Your Main Tasks:

Time Measurement:
- **Measure the execution time for each command to assess their
   performance.
   ``` bash
   I will use $time {command}
```

System Interaction Identification:
- **Identify which system stack (e.g., file system, network) each
command
  interacts with during execution.
   ``` bash
   I will use $ strace -c -e trace={stack} {command}
```

Syscall Time Breakdown:
- **Break down the total execution time of each command into time per
  system call to understand their resource consumption.
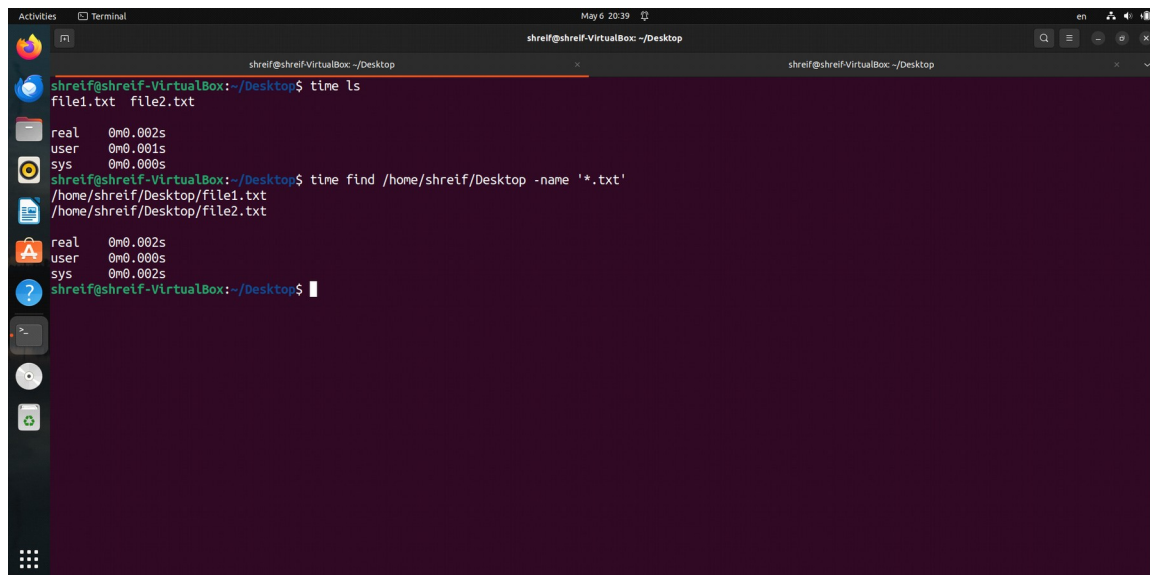   ``` bash
   I will use $ strace -c {command}
```

   ### Performance Evaluation:
- **Analyze the results to determine which command performs better
than the
  other based on execution time, system interaction, and syscall
breakdown.

# ls vs. find

```
# cp vs. rsync
```

```
shreif@shreif-VirtualBox:~$ time cp output.txt ./Desktop/

real    0m0.002s
user    0m0.002s
sys     0m0.001s
shreif@shreif-VirtualBox:~$ time rsync output.txt  ./Desktop/

real    0m0.095s
user    0m0.006s
sys     0m0.009s
shreif@shreif-VirtualBox:~$
```

```
shreif@shreif-VirtualBox:~$ strace -c cp output.txt ./Desktop/
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 35.41    0.000216          21        10           openat
 14.59    0.000089           6        13         1 newfstatat
 10.33    0.000063           7         9           read
  7.38    0.000045          22         2         2 statfs
  7.05    0.000043          43         1           write
  6.89    0.000042           3        13           close
  5.90    0.000036           1        27           mmap
  3.77    0.000023           7         3           brk
  3.28    0.000020          10         2           munmap
  1.97    0.000012           6         2         2 access
  1.31    0.000008           8         1           getrandom
  0.82    0.000005           5         1           geteuid
  0.82    0.000005           5         1           fadvise64
  0.49    0.000003           3         1         1 lseek
  0.00    0.000000           0        10           mprotect
  0.00    0.000000           0         4           pread64
  0.00    0.000000           0         1           execve
  0.00    0.000000           0         2         1 arch_prctl
  0.00    0.000000           0         1           set_tid_address
  0.00    0.000000           0         1           set_robust_list
  0.00    0.000000           0         1           prlimit64
  0.00    0.000000           0         1           rseq
------ ----------- ----------- --------- --------- ----------------
100.00    0.000610           5       107         7 total
shreif@shreif-VirtualBox:~$
```

```
shreif@shreif-VirtualBox:~$ strace -c rsync output.txt  ./Desktop/
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 39.83    0.000640         106         6         3 wait4
 23.71    0.000381           9        42           mmap
 12.69    0.000204          14        14           mprotect
  5.04    0.000081          81         1           clone
  5.04    0.000081           5        15         2 openat
  4.48    0.000072           4        16         1 newfstatat
  3.24    0.000052           2        23           read
  1.37    0.000022           1        15           close
  0.81    0.000013           6         2           socketpair
  0.62    0.000010           0        17           futex
  0.56    0.000009           2         4           pread64
  0.50    0.000008           0        11           fcntl
  0.44    0.000007           0        13           pselect6
  0.37    0.000006           0         7           write
  0.31    0.000005           0        11           rt_sigaction
  0.31    0.000005           5         1           getcwd
  0.25    0.000004           2         2         1 arch_prctl
  0.12    0.000002           2         1           set_tid_address
  0.12    0.000002           2         1           set_robust_list
  0.12    0.000002           2         1           rseq
  0.06    0.000001           1         1           rt_sigprocmask
  0.00    0.000000           0         1           munmap
  0.00    0.000000           0         6           brk
  0.00    0.000000           0         1         1 rt_sigreturn
  0.00    0.000000           0         1         1 access
  0.00    0.000000           0         1           execve
  0.00    0.000000           0         2           umask
  0.00    0.000000           0         1           geteuid
  0.00    0.000000           0         1           getegid
  0.00    0.000000           0         3         1 clock_nanosleep
  0.00    0.000000           0         1           prlimit64
  0.00    0.000000           0         1           getrandom
------ ----------- ----------- --------- --------- ----------------
100.00    0.001607           7       223        10 total
shreif@shreif-VirtualBox:~$
```

diff vs. cmp

sort vs. uniq

shreif@shreif-VirtualBox: ~

```
shreif@shreif-VirtualBox:~$ time uniq /home/shreif/Desktop/file1.txt
root:x:0:0:root:/root:/bin/bash
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
bin:x:2:2:bin:/bin:/usr/sbin/nologin
sys:x:3:3:sys:/dev:/usr/sbin/nologin
sync:x:4:65534:sync:/bin:/bin/sync
games:x:5:60:games:/usr/games:/usr/sbin/nologin
man:x:6:12:man:/var/cache/man:/usr/sbin/nologin
lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin
mail:x:8:8:mail:/var/mail:/usr/sbin/nologin
news:x:9:9:news:/var/spool/news:/usr/sbin/nologin
uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin
proxy:x:13:13:proxy:/bin:/usr/sbin/nologin
www-data:x:33:33:www-data:/var/www:/usr/sbin/nologin
backup:x:34:34:backup:/var/backups:/usr/sbin/nologin
list:x:38:38:Mailing List Manager:/var/list:/usr/sbin/nologin
irc:x:39:39:ircd:/run/ircd:/usr/sbin/nologin
gnats:x:41:41:Gnats Bug-Reporting System (admin):/var/lib/gnats:/usr/sbin/nologin
nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin/nologin
systemd-network:x:100:102:systemd Network Management,,,:/run/systemd:/usr/sbin/nologin
systemd-resolve:x:101:103:systemd Resolver,,,:/run/systemd:/usr/sbin/nologin
messagebus:x:102:105:/nonexistent:/usr/sbin/nologin
systemd-timesync:x:103:106:systemd Time Synchronization,,,:/run/systemd:/usr/sbin/nologin
syslog:x:104:111:/home/syslog:/usr/sbin/nologin
_apt:x:105:65534:/nonexistent:/usr/sbin/nologin
tss:x:106:113:TPM software stack,,,:/var/lib/tpm:/bin/false
uuidd:x:107:116:/run/uuidd:/usr/sbin/nologin
systemd-oom:x:108:117:systemd Userspace OOM Killer,,,:/run/systemd:/usr/sbin/nologin
tcpdump:x:109:118:/nonexistent:/usr/sbin/nologin
avahi-autoipd:x:110:119:Avahi autoip daemon,,,:/var/lib/avahi-autoipd:/usr/sbin/nologin
usbmux:x:111:46:usbmux daemon,,,:/var/lib/usbmux:/usr/sbin/nologin
dnsmasq:x:112:65534:dnsmasq,,,:/var/lib/misc:/usr/sbin/nologin
kernoops:x:113:65534:Kernel Oops Tracking Daemon,,,:/:/usr/sbin/nologin
avahi:x:114:121:Avahi mDNS daemon,,,:/run/avahi-daemon:/usr/sbin/nologin
cups-pk-helper:x:115:122:user for cups-pk-helper service,,,:/home/cups-pk-helper:/usr/sbin/nologin
rtkit:x:116:123:RealtimeKit,,,:/proc:/usr/sbin/nologin
whoopsie:x:117:124::/nonexistent:/bin/false
sssd:x:118:125:SSSD system user,,,:/var/lib/sss:/usr/sbin/nologin
speech-dispatcher:x:119:29:Speech Dispatcher,,,:/run/speech-dispatcher:/bin/false
fwupd-refresh:x:120:126:fwupd-refresh user,,,:/run/systemd:/usr/sbin/nologin
nm-openvpn:x:121:127:NetworkManager OpenVPN,,,:/var/lib/openvpn/chroot:/usr/sbin/nologin
saned:x:122:129::/var/lib/saned:/usr/sbin/nologin
colord:x:123:130:colord colour management daemon,,,:/var/lib/colord:/usr/sbin/nologin
geoclue:x:124:131::/var/lib/geoclue:/usr/sbin/nologin
pulse:x:125:132:PulseAudio daemon,,,:/run/pulse:/usr/sbin/nologin
gnome-initial-setup:x:126:65534::/run/gnome-initial-setup/:/bin/false
hplip:x:127:7:HPLIP system user,,,:/var/run/hplip:/bin/false
gdm:x:128:134:Gnome Display Manager:/var/lib/gdm3:/bin/false
shreif:x:1000:1000:,,,:/home/shreif:/bin/bash
vboxadd:x:999:1::/var/run/vboxadd:/bin/false


real    0m0.103s
user    0m0.000s
sys     0m0.006s
shreif@shreif-VirtualBox:~$
```

shreif@shreif-VirtualBox: ~

```
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 27.54    0.000656          13        49           write
 21.96    0.000523         130         4           mprotect
 10.58    0.000252          36         7           newfstatat
  8.82    0.000210           9        23           rt_sigaction
  8.77    0.000209          52         4           openat
  4.87    0.000116          38         3           brk
  4.28    0.000102          51         2           munmap
  2.48    0.000059           5        10           mmap
  2.39    0.000057          14         4           prlimit64
  1.64    0.000039           6         6           close
  1.13    0.000027          27         1           getrandom
  0.97    0.000023           7         3           read
  0.97    0.000023          11         2           sysinfo
  0.50    0.000012           6         2         1 access
  0.46    0.000011          11         1           sched_getaffinity
  0.42    0.000010          10         1           fcntl
  0.38    0.000009           9         1           lseek
  0.38    0.000009           9         1           getgid
  0.38    0.000009           9         1           geteuid
  0.38    0.000009           9         1           getegid
  0.38    0.000009           9         1           fadvise64
  0.34    0.000008           8         1           getuid
  0.00    0.000000           0         4           pread64
  0.00    0.000000           0         1           execve
  0.00    0.000000           0         2         1 arch_prctl
  0.00    0.000000           0         1           set_tid_address
  0.00    0.000000           0         1           set_robust_list
  0.00    0.000000           0         1           rseq
------ ----------- ----------- --------- --------- ----------------
100.00    0.002382          17       138         2 total
shreif@shreif-VirtualBox:~$
```

shreif@shreif-VirtualBox: ~

```
vboxadd:x:999:1:::/var/run/vboxadd:/bin/false
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 24.84    0.001508        1508         1           execve
 17.43    0.001058          21        49           write
 16.06    0.000975         108         9           mmap
  7.76    0.000471         117         4           mprotect
  5.60    0.000340          85         4           openat
  5.32    0.000323          64         5           newfstatat
  4.12    0.000250          35         7           close
  3.56    0.000216          54         4           pread64
  2.88    0.000175         175         1           munmap
  2.83    0.000172          57         3           brk
  2.06    0.000125          41         3           read
  1.30    0.000079          79         1           getrandom
  1.27    0.000077          38         2         1 arch_prctl
  1.20    0.000073          73         1         1 access
  0.71    0.000043          43         1           rseq
  0.69    0.000042          42         1           prlimit64
  0.68    0.000041          41         1           set_tid_address
  0.68    0.000041          41         1           set_robust_list
  0.58    0.000035          35         1           dup3
  0.23    0.000014          14         1           fadvise64
  0.20    0.000012          12         1           lseek
------ ----------- ----------- --------- --------- ----------------
100.00    0.006070          60       101         2 total
shreif@shreif-VirtualBox:~$
```

grep vs. sed

```
shreif@shreif-VirtualBox:~$ strace -c sed -n '5p' /home/shreif/Desktop/file1.txt
sync:x:4:65534:sync:/bin:/bin/sync
% time     seconds  usecs/call     calls    errors syscall
------ ----------- ----------- --------- --------- ----------------
 22.01    0.000068           7         9           openat
 16.83    0.000052           5        10           close
 16.83    0.000052          26         2         2 access
 16.18    0.000050           5        10           newfstatat
 12.30    0.000038           1        23           mmap
  7.44    0.000023           2         8           read
  5.50    0.000017          17         1           write
  2.91    0.000009           9         1           futex
  0.00    0.000000           0         9           mprotect
  0.00    0.000000           0         1           munmap
  0.00    0.000000           0         3           brk
  0.00    0.000000           0         4           pread64
  0.00    0.000000           0         1           execve
  0.00    0.000000           0         2         2 statfs
  0.00    0.000000           0         2         1 arch_prctl
  0.00    0.000000           0         1           set_tid_address
  0.00    0.000000           0         1           set_robust_list
  0.00    0.000000           0         1           prlimit64
  0.00    0.000000           0         1           getrandom
  0.00    0.000000           0         1           rseq
------ ----------- ----------- --------- --------- ----------------
100.00    0.000309           3        91         5 total
shreif@shreif-VirtualBox:~$ strace -c grep "sync:x:4:65534:sync:/bin:/bin/sync" /home/shreif/Desktop/file1.txt
```

Command	Time	No.of Stacks	Time break down	Performance
ls vs. find	ls	same number	ls	ls
cp vs. rsync	cp	rsync	cp	cp
diff vs. cmp	same time	same number	cmp	cmp
sort vs. uniq	sort	same number	sort	sort
grep vs. sed	sed	same number	grep	grep

Filesystem Stack	Network Stack	Memory management Stack	Process Stack
ls, find	rsync	ls, find	ls, find
cp, rsync	------	cp, rsync	cp, rsync
diff, cmp	------	diff, cmp	diff, cmp
sort, uniq	------	sort, uniq	sort, uniq
grep, sed	------	grep, sed	grep, sed