CS554 - Homework #0 - FALL 21

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September 8, 2021

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a.

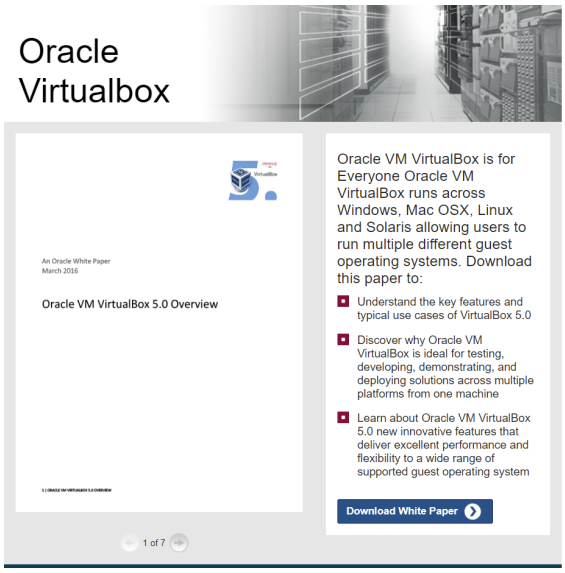


Figure 1: Oracle Virtual Box White paper

b. Downloading Oracle Virtualbox

Figure 2: Oracle Virtual Box V. 6.1.26 Download

d. Downloading Ubuntu Desktop 20.04.3 LTS Linux ISO image

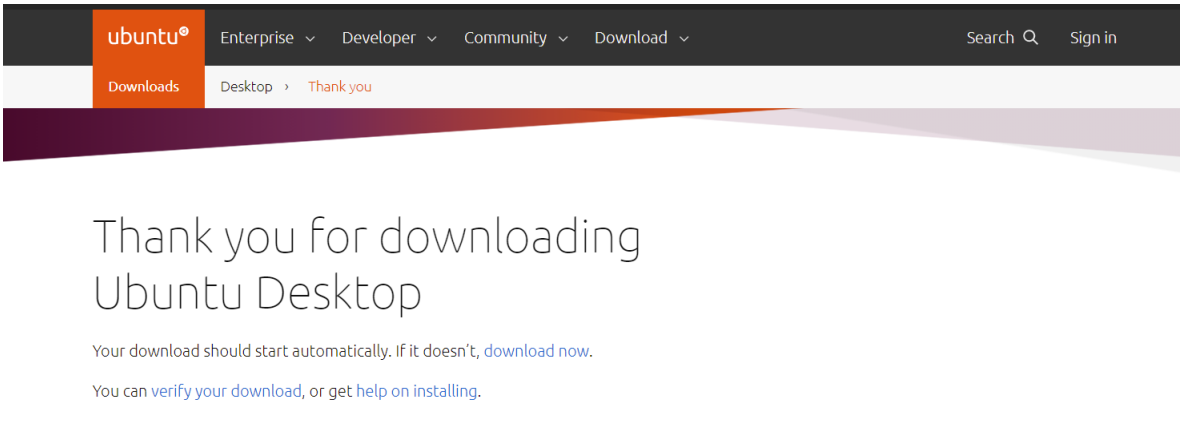


Figure 3: Ubuntu Desktop 20.04.3 LTS Linux ISO Download

c, e.

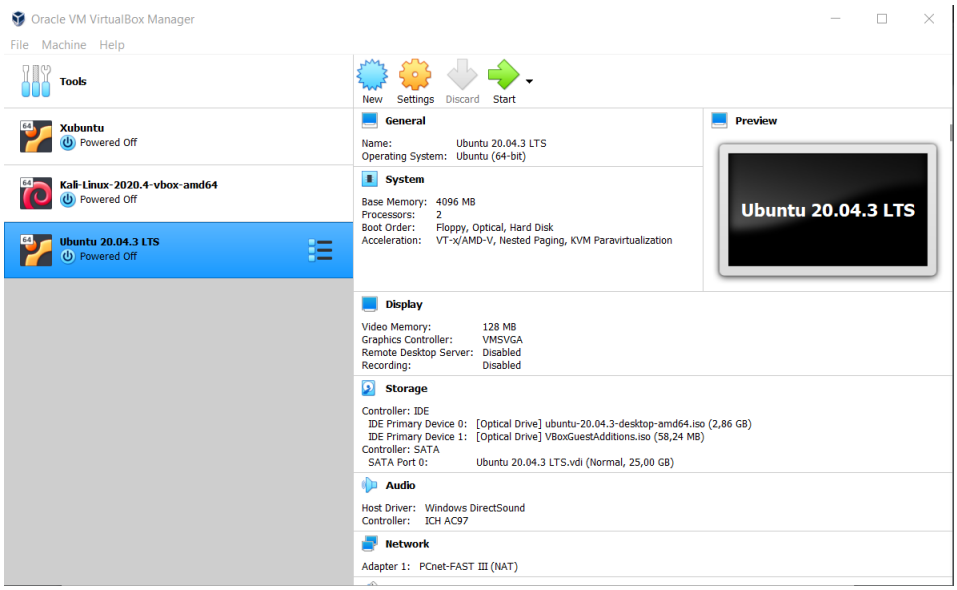


Figure 4: Ubuntu VM Created

f, g.

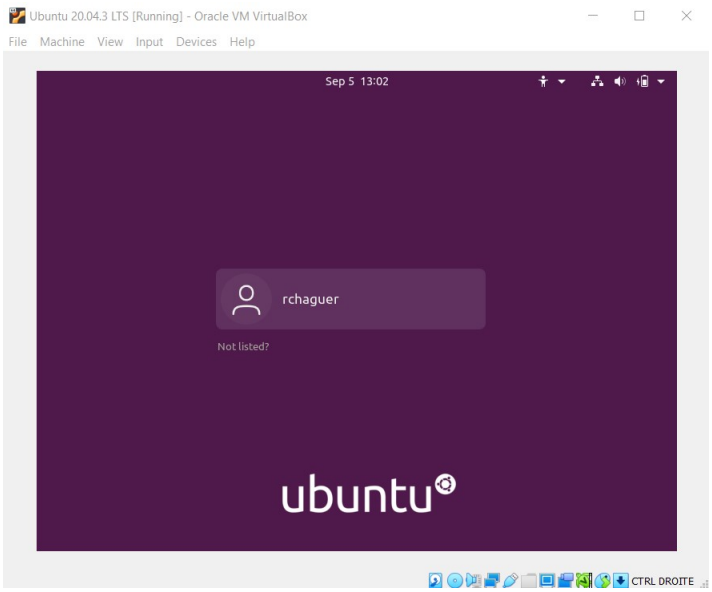


Figure 5: Linux installed from ISO image

h.

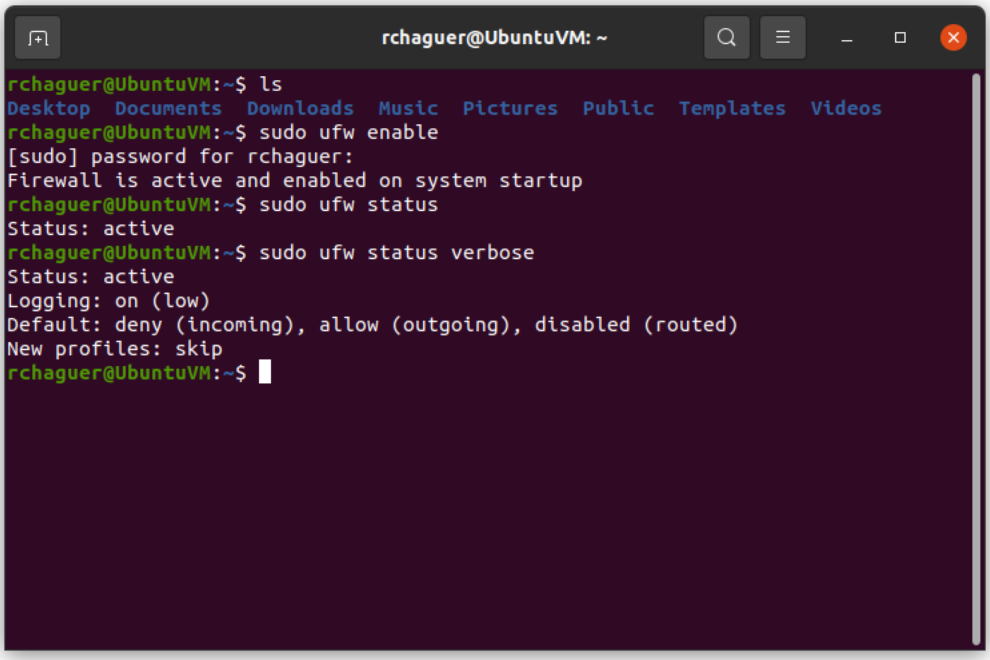


Figure 6: Firewall enabled and All ports blocked

i.

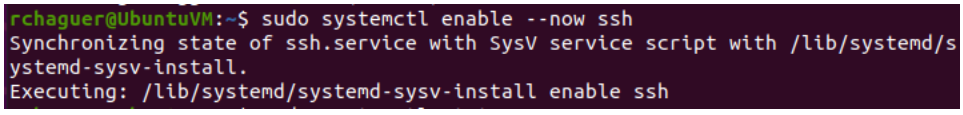


Figure 7: Enabling SSH access

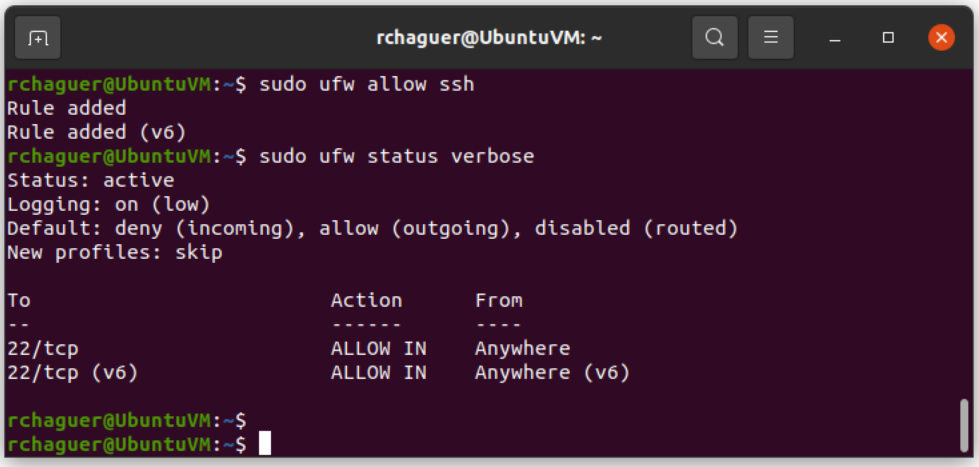


Figure 8: Opening SSH port in firewall

j.

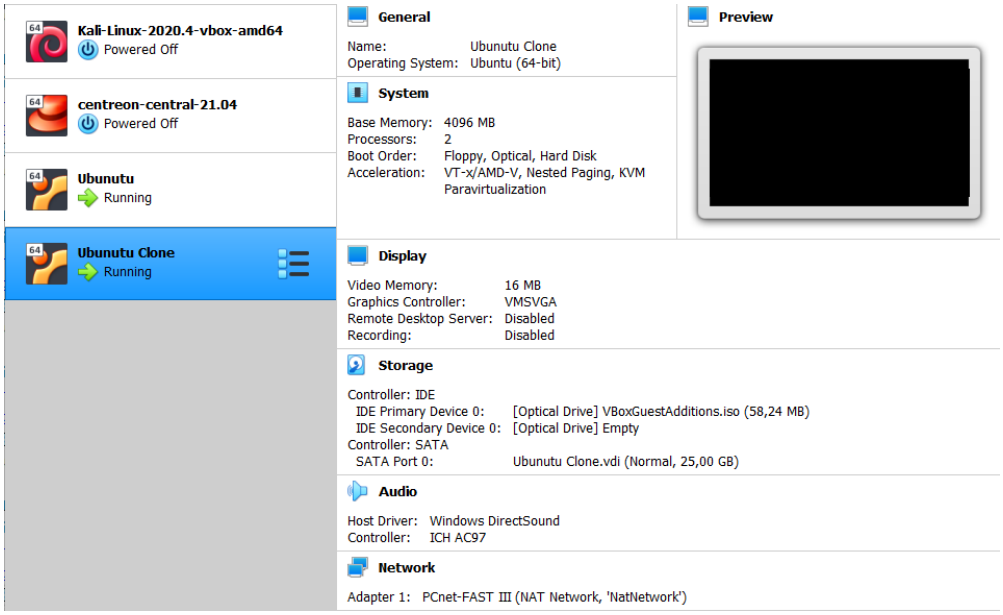


Figure 9: Creating another VM with same configuration and putting both of the VMs in the same NAT network

k.

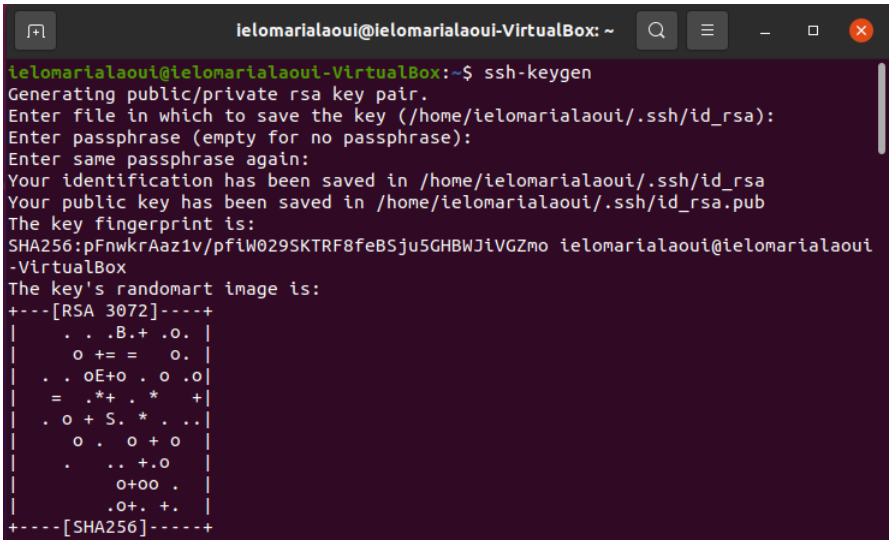


Figure 10: Creating private/public keys

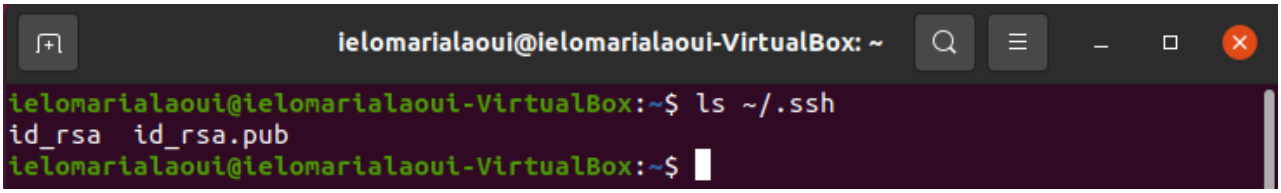


Figure 11: Testing key generation

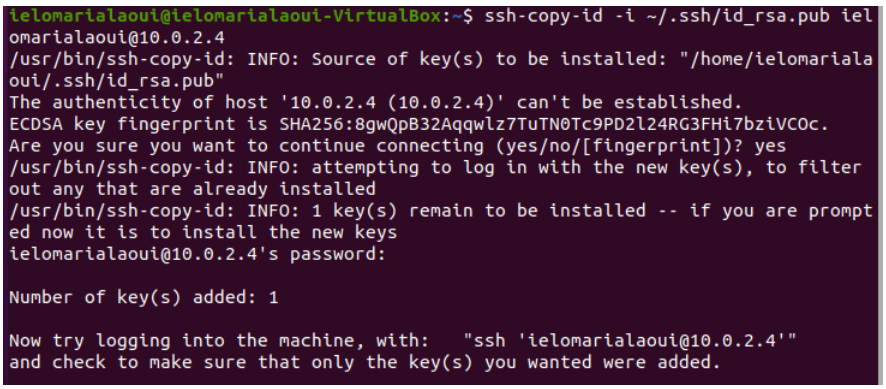


Figure 12: Copying public key from one VM to the other for both VMs

l.

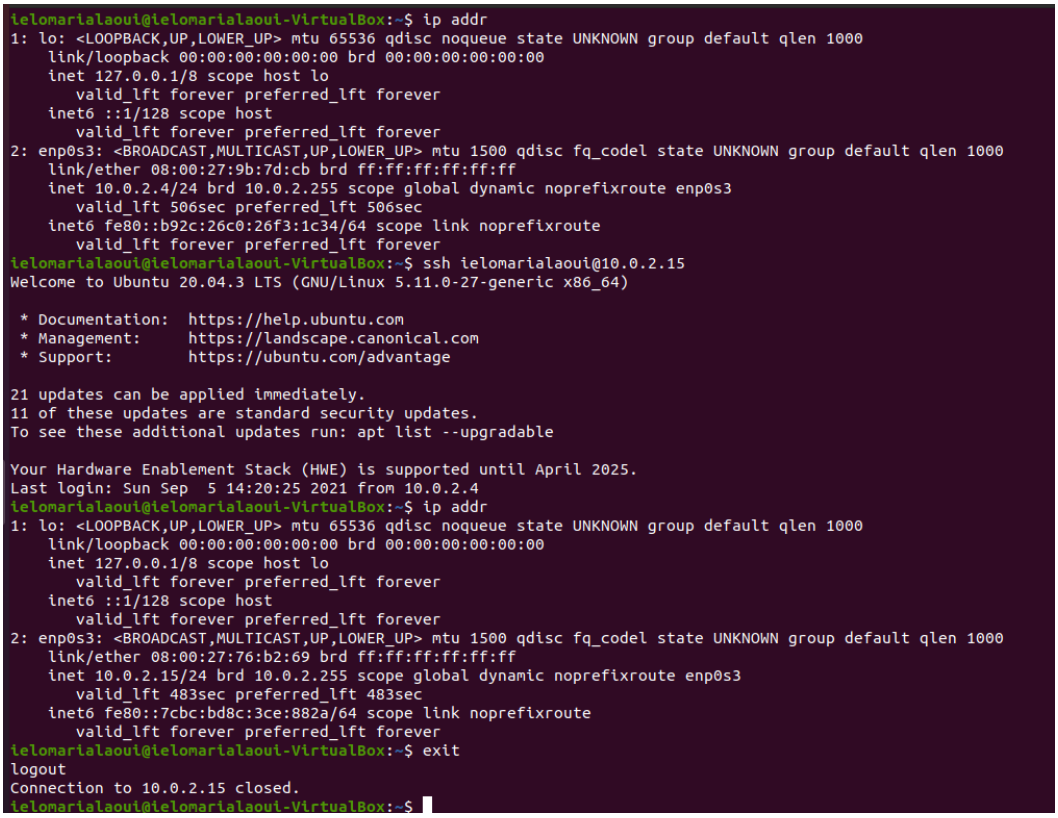
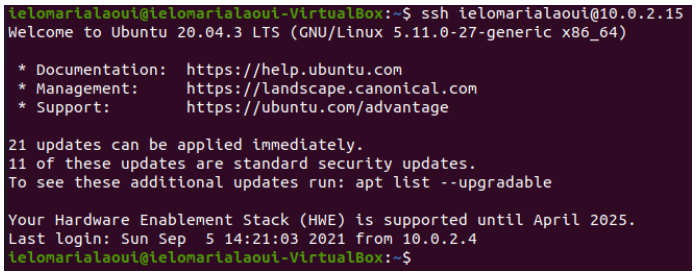


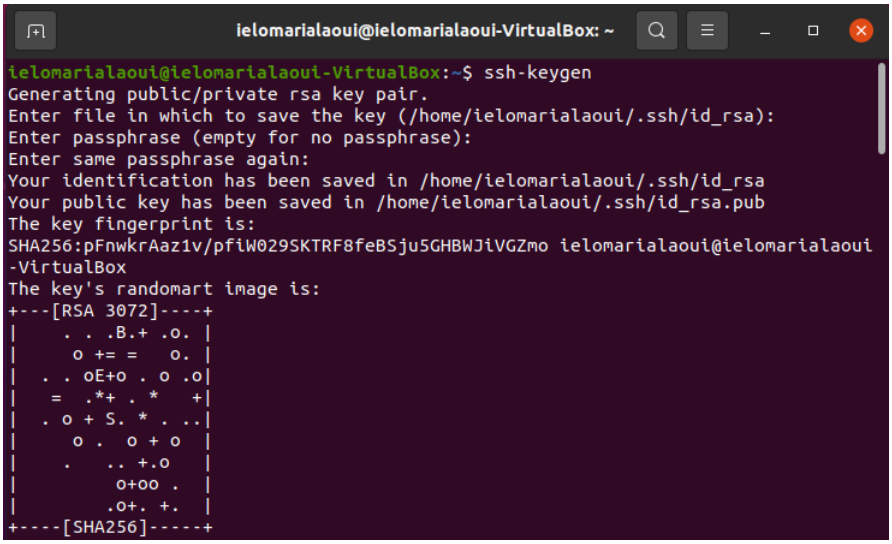
Figure 13: Testing connection between VMs

2

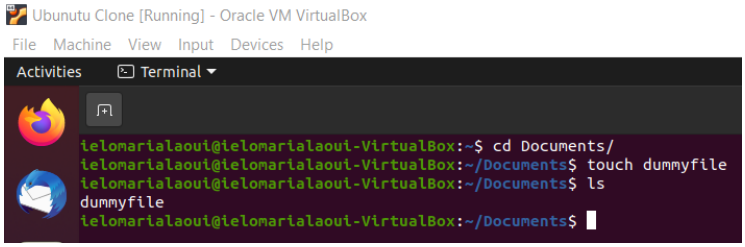
- a : **ssh** : Connect two hosts through a secure encrypted connection.



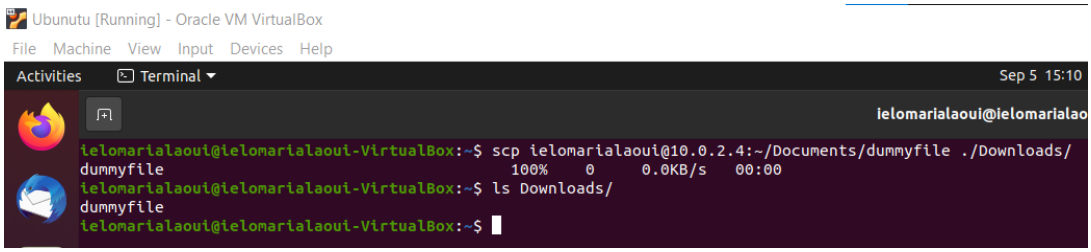
- b : **ssh-keygen** : Create a key pair for public key authentication.



- c : **scp** : Securely copy files and directories between two distant locations through ssh. A dummy file is created in "Ubuntu Clone" VM.



We copy this file securely with scp to "Ubuntu" VM.



- d : **history** : Show the history of the commands that executed in the shell.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ history
    1  ./autorun.sh
    2  sudo apt install gcc perl make
    3  sudo ./autorun.sh
    4  restart -now
    5  sudo ufw enable
    6  sudo ufw status verbose
    7  sudo apt update
    8  sudo apt install openssh-server
    9  sudu systemctl status ssh
   10  sudo systemctl status ssh
   11  sudo ufw allow ssh
   12  ssh-keygen
   13  ip config
   14  ip addr
   15  ipconfig
   16  ifconfig
   17  ip addr
   18  ls
   19  cat ~/.ssh/rsa_pub
   20  cat ~/.ssh/id_rsa
   21  ls ~/.ssh/
   22  cat ~/.ssh/id_rsa.pub
   23  clear
   24  ls ~/.ssh
   25  ip adddr
   26  ip addr
   27  service sshd status
   28  ip addr
   29  man ssh-keygen
   30  ls
   31  ls ~/.ssh
   32  ssh-copy-id -i ~/.ssh/id_rsa.pub ielomarialaoui@10.0.2.4
   33  ip addr
   34  clear
   35  ip addr
   36  clear
   37  scp ielomarialaoui@10.0.2.4:~/Documents/dummyfile ./Downloads/
   38  ls Downloads/
   39  history
```

- e : **sudo** : Execute a command as a Super Admin with superior privileges.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ apt install hello-world
E: Could not open lock file /var/lib/dpkg/lock-frontend - open (13: Permission denied)
E: Unable to acquire the dpkg frontend lock (/var/lib/dpkg/lock-frontend), are you root?
ielomarialaoui@ielomarialaoui-VirtualBox:~$ sudo apt install hello-world
[sudo] password for ielomarialaoui:
```

- f : **ip** : Manage and Configure the Network devices, interfaces and tunnels.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ ip addr
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
       valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UNKNOWN group default qlen 1000
    link/ether 08:00:27:76:b2:69 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 448sec preferred_lft 448sec
    inet6 fe80::7cbc:bd8c:3ce:882a/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
```

- g : **dd** : Convert and Copy files.
  In the following exmaple, 100 Mb of zeros were copied to the garbage can

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ dd if=/dev/zero of=/dev/null bs=100M count=1
1+0 records in
1+0 records out
104857600 bytes (105 MB, 100 MiB) copied, 0.527046 s, 199 MB/s
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- h : **fdisk** : Manage Disks' partition tables.
  Available partitions can be viewed using the command below.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ sudo fdisk -l
[sudo] password for ielomarialaoui:
Disk /dev/loop0: 216.96 MiB, 227471360 bytes, 444280 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: 99.35 MiB, 104169472 bytes, 203456 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/loop2: 55.45 MiB, 58130432 bytes, 113536 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/loop3: 219 MiB, 229638144 bytes, 448512 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/loop4: 65.1 MiB, 68259840 bytes, 133320 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/loop5: 50.98 MiB, 53432320 bytes, 104360 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/loop6: 32.3 MiB, 33865728 bytes, 66144 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
```

- i : **apt** : Install, Update, Remove and Manage deb packages on Ubuntu (Debian).

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ sudo apt install cmake
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  cmake-data libjsoncpp1 librhash0
Suggested packages:
  cmake-doc ninja-build
The following NEW packages will be installed:
  cmake cmake-data libjsoncpp1 librhash0
0 upgraded, 4 newly installed, 0 to remove and 21 not upgraded.
Need to get 5,470 kB of archives.
After this operation, 28.3 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://us.archive.ubuntu.com/ubuntu focal/main amd64 cmake-data all 3.16.3-1ubuntu1 [1,612 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu focal/main amd64 libjsoncpp1 amd64 1.7.4-3.1ubuntu2 [75.6 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal/main amd64 librhash0 amd64 1.3.9-1 [113 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu focal/main amd64 cmake amd64 3.16.3-1ubuntu1 [3,669 kB]
Fetched 5,470 kB in 3s (1,944 kB/s)
Selecting previously unselected package cmake-data.
(Reading database ... 152830 files and directories currently installed.)
Preparing to unpack .../cmake-data_3.16.3-1ubuntu1_all.deb ...
Unpacking cmake-data (3.16.3-1ubuntu1) ...
Selecting previously unselected package libjsoncpp1:amd64.
Preparing to unpack .../libjsoncpp1_1.7.4-3.1ubuntu2_amd64.deb ...
Unpacking libjsoncpp1:amd64 (1.7.4-3.1ubuntu2) ...
Selecting previously unselected package librhash0:amd64.
Preparing to unpack .../librhash0_1.3.9-1_amd64.deb ...
Unpacking librhash0:amd64 (1.3.9-1) ...
Selecting previously unselected package cmake.
Preparing to unpack .../cmake_3.16.3-1ubuntu1_amd64.deb ...
Unpacking cmake (3.16.3-1ubuntu1) ...
Setting up librhash0:amd64 (1.3.9-1) ...
Setting up cmake-data (3.16.3-1ubuntu1) ...
Setting up libjsoncpp1:amd64 (1.7.4-3.1ubuntu2) ...
Setting up cmake (3.16.3-1ubuntu1) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.2) ...
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- j : **vi** : Open 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
~
~                  Help poor children in Uganda!
~         type  :help iccf<Enter>       for information
~
~         type  :q<Enter>               to exit
~         type  :help<Enter>  or  <F1>  for on-line help
~         type  :help version8<Enter>   for version info
~
~
~                                                  0,0-1         All
```

- k : **time** : Determine the period of time a given command takes to run.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ time ls
Desktop  Documents  Downloads  Music  Pictures  Public  snap  Templates  Videos

real    0m0.003s
user    0m0.003s
sys     0m0.000s
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- l : **tar** : Compress, Decompress and Manage archives in Linux.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$ tar -cvf dummyarchive.tar dummyfile
dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$ ls
dummyarchive.tar  dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$
```

- m : **cat** : Read, Concatenate and Write file contents and print on the standard output.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$ echo "hello world" >> dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$ cat dummyfile
hello world
ielomarialaoui@ielomarialaoui-VirtualBox:~/Downloads$
```

- n : **watch** : Run any command multiple times and displays the outputs and errors.

```
ielomarialaoui@ielomarialaoui-VirtualBox: ~/Downloads
Every 2.0s: ls            ielomarialaoui-VirtualBox: Sun Sep  5 15:35:54 2021

dummyarchive.tar
dummyfile
```

- o : **ps** : Show the list of the current active processes

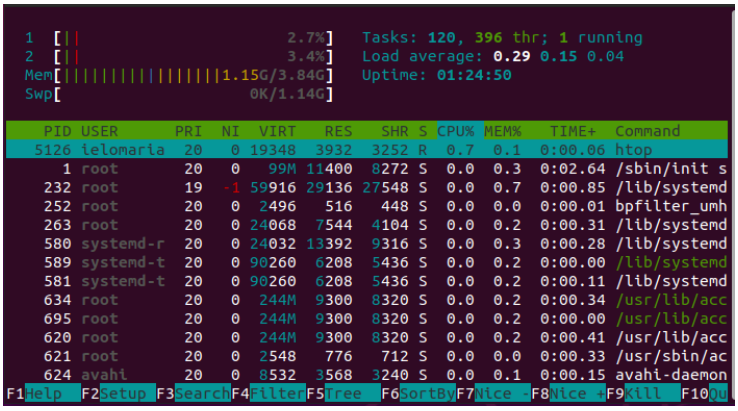
```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ firefox &
[1] 4250
ielomarialaoui@ielomarialaoui-VirtualBox:~$ ps
    PID TTY          TIME CMD
   2198 pts/0    00:00:00 bash
   4250 pts/0    00:00:01 firefox
   4297 pts/0    00:00:00 ps
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- p : **top** : Show in real-time the list with details of the running processes.

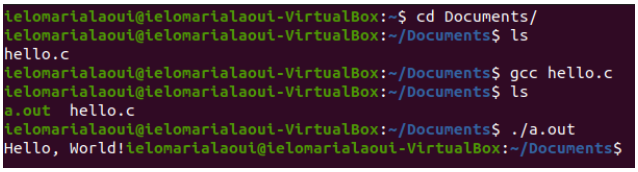
```
top - 15:37:45 up  1:23,  1 user,  load average: 0.21, 0.11, 0.03
Tasks: 200 total,   1 running, 199 sleeping,   0 stopped,   0 zombie
%Cpu(s):  4.7 us, 10.0 sy,  0.0 ni, 84.7 id,  0.0 wa,  0.0 hi,  0.6 si,  0.0
MiB Mem :   3933.7 total,   1216.4 free,   1137.5 used,   1579.8 buff/cache
MiB Swap:   1162.4 total,   1162.4 free,      0.0 used.   2520.8 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+
   1003 ielomar+  20   0  883896 105896  62644 S  18.9   2.6   0:43.35
   1288 ielomar+  20   0 4274580 399620 134408 S  16.9   9.9   0:46.45
   2187 ielomar+  20   0  824108  51756  38692 S   3.0   1.3   0:11.07
   1197 ielomar+  20   0  163996   2824   2452 S   0.7   0.1   0:41.65
    122 root       0 -20       0      0      0 I   0.3   0.0   0:01.61
   1342 ielomar+  20   0  162912   6592   5952 S   0.3   0.2   0:00.14
   4224 root      20   0       0      0      0 I   0.3   0.0   0:00.10
      1 root      20   0  102056  11400   8272 S   0.0   0.3   0:02.64
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.01
      3 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      5 root      20   0       0      0      0 I   0.0   0.0   0:02.76
      6 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
      8 root       0 -20       0      0      0 I   0.0   0.0   0:00.00
```

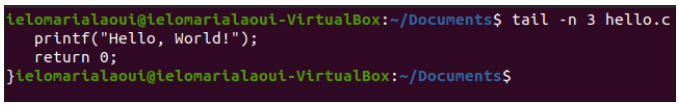
- q : **htop** : Interactive Process Viewer version of `top`. Visualize the information in colors and a more user-friendly way.



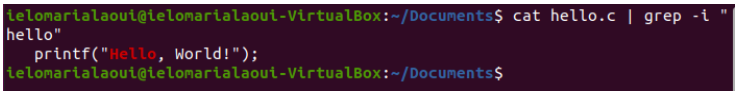
- r : **gcc** : C and C++ Compiler



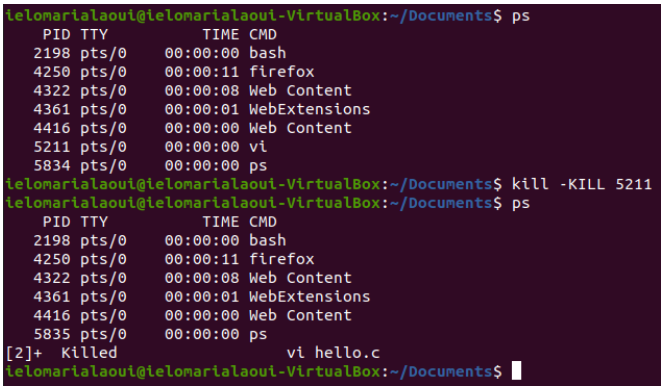
- s : **tail** : Display the last lines of file.



- t : **grep** : Search for patterns in files.



- u : **kill** : Send different types of Signals to processes using `PID`.



- v : **killall** : Same as `kill`, but using process names.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ vi

[1]+  Stopped                 vi
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ps
    PID TTY          TIME CMD
   2198 pts/0    00:00:00 bash
   6325 pts/0    00:00:00 vi
   6326 pts/0    00:00:00 ps
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ killall -s 9 vi
[1]+  Killed                  vi
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ps
    PID TTY          TIME CMD
   2198 pts/0    00:00:00 bash
   6329 pts/0    00:00:00 ps
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- w : **du** : Display the disk usage of a given file or directory in bytes.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls
a.out  hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ du a.out
20      a.out
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- x : **df** : Get a detailed report on the system's disk space usage.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ df
Filesystem     1K-blocks    Used Available Use% Mounted on
udev             1984428       0   1984428   0% /dev
tmpfs             402812    1412    401400   1% /run
/dev/sda5       25152772 7901472  15950564  34% /
tmpfs            2014044   20392   1993652   2% /dev/shm
tmpfs               5120       4      5116   1% /run/lock
tmpfs            2014044       0   2014044   0% /sys/fs/cgroup
/dev/loop0        222208  222208         0 100% /snap/code/73
/dev/loop2         56832   56832         0 100% /snap/core18/2128
/dev/loop3        224256  224256         0 100% /snap/gnome-3-34-1804/72
/dev/loop1        101760  101760         0 100% /snap/core/11606
/dev/loop4         66688   66688         0 100% /snap/gtk-common-themes/1515
/dev/loop5         52224   52224         0 100% /snap/snap-store/547
/dev/loop6         33152   33152         0 100% /snap/snapd/12704
/dev/sda1         523248       4    523244   1% /boot/efi
tmpfs             402808      40    402768   1% /run/user/1000
/dev/sr0           59642   59642         0 100% /media/ielomarialaoui/VBox_GA
s_6.1.26
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- y : **screen** : Launch and Use multiple shell sessions from a single ssh session.

```
GNU Screen version 4.08.00 (GNU) 05-Feb-20

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This program is free software; you can redistribute it and/or modify it
under the terms of the GNU General Public License as published by the Free
Software Foundation; either version 3, or (at your option) any later
version.

This program is distributed in the hope that it will be useful, but WITHOUT

              [Press Space for next page; Return to end.]
```

- z : **vim** : Launch the VIM text editor.

```
#include <stdio.h>
int main() {
   // printf() displays the string inside quotation
   printf("Hello, World!");
   return 0;
}
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"hello.c" [noeol] 6L, 126C                                    1,1           All
```

- aa : **chmod** : Change a file or directory rights (Read, Write, Execute).

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al hello.c
-rw-rw-r-- 1 ielomarialaoui ielomarialaoui 126 Sep  5 15:42 hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ chmod +x hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al hello.c
-rwxrwxr-x 1 ielomarialaoui ielomarialaoui 126 Sep  5 15:42 hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- bb : **chown** : Change the User or Group ownership of a given file.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al hello.c
-rwxrwxr-x 1 ielomarialaoui ielomarialaoui 126 Sep  5 15:42 hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ sudo chown root hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al hello.c
-rwxrwxr-x 1 root ielomarialaoui 126 Sep  5 15:42 hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- cc : **useradd** : Create and Configure new users.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ sudo useradd dummyuser
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- dd : **man** : Provide the reference manual for commands.

```
LS(1)                          User Commands                          LS(1)

NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List information about the FILEs (the current directory by default).
       Sort entries alphabetically if none of -cftuvSUX nor --sort is spec-
       ified.

       Mandatory  arguments to long options are mandatory for short options
       too.

       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
 Manual page ls(1) line 1 (press h for help or q to quit)
```

- ee : **locate** : Locate a file by the name.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ locate hello.c
/home/ielomarialaoui/Documents/hello.c
/snap/gnome-3-34-1804/72/usr/lib/peas-demo/plugins/pythonhello/__pycache__/py
thonhello.cpython-36.opt-1.pyc
/snap/gnome-3-34-1804/72/usr/lib/peas-demo/plugins/pythonhello/__pycache__/py
thonhello.cpython-36.pyc
```

- ff : **find** : Search for a file recursively in a given directory.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ mkdir dummydirectory
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ mv hello.c dummydirecto
ry/
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ cd ..
ielomarialaoui@ielomarialaoui-VirtualBox:~$ find Documents/ -name hello.c
Documents/dummydirectory/hello.c
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- gg : **sed** : (Stream Editor) Perform basic text manipulation on files.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ cat dummyfile
Hello friend!
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ sed "s/Hello/Bye/" dumm
yfile
Bye friend!
```

- hh : **awk** : Process textual data files and text patterns.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al
total 16
drwxr-xr-x  3 ielomarialaoui ielomarialaoui 4096 Sep  5 16:13 .
drwxr-xr-x 19 ielomarialaoui ielomarialaoui 4096 Sep  5 16:03 ..
drwxrwxr-x  2 ielomarialaoui ielomarialaoui 4096 Sep  5 16:11 dummydirectory
-rw-rw-r--  1 ielomarialaoui ielomarialaoui   14 Sep  5 16:14 dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls -al | grep -v total
| awk '{print $3, $9}'
ielomarialaoui .
ielomarialaoui ..
ielomarialaoui dummydirectory
ielomarialaoui dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- ii : **diff** : Compare between different files lines.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ cp dummyfile ./dummyfil
e2
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ ls
dummydirectory  dummyfile  dummyfile2
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ diff dummyfile dummyfil
e2
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ echo "++" >> dummyfile2
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ diff dummyfile dummyfil
e2
1a2
> ++
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- jj : **sort** : Sort the lines of files.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ echo -e "b\nd\na\nc" >
dummyfile
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ cat dummyfile
b
d
a
c
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ sort dummyfile
a
b
c
d
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- kk : **export** : Export environment variables to child processes.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ export -p |  head -5
declare -x COLORTERM="truecolor"
declare -x DBUS_SESSION_BUS_ADDRESS="unix:path=/run/user/1000/bus"
declare -x DESKTOP_SESSION="ubuntu"
declare -x DISPLAY=":0"
declare -x GDMSESSION="ubuntu"
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- ll : **pwd** : Print current working directory.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ pwd
/home/ielomarialaoui/Documents
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- mm : **crontab** : Display, Edit and Remove scheduled cron jobs.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ crontab -l
no crontab for ielomarialaoui
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- nn : **mount** : Mount the file system found on a device to the Linux system.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ mount -l | head -5
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=1984428k,nr_inodes=496107,mode=755,inode64)
devpts on /dev/pts type devpts (rw,nosuid,noexec,relatime,gid=5,mode=620,ptmxmode=000)
tmpfs on /run type tmpfs (rw,nosuid,nodev,noexec,relatime,size=402812k,mode=755,inode64)
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- oo : **passwd** : Change User password.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ sudo passwd -Sa | head -5
root L 09/05/2021 0 99999 7 -1
daemon L 08/19/2021 0 99999 7 -1
bin L 08/19/2021 0 99999 7 -1
sys L 08/19/2021 0 99999 7 -1
sync L 08/19/2021 0 99999 7 -1
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- pp : **uname** : Display System Information.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ uname -a
Linux ielomarialaoui-VirtualBox 5.11.0-27-generic #29~20.04.1-Ubuntu SMP Wed Aug 11 15:58:17 UTC 2021 x86_64 x86_64 x86_64 GNU/Linux
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- qq : **whereis** : Locate execution files of a given command.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ whereis gcc
gcc: /usr/bin/gcc /usr/lib/gcc /usr/share/gcc /usr/share/man/man1/gcc.1.gz
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

- rr : **whatis** : Display a one-line manual page description of a given command.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$ whatis gcc
gcc (1)              - GNU project C and C++ compiler
ielomarialaoui@ielomarialaoui-VirtualBox:~/Documents$
```

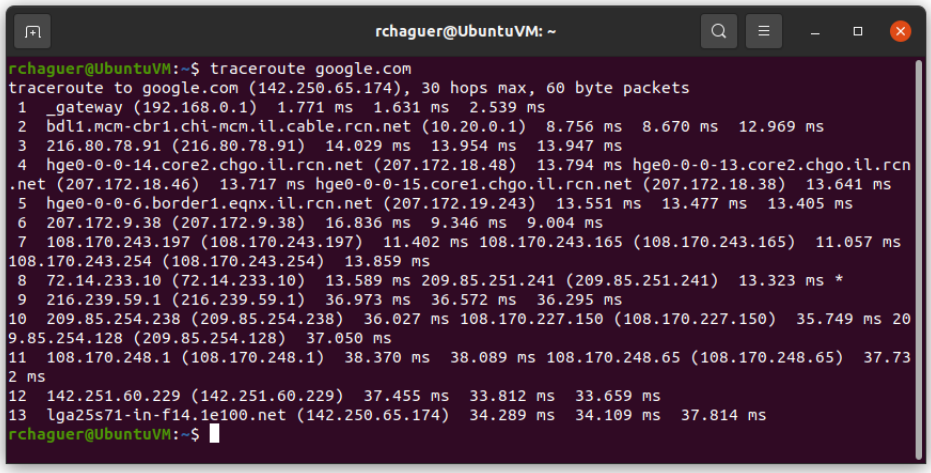
- ss : **su** : Run commands with another user's privileges.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ su -l dummyuser
Password:
su: warning: cannot change directory to /home/dummyuser: No such file or directory
$ exit
ielomarialaoui@ielomarialaoui-VirtualBox:~$ su -p dummyuser
Password:
dummyuser@ielomarialaoui-VirtualBox:~$
```

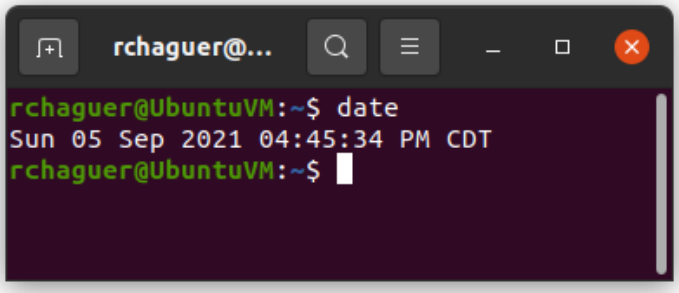
- tt : **ping** : Check whether a network is available and if a host is reachable by sending packages.

```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ ping 10.0.2.4
PING 10.0.2.4 (10.0.2.4) 56(84) bytes of data.
64 bytes from 10.0.2.4: icmp_seq=1 ttl=64 time=1.12 ms
64 bytes from 10.0.2.4: icmp_seq=2 ttl=64 time=3.34 ms
64 bytes from 10.0.2.4: icmp_seq=3 ttl=64 time=4.16 ms
64 bytes from 10.0.2.4: icmp_seq=4 ttl=64 time=3.50 ms
64 bytes from 10.0.2.4: icmp_seq=5 ttl=64 time=1.07 ms
64 bytes from 10.0.2.4: icmp_seq=6 ttl=64 time=3.88 ms
64 bytes from 10.0.2.4: icmp_seq=7 ttl=64 time=0.960 ms
^C
--- 10.0.2.4 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6012ms
rtt min/avg/max/mdev = 0.960/2.573/4.159/1.345 ms
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

- uu : **traceroute** : Display the route of packets from your computer on their way to a given host.



- vv : **date** : Display the system date and time.

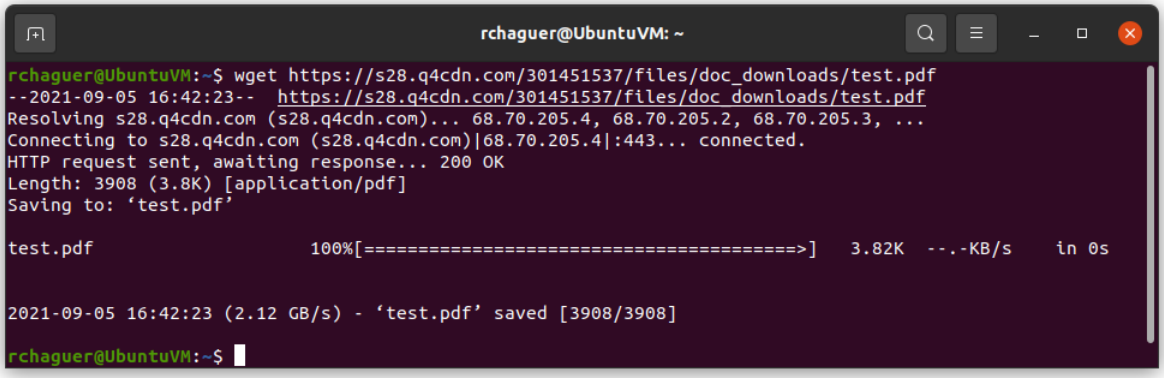


- ww : **time** : Determine the period of time a given command takes to run.

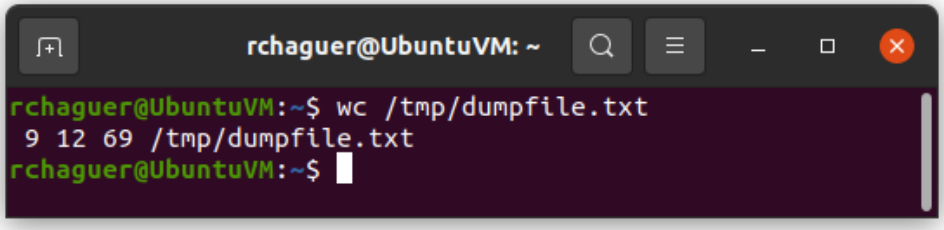
```
ielomarialaoui@ielomarialaoui-VirtualBox:~$ time ls
Desktop  Documents  Downloads  Music  Pictures  Public  snap  Templates  Videos

real    0m0.003s
user    0m0.003s
sys     0m0.000s
ielomarialaoui@ielomarialaoui-VirtualBox:~$
```

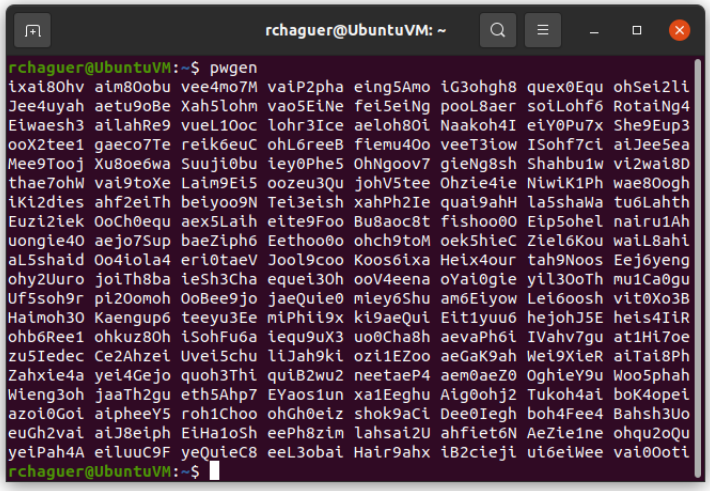
- xx : **wget** : Download files using HTTP, HTTPS, and FTP protocols.



- yy : **wc** : Get the newline count, word count and byte count from a given file.



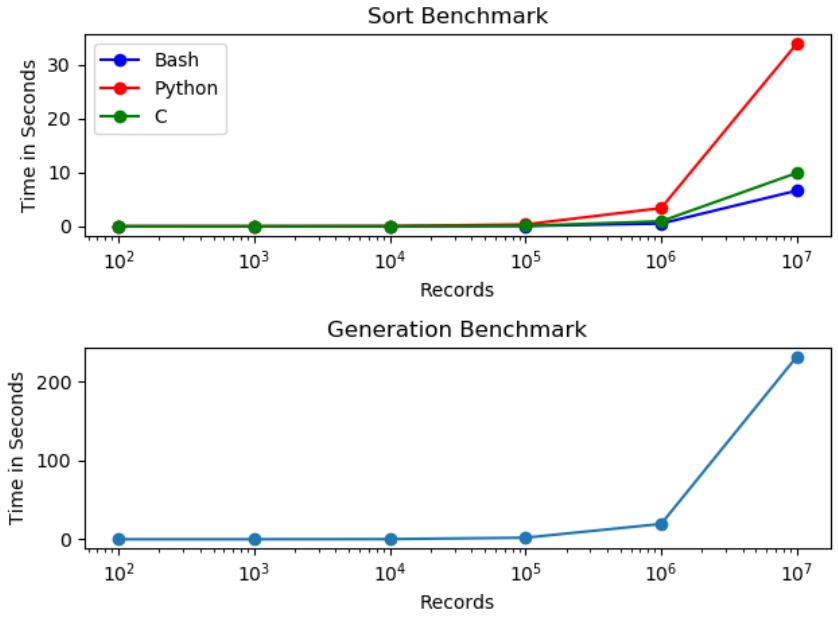
- zz : **pwgen** : Generate passwords which are easily memorized by humans.



3

All the required scripts are present in the source folder of our project.

a. *generate-dataset.sh* **b.** *sort-data.sh* **c.** *sort-data.c* **d.** *sort-data.py* **e.** *generate-graph.py*



4

a. *Number of Processor Configuration*

The decision to increase or decrease number of processors available to a VM's use must be taken after knowing the purpose of the VM. If the user will use the guest operating system to do casual work, 1 to 2 processors are more than enough. On the contrary, if the VM will be used to do computation, gaming, simulation and complex applications, adding processors is recommended and can be even compulsory for a fully functional guest OS.
In general, using all of the processors for a VM is really a bad idea as this consumes all of the host machine's computing power and would definitely cause bad performance. But, there is some scenarios where we want to bypass the host machine completely, the following link is a youtube video where we try to operate seven VMs with 2 CPUs and 7 GPUs: https://www.youtube.com/watch?v=LXOaCkbt4lI. The title of the video is "7 Gamers and 1 CPU" as these VMs will be used for gaming, the number of processors available for each VM's use is maximised.

b. *Paravirtualization Configuration*

In Oracle's paravirtualization providers documentation, the paravirtualization options are defined as follows:

- **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. Oracle VM 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. *Storage Control Configuration*

- **IDE:** Integrated Drive Electronics is a standard way for a storage device to connect to a computer. *Example use case:* IDE has maximum compatibility but lacks transfer speed firstly and support for new technology such as native command queuing and hot-plugging hard drives.
- **SATA:** Serial Advanced Technology Attachment is the new standard for connecting and transferring data components inside of your computer. It is a bus interface that connects host bus adapters to mass storage devices. If a virtual machine has multiple hard disks or CD/DVD-ROM devices, you can add up to three additional SATA controllers to assign the devices to. When you spread the devices among several controllers, you can improve performance and avoid data traffic congestion.
  Example use case: SATA is a great technology to have in your computer when storing information that you don't need to use on a regular basis, because it works at a slower pace when it transfers data out of the storage drive.
- **NVMe:** Non-Volatile Memory express is a new storage access and transport protocol for flash and next-generation solid-state drives (SSDs) that delivers the highest throughput and fastest response times yet for all types of enterprise workloads. Using an NVMe controller in a VM significantly reduces the software overhead for processing guest OS I/O, as compared to AHCI SATA or SCSI controllers.
  Example use case: NVMe storage is already being used in business scenarios where every microsecond counts such as AI, ML, big data, e-commerce or even devops enabling you to run more iterations in less time.

d. *Network Configuration*

- **NAT:** With NAT, a virtual machine does not have its own IP address on the external network. Instead, a separate private network is set up on the host system. In the default configuration, a virtual machine gets an address on this private network from the virtual DHCP server. The virtual machine and the host system share a single network identity that is not visible on the external network.
- **Bridged Adapter:** Bridged networking connects a virtual machine to a network by using the network adapter on the host system. If the host system is on a network, bridged networking is often the easiest way to give the virtual machine access to that network.
- **Internal Network:** This can be used to create a different kind of software-based network which is visible to selected virtual machines, but not to applications running on the host or to the outside world.
- **Host-only Network:** Host-only networking creates a network that is completely contained within the host computer. Host-only networking provides a network connection between the virtual machine and the host system by using a virtual network adapter that is visible on the host operating system.

e. *USB Configuration*

- **USB 1.1** operates at a maximum transfer bandwidth of $12Mb/s$. This type of USB connection is sufficient to connect devices that require little bandwidth, such as a keyboard, mouse, printer, etc.
- **USB 2.0** operates at a maximum transfer bandwidth of $480Mb/s$ called *high speed* and uses only 4 pins. The connector is often black in color.
- **USB 3.0** operates at a maximum transfer bandwidth of $5Gb/s$ called *super speed* and it uses a blue connector with more pins, to differentiate it from **USB 2.0**.