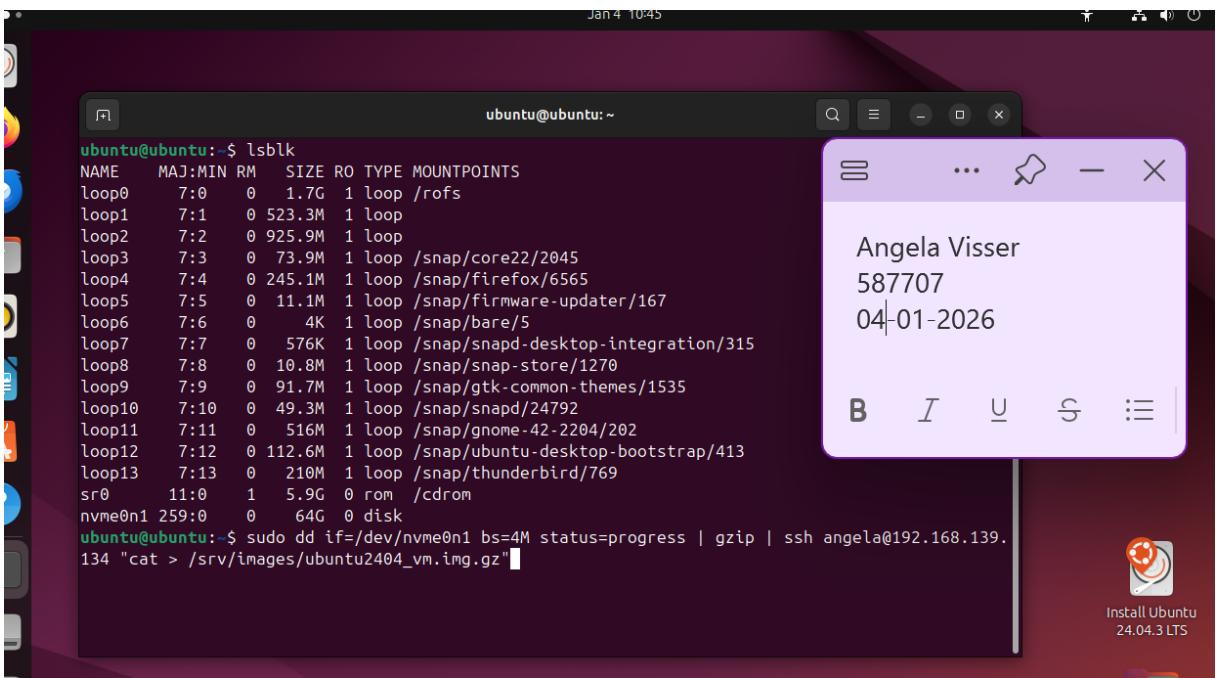
```

Figure 15. connectivity test

- ubuntu Disk capture



- Image storage



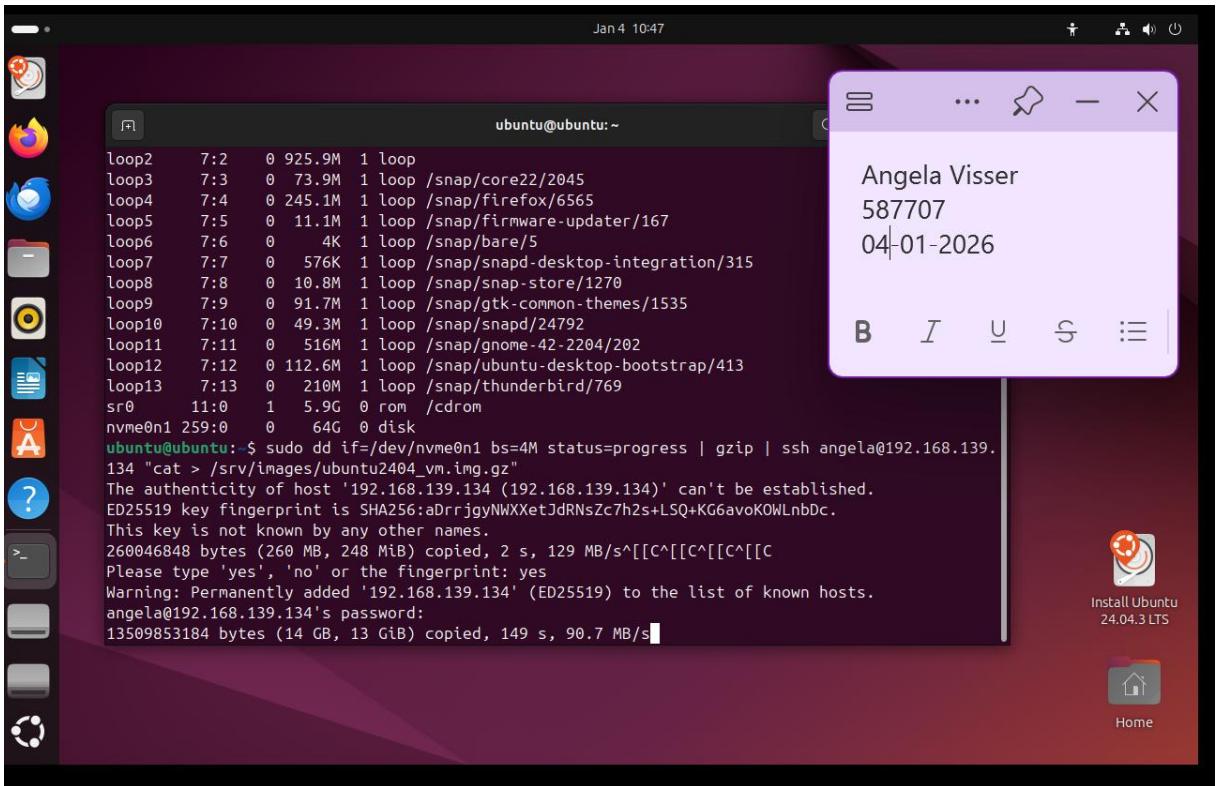


Figure 16. copying in process

- Restore process

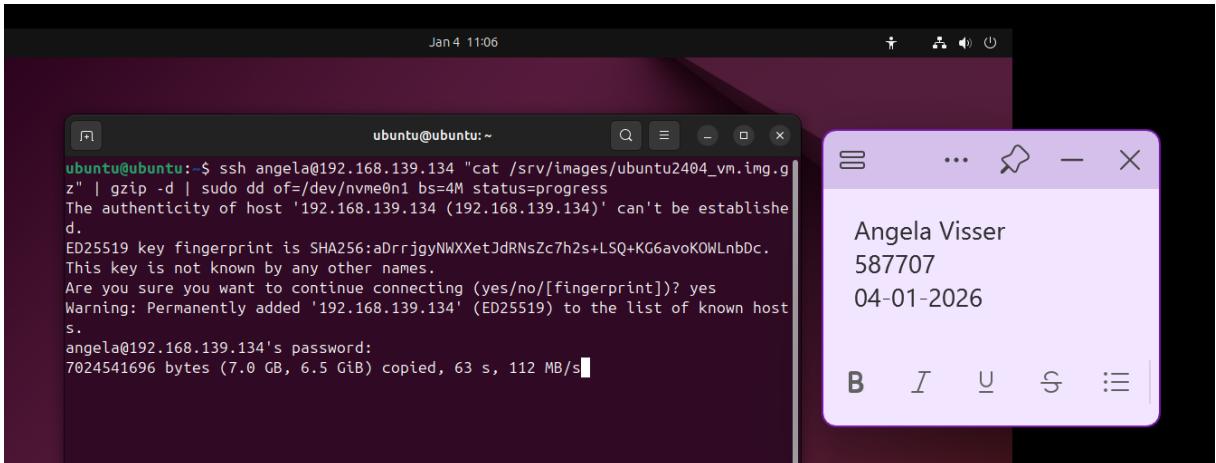


Figure 17. restoring by copying in progress

- Proof that the Debian 13 server stored a back-up image of the Ubuntu 24.04 Desktop VM.

```

angela@ITF587707:~$ sudo apt update
Hit:1 http://security.debian.org/debian-security trixie-security InRelease
Hit:2 http://deb.debian.org/debian trixie InRelease
Hit:3 http://deb.debian.org/debian-trixie-updates InRelease
1 package can be upgraded. Run 'apt list --upgradable' to see it.
angela@ITF587707:~$ sudo apt install openssh-server -y
openssh-server is already the newest version (1:10.0p1-7).
openssh-server set to manually installed.
Summary:
  Upgrading: 0, Installing: 0, Removing: 0, Not Upgrading: 1
angela@ITF587707:~$ 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
angela@ITF587707:~$ sudo mkdir -p /srv/images
mkdir: invalid option -- '-'
Try 'mkdir --help' for more information.
angela@ITF587707:~$ sudo chmod $USER:$USER /srv/images
angela@ITF587707:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback brd 00:00:00:00:00:00
    inet 127.0.0.1/8 brd 00:00:00:00:00:00 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 brd 00:00:00:00:00:00 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:29:4c:4a:b6 brd ff:ff:ff:ff:ff:ff
    altname enp2s1
    altname enp0s1
    inet 192.168.139.134/24 brd 192.168.139.255 scope global dynamic noprefixroute ens3
        valid_lft 1136sec preferred_lft 911sec
    inet6 fe80::0c29:4c4a:9b:b6ff/64 scope link
        valid_lft forever preferred_lft forever
angela@ITF587707:~$ cd /srv/images
angela@ITF587707:/srv/images$ ls
ubuntu2404.vmdk.gz
angela@ITF587707:/srv/images$ 

```

- Proof that you can restore the back-up image into an empty VM.
This was discussed with the teacher.

Ready? Save this file and export it as a pdf file with the name: [week5.pdf](#)