

BINF2111 - Introduction to Bioinformatics

Computing

UNIX 101



**Richard Allen White III, PhD
RAW Lab**

Lecture 2 - Thursday Aug 21st, 2025

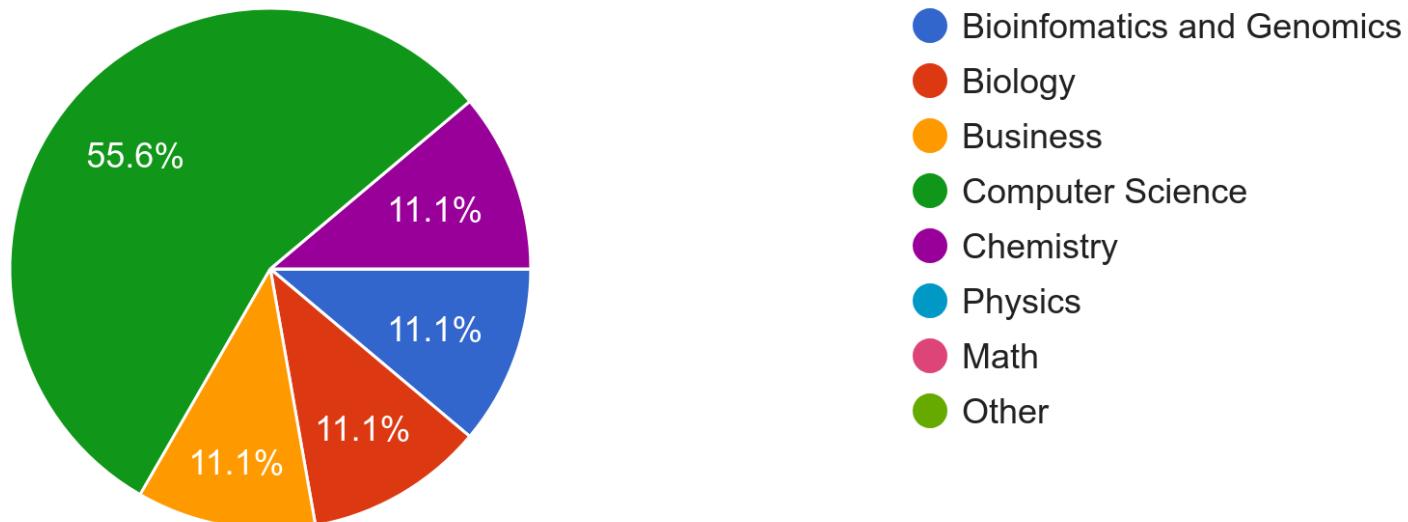
Learning Objectives

- History of Unix
- Memory over time
- Linux vs. Unix vs. Windows
- Introduction to command line (In class demos)
- Quiz 2

What is your major department ? (2021)

Which department?

9 responses

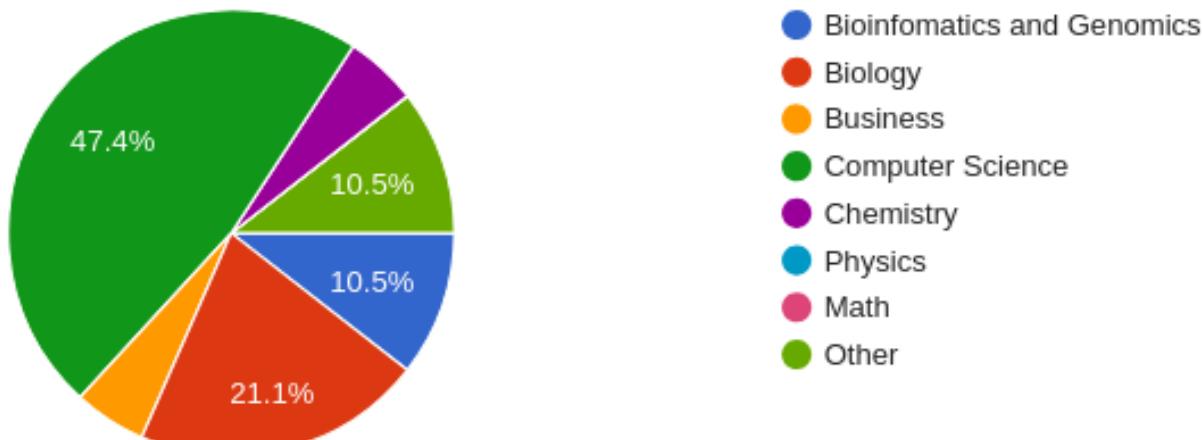


What is your major department ? (2025)

Which department?

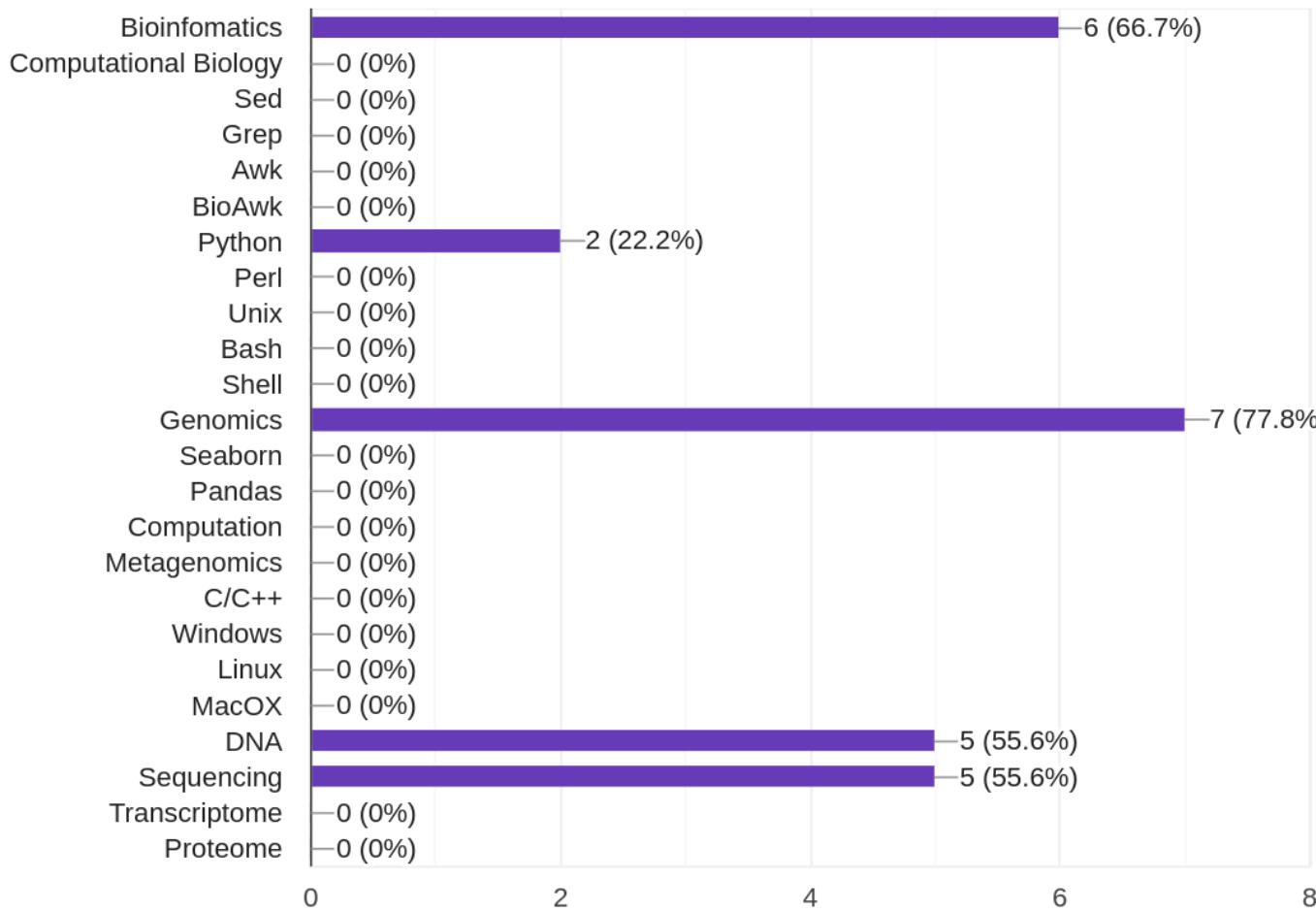
 Copy chart

19 responses



Introduction - Term Experiment (2021)

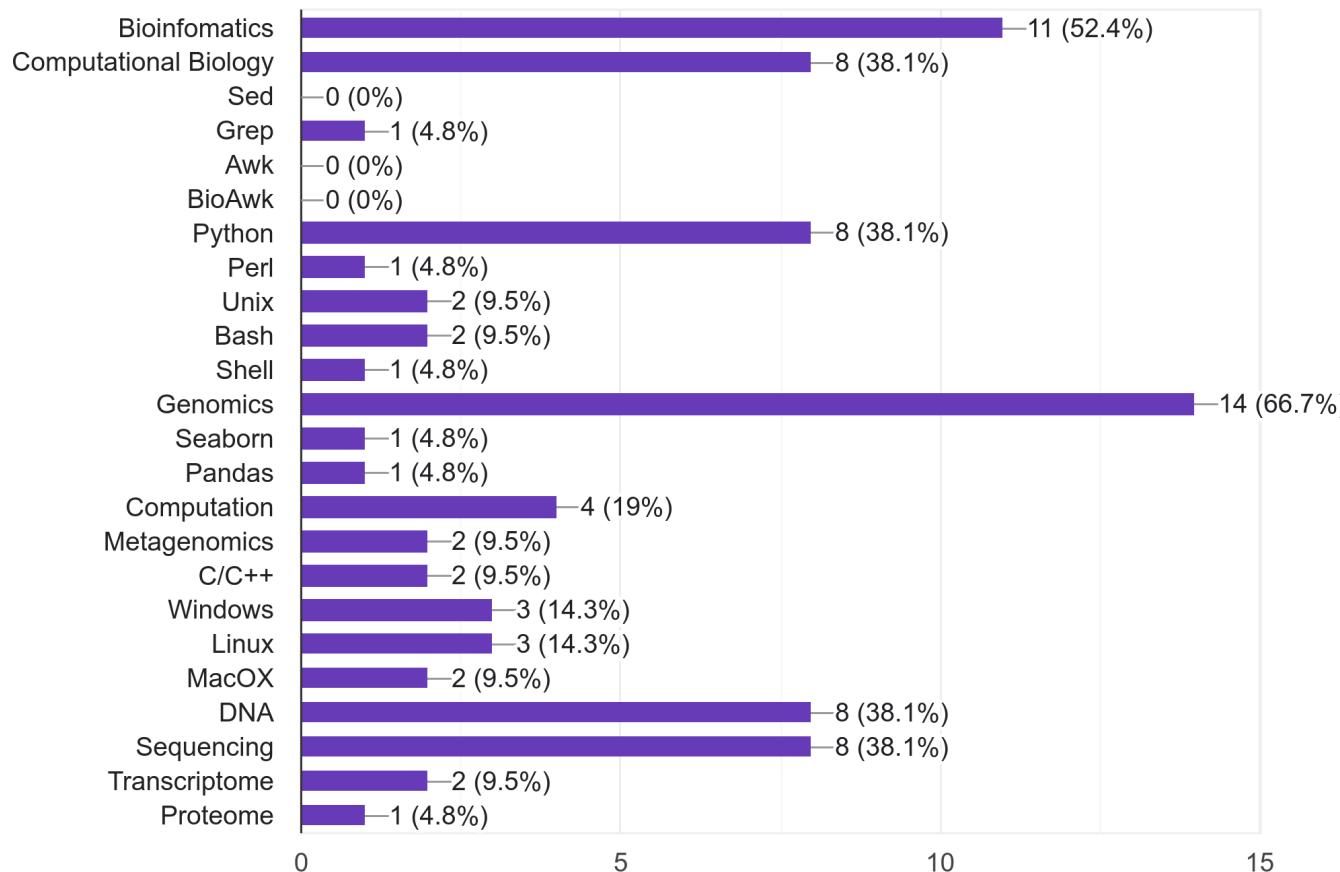
9 responses



Introduction - Term Experiment (2022)

Terms in bioinfomatics (pick 3)

21 responses

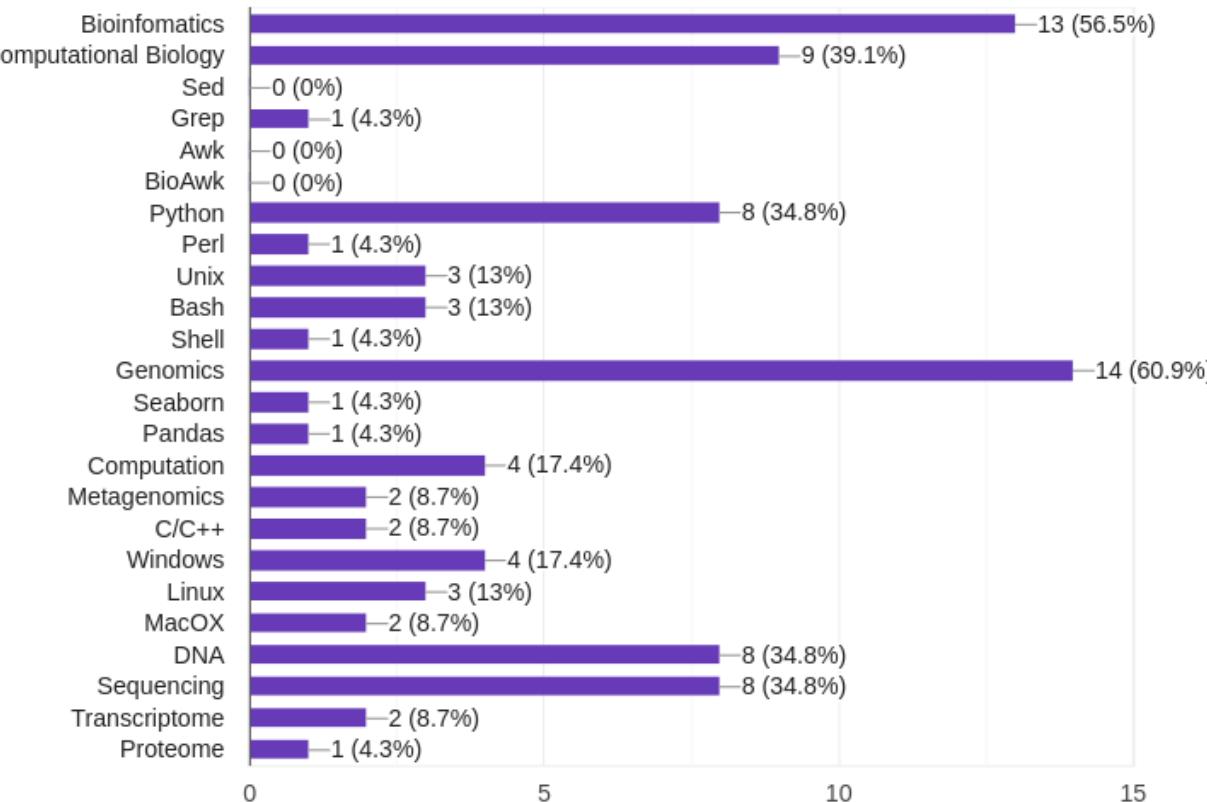


Introduction - Term Experiment (2025)

Terms in bioinfomatics (pick 3)

23 responses

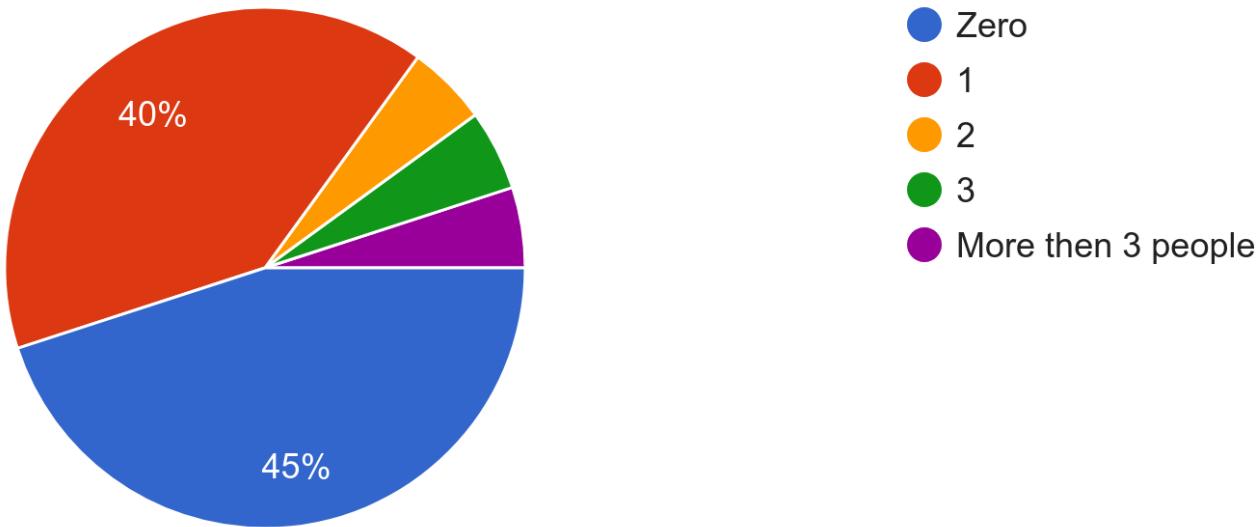
 Copy chart



Introduction – How many? 2022

How many people in the class do you know?

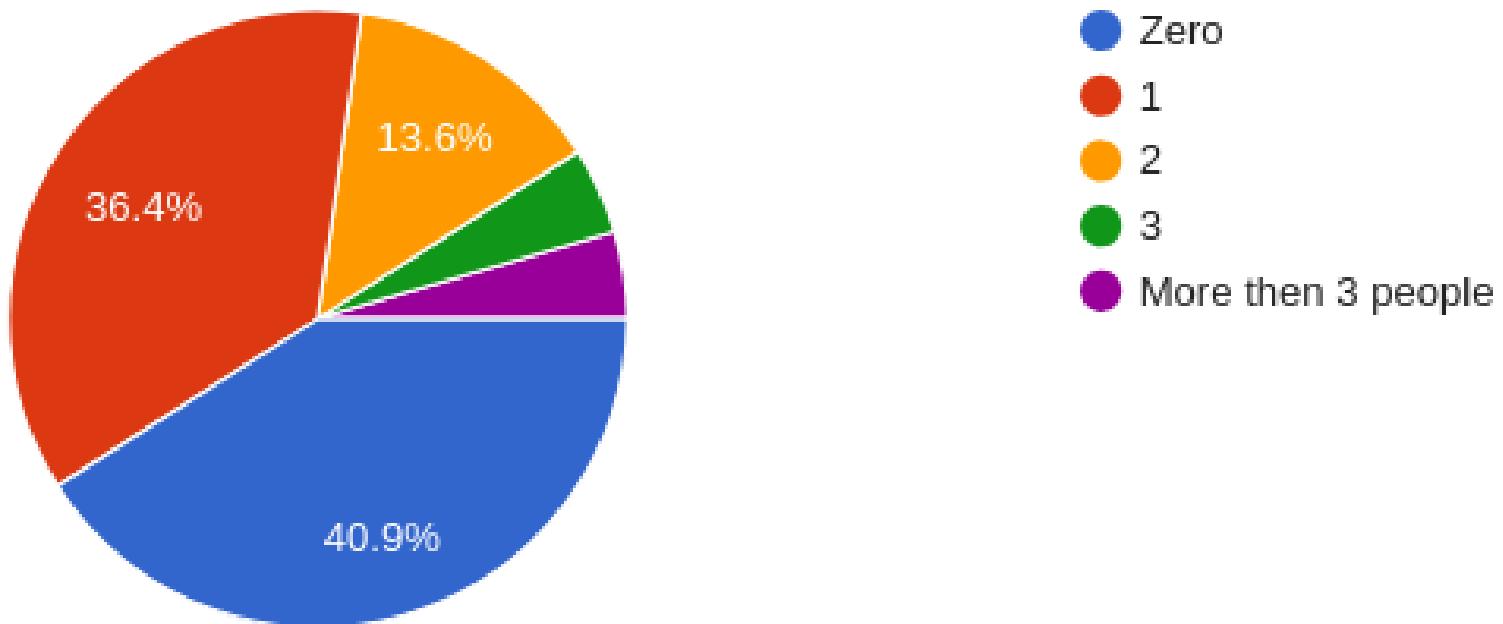
20 responses



Introduction – How many? 2025

How many people in the class do you know?

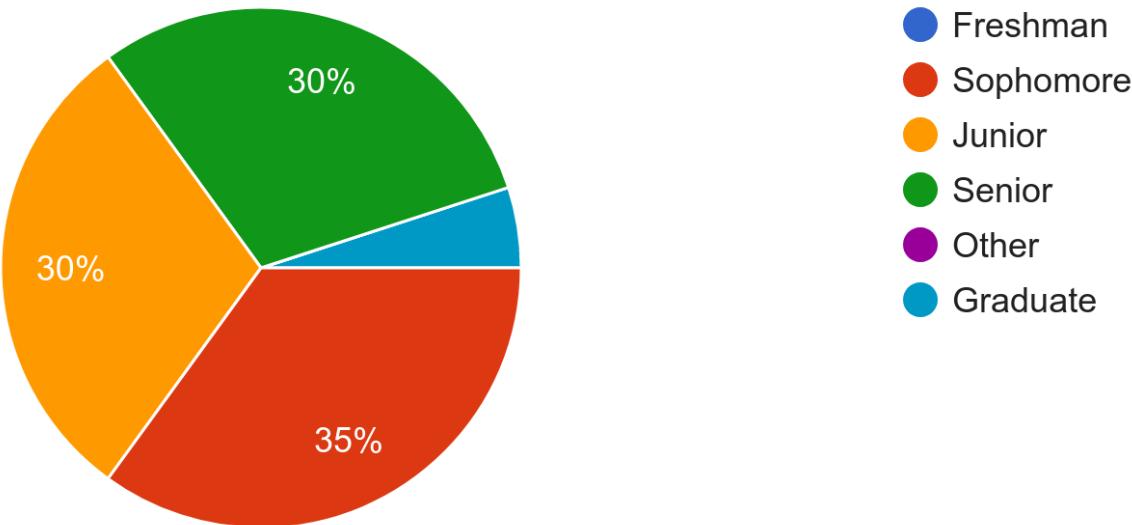
22 responses



Introduction – What year? 2022

Select one option

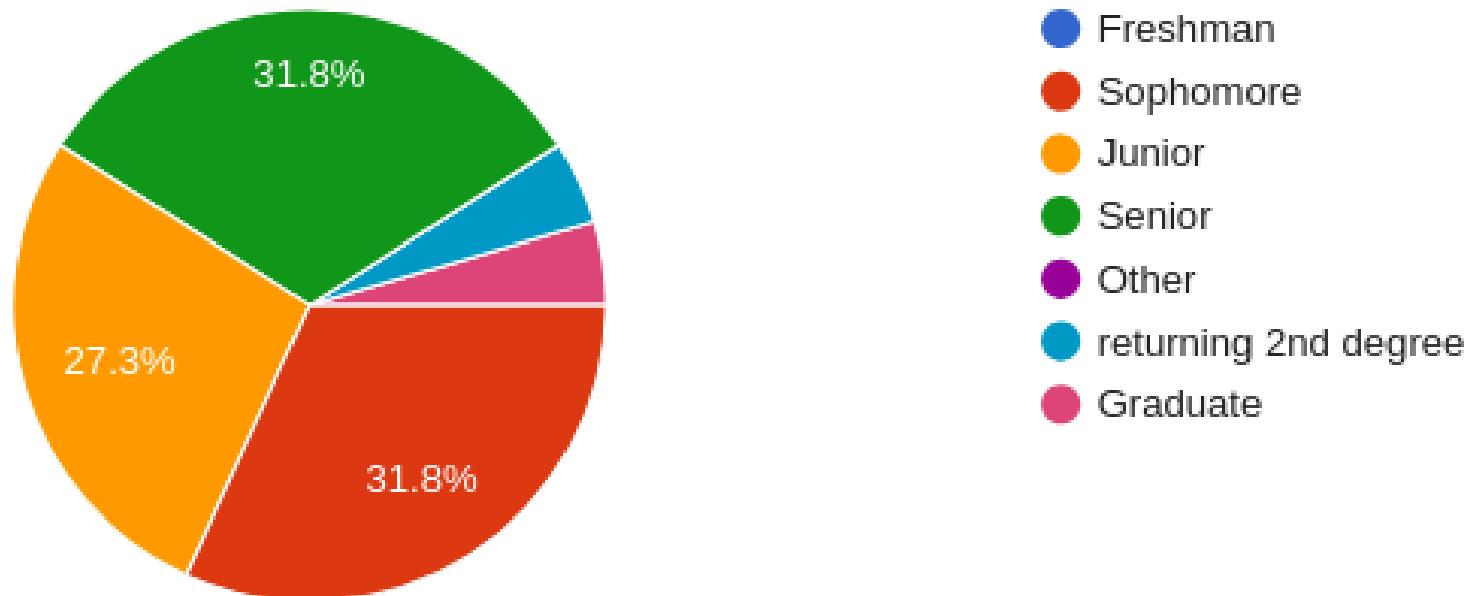
20 responses



Introduction – What year? 2025

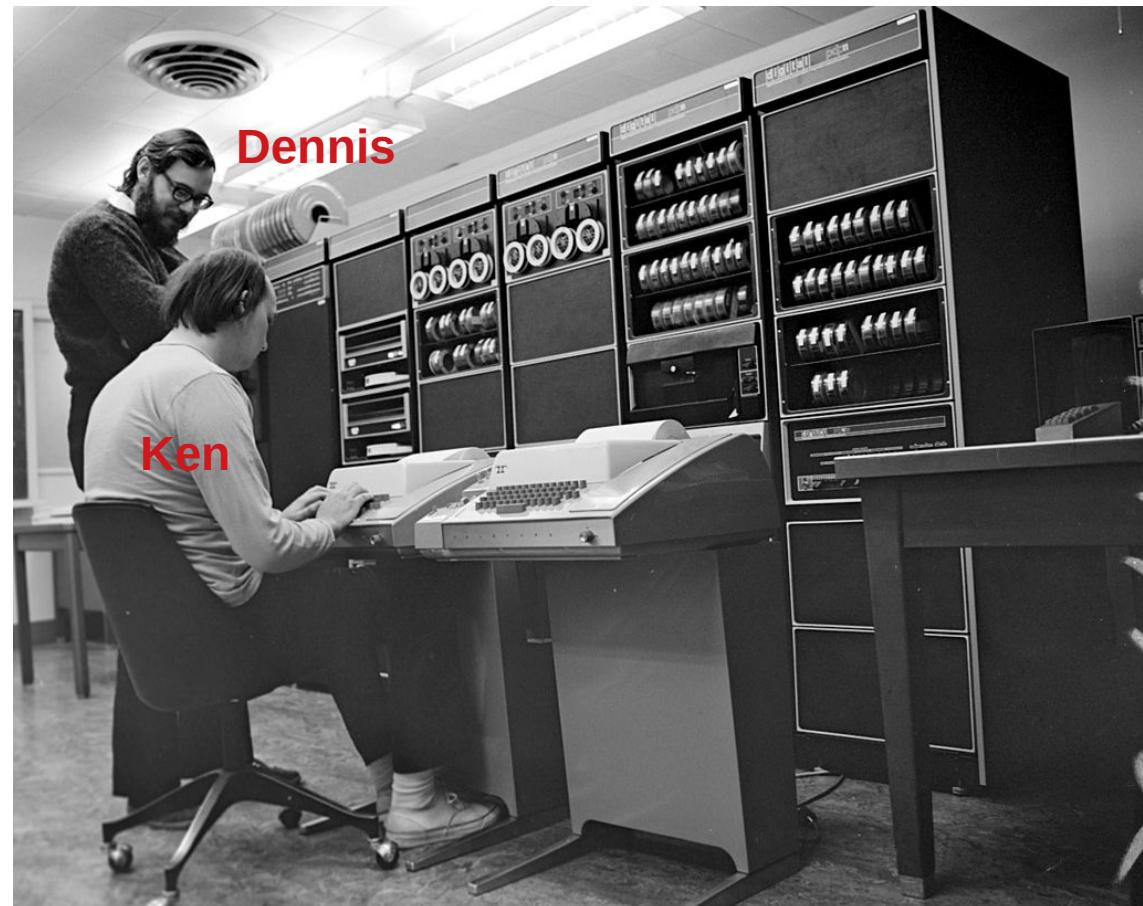
Select one option

22 responses



UNIX – History Part I

- Ken Thompson, Dennis Ritchie, Douglas McIlroy, and Joe Ossanna in the 1970s at Bell Labs (part of AT&T)
- UNIX is not an acronym; it is a pun on "Multics" (Multiplexed Information and Computing Service) was a mainframe timesharing operating system that began at MIT as a research project in 1965.
- Originally written in assembly language, but in 1973, Version 4 Unix was rewritten in C
- C and UNIX both written at Bell Labs (AT&T)



UNIX history Part II

- UNIX or UNIX-like (Linux) have been the standard for mathematical and scientific calculations based operating systems since the 1970s.
- The UNIX variant found in MacOS was a Berkeley Software Division (BSD) style UNIX.
- Today, it uses the Darwin version of UNIX. It was a grafting of an advance version Mach onto to BSD with some additional add-on from the Apple windowing system.
- PDR-7 minicomputer ('mini') in 1964
\$72,000 USD in 1964 (\$606,930 today)
4k words (9 kb mem) up to 144 kb
Weighted 1,100 lb (500 kg)





\$35,000 - 1956
Weighted over
1 Ton

5 MB hard disk drive - 1956

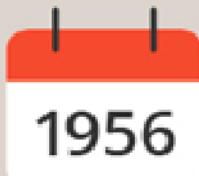


\$35,000 - 1956

\$349,608 - 2021

5 MB hard disk drive - 1956

1950s



Year Released

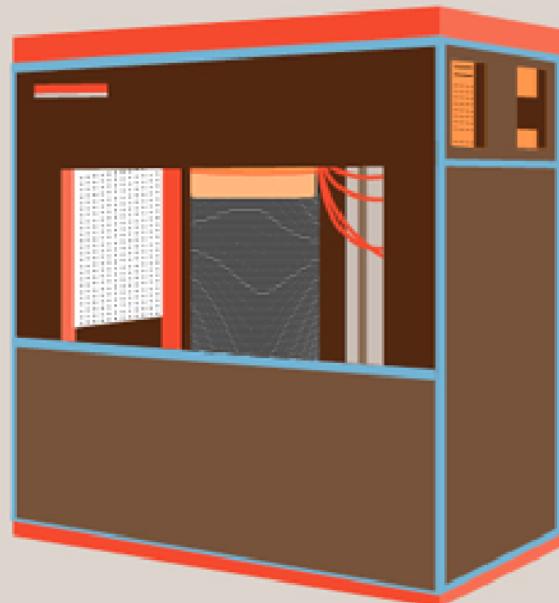


Capacity

200,000
IBM 350 RAMAC Disk Files
would have been required
to store

1TB
of data in
1956

Space
equivalent
to 3,151
soccer fields!



**IBM 350 RAMAC
Disk File**



A typical 3-minute
song takes up
approximately
5MB of storage
space



\$35,000
year to lease



The 1st disk
drive introduced
by IBM, and was
the size of a
large wardrobe



Consisted of 50,
24-inch discs
with a total
capacity of 5MB

1980s

1980

Year Released



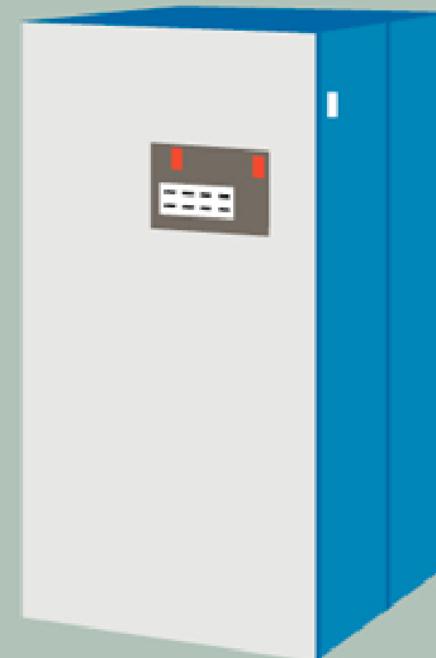
Capacity

397

DASDs
would have been required
to store

1TB
of data in
1980

To store 1 Terabyte of data,
you would need only 397
DASDs each the size of a
250 kg refrigerator, totalling
a whooping 109 tons!



With the introduction
of a new film head
technology, it stored
up to 2.52GB, almost
four times the
amount of previous
IBM storage devices

The World's first
gigabyte Hard
Drive was the size
of an average
refrigerator

\$2,170
per month



\$81,000

550
Pounds
(250 kg)

Weight

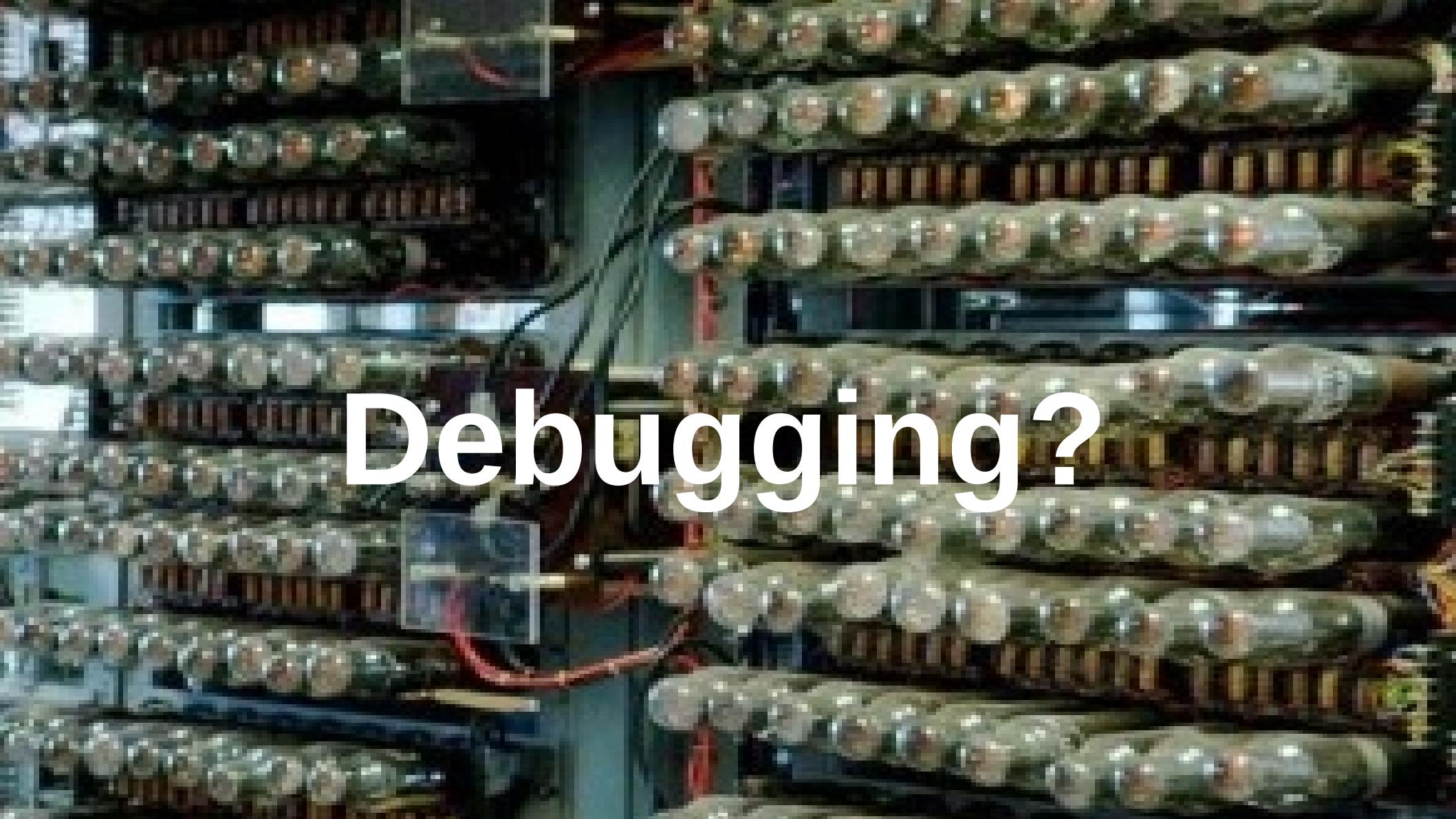
14"
Disk

IBM 3380 Direct Access Storage Device (DASD)

\$465 - 2021



1 TB micro SD card - 2020

A close-up photograph of a complex printed circuit board (PCB). The board is densely populated with numerous small, square components, likely surface-mount resistors or capacitors. A network of blue, red, and black wires connects the components across the board's layers. The overall texture is intricate and metallic.

Debugging?

Debugging?

92

9/9

0800 Actan started
1000 " stopped - actan ✓
13' ec (033) MP - ME { 1.2700 9.037 847 025
033 PRO 2 2.130476415 9.037 846 995 concub
couch 2.130676315
Relays 6-2 in 033 failed special sped test
in relay " 10.00 test.

1100 Started Cosine Tape (Sine check)
1525 Started Multi Adder Test.

1545 Relay #70 Panel F
(Moth) in relay.

1600 Actan started.
1700 closed down.

Relay 2145
Relay 3370



UNIX Architecture

- **Kernel: Heart of the OS**

- Interacts with hardware
- Memory management, task scheduling and file management

- **Shell: Utility to process requests**

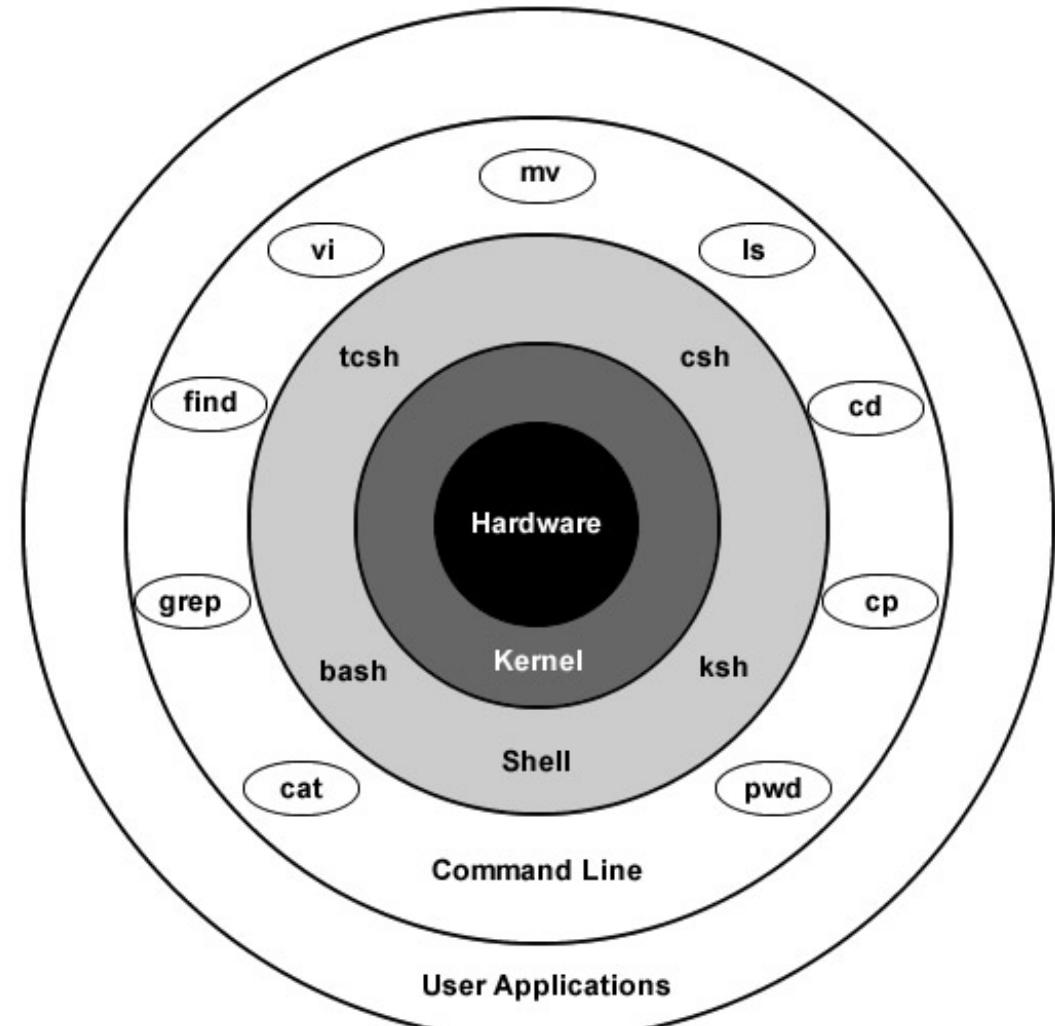
- Shell interprets the command and calls the program

- **Commands (Command line) and Utilities**

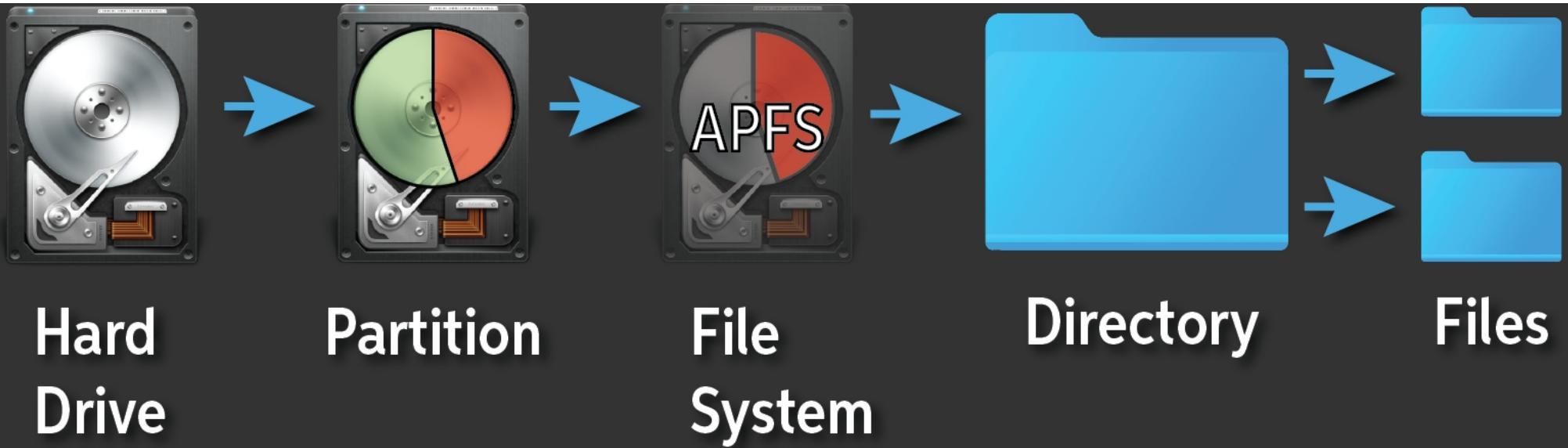
- e.g: cp, mv, cd, cat, grep

- **Files and directories**

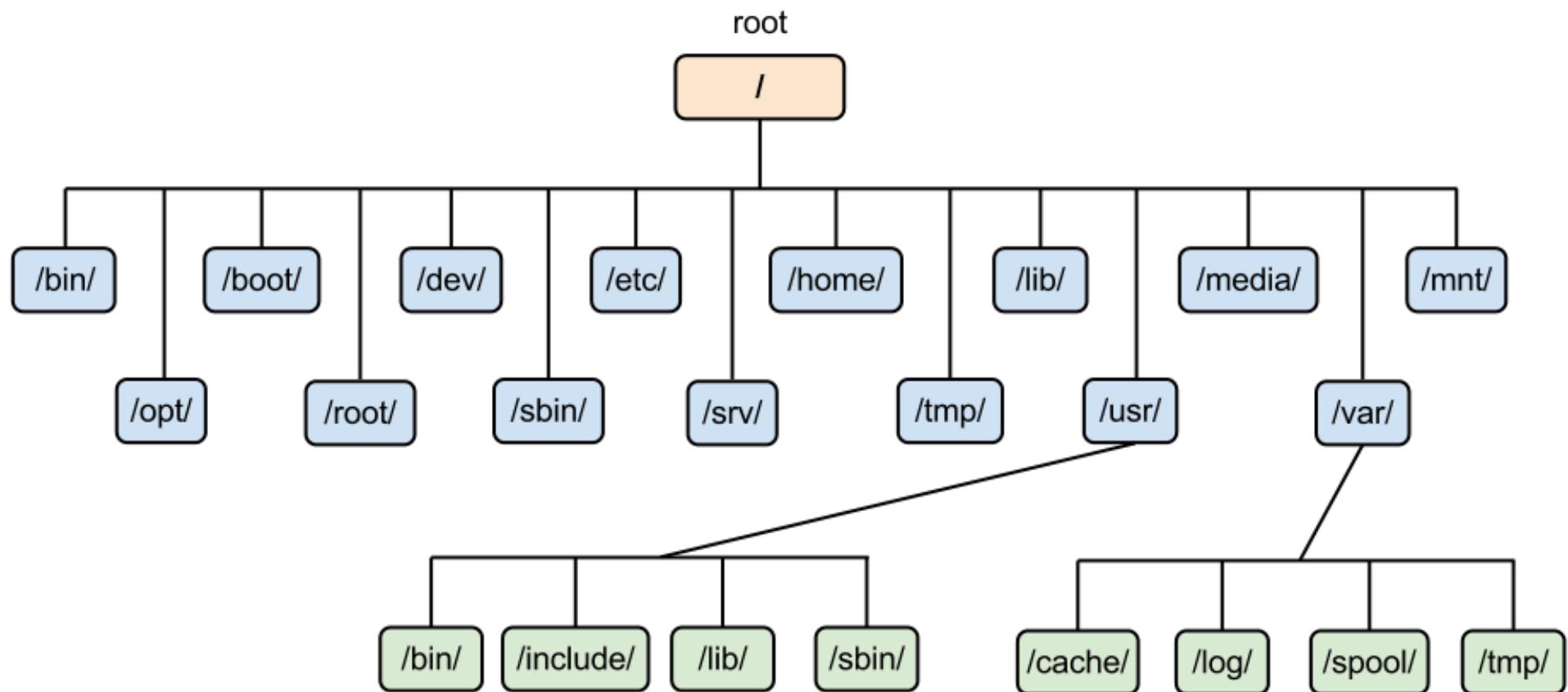
- All data is in files
- All files are in directories
- All directories are in filesystem (tree)



UNIX Architecture (filesystem workflow)



UNIX Architecture (filesystem management)



LINUX vs. UNIX

PARAMETER	LINUX	UNIX
Inception Year	1991	1969
Standard	Open source operating system which is freely available	Operating system can only be used by its copywriters
System type	Just the kernel	Complete Operating system
Target use	Can be used by anyone including home user and developer.	Developed mainly for servers, workstations and mainframes.
Cost	LINUX is freely available and distributed with no associated cost.	UNIX variants come as customized cost.
Security	60-100 viruses listed till date	85-120 viruses listed till date
Interface type	Primarily uses GUI with option of CLI	Primarily uses CLI
Portability	Portable	Not portable
Variants	Ubuntu, RedHat, Solaris, OpenSuse, etc.	AIX, HP-UX, BSD, etc
Source Code	The source code of Linux is available in general public.	The source code not available in general public.

LINUX vs. Windows

	Linux	Windows
Inception Year	1991	1985
Developer	Linus Torvalds	Microsoft
Cost	0	\$150-300
Source	Open	Closed
Hardware cost	low	high
Security	Secure	Insecure
Webserver share	70%	23%
Viruses	60-100	60000
Customizable	Yes	No

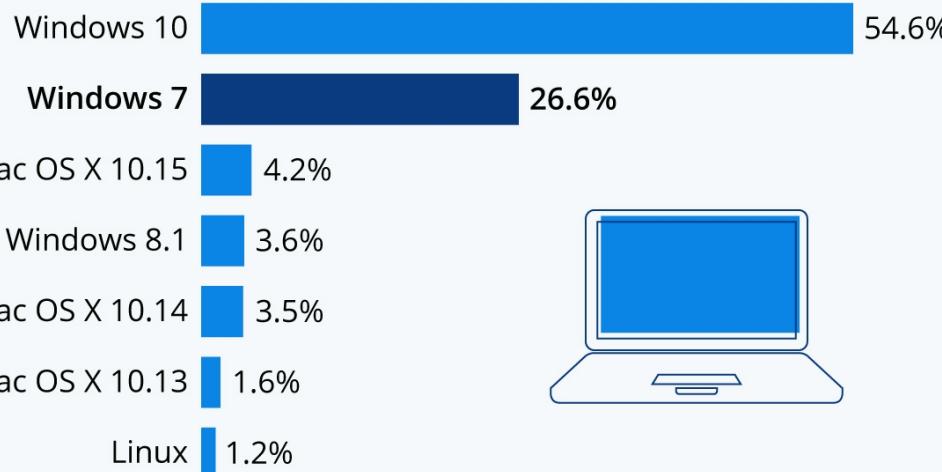
LINUX vs. Windows

Windows file/system structure	Linux File/System Structure
C:\ (main disk)	/ ("root" - system administrator)
C:\Windows (Windows installation directory)	/bin /usr/bin /sbin (programs)
C:\Program Files (software installed)	/etc (configuration files)
C:\Users (user files)	/root (administrative user only directory)
Control Panel -> Device Manager	/dev /proc (devices on <u>system</u>)
Limited functionality in cmd	/home (user files)
Software installed by .exe or .msi	/opt (optional program installation directory)
External drives mounted to drive letter	Fully-capable terminal
All system software integrated*	Software installed from <u>repository</u> (similar to Google Play Store or Apple App Store)
All source code is exclusive to Microsoft	External drives mounted as <u>directory</u>
User permissions only include Administrator and User	System and software installed as modules*
	Source code is <u>freely distributed</u> online
	Users can be assigned to multiple groups to decide permissions
	<u>Root</u> can limit the <u>permissions</u> that <u>adm</u> (administrative) group members are granted as well

LINUX vs. Windows

A Quarter of Computers Still Run on Windows 7

Market share of most common desktop operating systems worldwide in December 2019

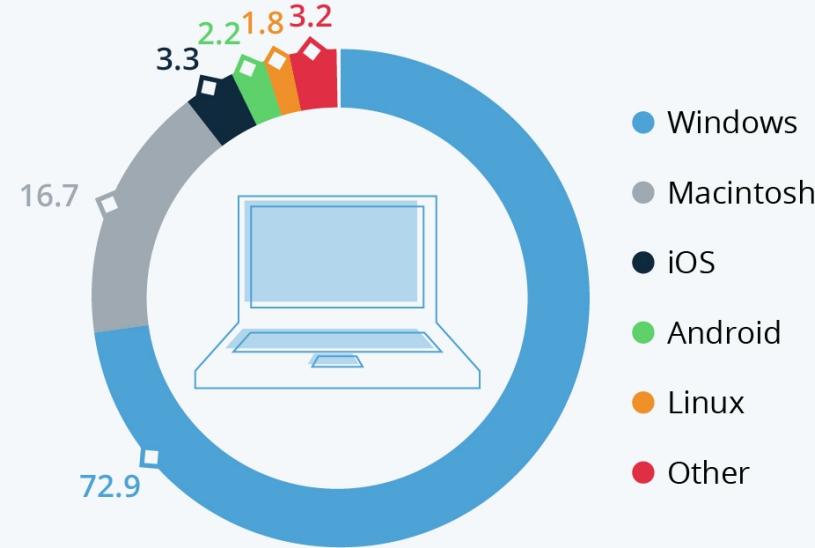


Source: Net Market Share



Microsoft's Windows Still Synonymous with Computer

Market share of the top computer operating systems worldwide as of February 2020



* Chart may not add up to exactly 100 due to rounding
Source: StatCounter



Command line introduction

- If you don't have a command terminal for your windows computer
 - Check files on Canvas (Windows-Install-linux.pdf)
 - Or the github page for the course (course materials)
<https://github.com/raw-lab/BINF2111/tree/main/course-materials>
- MacOS or Linux find your terminal

Command line (command anatomy)

```
$ ls -thor /home
```

ls (command or utility or program)

- t -h -o -r (options, or flags, controls the flavors of the command)

/home (argument – what is been operated on



about



theme ▾

write down a command-line to see the help text that matches each argument
try [showthedocs](#) for explaining other languages

EXPLAIN

examples

- :(){ :|:& };;
- for user in \$(cut -f1 -d: /etc/passwd); do crontab -u \$user -l 2>/dev/null; done
- file=\$(echo `basename "\$file"`)
- true && { echo success; } || { echo failed; }
- cut -d ' ' -f 1 /var/log/apache2/access_logs | uniq -c | sort -n
- tar zcf - some-dir | ssh some-server "cd /; tar xvzf -"
- tar xzvf archive.tar.gz
- find . -type f -print0
- ssh -i keyfile -f -N -L 1234:www.google.com:80 host
- git log --graph --abbrev-commit --pretty=oneline origin..mybranch

explainshell.com

about 

ls -thor



theme ▾

▼ ls(1) -thor

list directory contents

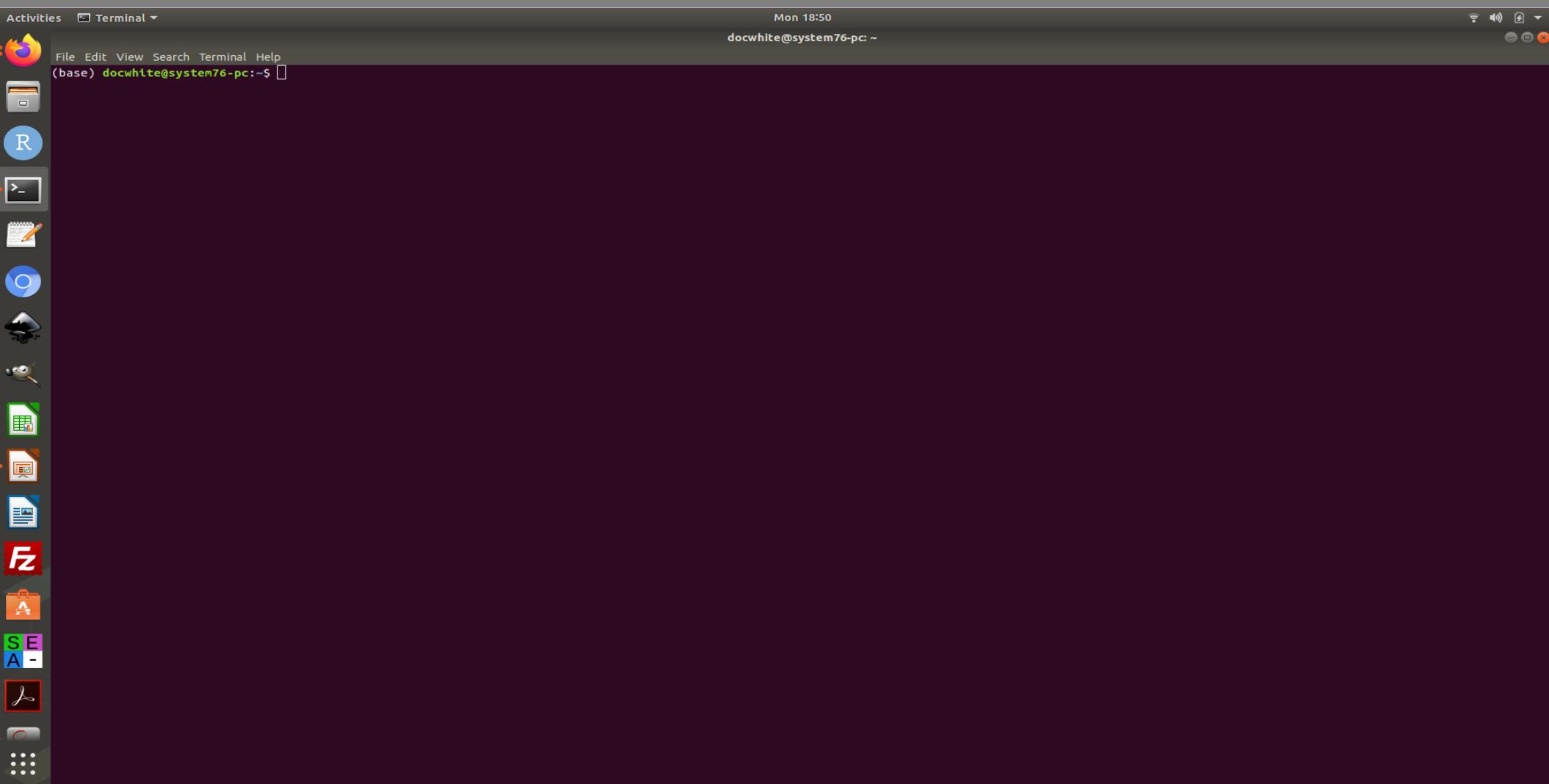
-t sort by modification time, newest first

-h, --human-readable
with **-l**, print sizes in human readable format (e.g., 1K 234M 2G)

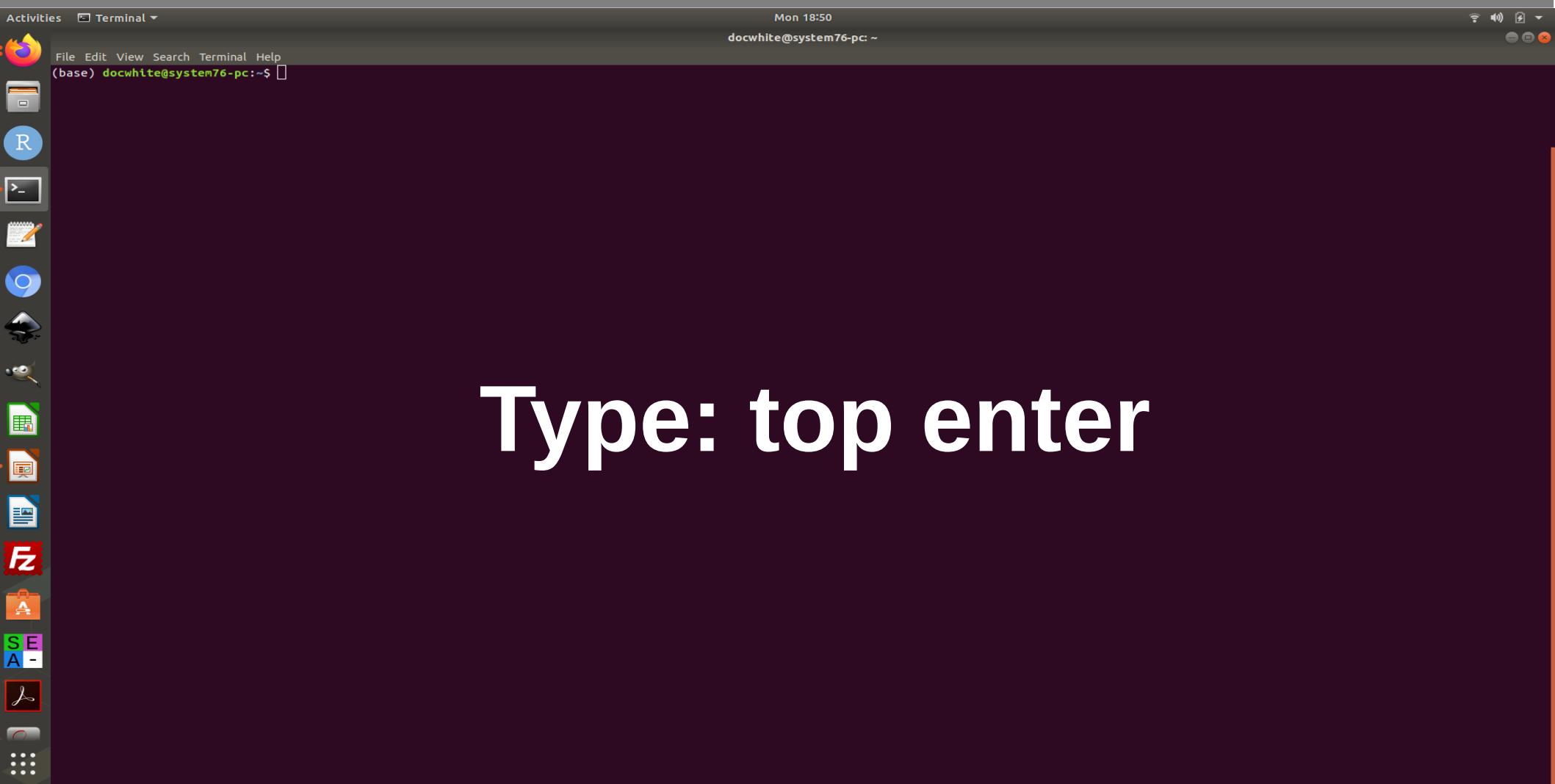
-o like **-l**, but do not list group information

-r, --reverse
reverse order while sorting

Command line introduction



Command line introduction



Type: top enter

Command line introduction

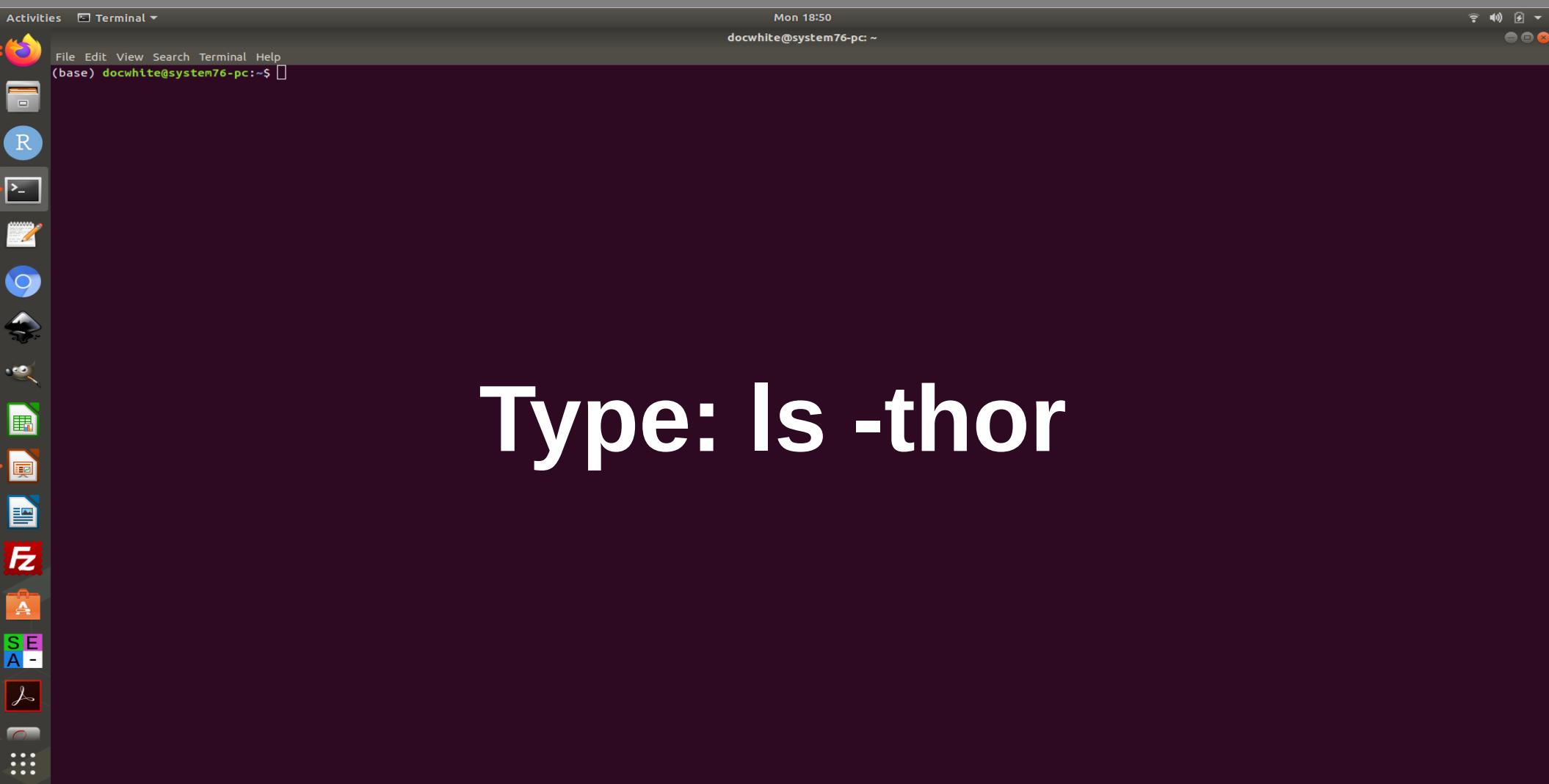
Activities Terminal Mon 18:50 docwhite@system76-pc: ~

```
File Edit View Search Terminal Help
top - 18:50:47 up 9:48, 1 user, load average: 0.27, 0.57, 0.66
Tasks: 342 total, 1 running, 277 sleeping, 0 stopped, 0 zombie
%Cpu(s): 4.7 us, 1.3 sy, 0.0 ni, 93.4 id, 0.1 wa, 0.0 hi, 0.5 si, 0.0 st
KiB Mem : 32836672 total, 21843932 free, 5678136 used, 5314604 buff/cache
KiB Swap: 4194300 total, 4194300 free, 0 used. 26143932 avail Mem
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
28503	docwhite	20	0	43048	4304	3436	R	18.8	0.0	0:00.04	top
1837	docwhite	9	-11	3248672	19612	14952	S	6.2	0.1	16:48.29	pulseaudio
2962	docwhite	20	0	3566188	435896	155748	S	6.2	1.3	15:56.17	Web Content
1	root	20	0	226328	10200	6860	S	0.0	0.0	0:31.16	systemd
2	root	20	0	0	0	0	S	0.0	0.0	0:00.02	kthreadd
3	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	rcu_gp
4	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	rcu_par_gp
9	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	mm_percpu_wq
10	root	20	0	0	0	0	S	0.0	0.0	0:00.46	ksoftirqd/0
11	root	20	0	0	0	0	I	0.0	0.0	0:11.36	rcu_sched
12	root	rt	0	0	0	0	S	0.0	0.0	0:00.13	migration/0
13	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/0
14	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/0
15	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/1
16	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/1
17	root	rt	0	0	0	0	S	0.0	0.0	0:00.34	migration/1
18	root	20	0	0	0	0	S	0.0	0.0	0:00.21	softirq/0/1
20	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/0:0H-kb
21	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/2
22	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/2
23	root	rt	0	0	0	0	S	0.0	0.0	0:00.32	migration/2
24	root	20	0	0	0	0	S	0.0	0.0	0:00.07	ksoftirqd/2
26	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/2:0H-kb
27	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/3
28	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/3
29	root	rt	0	0	0	0	S	0.0	0.0	0:00.35	migration/3
30	root	20	0	0	0	0	S	0.0	0.0	0:00.03	ksoftirqd/3
32	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/3:0H-kb
33	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/4
34	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/4
35	root	rt	0	0	0	0	S	0.0	0.0	0:00.35	migration/4
36	root	20	0	0	0	0	S	0.0	0.0	0:00.09	ksoftirqd/4
38	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/4:0H-kb
39	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/5
40	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/5
41	root	rt	0	0	0	0	S	0.0	0.0	0:00.34	migration/5
42	root	20	0	0	0	0	S	0.0	0.0	0:00.05	ksoftirqd/5
44	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/5:0H-kb
45	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/6
46	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/6
47	root	rt	0	0	0	0	S	0.0	0.0	0:00.37	migration/6
48	root	20	0	0	0	0	S	0.0	0.0	0:00.03	ksoftirqd/6
50	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/6:0H-kb
51	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cphup/7
52	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_inject/7
53	root	rt	0	0	0	0	S	0.0	0.0	0:00.34	migration/7
54	root	20	0	0	0	0	S	0.0	0.0	0:00.04	ksoftirqd/7
56	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/7:0H-kb

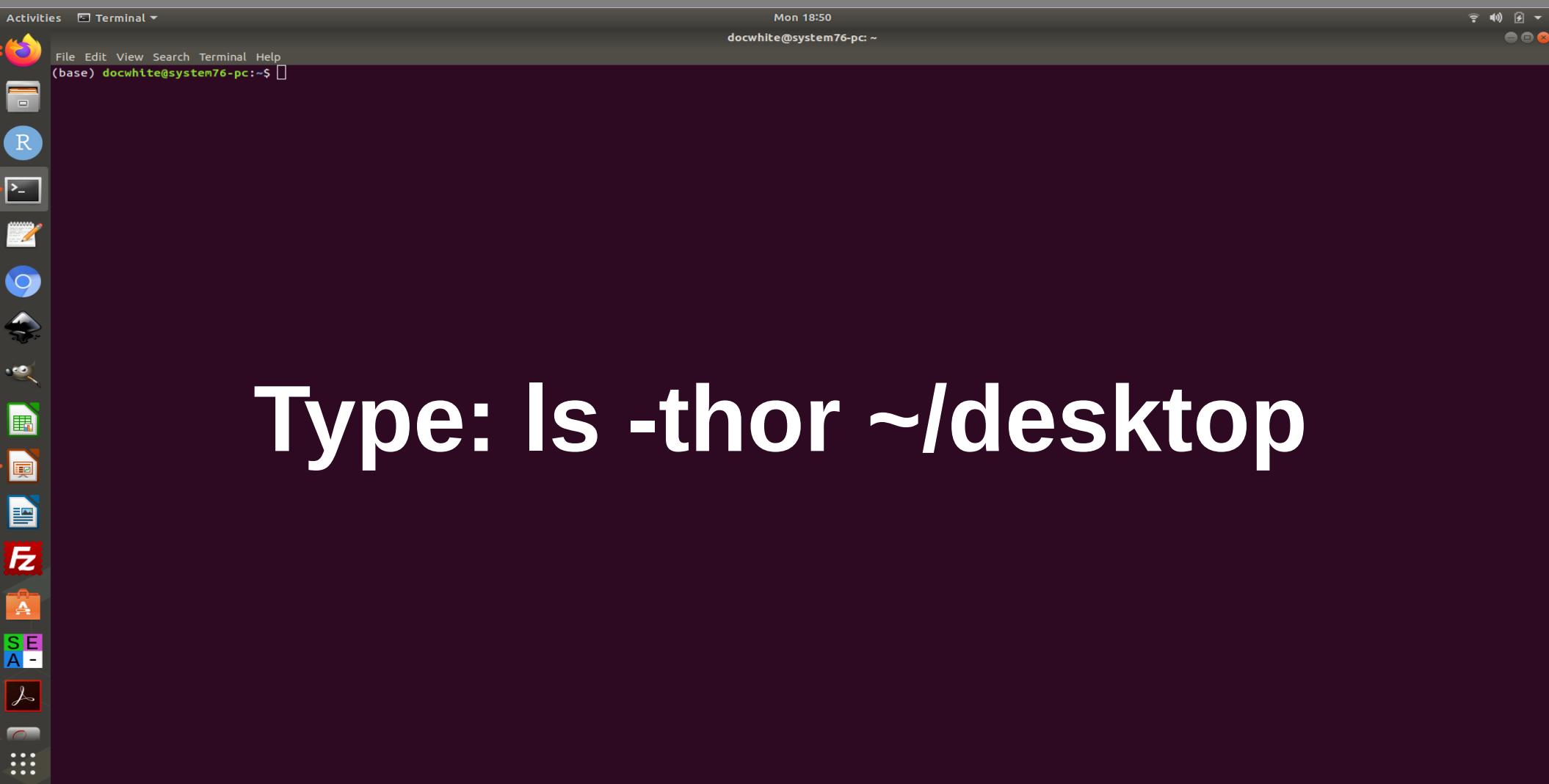
Type - ctrl c (exit)

Command line introduction



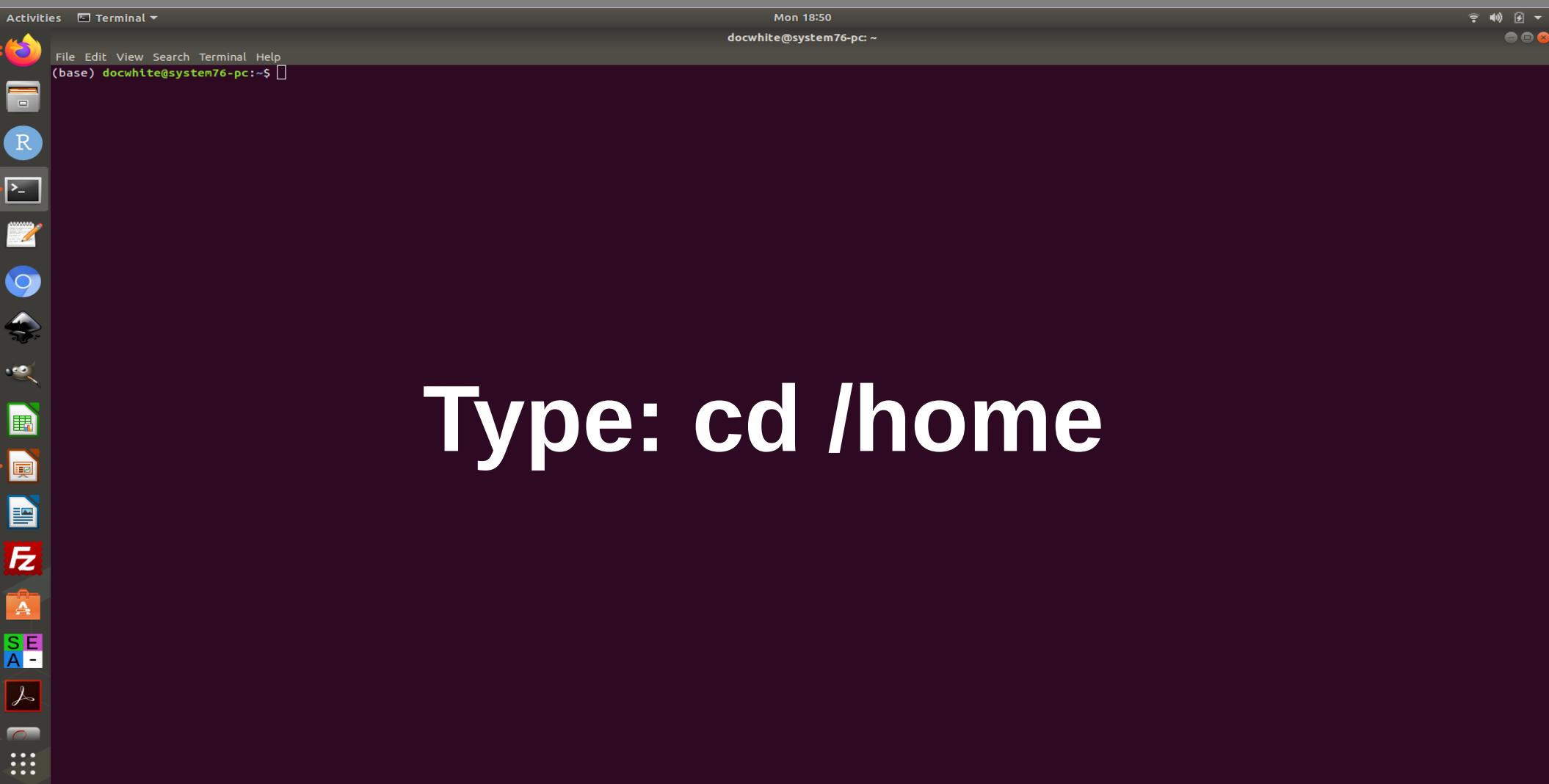
Type: ls -thor

Command line introduction



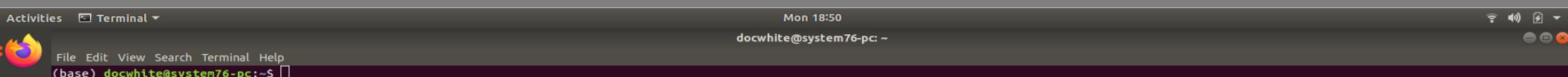
Type: ls -thor ~ /desktop

Command line introduction



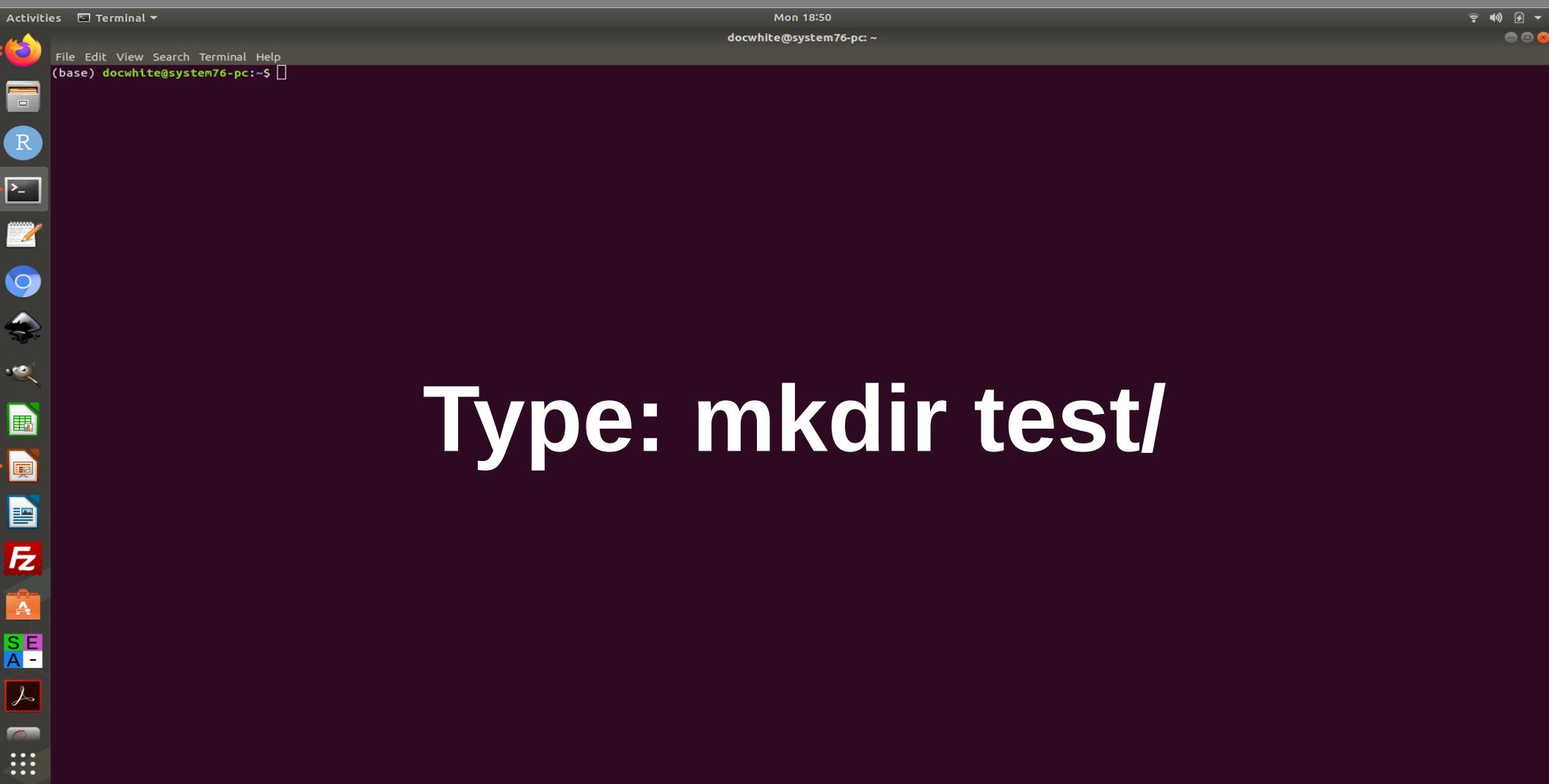
Type: cd /home

Command line introduction



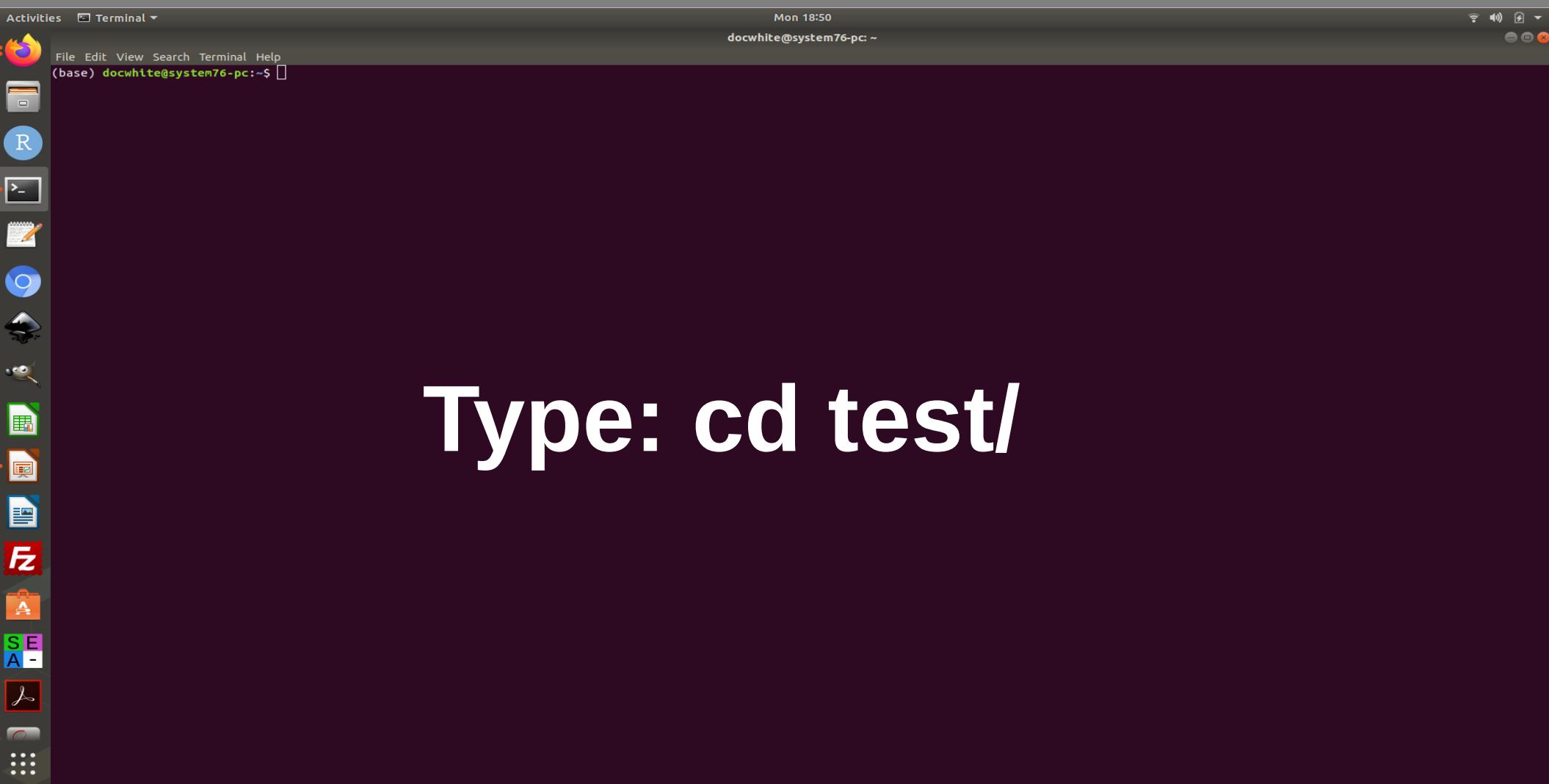
Type: cd

Command line introduction



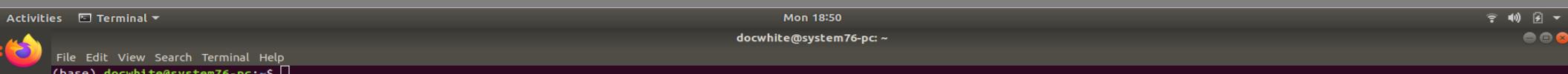
Type: **mkdir test/**

Command line introduction



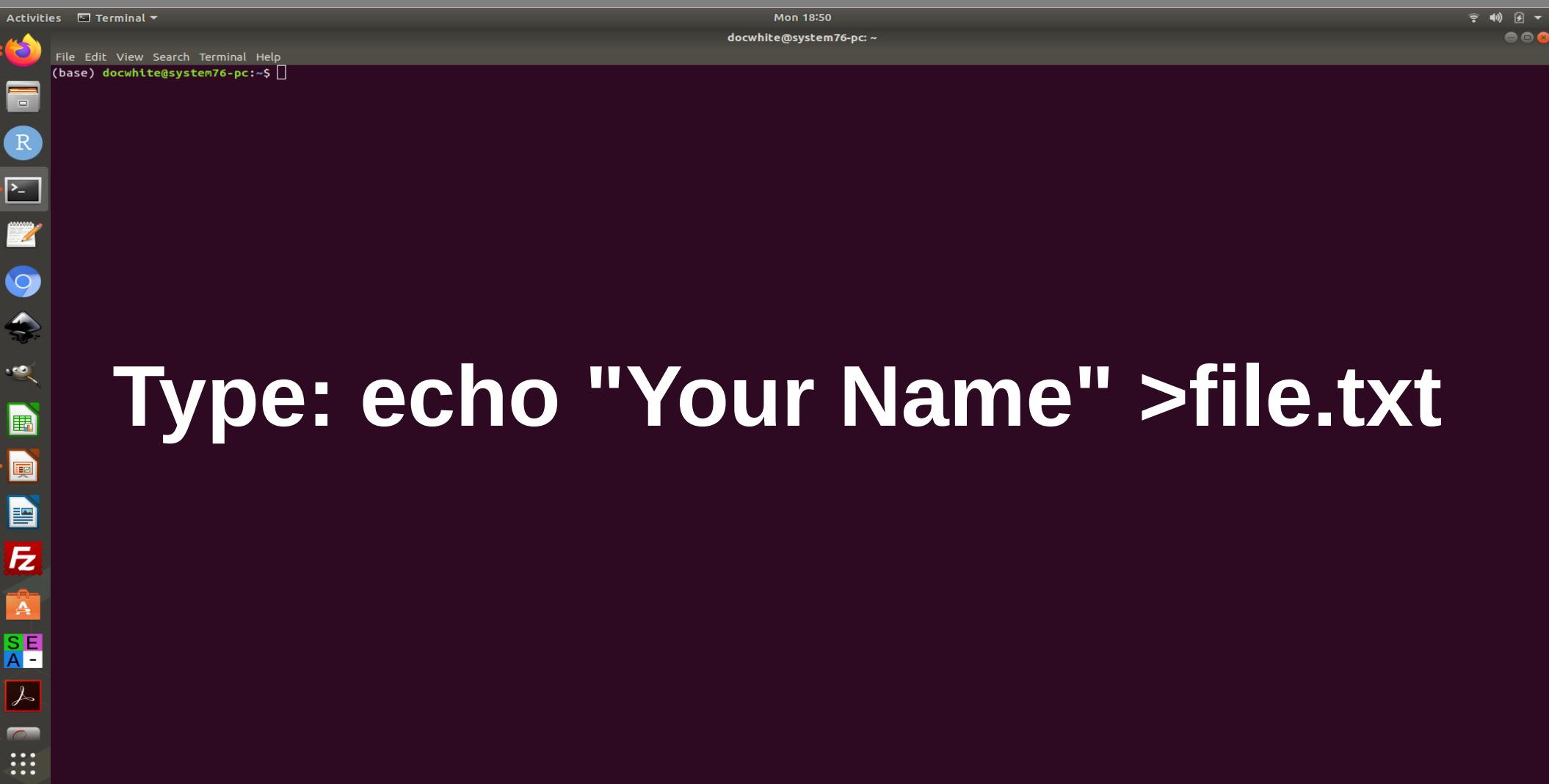
Type: cd test/

Command line introduction



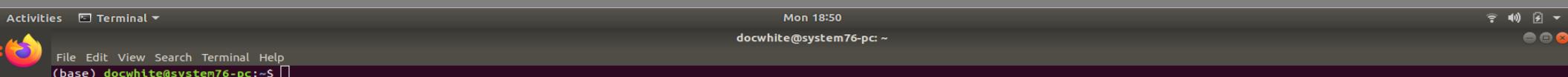
Type: touch file.txt

Command line introduction



Type: echo "Your Name" >file.txt

Command line introduction

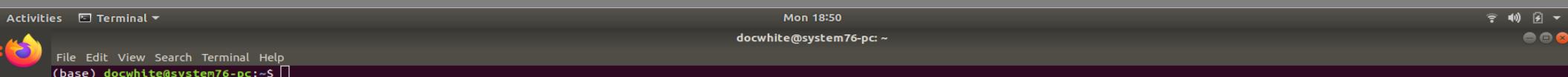


Type: more file.txt

Command line introduction

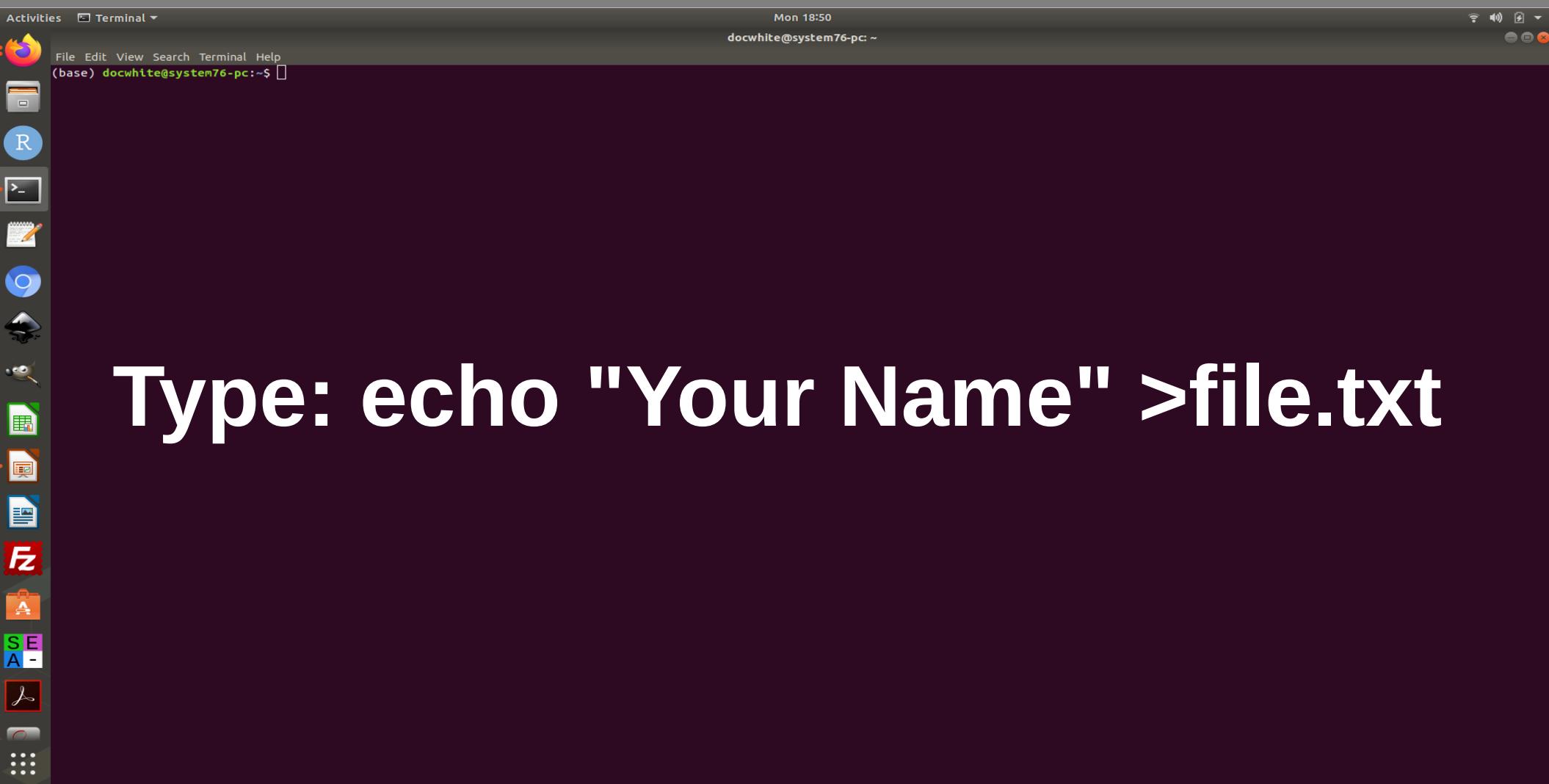
Type: echo "Your Name" >>file.txt

Command line introduction



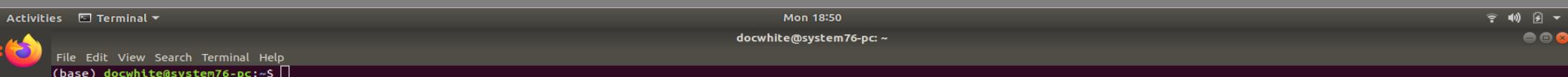
Type: more file.txt

Command line introduction



Type: echo "Your Name" >file.txt

Command line introduction



Type: more file.txt

Quiz 2

- On canvas now

multics