

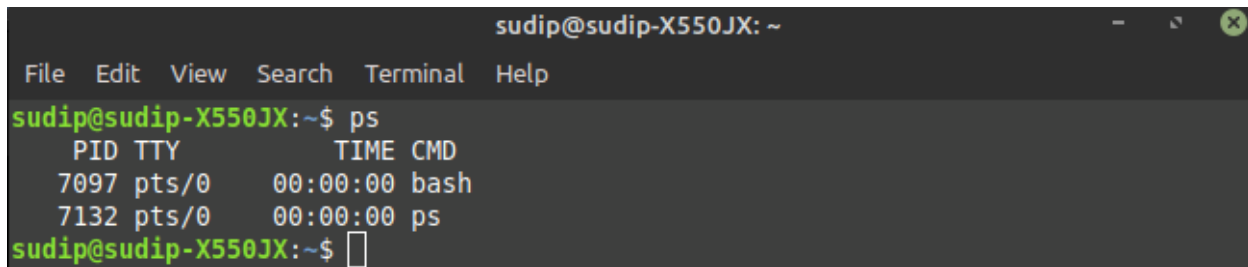
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M.Tech (CSE)  
Assignment 1  
CS 612

<https://github.com/David-jon/OS-Assignment-1-IITGN>

### Part 1 - Running inbuilt binaries

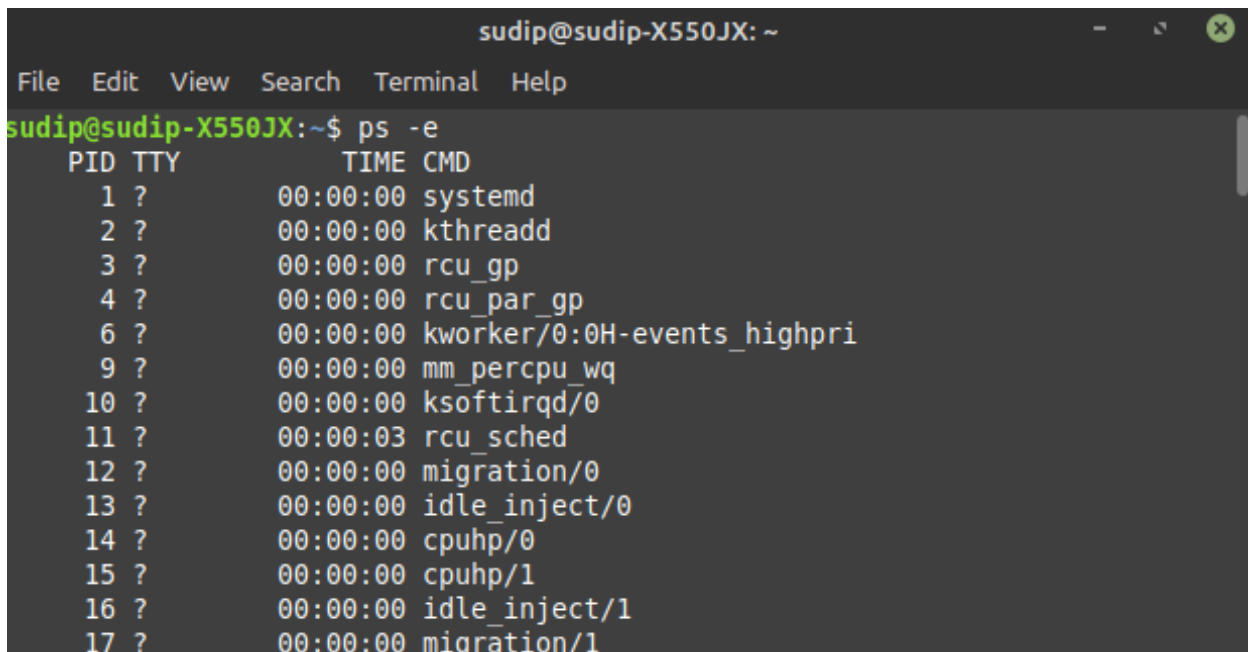
- a) **The ps command** – This function reports a snapshot of the current processes.

If it is not used without any arguments, it displays all the processes that is being run on the current shell

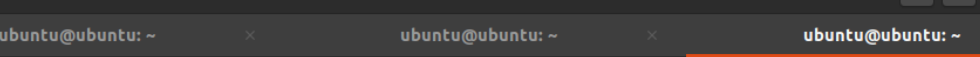


```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~$ ps  
  PID TTY          TIME CMD  
  7097 pts/0    00:00:00 bash  
  7132 pts/0    00:00:00 ps  
sudip@sudip-X550JX:~$
```

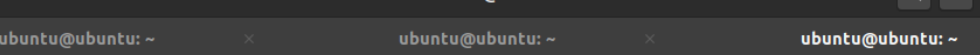
If we use the -e flag we can see all the processes and their details that are currently running in the system. By default the processes are sorted by their PID number



```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~$ ps -e  
  PID TTY          TIME CMD  
    1 ?           00:00:00 systemd  
    2 ?           00:00:00 kthreadd  
    3 ?           00:00:00 rcu_gp  
    4 ?           00:00:00 rcu_par_gp  
    6 ?           00:00:00 kworker/0:0H-events_highpri  
    9 ?           00:00:00 mm_percpu_wq  
   10 ?           00:00:00 ksoftirqd/0  
   11 ?           00:00:03 rcu_sched  
   12 ?           00:00:00 migration/0  
   13 ?           00:00:00 idle_inject/0  
   14 ?           00:00:00 cpuhp/0  
   15 ?           00:00:00 cpuhp/1  
   16 ?           00:00:00 idle_inject/1  
   17 ?           00:00:00 migration/1
```

[illegible]

```
ubuntu@ubuntu: ~  
ubuntu@ubuntu: ~  
ubuntu@ubuntu: ~  
Every 2.0s: ps -eo pid,ppid,cmd,%mem,%cpu --sort=-%mem | head  
PID    PPID  CMD                                %MEM  %CPU  
8421    6636  /usr/lib/firefox/firefox -c       5.3    2.1  
6636    1829  /usr/lib/firefox/firefox -n       3.9    7.7  
5020    1829  /usr/bin/gnome-shell              2.2    3.4  
6715    6636  /usr/lib/firefox/firefox -c       1.4    0.2  
11287   6636  /usr/lib/firefox/firefox -c       1.3    0.8  
11425   6636  /usr/lib/firefox/firefox -c       1.3    1.6  
4816    4814  /usr/lib/xorg/Xorg vt2 -dis       1.1    4.0  
6578    1829  /usr/bin/gedit --gapplicati       1.0    0.8  
7293    1829  /usr/bin/nautilus --gapplic       0.7    0.4
```



```
ubuntu@ubuntu: ~  
ubuntu@ubuntu: ~  
ubuntu@ubuntu: ~  
Every 2.0s: ps -eo pid,ppid,cmd,%mem,%cpu --sort=-%mem | head  
PID      PPID  CMD                                %MEM %CPU  
8421     6636  /usr/lib/firefox/firefox -c      5.3  2.1  
6636     1829  /usr/lib/firefox/firefox -n      3.9  7.7  
5020     1829  /usr/bin/gnome-shell             2.2  3.4  
6715     6636  /usr/lib/firefox/firefox -c      1.4  0.2  
11287    6636  /usr/lib/firefox/firefox -c      1.3  0.8  
11425    6636  /usr/lib/firefox/firefox -c      1.3  1.6  
4816     4814  /usr/lib/xorg/Xorg vt2 -dis      1.1  4.0  
6578     1829  /usr/bin/gedit --gapplicati     1.0  0.8  
7293     1829  /usr/bin/nautilus --gapplic     0.7  0.4
```

```

File Edit View Search Terminal Help
suid@pwsuid:~$ ps -aux | grep -i "firefox"
suid 2461 11.3 0 6 3688856 738066 ? Sl 10:00 27:16 /usr/lib/firefox/firefox
suid 2533 0.3 1.7 2706494 217630 ? Sl 10:00 0:49 /usr/lib/firefox/firefox -contentproc -childID 1 -isForBrowser -prefLen 1 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 2461 true tab
suid 2594 0.6 2.0 2780828 247176 ? Sl 10:00 1:29 /usr/lib/firefox/firefox -contentproc -childID 2 -isForBrowser -prefLen 6091 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 2461 true tab
suid 3015 1.6 7.8 3674328 951900 ? Sl 10:04 4:00 /usr/lib/firefox/firefox -contentproc -childID 5 -isForBrowser -prefLen 9581 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 2461 true tab
suid 3487 0.3 0.3 33328 43696 ? Sl 10:07 7:12 /usr/lib/firefox/firefox -contentproc -parentBuildID 20200917005511 -prefLen 9714 -prefMapSize 235580 -appdir /usr/lib/firefox/browser 2461 true rdd
suid 6038 25.6 6.2 3490148 765312 ? Sl 10:58 46:55 /usr/lib/firefox/firefox -contentproc -childID 14 -isForBrowser -prefLen 10011 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 246 true tab
suid 15302 5.4 3.6 3134672 445620 ? Sl 13:10 2:43 /usr/lib/firefox/firefox -contentproc -childID 34 -isForBrowser -prefLen 10109 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 246 true tab
suid 17463 1.3 2.1 2653608 261752 ? Sl 13:54 0:04 /usr/lib/firefox/firefox -contentproc -childID 43 -isForBrowser -prefLen 10110 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 246 true tab
suid 17507 1.0 1.5 2578940 193104 ? Sl 13:54 0:03 /usr/lib/firefox/firefox -contentproc -childID 44 -isForBrowser -prefLen 10110 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 246 true tab
suid 17535 0.0 0.6 2396084 81516 ? Sl 13:54 0:00 /usr/lib/firefox/firefox -contentproc -childID 45 -isForBrowser -prefLen 10110 -prefMapSize 235580 -parentBuildID 20200917005511 -appdir /usr/lib/firefox/browser 246 true tab
suid 17810 0.0 0.0 9032 2592 pts/0 S+ 14:00 0:00 grep --colorauto -i firefox
suid@pwsuid:~$

```

b) **The pmap command** - This command reports the memory map of the processes

Used the pmap command to find out the memory map of the firefox process. Here the one of the PID of firefox is 2461

```

sudip@sudip-X550JX: ~
File Edit View Search Terminal Help

sudip@sudip-X550JX:~$ pmap -xp 2461|sort -gk 2|head
-----
2461:  /usr/lib/firefox/firefox
Address      Kbytes      RSS      Dirty Mode  Mapping
total kB      3674676    583116   433000
00005567ba494000      4         4        4 r---- /usr/lib/firefox/firefox
00005567ba495000      4         4        4 rw--- /usr/lib/firefox/firefox
00007fe18a3ff000      4          0         0 ----- [ anon ]
00007fe18f1ff000      4          0         0 ----- [ anon ]
00007fe18f2ff000      4          0         0 ----- [ anon ]
00007fe18f3ff000      4          0         0 ----- [ anon ]
sudip@sudip-X550JX:~$ 

```

Used the extended flag along with the path flag for showing the memory map of the firefox process

[illegible]

Used the -XX flag which provide all the details that the kernel provides about firefox process

```
File Edit View Search Terminal Help
sudip@sudip-X550JK:~$ pmap -Xpg 2461 | sort -gk 6
```

2461: /usr/lib/firefox/firefox	Address	Perm	Offset	Device	Inode	Size	KernelPageSize	MMUPageSize	Rss	Pss	Shared_Clean	Shared_Dirty	Private_Clean	Private_Dirty	Referenced	Anonymous	LazyFree	AnonHugePages	ShmemPmdMapped	FilePmdMapped	Shared_Huge
lib Private	5567ba494000	r--p	00000000	08:07	667557	4	4	4	4	4	0	0	0	0	4	4	4	0	0	0	0
	0	0	0	0	0	4	rd	mr	mw	me	dw	ac	sd	/usr/lib/firefox/firefox	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	4	4	4	0	0	0	0
	0	0	0	0	0	4	rd	wr	mr	mw	me	dw	ac	sd	/usr/lib/firefox/firefox	0	0	0	0	0	0
	7fe18a3ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f1ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f2ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f3ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f4ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f5ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f6ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f7ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f8ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18f9ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18faf000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18fbff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe18fcff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1901ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1902ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1903ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1904ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1905ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1906ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe192fff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1930ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1931ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1932ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1933ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	7fe1934ff000	--p	00000000	00:00	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0

- c) **The wget command** – It is a non-interactive network downloader.

I used wget to download vlc media player from their site

```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~$ wget https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
--2020-10-03 21:36:06-- https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving get.videolan.org (get.videolan.org)... 195.154.241.219  
Connecting to get.videolan.org (get.videolan.org)|195.154.241.219|:443... connected.  
HTTP request sent, awaiting response... 302 Moved Temporarily  
Location: https://mirrors.estointernet.in/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe [following]  
--2020-10-03 21:36:07-- https://mirrors.estointernet.in/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving mirrors.estointernet.in (mirrors.estointernet.in)... 43.255.166.254, 2403:8940:3:1::f  
Connecting to mirrors.estointernet.in (mirrors.estointernet.in)|43.255.166.254|:443... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 40732864 (39M) [application/octet-stream]  
Saving to: 'vlc-3.0.11-win32.exe.2'  
  
vlc-3.0.11-win32.exe.2      100%[=====>] 38.85M  1.84MB/s   in 24s  
2020-10-03 21:36:31 (1.59 MB/s) - 'vlc-3.0.11-win32.exe.2' saved [40732864/40732864]  
  
sudip@sudip-X550JX:~$
```

Here we can see that that a executable file vlc.exe has been downloaded

```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~$ wget -O vlc.exe https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
--2020-10-03 22:00:14-- https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving get.videolan.org (get.videolan.org)... 195.154.241.219  
Connecting to get.videolan.org (get.videolan.org)|195.154.241.219|:443... connected.  
HTTP request sent, awaiting response... 302 Moved Temporarily  
Location: http://ftp.belnet.be/mirror/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe [following]  
--2020-10-03 22:00:15-- http://ftp.belnet.be/mirror/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving ftp.belnet.be (ftp.belnet.be)... 193.190.67.98, 2001:6a8:3c80:2::21  
Connecting to ftp.belnet.be (ftp.belnet.be)|193.190.67.98|:80... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 40732864 (39M) [application/x-msdos-program]  
Saving to: 'vlc.exe'  
  
vlc.exe                    100%[=====>] 38.85M  3.12MB/s   in 11s  
2020-10-03 22:00:27 (3.39 MB/s) - 'vlc.exe' saved [40732864/40732864]  
  
sudip@sudip-X550JX:~$ ls  
a.out      Downloads      HW3      lab3.pdf      OS-File-System-Utilities-master.zip  Templates  
Desktop    Firefox_wallpaper.png  lab3      Music          Pictures      Videos  
Documents  HW2              lab3_2    my_search.c   Public        vlc.exe  
sudip@sudip-X550JX:~$
```

I used wget to download 2 files, vlc media player of both mac and windows versions. We see that 2 files were created with the name vlc and having the extensions dmg and exe

```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~$ wget https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe vlc.dmg https://get  
.videolan.org/vlc/3.0.11.1/macosx/vlc-3.0.11.1.dmg  
--2020-10-03 22:07:08-- https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving get.videolan.org (get.videolan.org)... 195.154.241.219  
Connecting to get.videolan.org (get.videolan.org)|195.154.241.219|:443... connected.  
HTTP request sent, awaiting response... 302 Moved Temporarily  
Location: https://mirrors.estointernet.in/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe [following]  
--2020-10-03 22:07:09-- https://mirrors.estointernet.in/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe  
Resolving mirrors.estointernet.in (mirrors.estointernet.in)... 43.255.166.254, 2403:8940:3:1::f  
Connecting to mirrors.estointernet.in (mirrors.estointernet.in)|43.255.166.254|:443... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 40732864 (39M) [application/octet-stream]  
Saving to: 'vlc-3.0.11-win32.exe'  
  
vlc-3.0.11-win32.exe      100%[=====>] 38.85M  1.61MB/s   in 26s  
  
2020-10-03 22:07:35 (1.49 MB/s) - 'vlc-3.0.11-win32.exe' saved [40732864/40732864]  
  
--2020-10-03 22:07:35-- http://vlc.dmg/  
Resolving vlc.dmg (vlc.dmg)... failed: Name or service not known.  
wget: unable to resolve host address 'vlc.dmg'  
--2020-10-03 22:07:35-- https://get.videolan.org/vlc/3.0.11.1/macosx/vlc-3.0.11.1.dmg  
Connecting to get.videolan.org (get.videolan.org)|195.154.241.219|:443... connected.  
HTTP request sent, awaiting response... 302 Moved Temporarily  
Location: http://ftp.belnet.be/mirror/videolan/vlc/3.0.11.1/macosx/vlc-3.0.11.1.dmg [following]  
--2020-10-03 22:07:36-- http://ftp.belnet.be/mirror/videolan/vlc/3.0.11.1/macosx/vlc-3.0.11.1.dmg  
Resolving ftp.belnet.be (ftp.belnet.be)... 193.190.67.98, 2001:6a8:3c80:2::21  
Connecting to ftp.belnet.be (ftp.belnet.be)|193.190.67.98|:80... connected.  
HTTP request sent, awaiting response... 200 OK  
Length: 51971868 (50M) [application/x-apple-diskimage]  
Saving to: 'vlc-3.0.11.1.dmg'  
  
vlc-3.0.11.1.dmg        100%[=====>] 49.56M  5.01MB/s   in 11s  
  
2020-10-03 22:07:48 (4.43 MB/s) - 'vlc-3.0.11.1.dmg' saved [51971868/51971868]  
  
FINISHED --2020-10-03 22:07:48--  
Total wall clock time: 40s  
Downloaded: 2 files, 88M in 37s (2.37 MB/s)  
sudip@sudip-X550JX:~$ ls  
a.out      Firefox_wallpaper.png  lab3_2      OS-File-System-Utilities-master.zip  Videos  
Desktop    HW2                    lab3.pdf    Pictures                               vlc-3.0.11.1.dmg  
Documents  HW3                    Music       Public                               vlc-3.0.11-win32.exe  
Downloads  lab3                   my_search.c Templates                               vlc.dmg  
sudip@sudip-X550JX:~$
```



I used wget using the background flag. A log was created after the download has been completed.

```
sudip@sudip-X550JX: ~
File Edit View Search Terminal Help
sudip@sudip-X550JX:~$ wget -b /wget/log.txt https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe
Continuing in background, pid 10891.
Output will be written to 'wget-log'.
sudip@sudip-X550JX:~$ ls
a.out          HW2           Music          Templates      vlc.dmg
Desktop        HW3           my_search.c    Videos        wget-log
Documents      lab3          OS-File-System-Utilities-master.zip vlc-3.0.11.1.dmg
Downloads      lab3_2        Pictures        vlc-3.0.11-win32.exe
Firefox_wallpaper.png lab3.pdf      Public         vlc-3.0.11-win32.exe.1
sudip@sudip-X550JX:~$ cat wget-log
/wget/log.txt: Scheme missing.
--2020-10-03 22:10:23-- https://get.videolan.org/vlc/3.0.11/win32/vlc-3.0.11-win32.exe
Resolving get.videolan.org (get.videolan.org)... 62.210.246.226
Connecting to get.videolan.org (get.videolan.org)|62.210.246.226|:443... connected.
HTTP request sent, awaiting response... 302 Moved Temporarily
Location: http://ftp.belnet.be/mirror/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe [following]
--2020-10-03 22:10:25-- http://ftp.belnet.be/mirror/videolan/vlc/3.0.11/win32/vlc-3.0.11-win32.exe
Resolving ftp.belnet.be (ftp.belnet.be)... 193.190.67.98, 2001:6a8:3c80:2::21
Connecting to ftp.belnet.be (ftp.belnet.be)|193.190.67.98|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 40732864 (39M) [application/x-msdos-program]
Saving to: 'vlc-3.0.11-win32.exe.1'

 0K ..... 0% 541K 73s
 50K ..... 0% 2.26M 45s
100K ..... 0% 2.12M 36s
150K ..... 0% 3.70M 30s
200K ..... 0% 2.48M 27s
250K ..... 0% 3.54M 24s
300K ..... 0% 3.37M 22s
350K ..... 1% 3.11M 21s
400K ..... 1% 1.92M 21s
450K ..... 1% 1.47M 21s
500K ..... 1% 1.37M 22s
550K ..... 1% 1.13M 23s
600K ..... 1% 2.20M 22s
650K ..... 1% 2.46M 22s
700K ..... 1% 1.55M 22s
750K ..... 2% 2.18M 22s
800K ..... 2% 1.88M 22s
850K ..... 2% 2.55M 21s
900K ..... 2% 2.25M 21s
950K ..... 2% 1.40M 21s
1000K ..... 2% 517K 24s
1050K ..... 2% 8.28M 23s
```

d) **The strace command** - This command traces system calls and signals

I called strace command on ls -l. We can see in the below figure some of the systems calls that ls -l executes. At first execve() is called, then some dependency files are opened then memory is allocated etc.

```
sudip@sudip-X550JX: ~  
File Edit View Search Terminal Help  
  
sudip@sudip-X550JX:~$ strace ls -l  
execve("/bin/ls", ["ls", "-l"], 0x7ffe7415a2d8 /* 49 vars */) = 0  
brk(NULL)                                = 0x559ee6b4a000  
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffde74dca40) = -1 EINVAL (Invalid argument)  
access("/etc/ld.so.preload", R_OK)       = -1 ENOENT (No such file or directory)  
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3  
fstat(3, {st_mode=S_IFREG|0644, st_size=99144, ...}) = 0  
mmap(NULL, 99144, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7fe13ea1f000  
close(3)                                  = 0  
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libselinux.so.1", O_RDONLY|O_CLOEXEC) = 3  
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0@p\0\0\0\0\0\0"... , 832) = 832  
fstat(3, {st_mode=S_IFREG|0644, st_size=163200, ...}) = 0  
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7fe13eald000  
mmap(NULL, 174600, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fe13e9f2000  
mprotect(0x7fe13e9f8000, 135168, PROT_NONE) = 0  
mmap(0x7fe13e9f8000, 102400, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6000) = 0x7fe13e9f8000  
mmap(0x7fe13ea11000, 28672, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1f000) = 0x7fe13ea11000  
mmap(0x7fe13ea19000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7fe13ea19000  
mmap(0x7fe13ea1b000, 6664, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7fe13ea1b000  
close(3)                                  = 0  
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3  
read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\360q\2\0\0\0\0\0"... , 832) = 832  
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0\0\0@\0\0\0\0\0\0\0\0\0\0\0\0\0"... , 784, 64) = 784  
pread64(3, "\4\0\0\0\2\0\0\0\5\0\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0"... , 32, 848) = 32  
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"... , 68, 880) = 68  
fstat(3, {st_mode=S_IFREG|0755, st_size=2029224, ...}) = 0  
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0\0\0@\0\0\0\0\0\0\0\0\0\0\0\0\0"... , 784, 64) = 784  
pread64(3, "\4\0\0\0\2\0\0\0\5\0\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0"... , 32, 848) = 32  
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"... , 68, 880) = 68  
mmap(NULL, 2036952, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fe13e800000  
mprotect(0x7fe13e825000, 1847296, PROT_NONE) = 0  
mmap(0x7fe13e825000, 1540096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7fe13e825000  
mmap(0x7fe13e99d000, 303104, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0x7fe13e99d000  
mmap(0x7fe13e9e8000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xe7000) = 0x7fe13e9e8000  
mmap(0x7fe13e9ee000, 13528, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7fe13e9ee000  
close(3)                                  = 0  
openat(AT_FDCWD, "/usr/lib/x86_64-linux-gnu/libpcr-2.8.so.0", O_RDONLY|O_CLOEXEC) = 3  
read(3, "\177ELF\2\1\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\340\"\0\0\0\0\0\0"... , 832) = 832  
fstat(3, {st_mode=S_IFREG|0644, st_size=584392, ...}) = 0  
mmap(NULL, 586536, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fe13e770000  
mmap(0x7fe13e772000, 409600, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7fe13e772000  
mmap(0x7fe13e7d6000, 163840, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x66000) = 0x7fe13e7d6000
```



```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ strace rm 1.txt
execve("/bin/rm", ["rm", "1.txt"], 0x7ffe44e8f778 /* 50 vars */) = 0
brk(NULL) = 0x561b7a4ab000
arch_prctl(0x3001 /* ARCH ??? */, 0x7ffd49067bc0) = -1 EINVAL (Invalid argument)
access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=99144, ...}) = 0
mmap(NULL, 99144, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f4767358000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\3\0-\0\1\0\0\360q\2\0\0\0\0"... , 832) = 832
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"... , 784, 64) = 784
pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0"... , 32, 848) = 32
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"... , 68, 880) = 68
fstat(3, {st_mode=S_IFREG|0755, st_size=2029224, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f4767356000
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"... , 784, 64) = 784
pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0"... , 32, 848) = 32
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"... , 68, 880) = 68
mmap(NULL, 2036952, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f4767164000
mprotect(0x7f4767189000, 1847296, PROT_NONE) = 0
mmap(0x7f4767189000, 1540096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7f4767189000
mmap(0x7f4767301000, 303104, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0x7f4767301000
mmap(0x7f476734c000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7f476734c000
mmap(0x7f4767352000, 13528, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f4767352000
close(3) = 0
arch_prctl(ARCH_SET_FS, 0x7f4767357580) = 0
mprotect(0x7f476734c000, 12288, PROT_READ) = 0
mprotect(0x561b78e9e000, 4096, PROT_READ) = 0
mprotect(0x7f476739e000, 4096, PROT_READ) = 0
munmap(0x7f4767358000, 99144) = 0
openat(AT_FDCWD, "/usr/lib/locale/locale-archive", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=5699248, ...}) = 0
mmap(NULL, 5699248, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f4766bf4000
close(3) = 0
brk(NULL) = 0x561b7a4ab000
brk(0x561b7a4cc000) = 0x561b7a4cc000
ioctl(0, TCGETS, {B38400 opost isig icanon echo ...}) = 0
newfstatat(AT_FDCWD, "1.txt", {st_mode=S_IFREG|0664, st_size=245, ...}, AT_SYMLINK_NOFOLLOW) = 0
getuid() = 1000
newfstatat(AT_FDCWD, "1.txt", {st_mode=S_IFREG|0664, st_size=245, ...}, AT_SYMLINK_NOFOLLOW) = 0
faccessat(AT_FDCWD, "1.txt", W_OK) = 0
unlinkat(AT_FDCWD, "1.txt", 0) = 0
lseek(0, 0, SEEK_CUR) = -1 EPIPE (Illegal seek)
close(0) = 0
close(1) = 0
close(2) = 0
exit_group(0) = ?
+++ exited with 0 +++
sudip@sudip-X550JX:~/Pictures$
```

- e) **The sudo command** – It executes a command as another user. It stands for super user do. When a process can't execute due to lack of permissions, we can use sudo along with the system password to make the process execute seamlessly.

Here I have updated the list of latest versions of packages that can be used for updating system processes

```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ apt-get update
Reading package lists... Done
E: Could not open lock file /var/lib/apt/lists/lock - open (13: Permission denied)
E: Unable to lock directory /var/lib/apt/lists/
W: Problem unlinking the file /var/cache/apt/pkgcache.bin - RemoveCaches (13: Permission denied)
W: Problem unlinking the file /var/cache/apt/srcpkgcache.bin - RemoveCaches (13: Permission denied)
sudip@sudip-X550JX:~/Pictures$ sudo apt-get update
Ign:1 http://mint.mirrors.estointernet.in/repos ulyana InRelease
Hit:2 http://archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://mint.mirrors.estointernet.in/repos ulyana Release
Hit:4 https://packages.microsoft.com/repos/ms-teams stable InRelease
Hit:5 https://packages.microsoft.com/repos/vscode stable InRelease
Hit:7 http://archive.canonical.com/ubuntu focal InRelease
Hit:8 http://archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:9 http://archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:10 http://security.ubuntu.com/ubuntu focal-security InRelease
Hit:11 http://ppa.launchpad.net/libreoffice/libreoffice-7-0/ubuntu focal InRelease
Reading package lists... Done
sudip@sudip-X550JX:~/Pictures$
```

After updating the latest versions, if we want we can update all the packages to the latest versions using apt-get upgrade command. Since updating packages is an important process, it can't be done without super user privileges.

```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ apt-get upgrade
E: Could not open lock file /var/lib/dpkg/lock-frontent - open (13: Permission denied)
E: Unable to acquire the dpkg frontend lock (/var/lib/dpkg/lock-frontent), are you root?
sudip@sudip-X550JX:~/Pictures$ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages will be upgraded:
  file-roller libnvidia-cfg1-450 libnvidia-common-450
  libnvidia-compute-440:i386 libnvidia-compute-450 libnvidia-compute-450:i386
  libnvidia-decode-440:i386 libnvidia-decode-450 libnvidia-decode-450:i386
  libnvidia-encode-440:i386 libnvidia-encode-450 libnvidia-encode-450:i386
  libnvidia-extra-450 libnvidia-fbc1-440:i386 libnvidia-fbc1-450
  libnvidia-fbc1-450:i386 libnvidia-gl-440:i386 libnvidia-gl-450
  libnvidia-gl-450:i386 libnvidia-ifr1-440:i386 libnvidia-ifr1-450
  libnvidia-ifr1-450:i386 nvidia-compute-utils-450 nvidia-dkms-450
  nvidia-driver-440 nvidia-driver-450 nvidia-kernel-common-450
  nvidia-kernel-source-450 nvidia-utils-450 xserver-xorg-video-nvidia-450
30 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
Need to get 140 MB of archives.
After this operation, 1,532 kB of additional disk space will be used.
Do you want to continue? [Y/n] ☐
```

## Part 2 - Implementation of commands

Github repository link : <https://github.com/David-jon/OS-Assignment-1-IITGN>

### a. ls command

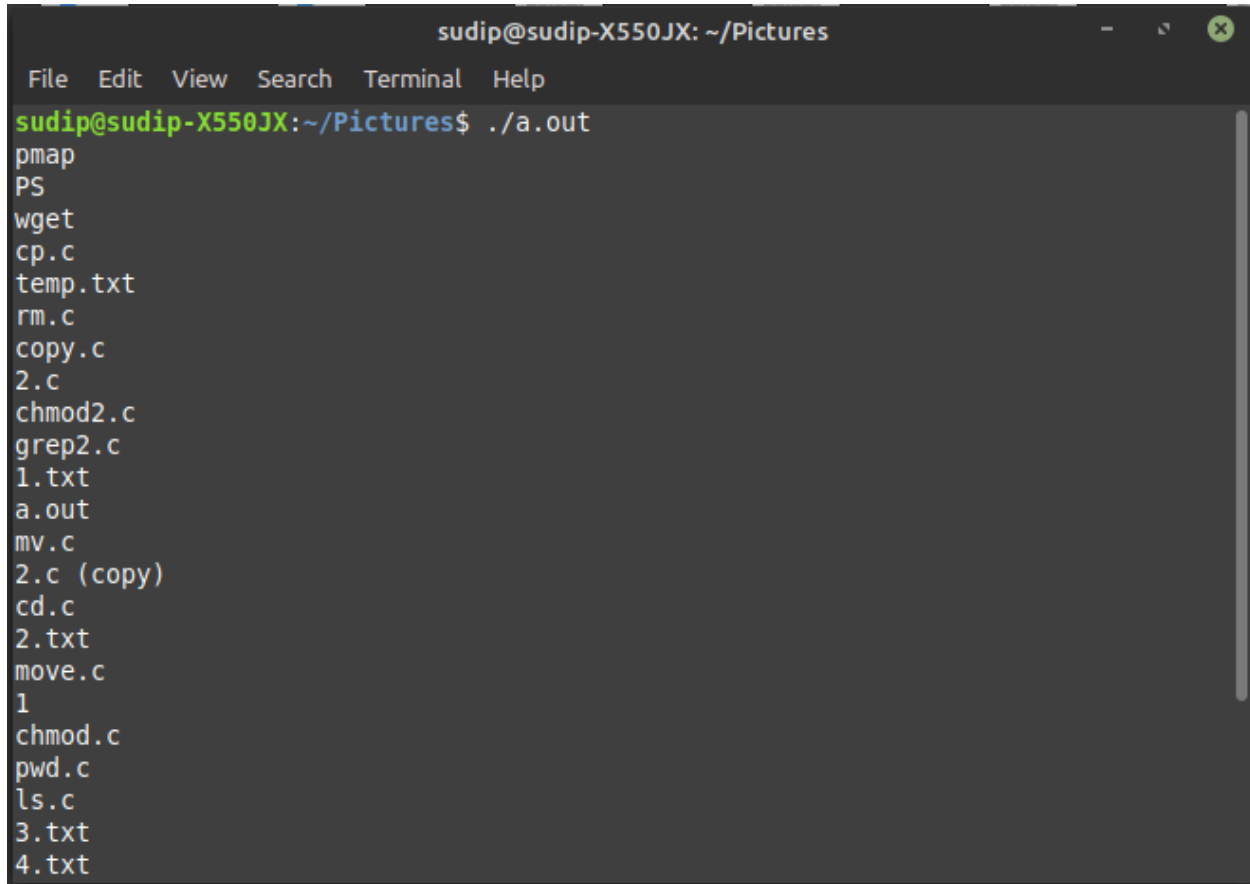
Source Code:

```
#include <fcntl.h>
#include <dirent.h>
#include <stdio.h>
#include <unistd.h>
#include <stdio.h>
#include <sys/stat.h>
#include <sys/types.h>

int main(int argc, char **argv)
{ //store the current directory value
    DIR *dir = opendir(".");
    if (argc == 2)
        dir = opendir(argv[1]);
    struct dirent *strdir = readdir(dir);
    while (strdir != NULL)
    {
        if (strdir->d_name[0] != '.' && strdir->d_name[0] != '\0')
        {
            //print the contents of the current working directory one at a time
            printf("%s\n", strdir->d_name);
        }
        strdir = readdir(dir);
    }
    printf("\n");
}
```

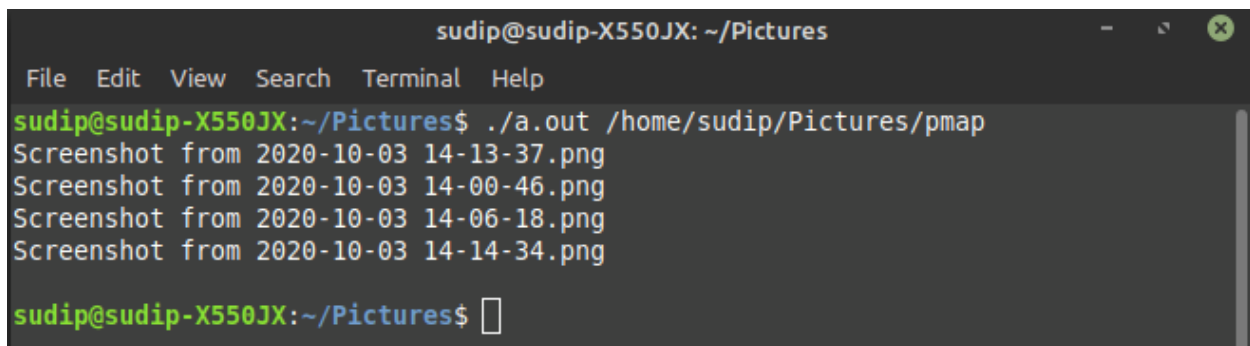
```
closedir(dir);  
}
```

Using ls command without any arguments lists the contents of a directory.



```
sudip@sudip-X550JX: ~/Pictures  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~/Pictures$ ./a.out  
pmap  
PS  
wget  
cp.c  
temp.txt  
rm.c  
copy.c  
2.c  
chmod2.c  
grep2.c  
1.txt  
a.out  
mv.c  
2.c (copy)  
cd.c  
2.txt  
move.c  
1  
chmod.c  
pwd.c  
ls.c  
3.txt  
4.txt
```

Using ls command with argument as the location of the directory lists all the contents of the given directory.



```
sudip@sudip-X550JX: ~/Pictures  
File Edit View Search Terminal Help  
sudip@sudip-X550JX:~/Pictures$ ./a.out /home/sudip/Pictures/pmap  
Screenshot from 2020-10-03 14-13-37.png  
Screenshot from 2020-10-03 14-00-46.png  
Screenshot from 2020-10-03 14-06-18.png  
Screenshot from 2020-10-03 14-14-34.png  
sudip@sudip-X550JX:~/Pictures$
```



## b)grep command

Source Code:

```
#include <stdio.h>

#include <string.h>

#include <stdlib.h>

int main(int argc, char *argv[])
{
    char lineBuffer[512];
    FILE *fp = NULL;
    size_t n = 0;
    int flag = 0;
    char *buffer = NULL;
    int count = 0;

    //flag variable if 1 uses a temporary file temp.txt to already use the existing code for when
    argument count is greater than 2
    if (argc == 1)
    {
        printf("wgrep: searchterm [file ...]\n");
        exit(1);
    }
    if (argc == 2)
    {
        flag = 1;
        printf("Enter text\n");
        char str[2000];
        fgets(str, 2000, stdin);
        fp = fopen("temp.txt", "w");
        fputs(str, fp);
        fclose(fp);
```

```

    //strcpy(argv[2], "temp.txt");
}
//for loop the grep for every argument vector value
for (int i = 2; i < argc || flag; i++)
{
    if (flag == 0)
    {
        fp = fopen(argv[i], "r");
        if (!fp)
        {
            printf("wgrep: cannot open file%s\n", argv[i]);
            exit(2);
        }
    }
    else
    {
        fp = fopen("temp.txt", "r");
    }
    // getline function for making the buffer size as dynamic as opposed to fgets()
    while (getline(&buffer, &n, fp) != -1)
    {
        //printf("What da 2\n");
        if (strstr(buffer, argv[1]))
        {
            if (flag == 0)
            {
                printf("\n%s %s", argv[i], buffer);
            }
        }
    }
}

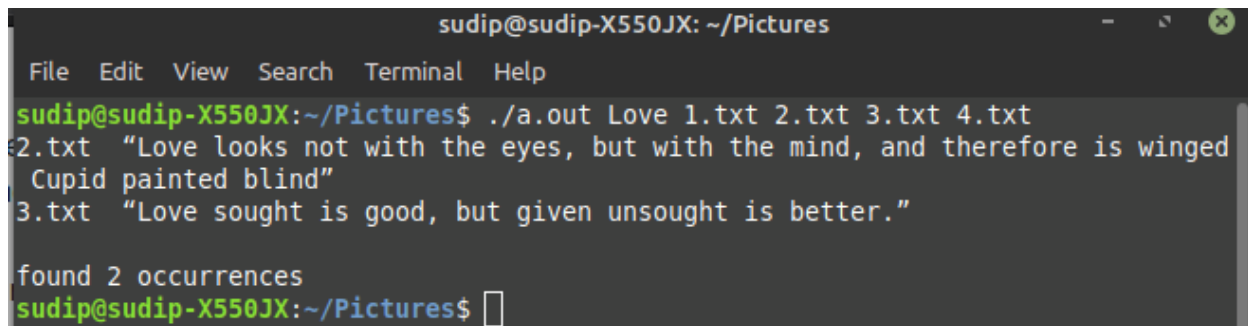
```

```

        else
            printf("\n%s ", buffer);
            ++count;
        }
    }
    if (flag == 1)
        flag = 0;
    fclose(fp);
}
printf("\nfound %d occurrences\n", count);
return 0;
}

```

I have given four files text files each containing shakespeare texts and used the pattern “Love”.



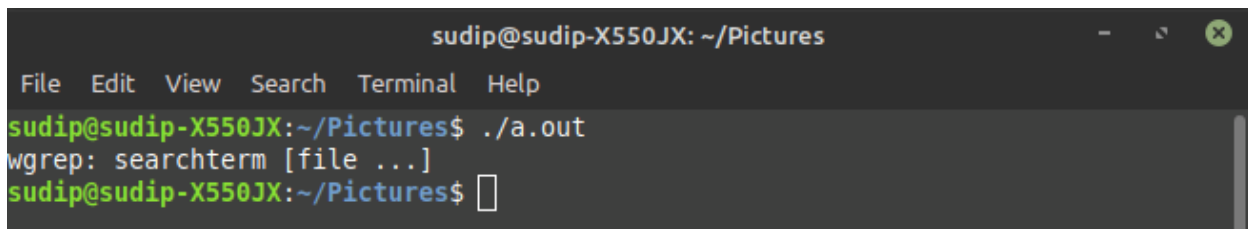
```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out Love 1.txt 2.txt 3.txt 4.txt
2.txt "Love looks not with the eyes, but with the mind, and therefore is winged
Cupid painted blind"
3.txt "Love sought is good, but given unsought is better."

found 2 occurrences
sudip@sudip-X550JX:~/Pictures$

```

Running the program normally will give the function syntax

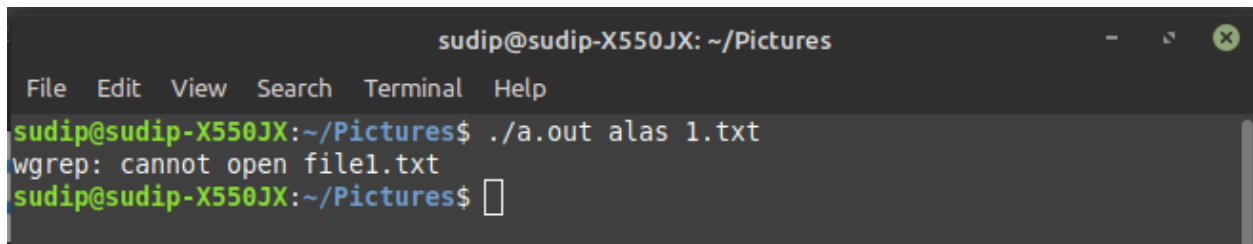


```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out
wgrep: searchterm [file ...]
sudip@sudip-X550JX:~/Pictures$

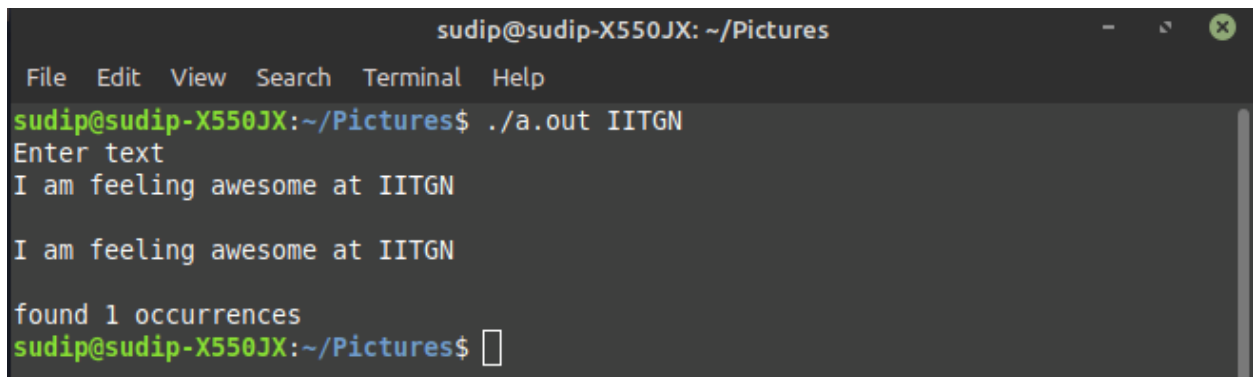
```

If the file can't be opened, an appropriate error message will be displayed.

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The user enters './a.out alas 1.txt'. The output is 'wgrep: cannot open file1.txt'. The prompt returns to 'sudip@sudip-X550JX:~/Pictures\$' with a cursor.

```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out alas 1.txt
wgrep: cannot open file1.txt
sudip@sudip-X550JX:~/Pictures$
```

If we give only the search pattern, it will open an editor in which we can type anything and then we can search this text with the given pattern

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The user enters './a.out IITGN'. The output is 'Enter text', followed by 'I am feeling awesome at IITGN' on two lines. Then 'found 1 occurrences' is displayed. The prompt returns to 'sudip@sudip-X550JX:~/Pictures\$' with a cursor.

```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out IITGN
Enter text
I am feeling awesome at IITGN
I am feeling awesome at IITGN
found 1 occurrences
sudip@sudip-X550JX:~/Pictures$
```

### c)cat command

Source Code:

```
#include <stdio.h>

#include <string.h>

#include <stdlib.h>

#include <fcntl.h>

#include <errno.h>

#include <sys/types.h>

#include <unistd.h>

int main(int argc, char *argv[])
{
    int fp, op;
    char ch[1000];
    if (argc == 1)
        return 0;
    for (int i = 1; i < argc; i++)
    {
        fp = open(argv[i], O_RDONLY);
        //File can't be opened if returned value is -1
        if (fp == -1)
        {
            printf("wcat: cannot open file\n");
            exit(1);
        }
        //read every charecter and display on the screen
        while (op = read(fp, ch, 1000))
        {
            write(1, ch, op);
```

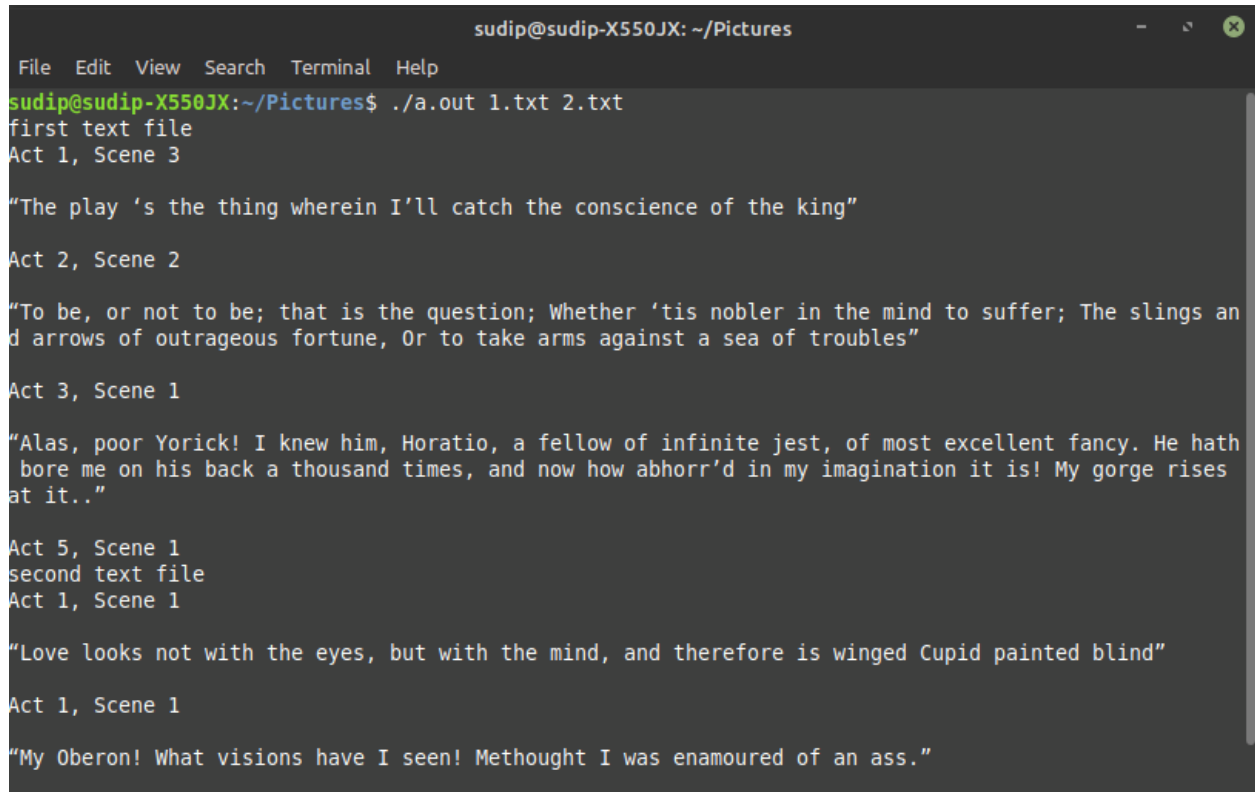


```

    }
    close(fp);
}
return 0;
}

```

I have used my cat program to display two text files, in order.



```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out 1.txt 2.txt
first text file
Act 1, Scene 3

"The play 's the thing wherein I'll catch the conscience of the king"
Act 2, Scene 2

"To be, or not to be; that is the question; Whether 'tis nobler in the mind to suffer; The slings an
d arrows of outrageous fortune, Or to take arms against a sea of troubles"
Act 3, Scene 1

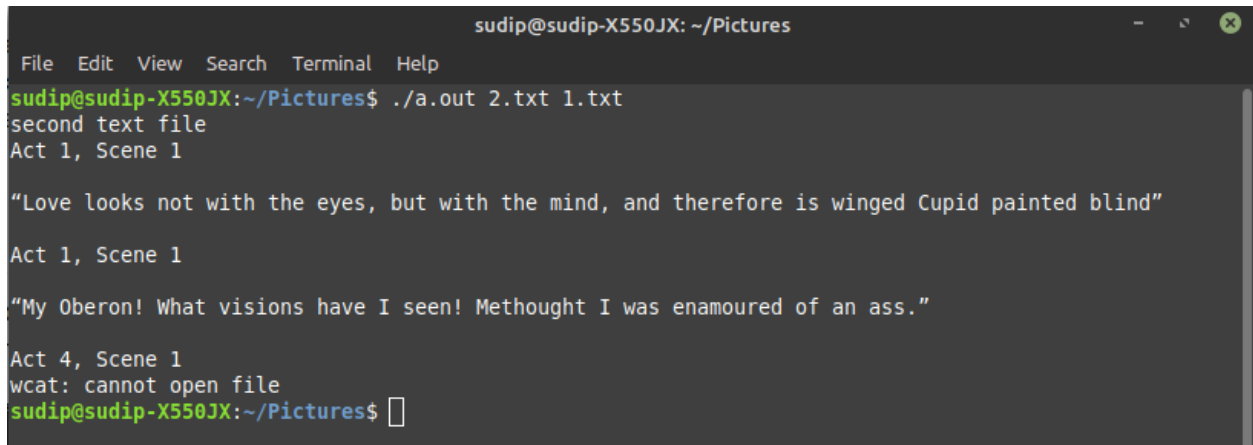
"Alas, poor Yorick! I knew him, Horatio, a fellow of infinite jest, of most excellent fancy. He hath
bore me on his back a thousand times, and now how abhorr'd in my imagination it is! My gorge rises
at it.."
Act 5, Scene 1
second text file
Act 1, Scene 1

"Love looks not with the eyes, but with the mind, and therefore is winged Cupid painted blind"
Act 1, Scene 1

"My Oberon! What visions have I seen! Methought I was enamoured of an ass."

```

I then changed permission of the 1.txt to have no permissions and then used the same command. The first file was displayed, where as for the second argument, the program displayed an appropriate error message and then exited

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The command './a.out 2.txt 1.txt' has been executed. The output is: 'second text file', 'Act 1, Scene 1', a quote '“Love looks not with the eyes, but with the mind, and therefore is winged Cupid painted blind”', 'Act 1, Scene 1', another quote '“My Oberon! What visions have I seen! Methought I was enamoured of an ass.”', 'Act 4, Scene 1', and an error message 'wcat: cannot open file'. The prompt is now 'sudip@sudip-X550JX:~/Pictures\$' with a cursor.

```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out 2.txt 1.txt
second text file
Act 1, Scene 1

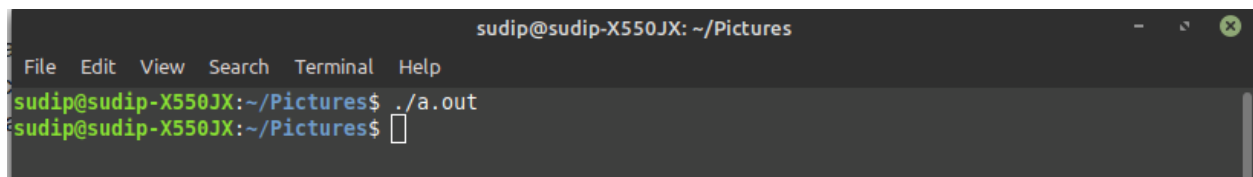
“Love looks not with the eyes, but with the mind, and therefore is winged Cupid painted blind”

Act 1, Scene 1

“My Oberon! What visions have I seen! Methought I was enamoured of an ass.”

Act 4, Scene 1
wcat: cannot open file
sudip@sudip-X550JX:~/Pictures$
```

Running the program without giving any arguments produces no error as described in the requirements section.

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The command './a.out' has been executed. The prompt is now 'sudip@sudip-X550JX:~/Pictures\$' with a cursor.

```
sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out
sudip@sudip-X550JX:~/Pictures$
```

#### d) mv command

Source Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <dirent.h>

#include <unistd.h>

#include <string.h>

int main(int argc, char *argv[])

{

    char *file = argv[1];

    char *location = argv[2];

    char move_location[100];

    if (argc != 3)

    { //display the syntax if and when there is an error in the number of arguments

        printf("\nUsage: mv [source] [destination]\n");

        exit(EXIT_FAILURE);

    }

    else

    {

        DIR *dir;

        dir = opendir(location);

        if (dir == NULL)

        {

            //error if directory doesn't exist

            if (rename(file, location) != 0)

                printf("mv: cannot stat '%s': No such file or directory\n", argv[1]);

        }

    }

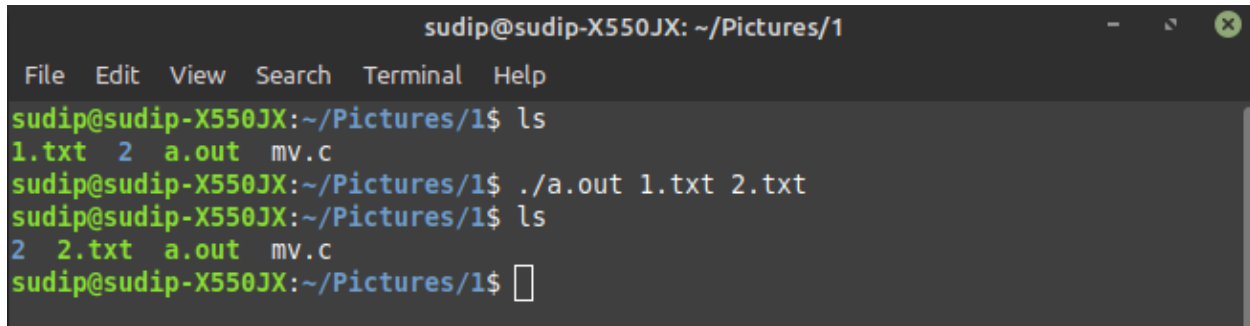
}
```

```

else
{
    char *ptr;
    ptr = getcwd(move_location, 100);
    strcat(move_location, "/");
    strcat(move_location, location);
    strcat(move_location, "/");
    strcat(move_location, file);
    if (rename(file, ptr) == -1)
        printf("mv: cannot stat '%s': No such file or directory\n", argv[1]);
    closedir(dir);
}
}
return 0;
}

```

I used mv program to rename a file 1.txt to 2.txt

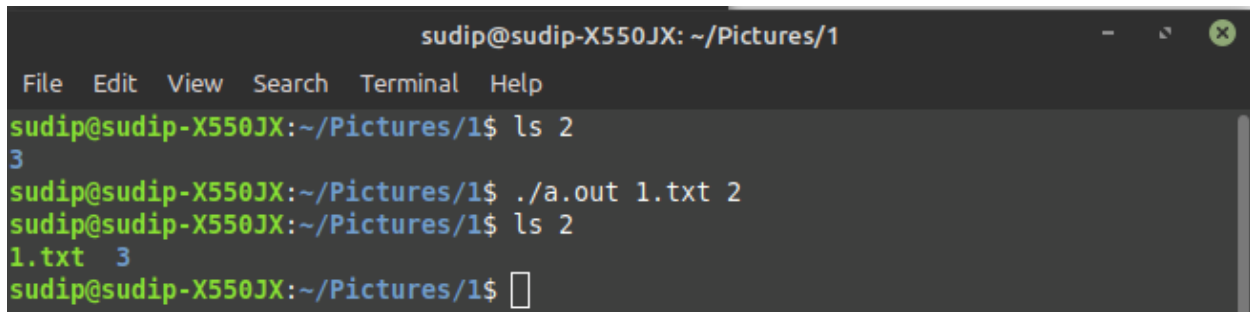


```

sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ ls
1.txt 2 a.out mv.c
sudip@sudip-X550JX:~/Pictures/1$ ./a.out 1.txt 2.txt
sudip@sudip-X550JX:~/Pictures/1$ ls
2 2.txt a.out mv.c
sudip@sudip-X550JX:~/Pictures/1$ 

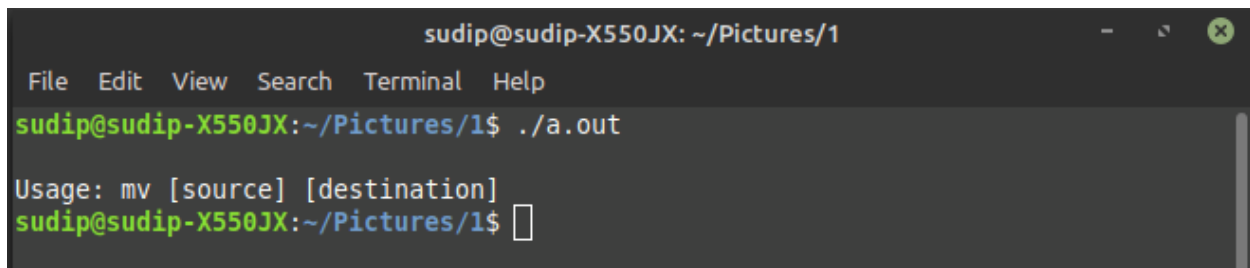
```

I then moved the file given as argument to a new directory also given as a argument. I displayed all the contents of the file using built in ls command to display before and after the program execution

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following commands and output:

```
sudip@sudip-X550JX:~/Pictures/1$ ls 2
3
sudip@sudip-X550JX:~/Pictures/1$ ./a.out 1.txt 2
sudip@sudip-X550JX:~/Pictures/1$ ls 2
1.txt 3
sudip@sudip-X550JX:~/Pictures/1$
```

When the program is run by giving an incomplete number of arguments, a syntax message is printed.

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following command and output:

```
sudip@sudip-X550JX:~/Pictures/1$ ./a.out

Usage: mv [source] [destination]
sudip@sudip-X550JX:~/Pictures/1$
```



#### e) **cp command**

Source Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <fcntl.h>

#include <errno.h>

#define SIZE 1024


int main(int argc, char *argv[])
{
    int Source, Destination, ReadBuffer, WriteBuffer;
    char *buff[SIZE];

    //help syntax during error
    if (argc != 3 || argv[1] == "--help")
    {
        printf("\nUsage: cp source destination\n");
        exit(EXIT_FAILURE);
    }

    Source = open(argv[1], O_RDONLY);

    if (Source == -1)
    {
        printf("\nError opening file %s errno = %d\n", argv[1], errno);
        exit(EXIT_FAILURE);
    }

    //making sure we have the permission to create a file there
    Destination = open(argv[2], O_WRONLY | O_CREAT | O_TRUNC, S_IRUSR |
S_IWUSR | S_IRGRP | S_IWGRP | S_IROTH | S_IWOTH);
```

```

if (Destination == -1)
{
    printf("\nError opening file %s errno = %d\n", argv[2], errno);
    exit(EXIT_FAILURE);
}

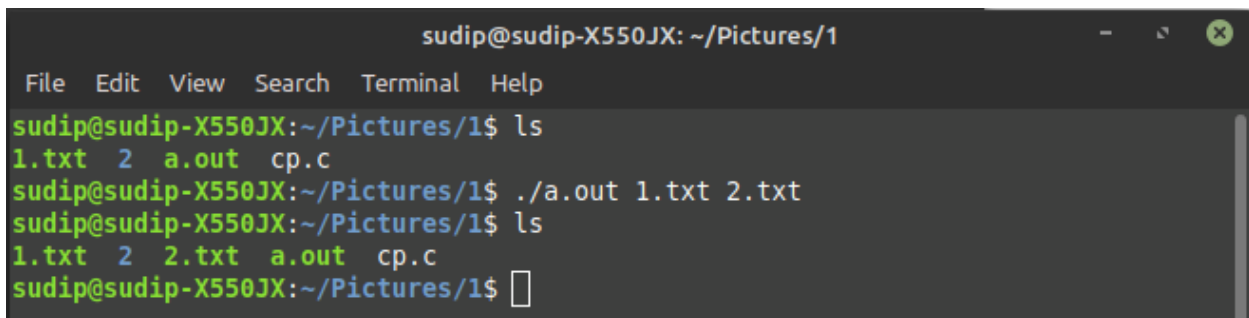
while ((ReadBuffer = read(Source, buff, SIZE)) > 0)
{
    if (write(Destination, buff, ReadBuffer) != ReadBuffer)
        printf("\nError in writing data to \n");
}

if (close(Source) == -1)
    printf("\nError in closing file\n");

if (close(Destination) == -1)
    printf("\nError in closing file\n");
}

```

I have used the copy program to copy 1.txt and renamed the copied file to 2.txt. I then displayed all the contents of the file using built in ls command to display before and after the program execution

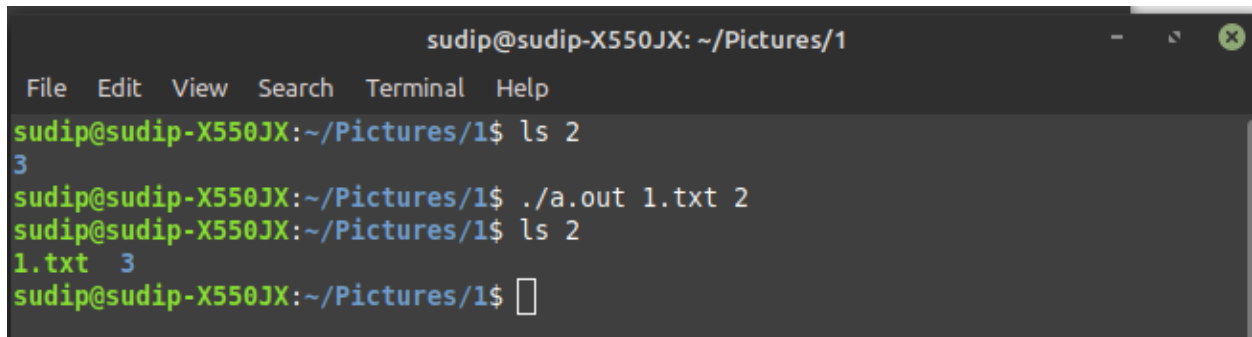


```

sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ ls
1.txt 2 a.out cp.c
sudip@sudip-X550JX:~/Pictures/1$ ./a.out 1.txt 2.txt
sudip@sudip-X550JX:~/Pictures/1$ ls
1.txt 2 2.txt a.out cp.c
sudip@sudip-X550JX:~/Pictures/1$ 

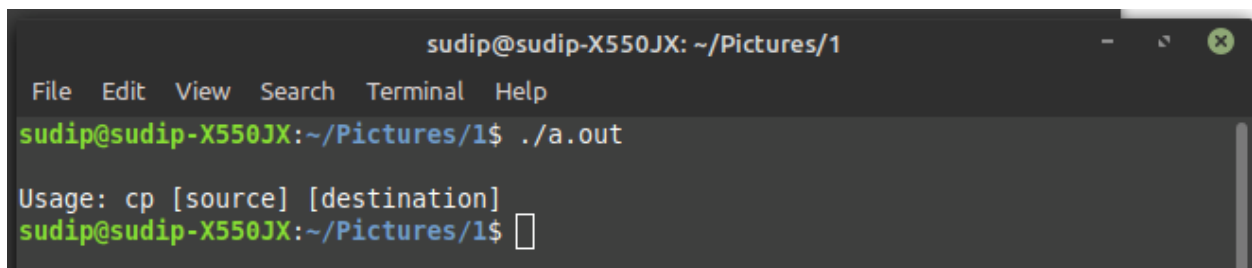
```

I then copied 1.txt to the directory 2. Then I displayed all the contents of the file using built in ls command to display before and after the program execution

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following commands and output:

```
sudip@sudip-X550JX:~/Pictures/1$ ls 2
3
sudip@sudip-X550JX:~/Pictures/1$ ./a.out 1.txt 2
sudip@sudip-X550JX:~/Pictures/1$ ls 2
1.txt 3
sudip@sudip-X550JX:~/Pictures/1$
```

When the program is run without any argument, it prints out the syntax of the input command

A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following command and output:

```
sudip@sudip-X550JX:~/Pictures/1$ ./a.out

Usage: cp [source] [destination]
sudip@sudip-X550JX:~/Pictures/1$
```

#### f) **cd command**

Source Code:

```
#include <unistd.h>

#include <stdio.h>

#include <errno.h>

#include <stdlib.h>


int main(int argc, char *argv[])
{
    char *p = argv[1], dir[10000];
    if (argc != 2)
    {
        printf("Usage cd [Directory]\n");
        exit(EXIT_FAILURE);
    }
    //We are using chdir to change the directory
    else if (chdir(p) == -1)
    {
        perror("chdir");
        exit(EXIT_FAILURE);
    }
    else if (getcwd(dir, sizeof(dir)) != NULL)
        printf("Working dir: %s\n", dir);
    else
        perror("Error");

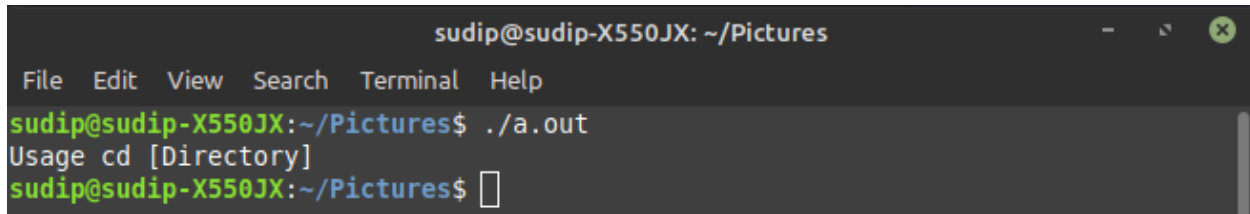
    /*
```

The program changes the directory but the shell reverts back to the original working directory.

It is because when the program is executed in the shell, the shell follows fork on exec mechanism. So, it doesn't affect the current shell.

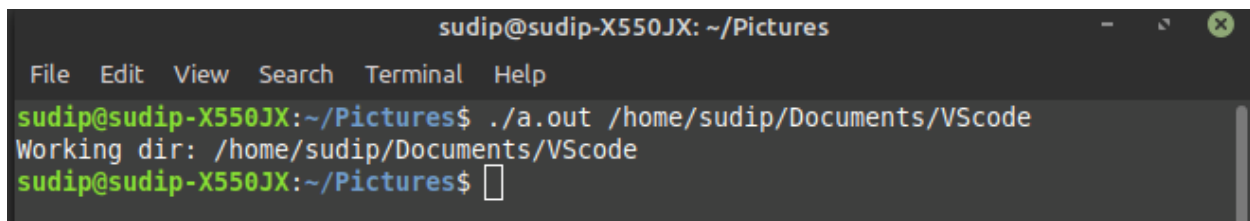
```
*/  
  
return 0;  
  
}
```

If we are not giving any argument in the function a syntax message is displayed



A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The user enters './a.out', and the terminal displays 'Usage cd [Directory]' as an error message. The prompt returns to 'sudip@sudip-X550JX:~/Pictures\$'.

I changed the directory from current directory to home/sudip/Documents/Vscode. The directory changed and it reverted back to the original directory. It is because when the program is executed in the shell, the shell follows fork on exec mechanism. So, it doesn't affect the current shell.



A terminal window titled 'sudip@sudip-X550JX: ~/Pictures' with a menu bar (File, Edit, View, Search, Terminal, Help). The prompt is 'sudip@sudip-X550JX:~/Pictures\$'. The user enters './a.out /home/sudip/Documents/Vscode', and the terminal displays 'Working dir: /home/sudip/Documents/Vscode'. The prompt returns to 'sudip@sudip-X550JX:~/Pictures\$'.



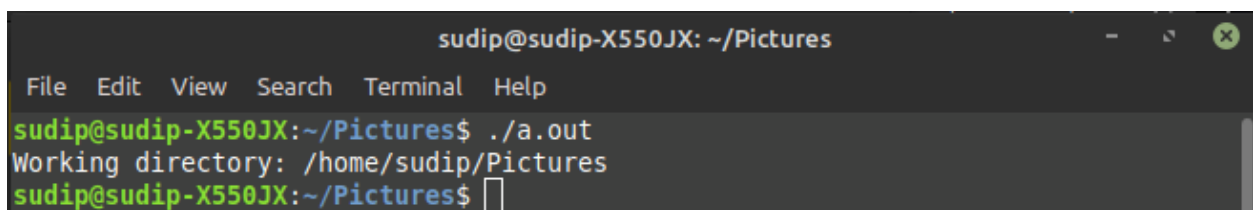
### g) pwd command

Source code:

```
#include <unistd.h>
#include <stdio.h>
#include <errno.h>
#include <stdlib.h>

void main(int argc)
{
    char *p = ".", dir[10000];
    if (argc != 1)
    {
        printf("Usage pwd\n");
        exit(EXIT_FAILURE);
    } //just print the current working directory
    else if (getcwd(dir, sizeof(dir)) != NULL)
        printf("Working directory: %s\n", dir);
}
```

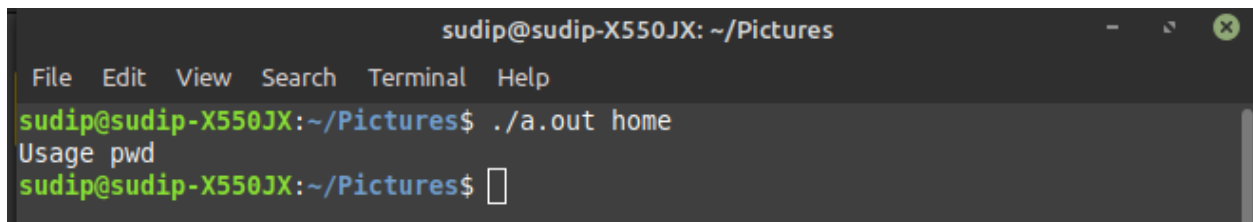
Using pwd command prints the current working directory



```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out
Working directory: /home/sudip/Pictures
sudip@sudip-X550JX:~/Pictures$
```

if we use pwd command with arguments, it gives the usage of the command.



```

sudip@sudip-X550JX: ~/Pictures
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures$ ./a.out home
Usage pwd
sudip@sudip-X550JX:~/Pictures$
```

#### h) **rm command**

Source code:

```
#include <stdio.h>

#include <unistd.h>

#include <string.h>
```

```
int main(int argc, char *argv[])
{
    //use exec function to recursively delete the files inside a non-empty directory
    if (argc == 3 && !(strcmp(argv[1], "-r")))
    {
        execlp("rm", "rm", "-r", argv[2], NULL);
        return 0;
    }
    if (argc != 2 || argv[1] == "--help")
    {
        printf("\nusage: rm [File Name] or rm -r [File Name]\n");
        return 0;
    }
    //use remove function if the directory is empty, or when we are removing a file
    int status;
    status = remove(argv[1]);
    if (status != 0)
        printf("rm: cannot remove '%s': No such file or directory\n", argv[1]);
    return 0;
}
```

Using the remove program with argument as the file name removes the file name. It can also remove empty directory

```

sudip@sudip-X550JX: ~/Pictures/1/2/3
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1/2/3$ ls
1.txt 4 a.out rm.c
sudip@sudip-X550JX:~/Pictures/1/2/3$ ./a.out 1.txt
sudip@sudip-X550JX:~/Pictures/1/2/3$ ls
4 a.out rm.c
sudip@sudip-X550JX:~/Pictures/1/2/3$
```

Using the remove program with the -r flag will also remove directories which are not empty

```

sudip@sudip-X550JX: ~/Pictures/1/2/3
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1/2/3$ ls 4/5
6
sudip@sudip-X550JX:~/Pictures/1/2/3$ ./a.out -r 4
sudip@sudip-X550JX:~/Pictures/1/2/3$ ls
a.out rm.c
sudip@sudip-X550JX:~/Pictures/1/2/3$
```

If the user types incorrect number of arguments, the syntax of the input is displayed

```

sudip@sudip-X550JX: ~/Pictures/1/2/3
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1/2/3$ ./a.out
usage: rm [File Name] or rm -r [File Name]
sudip@sudip-X550JX:~/Pictures/1/2/3$
```

### i) **chmod** command

Source code:

```
#include <sys/stat.h>

#include <stdlib.h>

#include <stdio.h>

int main(int argc, char *argv[])
{
    if (argc != 3)
    {
        printf("chmod [0-7][0-7][0-7] [Filename]\n");
        exit(1);
    }

    struct stat st;

    mode_t mode;

    const char *path = argv[2];

    int num = atoi(argv[1]);

    stat(path, &st);

    mode = st.st_mode & 07777;

    //first removing all the permissions of the current file
    mode &= ~(S_IRUSR);
    mode &= ~(S_IWUSR);
    mode &= ~(S_IXUSR);
    mode &= ~(S_IRGRP);
    mode &= ~(S_IWGRP);
    mode &= ~(S_IXGRP);
    mode &= ~(S_IROTH);
    mode &= ~(S_IWOTH);
```

```

mode &= ~(S_IXOTH);
chmod(path, mode);

//dividing the input number into three categories
int others = num % 10;
num /= 10;
int group = num % 10;
num /= 10;
int user = num % 10;

//printf("user %d,group %d,others %d argc %d num %d\n", user, group, others, argc,
num);

//setting the permissions using bitwise operators
if (user & 4)
    mode |= S_IRUSR;

if (user & 2)
    mode |= S_IWUSR;

if (user & 1)
    mode |= S_IXUSR;

if (user & 4)
    mode |= S_IRGRP;

if (user & 2)
    mode |= S_IWGRP;

if (user & 1)
    mode |= S_IXGRP;

```

```

    if (user & 4)
        mode |= S_IROTH;

    if (user & 2)
        mode |= S_IWOTH;

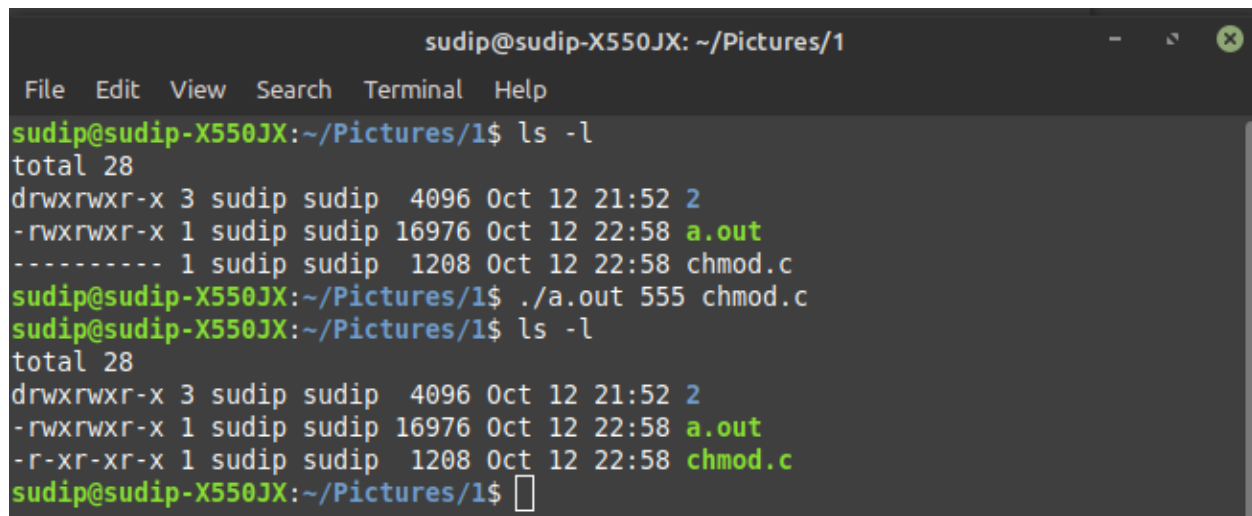
    if (user & 1)
        mode |= S_IXOTH;

    chmod(path, mode);

    return 0;
}

```

I changed the permissions from 000 of chmod.c to 777. I displayed the permissions of the files using ls -l command.



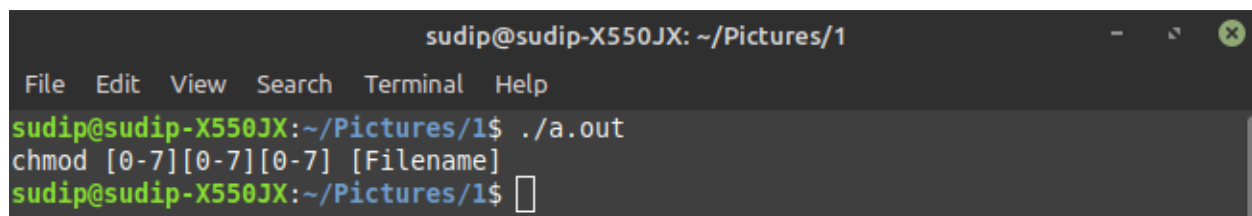
A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' showing the execution of a program. The user runs 'ls -l' and sees the permissions for 'a.out' and 'chmod.c'. Then, they run './a.out 555 chmod.c', and a subsequent 'ls -l' shows that the permissions for 'chmod.c' have been changed from 000 to 555.

```

sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ ls -l
total 28
drwxrwxr-x 3 sudip sudip 4096 Oct 12 21:52 2
-rwxrwxr-x 1 sudip sudip 16976 Oct 12 22:58 a.out
----- 1 sudip sudip 1208 Oct 12 22:58 chmod.c
sudip@sudip-X550JX:~/Pictures/1$ ./a.out 555 chmod.c
sudip@sudip-X550JX:~/Pictures/1$ ls -l
total 28
drwxrwxr-x 3 sudip sudip 4096 Oct 12 21:52 2
-rwxrwxr-x 1 sudip sudip 16976 Oct 12 22:58 a.out
-r-xr-xr-x 1 sudip sudip 1208 Oct 12 22:58 chmod.c
sudip@sudip-X550JX:~/Pictures/1$ 

```

If the number of arguments is incorrect, the proper syntax is displayed. This program only takes input as three digit octal integer for setting the file permissions



A terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' showing the user running './a.out' without arguments. The program displays an error message: 'chmod [0-7][0-7][0-7] [Filename]', indicating the expected input format.

```

sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ ./a.out
chmod [0-7][0-7][0-7] [Filename]
sudip@sudip-X550JX:~/Pictures/1$ 

```

## j) **mkdir** command

Source code:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <unistd.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <sys/stat.h>
#include <fcntl.h>

void main(int argc, char *argv[])
{

    if (argc != 2 || argv[1] == "--help")
    {
        printf("\nusage: mkdir [Directory name]\n");
        // break;
    }

    char *cmd = "mkdir";
    char *args[3];
    args[0] = "mkdir";
    args[1] = argv[1];
    args[2] = NULL;

    //using execvp to execute the mkdir command. We are passing the arguments that are taken from
    the command line
    execvp(cmd, argv);
}
```

I created a directory using mkdir program. Then I created a sub-directory inside the directory which I just created. I displayed the changes that were made by the program using ls command

```

sudip@sudip-X550JX: ~/Pictures/1/2
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1/2$ ls
a.out  mkdir.c
sudip@sudip-X550JX:~/Pictures/1/2$ ./a.out 3
sudip@sudip-X550JX:~/Pictures/1/2$ ls
3  a.out  mkdir.c
sudip@sudip-X550JX:~/Pictures/1/2$ ./a.out 3/4
sudip@sudip-X550JX:~/Pictures/1/2$ ls 3
4
sudip@sudip-X550JX:~/Pictures/1/2$
```

Running the program with incorrect number of arguments gives the syntax for correctly running the program

```

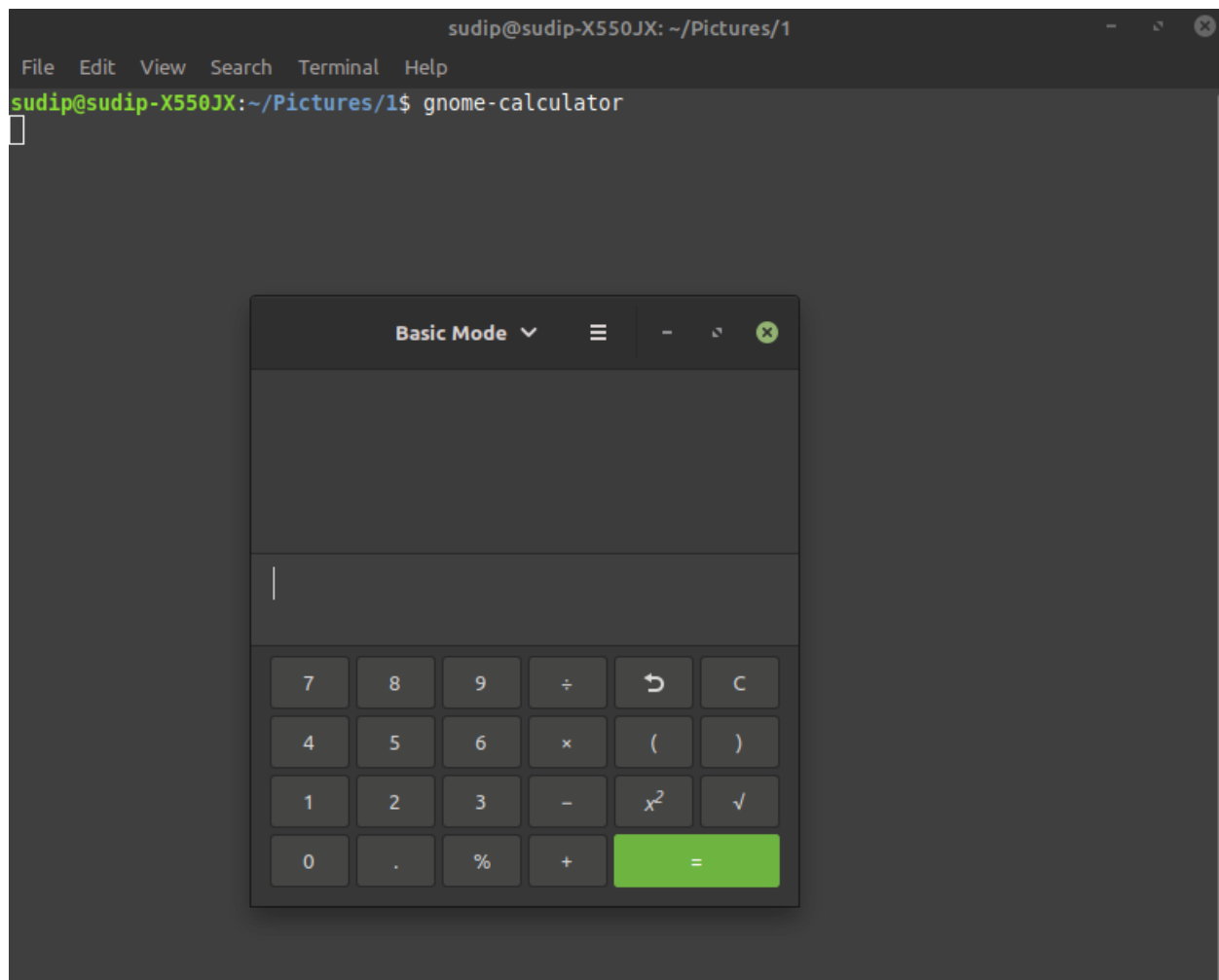
sudip@sudip-X550JX: ~/Pictures/1/2
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1/2$ ./a.out

usage: mkdir [Directory name]
./a.out: missing operand
Try './a.out --help' for more information.
sudip@sudip-X550JX:~/Pictures/1/2$
```

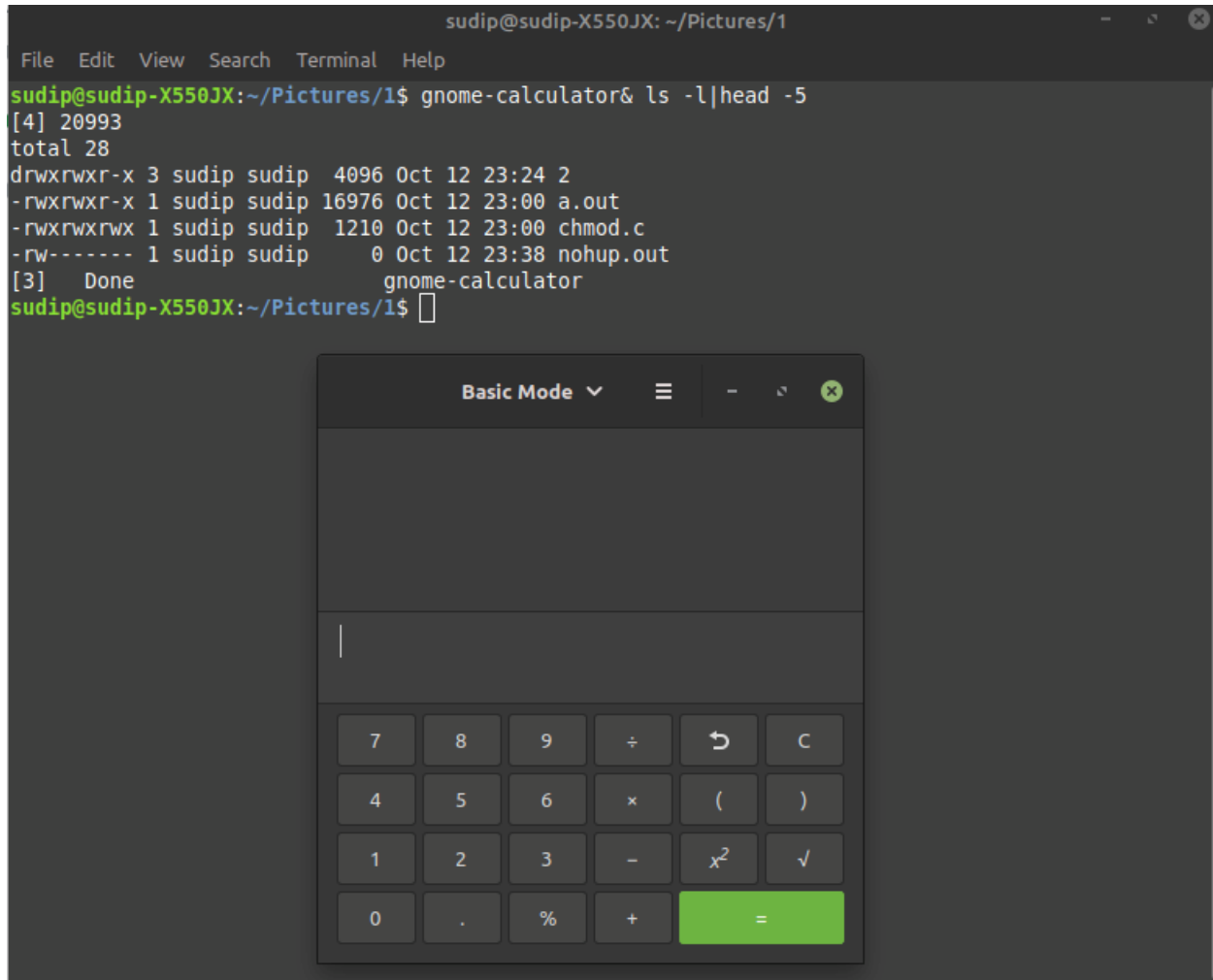


### Part 3 - Run programs in background using & at the end

We can open the Gnome calculator using a simple command.



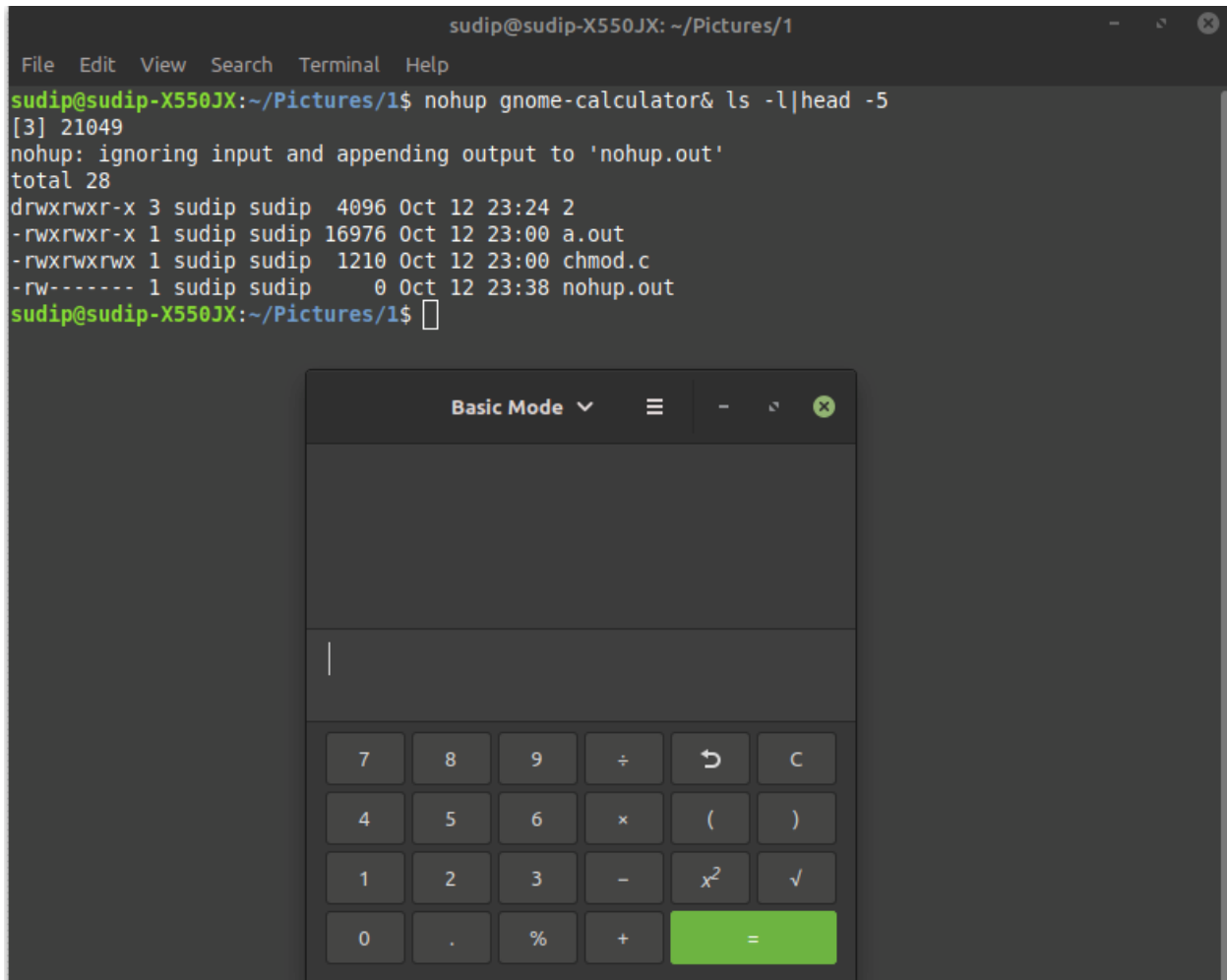
Using ampersand we can make the calculator as a background process, and we can still use the terminal. One disadvantage to using this method is, when we close the terminal, the calculator app also closes. To fix the above problem we use nohup command in the beginning of the sentence.



The image shows a terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal output shows the command 'gnome-calculator& ls -l|head -5' being executed. The output of 'ls -l|head -5' is displayed, showing file permissions, owner, group, size, date, and filename. The output of 'gnome-calculator' is 'Done'. The terminal prompt is 'sudip@sudip-X550JX:~/Pictures/1\$'. Overlaid on the terminal is a 'Basic Mode' calculator window with a numeric keypad and various mathematical function buttons.

```
sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ gnome-calculator& ls -l|head -5
[4] 20993
total 28
drwxrwxr-x 3 sudip sudip 4096 Oct 12 23:24 2
-rwxrwxr-x 1 sudip sudip 16976 Oct 12 23:00 a.out
-rwxrwxrwx 1 sudip sudip 1210 Oct 12 23:00 chmod.c
-rw----- 1 sudip sudip 0 Oct 12 23:38 nohup.out
[3] Done
gnome-calculator
sudip@sudip-X550JX:~/Pictures/1$
```

When we use `nohup` command, a `nohup.out` file is created which runs in the background. So even when we close the terminal, the calculator app still runs.



The screenshot shows a terminal window titled 'sudip@sudip-X550JX: ~/Pictures/1' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal output shows the command `nohup gnome-calculator& ls -l|head -5` being executed. The output includes the PID [3] 21049, a message 'nohup: ignoring input and appending output to 'nohup.out'', and a directory listing for the current directory. The listing shows files `a.out`, `chmod.c`, and `nohup.out`. Below the terminal, a 'Basic Mode' calculator application is open, displaying a numeric keypad and a display area.

```
sudip@sudip-X550JX: ~/Pictures/1
File Edit View Search Terminal Help
sudip@sudip-X550JX:~/Pictures/1$ nohup gnome-calculator& ls -l|head -5
[3] 21049
nohup: ignoring input and appending output to 'nohup.out'
total 28
drwxrwxr-x 3 sudip sudip 4096 Oct 12 23:24 .
-rwxrwxr-x 1 sudip sudip 16976 Oct 12 23:00 a.out
-rwxrwxrwx 1 sudip sudip 1210 Oct 12 23:00 chmod.c
-rw----- 1 sudip sudip    0 Oct 12 23:38 nohup.out
sudip@sudip-X550JX:~/Pictures/1$
```