

# ASSIGNMENT 0 - CS 554 - Summer 21

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## Exercice 1 :

a :

Oracle Virtual Box White paper :

<https://www.oracle.com/us/technologies/virtualization/oracle-vm-virtualbox-overview-2981353.pdf>

pdf

b, c, d ,e, f :

Installing Virtual Box and creating an Ubuntu Virtual Machine with the specific configuration :

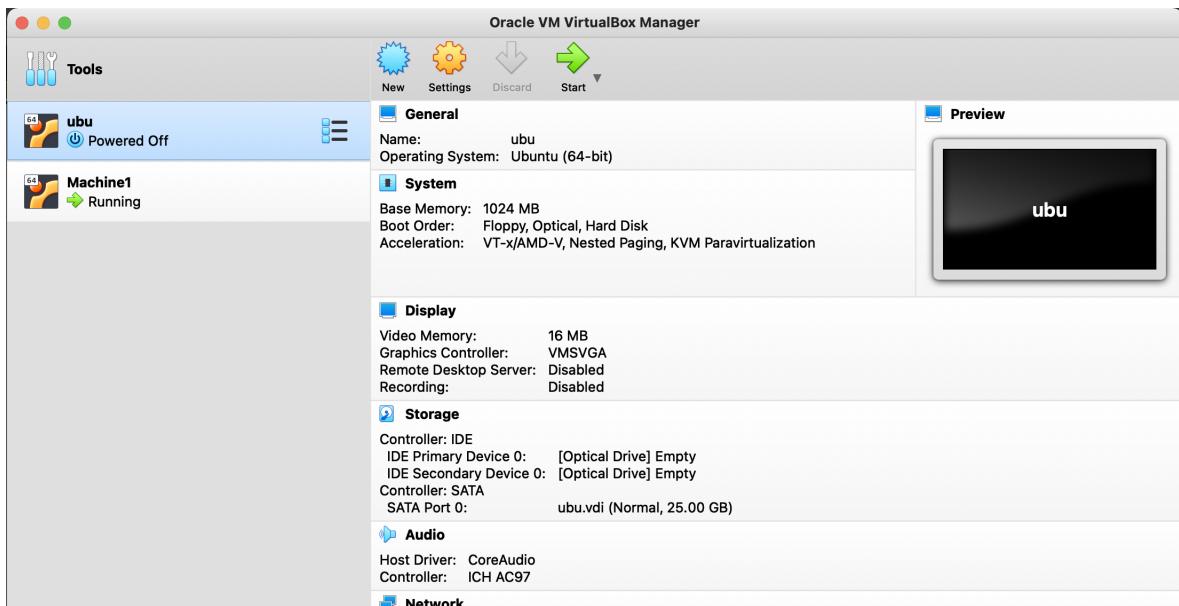


FIGURE 1 – Virtual Box

g :

Creating User :

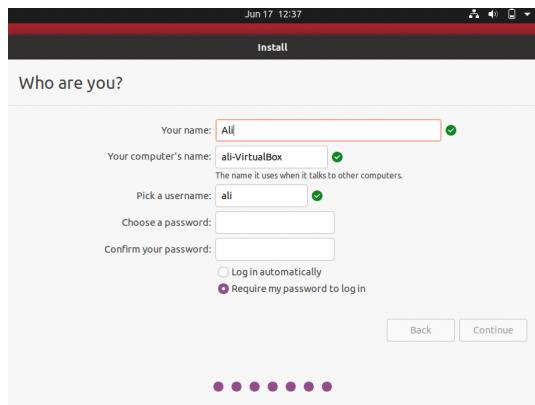


FIGURE 2 – Create User

h, i :

Turning on Firewall with `sudo ufw enable`

```

Activities Terminal Jun 17 13:19
ali@ali-VirtualBox: ~
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ali@ali-VirtualBox:~$ ls
Desktop Documents Downloads Music Pictures Public Templates Videos
ali@ali-VirtualBox:~$ sudo ufw status verbose
[sudo] password for ali:
Status: inactive
ali@ali-VirtualBox:~$ sudo ufw enable
Firewall is active and enabled on system startup
ali@ali-VirtualBox:~$ sudo ufw status verbose
Status: active
Logging: on (low)
Default: deny (incoming), allow (outgoing), disabled (routed)
New profiles: skip
ali@ali-VirtualBox:~$
```

FIGURE 3 – Firewall

k :

Creating private/public keys :

```

ali@ali-VirtualBox:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ali/.ssh/id_rsa):
Created directory '/home/ali/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ali/.ssh/id_rsa
Your public key has been saved in /home/ali/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:lkXBX51yJ1guvzLR0X6iyMWMYWieSLL/Y4AseTj4hY ali@ali-VirtualBox
The key's randomart image is:
+---[RSA 3072]----+
|     . . +.. |
|     .= +... |
| o   +. o.oo. |
| o o  .. o .+ o |
| =   oS. +. + o |
| E o. + . + o o. |
| .. o..+ o   .+ . |
| ..o o.... .+. o |
| ... .ooooo. |
+---[SHA256]----+

```

FIGURE 4 – Keys

**I :** Unfortunately, due to the lack of time in the homework, the connection could not be established between the two machines.

```

ali@ali-VirtualBox:~$ ssh-copy-id ali2@10.0.2.15
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed: "/home/ali/.ssh/id_rsa.pub"
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter
out any that are already installed

/usr/bin/ssh-copy-id: ERROR: ssh: connect to host 10.0.2.15 port 22: Connection
refused

```

FIGURE 5 – Connection

## Exercice 2 :

— a : **ssh** : Connect to a certain hostname through secure shell.

```

ali2@ali2-VirtualBox:~$ ssh ali@10.0.2.15
ssh: connect to host 10.0.2.15 port 22: Connection refused

```

FIGURE 6 – ssh

— b : **ssh-keygen** : Generates, manages and converts an authentication key to an SSH client.

```

ali@ali-VirtualBox:~$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ali/.ssh/id_rsa):
Created directory '/home/ali/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ali/.ssh/id_rsa
Your public key has been saved in /home/ali/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:lkXBX51yJ1guvzLR0X6iyMWMYWieSLL/Y4AseTj4hY ali@ali-VirtualBox
The key's randomart image is:
+---[RSA 3072]----+
|     . . +.. |
|     .= +... |
| o   +. o.oo. |
| o o  .. o .+ o |
| =   oS. +. + o |
| E o. + . + o o. |
| . o..+ o   .+ . |
| .o  o....+. o |
| ... .oooo. |
+---[SHA256]-----+

```

FIGURE 7 – ssh-keygen

- c : **scp** : Securely copies files from and to a distance machine through secure shell.  
Usage : scp [OPTION] [user@]SRC\_HOST [:]file1 [user@]DEST\_HOST [:]file2
- d : **history** : Shows the history of all the commands that were executed in the shell

```

ali@ali-VirtualBox:~$ history
1 history
2 ls
3 grep
4 clear
5 history

```

FIGURE 8 – history

- e : **sudo** : Execute a command as the root, admin or superior user.

```

ali@ali-VirtualBox:~$ sudo ls
[sudo] password for ali:
Desktop  Documents  Downloads  Music  Pictures  Public  Templates  Videos

```

FIGURE 9 – sudo

- f : **ip** : View, configure, add and delete network devices, interfaces and tunnels.

```

ali@ali-VirtualBox:~$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defau
lt 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
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP g
roup default qlen 1000
    link/ether 08:00:27:e8:fc:a1 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute enp0s3
        valid_lft 86225sec preferred_lft 86225sec
    inet6 fe80::7e19:8d53:b9d2:53bb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever

```

FIGURE 10 – ip

— g : **dd** : Copy a file and convert it using specific operands.

```
ali@ali-VirtualBox:~$ sudo dd if=/dev/sda bs=512 count=1 of=mbr.img
1+0 records in
1+0 records out
512 bytes copied, 0.00240112 s, 213 kB/s
```

FIGURE 11 – dd

— h : **fdisk** : Manipulate the partition tables of the disk

```
ali@ali-VirtualBox:~$ sudo fdisk -l
Disk /dev/loop0: 55.48 MiB, 58159104 bytes, 113592 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes

Disk /dev/loop1: 218.102 MiB, 229629952 bytes, 448496 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
```

FIGURE 12 – fdisk

— i : **apt** : A powerful command tool/interface for working with Ubuntu’s Advanced Packaging Tool.

```
ali@ali-VirtualBox:~$ sudo apt update
Hit:1 http://us.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:5 http://security.ubuntu.com/ubuntu focal-security/main amd64 DEP-11 Metadata [24.5 kB]
Get:6 http://security.ubuntu.com/ubuntu focal-security/universe amd64 DEP-11 Metadata [58.4 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/multiverse amd64 DEP-11 Metadata [2,464 B]
```

FIGURE 13 – apt

— j : **vi** : Open the VIM text editor.

```
VIM - Vi IMproved
version 8.1.2269
by Bram Moolenaar et al.
Modified by team+vim@tracker.debian.org
```

FIGURE 14 – vi

— k : **time** : Run a program or a command and summarize the time and resources that are being used.

```
ali@ali-VirtualBox:~$ time ls
a.out      Desktop   Downloads  mbr.img  Pictures  snap       text.txt
compressed.tar  Documents  e        Music    Public    Templates  Videos

real      0m0.004s
user      0m0.002s
sys       0m0.000s
```

FIGURE 15 – time

- l : **tar** : Manipulating archives in Ubuntu ( Archive, and extract ).

```
ali@ali-VirtualBox:~$ tar -cvf compressed.tar text.txt
```

FIGURE 16 – tar

- m : **cat** : Print a file on the standard output and concatenate files.

```
ali@ali-VirtualBox:~$ cat text.txt
hahah
```

FIGURE 17 – cat

- n : **watch** : Runs a program repeatedly and showing its outputs and errors, in order to watch it over time.

The command is : watch date

```
Every 2.0s: date                         ali-VirtualBox: Fri Jun 18 00:56:32 2021
Fri 18 Jun 2021 12:56:32 AM CDT
```

FIGURE 18 – watch

- o : **ps** : Show a summary of the current active processes

```
ali@ali-VirtualBox:~$ ps
  PID TTY          TIME CMD
 1838 pts/0    00:00:00 bash
 2862 pts/0    00:00:00 ps
```

FIGURE 19 – ps

- p : **top** : Shows a real-time view of the running system processes.

top - 00:59:42 up 15 min, 1 user, load average: 0.00, 0.03, 0.06												
Tasks: 180 total, 1 running, 179 sleeping, 0 stopped, 0 zombie												
%Cpu(s): 0.2 us, 0.3 sy, 0.0 ni, 98.8 id, 0.0 wa, 0.0 hi, 0.7 si, 0.0 st												
MiB Mem : 980.6 total, 130.2 free, 568.3 used, 282.1 buff/cache												
MiB Swap: 448.5 total, 329.5 free, 119.0 used. 262.6 avail Mem												
PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND	
1254	ali	9	-11	1753116	12596	10032	S	0.3	1.3	0:00.56	pulsea+	
1307	ali	20	0	830716	26496	13700	S	0.3	2.6	0:03.05	Xorg	
2865	ali	20	0	20496	3692	3180	R	0.3	0.4	0:00.01	top	
1	root	20	0	167872	7824	5596	S	0.0	0.8	0:01.20	systemd	
2	root	20	0	0	0	0	S	0.0	0.0	0:00.00	kthrea+	
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_pa+	
5	root	20	0	0	0	0	I	0.0	0.0	0:00.00	kworke+	
6	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworke+	
7	root	20	0	0	0	0	I	0.0	0.0	0:00.19	kworke+	
8	root	20	0	0	0	0	I	0.0	0.0	0:00.14	kworke+	
9	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	mm_per+	
10	root	20	0	0	0	0	S	0.0	0.0	0:00.12	ksoftti+	
11	root	20	0	0	0	0	I	0.0	0.0	0:00.31	rcu_sc+	
12	root	rt	0	0	0	0	S	0.0	0.0	0:00.00	migrat+	
13	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_i+	
14	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cpuhp/0	
15	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cpuhp/1	
16	root	-51	0	0	0	0	S	0.0	0.0	0:00.00	idle_i+	
17	root	rt	0	0	0	0	S	0.0	0.0	0:00.27	migrat+	
18	root	20	0	0	0	0	S	0.0	0.0	0:00.05	ksoftti+	

FIGURE 20 – top

— q : **htop** : Similar to top ( interactive process viewer ), plus it is with colors and it allows to scroll vertically and horizontally.

0[    3.2%] Tasks: 103, 268 thr; 1 running												
1[    1.3%] Load average: 0.28 0.09 0.08												
Mem[      575M/981M] Uptime: 00:16:22												
Swp[      164M/448M]												
PID	USER	PRI	NI	VIRT	RES	SHR	S	CPU%	MEM%	TIME+	Command	
1830	ali	20	0	805M	31696	19116	S	0.7	3.2	0:02.13	/usr/libexec/q	
3130	ali	20	0	6220	4532	3400	R	0.7	0.5	0:00.67	/snap/htop/264	
1	root	20	0	164M	9796	5940	S	0.0	1.0	0:01.85	/sbin/init spl	
223	root	19	-1	53928	11316	10352	S	0.0	1.1	0:00.50	/lib/systemd/s	
248	root	20	0	1076	0	0	S	0.0	0.0	0:00.00	bpfilter_umh	
251	root	20	0	23760	3000	2556	S	0.0	0.3	0:00.24	/lib/systemd/s	
564	systemd-r	20	0	24100	5952	4808	S	0.0	0.6	0:00.11	/lib/systemd/s	
565	systemd-t	20	0	90456	4232	3848	S	0.0	0.4	0:00.07	/lib/systemd/s	
587	systemd-t	20	0	90456	4232	3848	S	0.0	0.4	0:00.00	/lib/systemd/s	
590	root	20	0	244M	6048	5152	S	0.0	0.6	0:00.08	/usr/lib/acou	
591	root	20	0	2548	476	476	S	0.0	0.0	0:00.10	/usr/sbin/acpi	
593	avahi	20	0	8536	2432	2268	S	0.0	0.2	0:00.05	avahi-daemon:	
595	root	20	0	18052	1988	1880	S	0.0	0.2	0:00.00	/usr/sbin/cron	
596	root	20	0	37212	5084	4448	S	0.0	0.5	0:00.02	/usr/sbin/cups	
597	messagebu	20	0	9868	5132	3052	S	0.0	0.5	0:01.05	/usr/bin/dbus-	
599	root	20	0	339M	9316	7940	S	0.0	0.9	0:00.40	/usr/sbin/Netw	
600	root	20	0	244M	6048	5512	S	0.0	0.6	0:00.03	/usr/lib/acou	
608	root	20	0	81836	3104	2952	S	0.0	0.3	0:00.03	/usr/sbin/irqb	
610	root	20	0	47960	7876	5792	S	0.0	0.8	0:00.11	/usr/bin/pytho	
613	root	20	0	247M	9560	6708	S	0.0	1.0	0:01.56	/usr/lib/polic	
625	syslog	20	0	219M	2568	2464	S	0.0	0.3	0:00.10	/usr/sbin/rsys	

FIGURE 21 – htop

— r : **gcc** : Standard C and C++ compiler.

```
ali@ali-VirtualBox:~/e$ ls
file.c
ali@ali-VirtualBox:~/e$ gcc file.c
ali@ali-VirtualBox:~/e$ ls
a.out  file.c
```

FIGURE 22 – gcc

- s : **tail** : Displays the last n lines of a file.

```
ali@ali-VirtualBox:~$ tail text.txt -n 1
end
```

FIGURE 23 – tail

- t : **grep** : Look for line that match a certain pattern in the files.

```
ali@ali-VirtualBox:~$ grep haha text.txt
hahah
```

FIGURE 24 – grep

- u : **kill** : Used to send different signals to a process, the type of the signal is specified in the options.

```
ali@ali-VirtualBox:~$ kill -l
 1) SIGHUP      2) SIGINT      3) SIGQUIT      4) SIGILL      5) SIGTRAP
 6) SIGABRT     7) SIGBUS      8) SIGFPE       9) SIGKILL     10) SIGUSR1
11) SIGSEGV     12) SIGUSR2     13) SIGPIPE     14) SIGALRM     15) SIGTERM
16) SIGSTKFLT   17) SIGCHLD     18) SIGCONT     19) SIGSTOP     20) SIGTSTP
21) SIGTTIN     22) SIGTTOU     23) SIGURG      24) SIGXCPU    25) SIGXFSZ
26) SIGVTALRM   27) SIGPROF     28) SIGWINCH    29) SIGIO      30) SIGPWR
31) SIGSYS      34) SIGRTMIN    35) SIGRTMIN+1  36) SIGRTMIN+2  37) SIGRTMIN+3
38) SIGRTMIN+4  39) SIGRTMIN+5  40) SIGRTMIN+6  41) SIGRTMIN+7  42) SIGRTMIN+8
43) SIGRTMIN+9  44) SIGRTMIN+10 45) SIGRTMIN+11 46) SIGRTMIN+12 47) SIGRTMIN+13
48) SIGRTMIN+14 49) SIGRTMIN+15 50) SIGRTMAX-14 51) SIGRTMAX-13 52) SIGRTMAX-12
53) SIGRTMAX-11 54) SIGRTMAX-10 55) SIGRTMAX-9  56) SIGRTMAX-8  57) SIGRTMAX-7
58) SIGRTMAX-6  59) SIGRTMAX-5  60) SIGRTMAX-4  61) SIGRTMAX-3 62) SIGRTMAX-2
63) SIGRTMAX-1  64) SIGRTMAX
```

FIGURE 25 – kill

- v : **killall** : Kill a process by name. for example : killall emacs

- w : **du** : Shows a file or directory space usage.

```
ali@ali-VirtualBox:~$ du -h Desktop/
4.0K  Desktop/
```

FIGURE 26 – du

- x : **df** : Shows the free space in the file system.

```
ali@ali-VirtualBox:~$ df Desktop/
Filesystem      1K-blocks    Used Available Use% Mounted on
/dev/sda5        9736500  7029368  2192828  77% /
```

FIGURE 27 – df

- y : **screen** :

```
GNU Screen version 4.08.00 (GNU) 05-Feb-20
Copyright (c) 2018-2020 Alexander Naumov, Amadeusz Slawinski
Copyright (c) 2015-2017 Juergen Weigert, Alexander Naumov, Amadeusz Slawinski
Copyright (c) 2010-2014 Juergen Weigert, Sadrul Habib Chowdhury
Copyright (c) 2008-2009 Juergen Weigert, Michael Schroeder, Micah Cowan,
Sadrul Habib Chowdhury
Copyright (c) 1993-2007 Juergen Weigert, Michael Schroeder
Copyright (c) 1987 Oliver Laumann
```

FIGURE 28 – screen

— z : **vim** : Open the VIM text editor.

```
~                                         VIM - Vi IMproved
~                                         version 8.1.2269
~                                         by Bram Moolenaar et al.
~                                         Modified by team+vim@tracker.debian.org
~                                         Vim is open source and freely distributable
~                                         Become a registered Vim user!
~                                         type :help register<Enter>   for information
~                                         type :q<Enter>           to exit
~                                         type :help<Enter>  or <F1> for on-line help
~                                         type :help version8<Enter> for version info
```

FIGURE 29 – vim

— aa : **chmod** : Change a file mode (rights to write, read and execute.)

```
ali@ali-VirtualBox:~$ chmod 700 text.txt
```

FIGURE 30 – chmod

— bb : **chown** : Change a file's owner and group

```
ali@ali-VirtualBox:~$ chown root text.txt
chown: changing ownership of 'text.txt': Operation not permitted
```

FIGURE 31 – chown

— cc : **useradd** Create a new user and configure its parameters.

```
ali@ali-VirtualBox:~$ sudo useradd user2
ali@ali-VirtualBox:~$
```

FIGURE 32 – useradd

— dd : **man** : Open the system reference manual.

```
CAT(1)                               User Commands                               CAT(1)

NAME
    cat - concatenate files and print on the standard output

SYNOPSIS
    cat [OPTION]... [FILE]...

DESCRIPTION
    Concatenate FILE(s) to standard output.

    With no FILE, or when FILE is -, read standard input.

    -A, --show-all
        equivalent to -vET

    -b, --number-nonblank
        number nonempty output lines, overrides -n

    -e      equivalent to -vE
```

FIGURE 33 – man

— ee : **locate** : Locate a file by its name.

```
ali@ali-VirtualBox:~$ locate text.txt
/home/ali/text.txt
```

FIGURE 34 – locate

— ff : **find** : Search for a file in a directory hierarchy.

```
ali@ali-VirtualBox:~$ find -name text.txt
./text.txt
```

FIGURE 35 – find

— gg : **sed** : Open a stream text editor for some basic text transformations.

```
ali@ali-VirtualBox:~$ cat text.txt
hahah
end
ali@ali-VirtualBox:~$ sed 's/ha/je/p' text.txt
jehah
jehah
end
```

FIGURE 36 – sed

— hh : **awk** : Scan patterns and process text languages

```
ali@ali-VirtualBox:~$ awk '{print}' text.txt
hahah
end
```

FIGURE 37 – awk

— ii : **diff** : Compare the lines of different files.

```
ali@ali-VirtualBox:~$ diff text.txt e/file.c
1,2c1
< hahah
< end
---
> int main(void){}
```

FIGURE 38 – diff

- jj : **sort** : Sort the lines of a text file.

```
ali@ali-VirtualBox:~$ sort text.txt
end
hahah
```

FIGURE 39 – sort

- kk : **export** : Print all system variables and functions that can be passed to another process. Use example : export -p
- ll : **pwd** : Print the name of the current working directory

```
ali@ali-VirtualBox:~$ pwd
/home/ali
```

FIGURE 40 – pwd

- mm : **crontab** : Print scheduled cron jobs.

```
ali@ali-VirtualBox:~$ crontab -l
no crontab for ali
```

FIGURE 41 – crontab

- nn : **mount** : Mount and attach or remove a file system to the linux system.

```
sysfs on /sys type sysfs (rw,nosuid,nodev,noexec,relatime)
proc on /proc type proc (rw,nosuid,nodev,noexec,relatime)
udev on /dev type devtmpfs (rw,nosuid,noexec,relatime,size=472492k,nr_inodes=11
8123,mode=755)
devpts on /dev/pts type devpts (rw,nosuid,noexec,relatime,gid=5,mode=620,ptmxmo
de=000)
tmpfs on /run type tmpfs (rw,nosuid,nodev,noexec,relatime,size=100412k,mode=755
)
/dev/sda5 on / type ext4 (rw,relatime,errors=remount-ro)
securityfs on /sys/kernel/security type securityfs (rw,nosuid,nodev,noexec,rela
time)
tmpfs on /dev/shm type tmpfs (rw,nosuid,nodev)
tmpfs on /run/lock type tmpfs (rw,nosuid,nodev,noexec,relatime,size=5120k)
tmpfs on /sys/fs/cgroup type tmpfs (ro,nosuid,nodev,noexec,mode=755)
cgroup2 on /sys/fs/cgroup/unified type cgroup2 (rw,nosuid,nodev,noexec,relatime
,nsdelegate)
cgroup on /sys/fs/cgroup/systemd type cgroup (rw,nosuid,nodev,noexec,relatime,x
attr,name=systemd)
pstore on /sys/fs/pstore type pstore (rw,nosuid,nodev,noexec,relatime)
none on /sys/fs/bpf type bpf (rw,nosuid,nodev,noexec,relatime,mode=700)
cgroup on /sys/fs/cgroup/hugetlb type cgroup (rw,nosuid,nodev,noexec,relatime,h
ugetlb)
```

FIGURE 42 – mount

- oo : **passwd** : Change the user password.

```
ali@ali-VirtualBox:~$ passwd  
Changing password for ali.  
Current password: [REDACTED]
```

FIGURE 43 – passwd

- pp : **uname** : Print different system information.

```
ali@ali-VirtualBox:~$ uname  
Linux
```

FIGURE 44 – uname

- qq : **whereis** : Locate the directory of a given command.

```
ali@ali-VirtualBox:~$ whereis ls  
ls: /usr/bin/ls /usr/share/man/man1/ls.1.gz
```

FIGURE 45 – whereis

- rr : **whatis** : Display a brief description of a given command

```
ali@ali-VirtualBox:~$ whatis ls  
ls (1) - list directory contents
```

FIGURE 46 – whatis

- ss : **su** : Run a command with a given user or group ID.

```
ali@ali-VirtualBox:~$ su -l ali  
Password: [REDACTED]
```

FIGURE 47 – su

- tt : **ping** : Send a signal to a given host to test the status and speed of the connection.

```
ali@ali-VirtualBox:~$ ping www.iit.edu  
PING www.iit.edu (50.19.226.237) 56(84) bytes of data.  
64 bytes from ec2-50-19-226-237.compute-1.amazonaws.com (50.19.226.237): icmp_s  
eq=1 ttl=63 time=30.6 ms  
64 bytes from ec2-50-19-226-237.compute-1.amazonaws.com (50.19.226.237): icmp_s  
eq=2 ttl=63 time=30.8 ms  
64 bytes from ec2-50-19-226-237.compute-1.amazonaws.com (50.19.226.237): icmp_s  
eq=3 ttl=63 time=37.8 ms
```

FIGURE 48 – ping

- uu : **traceroute** : Print the tracked route packets taken from an IP network on their way to a given host.

```
ali@ali-VirtualBox:~$ traceroute -4 google.com
traceroute to google.com (142.250.80.110), 30 hops max, 60 byte packets
 1 iad-120374ab.atw.pa.smb.rcn.net (10.0.2.2)  1.964 ms  1.895 ms  1.853 ms
 2 192.168.0.1 (192.168.0.1)  4.230 ms  2.890 ms  3.155 ms
 3 bdl1.mcm-cbr1.chi-mcm.il.cable.rcn.net (10.20.0.1)  12.541 ms  12.502 ms  1
2.795 ms
 4 216.80.78.91 (216.80.78.91)  12.776 ms  16.522 ms  18.157 ms
 5 hge0-0-0-13.core1.chgo.il.rcn.net (207.172.18.34)  18.131 ms  207.172.18.116
(207.172.18.116)  18.101 ms hge0-0-0-13.core1.chgo.il.rcn.net (207.172.18.34)
18.270 ms
 6 hge0-0-0-7.border1.eqnx.il.rcn.net (207.172.19.15)  16.393 ms hge0-0-0-0.bo
rder1.eqnx.il.rcn.net (207.172.19.163)  11.626 ms  11.587 ms
 7 207.172.9.38 (207.172.9.38)  17.622 ms * *
 8 * * 108.170.243.175 (108.170.243.175)  15.916 ms
 9 216.239.59.163 (216.239.59.163)  16.133 ms * 216.239.59.151 (216.239.59.151)
) 23.982 ms
10 216.239.59.1 (216.239.59.1)  45.644 ms * *
11 209.85.255.37 (209.85.255.37)  45.793 ms 216.239.62.194 (216.239.62.194)  4
6.252 ms 216.239.62.197 (216.239.62.197)  36.987 ms
12 108.170.248.97 (108.170.248.97)  36.134 ms  42.612 ms  42.652 ms
13 142.251.65.115 (142.251.65.115)  42.393 ms 142.251.65.113 (142.251.65.113)
42.537 ms 142.251.65.115 (142.251.65.115)  42.365 ms
14 lga34s36-in-f14.1e100.net (142.250.80.110)  42.507 ms  41.050 ms  33.964 ms
```

FIGURE 49 – traceroute

— vv : **date** : Display the current system date and time.

```
ali@ali-VirtualBox:~$ date
Fri 18 Jun 2021 01:28:06 AM CDT
```

FIGURE 50 – date

— ww : **time** : Run a program or a command and summarize the time and ressources that are being used.

```
ali@ali-VirtualBox:~$ time ls
.a.out      Desktop   Downloads  mbr.img  Pictures  snap      text.txt
compressed.tar  Documents  e          Music    Public    Templates  Videos

real        0m0.004s
user        0m0.002s
sys         0m0.000s
```

FIGURE 51 – time

— xx : **wget** : Download the content of a given URL link.

```
ali@ali-VirtualBox:~$ wget www.google.com
--2021-06-18 01:28:53--  http://www.google.com/
Resolving www.google.com (www.google.com)... 172.217.1.36, 2607:f8b0:4006:819::2004
Connecting to www.google.com (www.google.com)|172.217.1.36|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [text/html]
Saving to: 'index.html'

index.html [ <=> ] 12.68K ---KB/s in 0s

2021-06-18 01:28:53 (269 MB/s) - 'index.html' saved [12980]
```

FIGURE 52 – wget

— yy : **wc** : Print counts of the new lines, words and bytes of a given file.

```
ali@ali-VirtualBox:~$ wc text.txt
2 2 10 text.txt
```

FIGURE 53 – wc

— zz : **pwgen** : Generate passwords that are easily memorized by humans.

```
ali@ali-VirtualBox:~$ pwgen
Kaechain aThae0sa IeTh2aRi shooj5Fi OhLeena8 SavaeNg6 taih1Dai eibaCae5
eithaKa6 iNgiac2g ain5ieDo Wa0Fe00h ooWaiqu8 iPhah3ae Agh4xeBe xo3Ka0li
eu4chieH Bohw6ok3 iejahd70 ohxeij9B Aecoh1So uN1Jaeng dahGho2x nix3ahSu
jie9ko4M Ohreequ2 Aiy1eech ieb5Iev6 EeBar0ye ojaSh4id Xoh8ohF9 Roh7ahh0
```

FIGURE 54 – pwgen

### Exercice 3 :

The different scripts are to be found in the github repository :

a.

generate-dataset.sh

b.

sort-data.sh

c.

sort.c

d.

sort.py

e.

1,000

./generate-dataset.sh file1.txt 1000 1.07s user 1.35s system 75% cpu 3.214 total

./sort-data.sh file1.txt 0.01s user 0.02s system 69% cpu 0.036 total

python3 sort.py file1.txt 0.03s user 0.01s system 90% cpu 0.047 total

./a.out file1.txt 0.07s user 0.00s system 97% cpu 0.071 total

100,000

./generate-dataset.sh file2.txt 100000 110.04s user 149.11s system 75% cpu 5 :43.12 total

./sort-data.sh file2.txt 0.56s user 0.06s system 92% cpu 0.673 total

python3 sort.py file2.txt 0.17s user 0.05s system 92% cpu 0.243 total

./a.out file2.txt 913.02s user 3.28s system 99/

1,000,000

Using my code, and the capacity of my computer, generating such a large file took a very long time and was not practical.

## Exercice 4.

a.

Choosing the number of virtual processors depend on the purpose behind the Virtual Machine, i.e. what we are going to do with the virtual machine. If the operations are usually simple, and sequential, then adding many processors would not improve the performance, it would probably do the opposite. However, if we are going to use some complicated programs that might require parallel computing and concurrent algorithms, then using multiple computers might help improve the performance.

Setting the number of processors to the maximum is generally a bad idea because it would consume all the computing capacity of the host operating system ( the real machine ), hence would result in a bad performance.

b.

**None** : Specifying none explicitly turns off exposing any paravirtualization interface.

**Legacy** : The legacy option is chosen for VMs which were created with older VirtualBox versions and will pick a paravirtualization interface while starting the VM with VirtualBox 5.0 and newer.

**Minimal** : Announces the presence of a virtualized environment. Additionally, reports the TSC and APIC frequency to the guest operating system. This provider is mandatory for running any Mac OS X guests.

**Hyper-V** : Presents a Microsoft Hyper-V hypervisor interface which is recognized by Windows 7 and newer operating systems. VirtualBox's implementation currently supports paravirtualized clocks, APIC frequency reporting, guest debugging, guest crash reporting and relaxed timer checks. This provider is recommended for Windows guests.

**KVM** : Presents a Linux KVM hypervisor interface which is recognized by Linux kernels starting with version 2.6.25. VirtualBox's implementation currently supports paravirtualized clocks and SMP spinlocks. **This provider is recommended for Linux guests.**

c.

**IDE** : (Integrated Drive Electronics) is a standard electronic interface used between a computer motherboard's data paths or bus and the computer's disk storage devices. The IDE interface is based on the IBM PC Industry Standard Architecture (ISA) 16-bit bus standard.

**SATA** controller (serial ATA controller) is a hardware interface that connects a hard drive to a computer's motherboard.

**NVMe** Express (NVMe) or Non-Volatile Memory Host Controller Interface Specification (NVMHCIS) is an open, logical-device interface specification for accessing a computer's non-volatile storage media usually attached via PCI Express (PCIe) bus.

**d.**

**NAT** mode will mask all network activity as if it came from your Host OS, although the VM can access external resources.

**Bridged** mode replicates another node on the physical network and your VM will receive its own IP address if DHCP is enabled in the network.

**Internal Networking** is similar to bridged networking in that the VM can directly communicate with the outside world. However, the "outside world" is limited to other VMs on the same host which connect to the same internal network

**Host-only** only permits network operations with the Host OS.

**d.**

**USB 1.1** : or Full-Bandwidth USB, specification was the first release to be widely adopted by the consumer market. This specification allowed for a maximum bandwidth of 12Mbps. This type of USB connection is ideal for connecting devices that have low bandwidth requirements, i.e. keyboard, mouse, printer, etc.

**USB 2.0** : it is also known as hi-speed USB. It was introduced in 2000. It is an updated version of USB 1.1, which provides improved functionalities and better speed. It is capable to deliver the maximum transfer speed of 480 Megabits per second.

**USB 3.0** : is the third major version of the Universal Serial Bus (USB) standard for interfacing computers and electronic devices. Among other improvements, USB 3.0 adds the new transfer rate referred to as SuperSpeed USB (SS) that can transfer data at up to 5 Gbit/s (625 MB/s), which is about 10 times faster than the USB 2.0 standard.