ECE 4310
Operating Systems for Embedded Application

Project 1

Choi Tim Antony Yung

March 4, 2021

1 Unix login server

1.1 `ls -l /`

Figure 1: Output of `ls -l /`

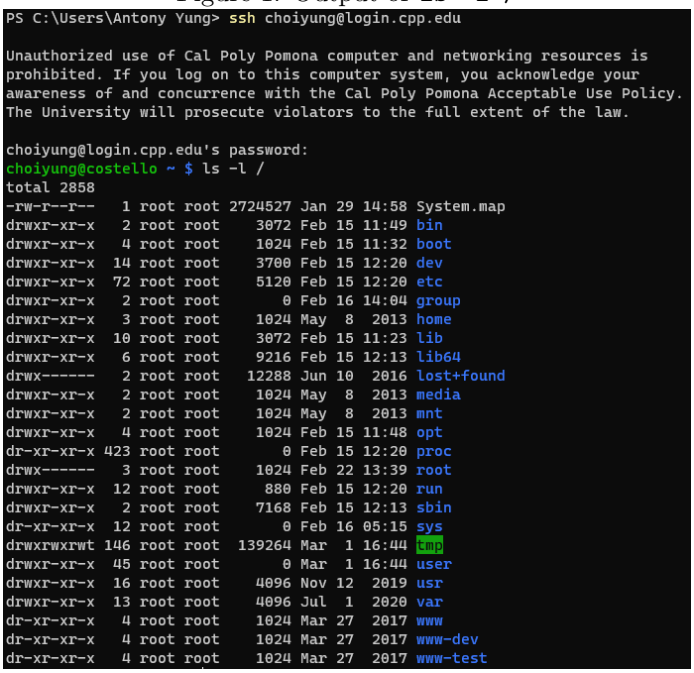
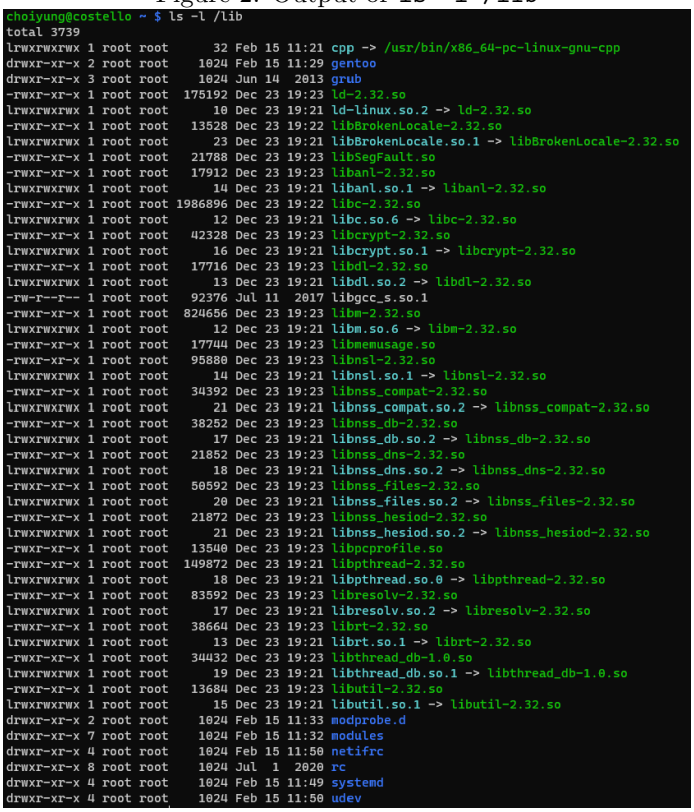
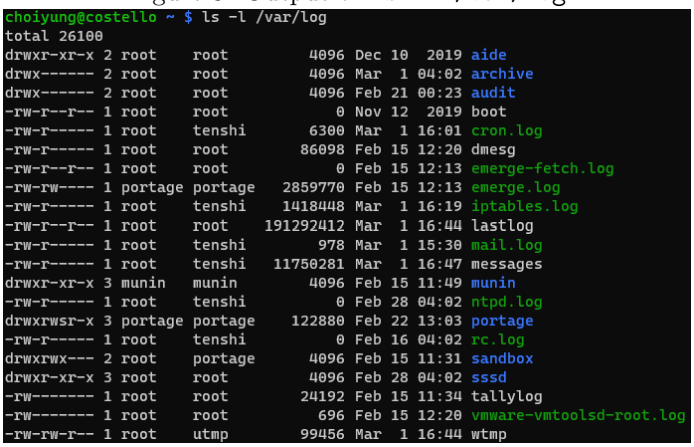


Figure 2: Output of `ls -l /lib`



```
choiyung@costello ~ $ ls -l /lib
total 3739
lrwxrwxrwx 1 root root      32 Feb 15 11:21 cpp -> /usr/bin/x86_64-pc-linux-gnu-cpp
drwxr-xr-x 2 root root    1024 Feb 15 11:29 gentoo
drwxr-xr-x 3 root root    1024 Jun 14  2013 grub
-rwxr-xr-x 1 root root  175192 Dec 23 19:23 ld-2.32.so
lrwxrwxrwx 1 root root      10 Dec 23 19:21 ld-linux.so.2 -> ld-2.32.so
-rwxr-xr-x 1 root root   13528 Dec 23 19:22 libBrokenLocale-2.32.so
lrwxrwxrwx 1 root root      23 Dec 23 19:21 libBrokenLocale.so.1 -> libBrokenLocale-2.32.so
-rwxr-xr-x 1 root root   21788 Dec 23 19:23 libSegFault.so
-rwxr-xr-x 1 root root   17912 Dec 23 19:23 libanl-2.32.so
lrwxrwxrwx 1 root root      14 Dec 23 19:21 libanl.so.1 -> libanl-2.32.so
-rwxr-xr-x 1 root root 1986896 Dec 23 19:22 libc-2.32.so
lrwxrwxrwx 1 root root      12 Dec 23 19:21 libc.so.6 -> libc-2.32.so
-rwxr-xr-x 1 root root   42328 Dec 23 19:23 libcrypt-2.32.so
lrwxrwxrwx 1 root root      16 Dec 23 19:21 libcrypt.so.1 -> libcrypt-2.32.so
-rwxr-xr-x 1 root root   17716 Dec 23 19:23 libdl-2.32.so
lrwxrwxrwx 1 root root      13 Dec 23 19:21 libdl.so.2 -> libdl-2.32.so
-rw-r--r-- 1 root root   92376 Jul 11  2017 libgcc_s.so.1
-rwxr-xr-x 1 root root  824656 Dec 23 19:23 libm-2.32.so
lrwxrwxrwx 1 root root      12 Dec 23 19:21 libm.so.6 -> libm-2.32.so
-rwxr-xr-x 1 root root   17744 Dec 23 19:23 libmemusage.so
-rwxr-xr-x 1 root root   95880 Dec 23 19:23 libnsl-2.32.so
lrwxrwxrwx 1 root root      14 Dec 23 19:21 libnsl.so.1 -> libnsl-2.32.so
-rwxr-xr-x 1 root root   34392 Dec 23 19:23 libnss_compat-2.32.so
lrwxrwxrwx 1 root root      21 Dec 23 19:21 libnss_compat.so.2 -> libnss_compat-2.32.so
-rwxr-xr-x 1 root root   38252 Dec 23 19:23 libnss_db-2.32.so
lrwxrwxrwx 1 root root      17 Dec 23 19:21 libnss_db.so.2 -> libnss_db-2.32.so
-rwxr-xr-x 1 root root   21852 Dec 23 19:23 libnss_dns-2.32.so
lrwxrwxrwx 1 root root      18 Dec 23 19:21 libnss_dns.so.2 -> libnss_dns-2.32.so
-rwxr-xr-x 1 root root   50592 Dec 23 19:23 libnss_files-2.32.so
lrwxrwxrwx 1 root root      20 Dec 23 19:21 libnss_files.so.2 -> libnss_files-2.32.so
-rwxr-xr-x 1 root root   21872 Dec 23 19:23 libnss_hesiod-2.32.so
lrwxrwxrwx 1 root root      21 Dec 23 19:21 libnss_hesiod.so.2 -> libnss_hesiod-2.32.so
-rwxr-xr-x 1 root root   13540 Dec 23 19:23 libpcprofile.so
-rwxr-xr-x 1 root root  149872 Dec 23 19:21 libpthread-2.32.so
lrwxrwxrwx 1 root root      18 Dec 23 19:21 libpthread.so.0 -> libpthread-2.32.so
-rwxr-xr-x 1 root root   83592 Dec 23 19:23 libresolv-2.32.so
lrwxrwxrwx 1 root root      17 Dec 23 19:21 libresolv.so.2 -> libresolv-2.32.so
-rwxr-xr-x 1 root root   38664 Dec 23 19:23 librt-2.32.so
lrwxrwxrwx 1 root root      13 Dec 23 19:21 librt.so.1 -> librt-2.32.so
-rwxr-xr-x 1 root root   34432 Dec 23 19:23 libthread_db-1.0.so
lrwxrwxrwx 1 root root      19 Dec 23 19:21 libthread_db.so.1 -> libthread_db-1.0.so
-rwxr-xr-x 1 root root   13684 Dec 23 19:23 libutil-2.32.so
lrwxrwxrwx 1 root root      15 Dec 23 19:21 libutil.so.1 -> libutil-2.32.so
drwxr-xr-x 2 root root    1024 Feb 15 11:33 modprobe.d
drwxr-xr-x 7 root root    1024 Feb 15 11:32 modules
drwxr-xr-x 4 root root    1024 Feb 15 11:50 netifrc
drwxr-xr-x 8 root root    1024 Jul  1  2020 rc
drwxr-xr-x 4 root root    1024 Feb 15 11:49 systemd
drwxr-xr-x 4 root root    1024 Feb 15 11:50 udev
```

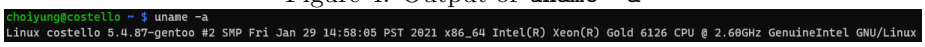
Figure 3: Output of `ls -l /var/log`



```
choiyung@costello ~ $ ls -l /var/log
total 26100
drwxr-xr-x 2 root    root         4096 Dec 10  2019 aide
drwx------ 2 root    root         4096 Mar  1 04:02 archive
drwx------ 2 root    root         4096 Feb 21 00:23 audit
-rw-r--r-- 1 root    root            0 Nov 12  2019 boot
-rw-r----- 1 root    tenshi       6300 Mar  1 16:01 cron.log
-rw-r----- 1 root    root        86098 Feb 15 12:20 dmesg
-rw-r--r-- 1 root    root            0 Feb 15 12:13 emerge-fetch.log
-rw-rw---- 1 portage portage   2859770 Feb 15 12:13 emerge.log
-rw-r----- 1 root    tenshi    1418448 Mar  1 16:19 iptables.log
-rw-r--r-- 1 root    root    191292412 Mar  1 16:44 lastlog
-rw-r----- 1 root    tenshi        978 Mar  1 15:30 mail.log
-rw-r----- 1 root    tenshi   11750281 Mar  1 16:47 messages
drwxr-xr-x 3 munin   munin        4096 Feb 15 11:49 munin
-rw-r----- 1 root    tenshi          0 Feb 28 04:02 ntpd.log
drwxrwsr-x 3 portage portage    122880 Feb 22 13:03 portage
-rw-r----- 1 root    tenshi          0 Feb 16 04:02 rc.log
drwxrwx--- 2 root    portage      4096 Feb 15 11:31 sandbox
drwxr-xr-x 3 root    root         4096 Feb 28 04:02 sssd
-rw------- 1 root    root        24192 Feb 15 11:34 tallylog
-rw------- 1 root    root          696 Feb 15 12:20 vmware-vmtoolsd-root.log
-rw-rw-r-- 1 root    utmp        99456 Mar  1 16:44 wtmp
```

1.2 `uname -a`

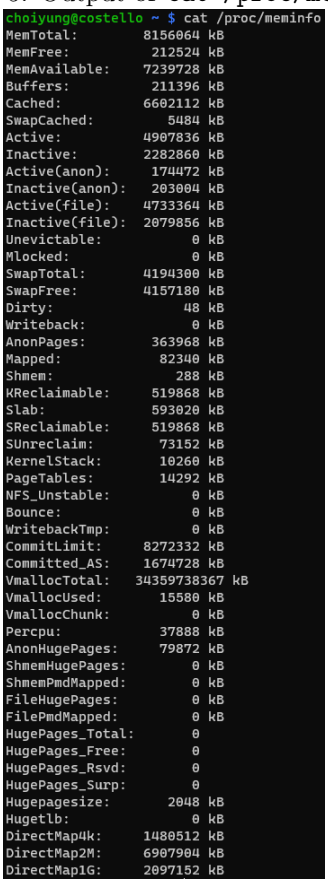
Figure 4: Output of `uname -a`



It uses 5.4.87-gentoo release of the Linux kernel. It was compiled on Fri Jan 29 14:58:05 PST 2021 for x86_64 architecture.

1.3 `cat /proc/meminfo`

Figure 5: Output of `cat /proc/meminfo`



212524 MB memory is free and $8156064 - 212524 = 7943540$ MB memory is used.

1.4 `cat /proc/cpuinfo`

Figure 6: Output of `cat /proc/cpuinfo`

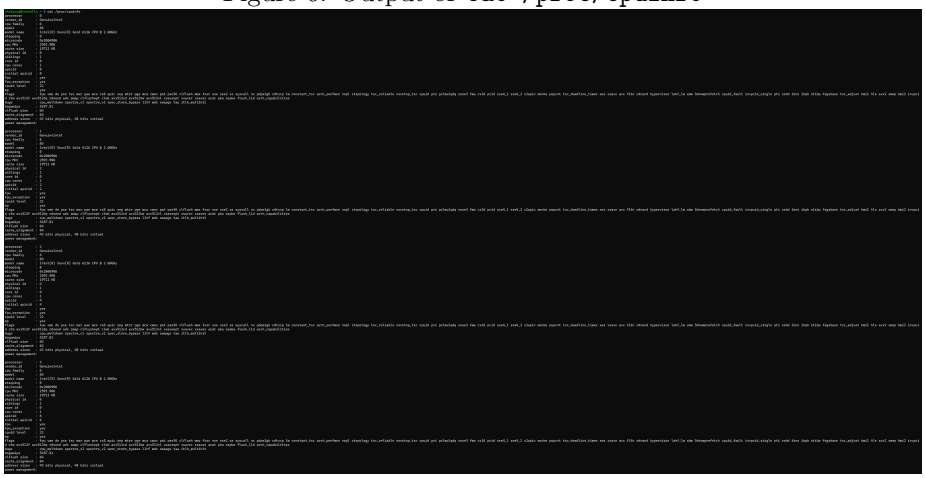
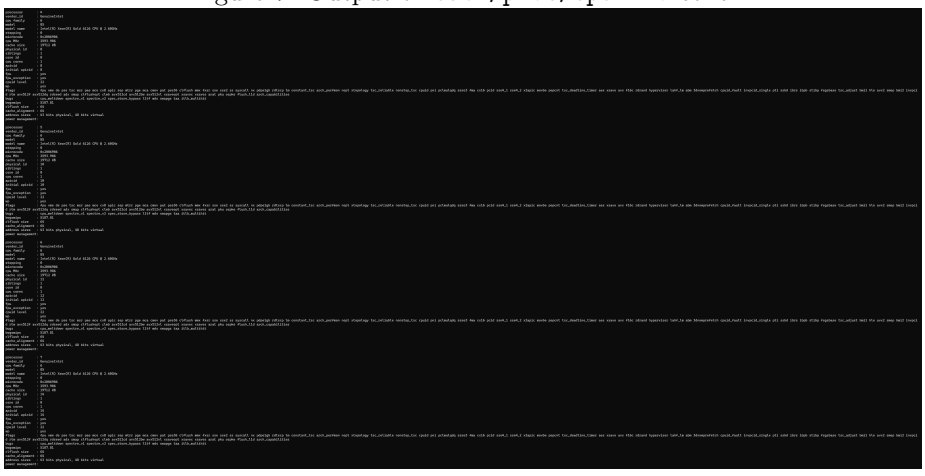


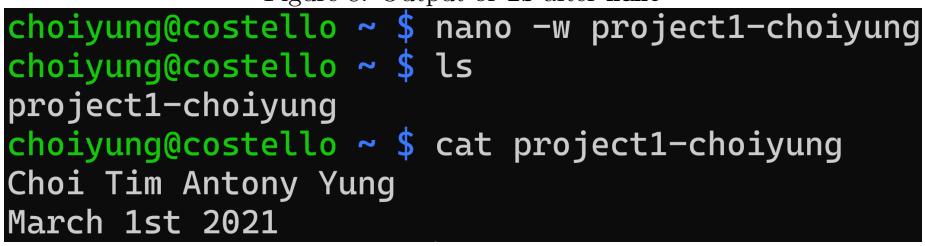
Figure 7: Output of `cat /proc/cpuinfo` cont.



There are a total of 8 CPUs that the operating system see and they are all Intel Xeon Gold 6126.

1.5 `nano -w project1-choiyung`

Figure 8: Output of `ls` after `nano`



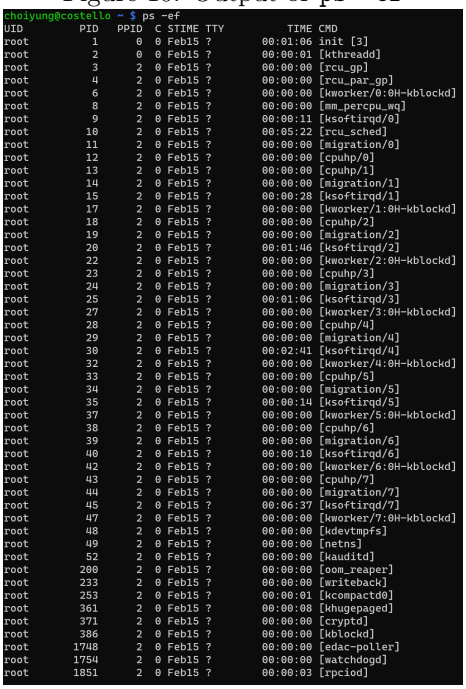
1.6 `ifconfig eth0`

Figure 9: Output of `ifconfig eth0`

IPv4 address is `134.71.246.204`, IPv6 address is `2620:df:8000:ff14:0:1:246:204`, MAC address is `00:50:56:89:24:d0`

2 ps

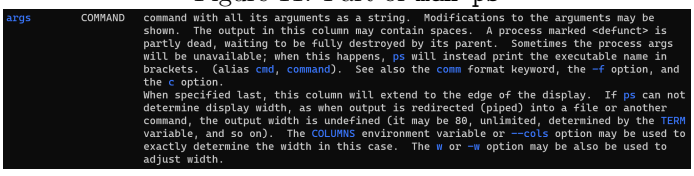
Figure 10: Output of `ps -ef`



```
choiyung@costello ~ $ ps -ef
UID          PID    PPID  C STIME TTY          TIME CMD
root           1       0  0 Feb15 ?        00:01:06 init [3]
root           2       0  0 Feb15 ?        00:00:01 [kthreadd]
root           3       2  0 Feb15 ?        00:00:00 [rcu_gp]
root           4       2  0 Feb15 ?        00:00:00 [rcu_par_gp]
root           6       2  0 Feb15 ?        00:00:00 [kworker/0:0H-kblockd]
root           8       2  0 Feb15 ?        00:00:00 [mm_percpu_wq]
root           9       2  0 Feb15 ?        00:00:11 [ksoftirqd/0]
root          10       2  0 Feb15 ?        00:05:22 [rcu_sched]
root          11       2  0 Feb15 ?        00:00:00 [migration/0]
root          12       2  0 Feb15 ?        00:00:00 [cpuhp/0]
root          13       2  0 Feb15 ?        00:00:00 [cpuhp/1]
root          14       2  0 Feb15 ?        00:00:00 [migration/1]
root          15       2  0 Feb15 ?        00:00:28 [ksoftirqd/1]
root          17       2  0 Feb15 ?        00:00:00 [kworker/1:0H-kblockd]
root          18       2  0 Feb15 ?        00:00:00 [cpuhp/2]
root          19       2  0 Feb15 ?        00:00:00 [migration/2]
root          20       2  0 Feb15 ?        00:01:46 [ksoftirqd/2]
root          22       2  0 Feb15 ?        00:00:00 [kworker/2:0H-kblockd]
root          23       2  0 Feb15 ?        00:00:00 [cpuhp/3]
root          24       2  0 Feb15 ?        00:00:00 [migration/3]
root          25       2  0 Feb15 ?        00:01:06 [ksoftirqd/3]
root          27       2  0 Feb15 ?        00:00:00 [kworker/3:0H-kblockd]
root          28       2  0 Feb15 ?        00:00:00 [cpuhp/4]
root          29       2  0 Feb15 ?        00:00:00 [migration/4]
root          30       2  0 Feb15 ?        00:02:41 [ksoftirqd/4]
root          32       2  0 Feb15 ?        00:00:00 [kworker/4:0H-kblockd]
root          33       2  0 Feb15 ?        00:00:00 [cpuhp/5]
root          34       2  0 Feb15 ?        00:00:00 [migration/5]
root          35       2  0 Feb15 ?        00:00:14 [ksoftirqd/5]
root          37       2  0 Feb15 ?        00:00:00 [kworker/5:0H-kblockd]
root          38       2  0 Feb15 ?        00:00:00 [cpuhp/6]
root          39       2  0 Feb15 ?        00:00:00 [migration/6]
root          40       2  0 Feb15 ?        00:00:10 [ksoftirqd/6]
root          42       2  0 Feb15 ?        00:00:00 [kworker/6:0H-kblockd]
root          43       2  0 Feb15 ?        00:00:00 [cpuhp/7]
root          44       2  0 Feb15 ?        00:00:00 [migration/7]
root          45       2  0 Feb15 ?        00:06:37 [ksoftirqd/7]
root          47       2  0 Feb15 ?        00:00:00 [kworker/7:0H-kblockd]
root          48       2  0 Feb15 ?        00:00:00 [kdevtmpfs]
root          49       2  0 Feb15 ?        00:00:00 [netns]
root          52       2  0 Feb15 ?        00:00:00 [kauditd]
root         200       2  0 Feb15 ?        00:00:00 [oom_reaper]
root         233       2  0 Feb15 ?        00:00:00 [writeback]
root         253       2  0 Feb15 ?        00:00:01 [kcompactd0]
root         361       2  0 Feb15 ?        00:00:08 [khugepaged]
root         371       2  0 Feb15 ?        00:00:00 [cryptd]
root         386       2  0 Feb15 ?        00:00:00 [kblockd]
root        1708       2  0 Feb15 ?        00:00:00 [edac-poller]
root        1754       2  0 Feb15 ?        00:00:00 [watchdogd]
root        1851       2  0 Feb15 ?        00:00:03 [rpciod]
```

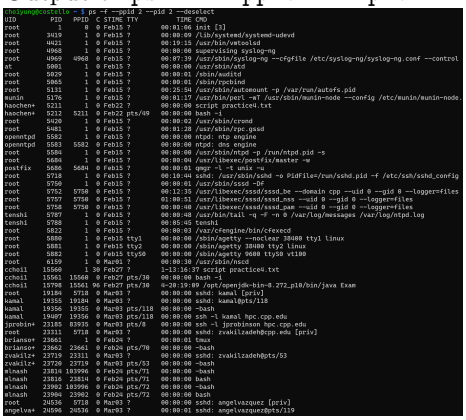
The `-e` option select all processes and the `-f` option use full-format listing. Processes listed with name in square bracket mean the process arguments are unavailable.

Figure 11: Part of `man ps`



```
args         COMMAND   command with all its arguments as a string.  Modifications to the arguments may be
                       shown.  The output in this column may contain spaces.  A process marked <defunct> is
                       partly dead, waiting to be fully destroyed by its parent.  Sometimes the process args
                       will be unavailable; when this happens, ps will instead print the executable name in
                       brackets.  (alias cmd, command).  See also the comm format keyword, the -f option, and
                       the c option.
                       When specified last, this column will extend to the edge of the display.  If ps can not
                       determine display width, as when output is redirected (piped) into a file or another
                       command, the output width is undefined (it may be 80, unlimited, determined by the TERM
                       variable, and so on).  The COLUMNS environment variable or --cols option may be used to
                       exactly determine the width in this case.  The w or -w option may be also be used to
                       adjust width.
```

Figure 12: Output of `ps -f --ppid 2 --pid 2 --deselect`



Kernel threads are spawn by the kernel thread daemon `kthreadd`, which have `pid` of `2`. `--ppid 2` option select all child processes of `kthreadd`, while `--pid 2` option select `kthreadd` itself. The two options combined will select all kernel threads. `--deselect` option will then negates the selection which result in all user-space threads selected.

Figure 13: Output of `ps -ef | grep choiyung`

```
choiyung@costello ~ $ ps -ef | grep choiyung
root       81802   5718  0 16:43 ?        00:00:00 sshd: choiyung [priv]
choiyung   81943  81802  0 16:44 ?        00:00:00 sshd: choiyung@pts/126
choiyung   81944  81943  0 16:44 pts/126  00:00:00 -bash
choiyung   92853  81944  0 17:18 pts/126  00:00:00 ps -ef
choiyung   92854  81944  0 17:18 pts/126  00:00:00 grep --colour=auto choiyung
```

5 processes was associated with my username. Two from the secure shell daemon, one from the bash shell, one from the ps command and one from the grep command.