

## 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}

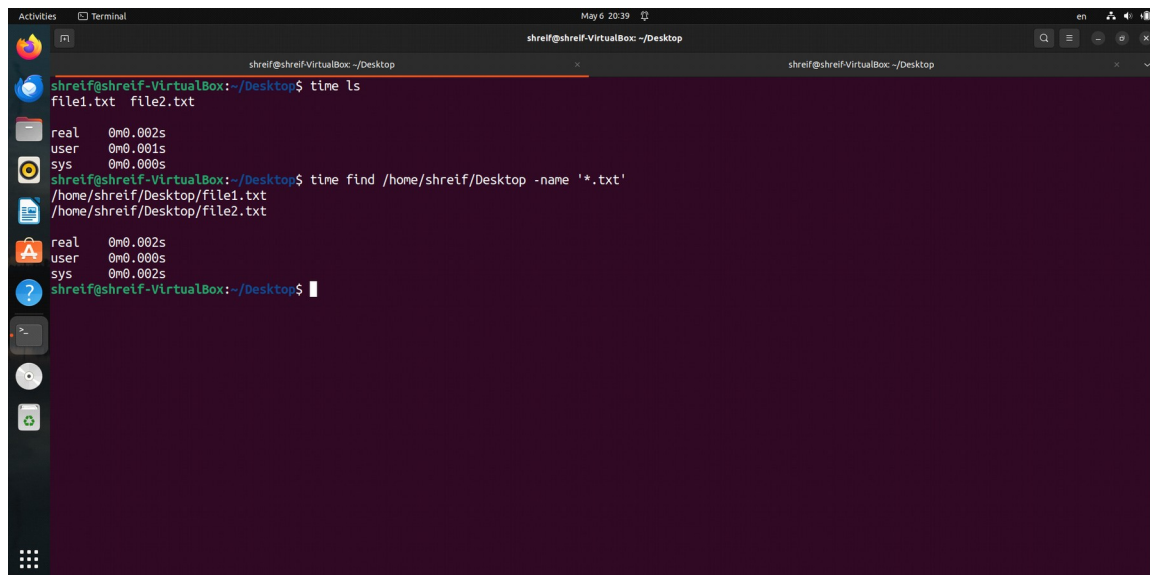
```

### 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



The screenshot shows a terminal window with the following commands and output:

```
shreif@shreif-VirtualBox: ~/Desktop$ time ls
file1.txt file2.txt
real    0m0.002s
user    0m0.001s
sys     0m0.000s
shreif@shreif-VirtualBox: ~/Desktop$ time find /home/shreif/Desktop -name '*.txt'
/home/shreif/Desktop/file1.txt
/home/shreif/Desktop/file2.txt
real    0m0.002s
user    0m0.000s
sys     0m0.002s
shreif@shreif-VirtualBox: ~/Desktop$
```

```
Activities Terminal May 6 21:01 shreif@shreif-VirtualBox: ~ shreif@shreif-VirtualBox: ~/Desktop
shreif@shreif-VirtualBox:~$ strace -c ls ./Desktop/
file1.txt file2.txt
% time seconds usecs/call calls errors syscall
-----
31.56 0.000113 16 7 mprotect
21.51 0.000077 4 18 mmap
8.10 0.000029 4 7 openat
5.31 0.000019 3 5 read
4.75 0.000017 1 9 close
4.47 0.000016 2 8 newfstatat
4.19 0.000015 15 1 munmap
3.91 0.000014 14 1 write
3.91 0.000014 7 2 2 statfs
3.63 0.000013 6 2 getdents64
1.68 0.000006 2 3 brk
1.40 0.000005 2 2 ioctl
1.40 0.000005 5 1 statx
0.84 0.000003 1 2 2 access
0.84 0.000003 3 1 getrandom
0.56 0.000002 2 1 set_tid_address
0.56 0.000002 2 1 set_robust_list
0.56 0.000002 2 1 prlimit64
0.56 0.000002 2 1 rseq
0.28 0.000001 0 2 1 arch_prctl
0.00 0.000000 0 4 pread64
0.00 0.000000 0 1 execve
-----
100.00 0.000358 4 80 5 total
shreif@shreif-VirtualBox:~$

Activities Terminal May 6 20:58 shreif@shreif-VirtualBox: ~ shreif@shreif-VirtualBox: ~/Desktop
shreif@shreif-VirtualBox:~$ strace -c cd /home/shreif/Desktop/
0.00 0.000000 0 1 rseq
-----
100.00 0.000000 0 115 17 total
shreif@shreif-VirtualBox:~/Desktop$ cd
/home/shreif/Desktop/file1.txt
/home/shreif/Desktop/file2.txt
shreif@shreif-VirtualBox:~/Desktop$ strace -c find /home/shreif/Desktop -name '*.txt'
% time seconds usecs/call calls errors syscall
-----
48.83 0.000187 8 22 12 openat
10.70 0.000041 5 7 read
8.88 0.000034 2 12 newfstatat
7.57 0.000029 2 14 close
6.79 0.000026 1 19 mmap
3.92 0.000015 7 2 write
3.66 0.000014 7 2 getdents64
2.61 0.000010 5 2 ioctl
2.09 0.000008 2 4 fcntl
1.83 0.000007 3 2 2 access
1.04 0.000004 4 1 uname
0.78 0.000003 3 1 fstatfs
0.78 0.000003 3 1 futex
0.52 0.000002 2 1 fchdir
0.00 0.000000 0 7 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 0.000383 3 115 17 total
shreif@shreif-VirtualBox:~/Desktop$
```

# 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      0      openat
14.59    0.000089       6          13      0      newfstatat
10.33    0.000063       7           9      0      read
7.38     0.000045      22           2      0      statfs
7.05     0.000043      43           1      0      write
6.89     0.000042       3          13      0      close
5.90     0.000036       1          27      0      mmap
3.77     0.000023       7           3      0      brk
3.28     0.000020      10           2      0      munmap
1.97     0.000012       6           2      0      access
1.31     0.000008       8           1      0      getrandom
0.82     0.000005       5           1      0      geteuid
0.82     0.000005       5           1      0      fadvise64
0.49     0.000003       3           1      0      lseek
0.00     0.000000       0          10      0      mprotect
0.00     0.000000       0           4      0      pread64
0.00     0.000000       0           1      0      execve
0.00     0.000000       0           2      0      arch_prctl
0.00     0.000000       0           1      0      set_tid_address
0.00     0.000000       0           1      0      set_robust_list
0.00     0.000000       0           1      0      prlimit64
0.00     0.000000       0           1      0      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      0      mmap
12.69    0.000204      14          14      0      mprotect
5.04     0.000081      81           1      0      clone
5.04     0.000081       5          15      2      openat
4.48     0.000072       4          16      1      newfstatat
3.24     0.000052       2          23      0      read
1.37     0.000022       1          15      0      close
0.81     0.000013       6           2      0      socketpair
0.62     0.000010       0          17      0      futex
0.56     0.000009       2           4      0      pread64
0.50     0.000008       0          11      0      fcntl
0.44     0.000007       0          13      0      pselect6
0.37     0.000006       0           7      0      write
0.31     0.000005       0          11      0      rt_sigaction
0.31     0.000005       5           1      0      getcwd
0.25     0.000004       2           2      1      arch_prctl
0.12     0.000002       2           1      0      set_tid_address
0.12     0.000002       2           1      0      set_robust_list
0.12     0.000002       2           1      0      rseq
0.06     0.000001       1           1      0      rt_sigprocmask
0.00     0.000000       0           1      0      munmap
0.00     0.000000       0           6      0      brk
0.00     0.000000       0           1      1      rt_sigreturn
0.00     0.000000       0           1      0      access
0.00     0.000000       0           1      0      execve
0.00     0.000000       0           2      0      umask
0.00     0.000000       0           1      0      geteuid
0.00     0.000000       0           1      0      getegid
0.00     0.000000       0           3      1      clock_nanosleep
0.00     0.000000       0           1      0      prlimit64
0.00     0.000000       0           1      0      getrandom
-----
100.00    0.001607       7          223     10 total
shreif@shreif-VirtualBox:~$
```

# diff vs. cmp

The image shows two screenshots of a terminal window on a Linux system, demonstrating the performance of the 'cmp' and 'diff' commands. The terminal window has a title bar that reads 'shreif@shreif-VirtualBox' and a status bar showing 'May 6 21:40'.

**Top Screenshot:**

```
shreif@shreif-VirtualBox:~$ time cmp /home/shreif/Desktop/file1.txt /home/shreif/Desktop/file2.txt
/home/shreif/Desktop/file1.txt /home/shreif/Desktop/file2.txt differ: byte 1, line 1

real    0m0.002s
user    0m0.001s
sys     0m0.000s
shreif@shreif-VirtualBox:~$ time diff /home/shreif/Desktop/file1.txt /home/shreif/Desktop/file2.txt
1,3c1,7
< t
< like
< turtles
...
> book
> book
> paper
> paper
> article
> article
> magazine

real    0m0.002s
user    0m0.001s
sys     0m0.000s
shreif@shreif-VirtualBox:~$
```

**Bottom Screenshot:**

```
> paper
> paper
> article
> article
> magazine
% time seconds usecs/call calls errors syscall
-----
21.96 0.000123 6 19 12 openat
19.46 0.000109 10 10 mmap
10.54 0.000059 8 7 newfstatat
9.82 0.000055 13 4 mprotect
6.61 0.000037 4 9 read
6.43 0.000036 3 12 write
5.89 0.000033 4 8 close
4.64 0.000026 6 4 pread64
4.11 0.000023 11 2 munmap
3.04 0.000017 5 3 brk
1.43 0.000008 8 1 getrandom
1.25 0.000007 2 3 fcntl
1.07 0.000006 6 1 prlimit64
0.89 0.000005 2 2 1 arch_prctl
0.89 0.000005 5 1 set_tid_address
0.89 0.000005 5 1 set_robust_list
0.89 0.000005 5 1 rseq
0.18 0.000001 0 2 rt_sigaction
0.00 0.000000 0 1 lseek
0.00 0.000000 0 1 1 access
0.00 0.000000 0 1 execve
0.00 0.000000 0 1 sigaltstack
-----
100.00 0.000560 5 94 14 total
shreif@shreif-VirtualBox:~$
```





```
Activities Terminal May 7 15:56 shreif@shreif-VirtualBox - 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
lpr:x:7:7:lpr:/usr/sbin:/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:logging list Manager:/usr/lib:/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
system-network:x:100:100:system Network Management:/:/run/systemd:/usr/sbin/nologin
system-resolve:x:101:101:system Resolved:/:/run/systemd:/usr/sbin/nologin
messagebus:x:182:182:system message bus:/:/run/systemd:/usr/sbin/nologin
systemd-timesync:x:102:102:system Time Synchronization:/:/run/systemd:/usr/sbin/nologin
syslog:x:104:104:system syslog:/var/log:/usr/sbin/nologin
_apt:x:1000:1000:apt:/var/lib/apt:/usr/sbin/nologin
sshd:x:1000:1000:ssh:/usr/sbin:/usr/sbin/nologin
tss:x:1001:1001:software tss:/:/usr/lib/tpm:/bin/false
utmpd:x:107:107:utmp:/usr/lib/utmp:/usr/sbin/nologin
systemd-user:x:108:107:systemd User Space OOM Killer:/:/run/systemd:/usr/sbin/nologin
tcpdump:x:109:109:tcpdump:/usr/sbin:/usr/sbin/nologin
avahi-autoipd:x:110:110:Avahi autoip daemon:/:/var/lib/avahi-autoipd:/usr/sbin/nologin
usbmuxd:x:111:60:usbmuxd daemon:/:/var/lib/usbmuxd:/usr/sbin/nologin
dmesgd:x:112:65534:dmesgd:/:/var/lib/dmesgd:/usr/sbin/nologin
kerneloops:x:113:65534:kerneloops Tracking Daemon:/:/usr/sbin/nologin
avahi:x:114:121:Avahi mDNS daemon:/:/run/avahi-daemon:/usr/sbin/nologin
cups-pk-helper:x:115:121:user for cups-pk-helper service:/:/home/cups-pk-helper:/usr/sbin/nologin
rtkit:x:116:122:RealtimeKit:/:/proc:/usr/sbin/nologin
uhubd:x:117:124:uhubd:/usr/sbin:/usr/sbin/nologin
sssd:x:118:125:SSSD system user:/:/var/lib/sss:/usr/sbin/nologin
speech-dispatcher:x:120:29:speech-dispatcher:/:/run/speech-dispatcher:/bin/false
fwupd-refresh:x:120:120:fwupd-refresh user:/:/run/systemd:/usr/sbin/nologin
nm-openvpn:x:121:127:NetworkManager OpenVPN:/:/var/lib/openvpn/chronos:/usr/sbin/nologin
samedie:x:122:126:/usr/lib/samedie:/usr/sbin/nologin
colord:x:123:130:colord colour management daemon:/:/var/lib/colord:/usr/sbin/nologin
goodies:x:124:131:/usr/lib/goodies:/usr/sbin/nologin
pulse:x:125:132:PulseAudio daemon:/:/run/pulse:/usr/sbin/nologin
grom:x:126:134:grom:/:/usr/lib/grom:/usr/sbin/nologin
hplip:x:127:7:HPLIP system user:/:/run/hplip:/bin/false
pols:x:128:134:Polkit Manager:/usr/lib/polkit:/bin/false
shreif:x:1000:1000:shreif:/:/home/shreif:/bin/false
vboxadd:x:999:1:/var/run/vboxadd:/bin/false

real    0m0.183s
user    0m0.000s
sys      0m0.000s
shreif@shreif-VirtualBox:~$

Activities Terminal May 7 15:58 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 gettid
0.38 0.000009 9 1 getuid
0.38 0.000009 9 1 getgid
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

Activities Terminal May 7 15:57 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:~$ time grep "sync:x:4:65534:sync:/bin:/bin/sync" /home/shreif/Desktop/file1.txt
sync:x:4:65534:sync:/bin:/bin/sync

real    0m0.003s
user    0m0.000s
sys     0m0.002s
shreif@shreif-VirtualBox:~$ time sed -n '5p' /home/shreif/Desktop/file1.txt
sync:x:4:65534:sync:/bin:/bin/sync

real    0m0.002s
user    0m0.000s
sys     0m0.002s
shreif@shreif-VirtualBox:~$
```

```
shreif@shreif-VirtualBox:~$ strace -c grep "sync:x:4:65534:sync:/bin:/bin/sync" /home/shreif/Desktop/file1.txt
sync:x:4:65534:sync:/bin:/bin/sync
% time seconds usecs/call calls errors syscall
-----
18.45 0.000019 1 10 newfstatat
17.48 0.000018 9 2 munmap
14.56 0.000015 1 10 close
13.59 0.000014 14 1 write
12.62 0.000013 1 8 read
8.74 0.000009 0 20 openat
6.80 0.000007 1 4 brk
4.85 0.000005 2 2 rt_sigaction
2.91 0.000003 3 1 sigaltstack
0.00 0.000000 0 1 lseek
0.00 0.000000 0 15 mmap
0.00 0.000000 0 5 mprotect
0.00 0.000000 0 4 pread64
0.00 0.000000 0 1 access
0.00 0.000000 0 1 execve
0.00 0.000000 0 2 arch_prctl
0.00 0.000000 0 1 futex
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 0.000103 1 93 14 total
shreif@shreif-VirtualBox:~$
```

```

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         0 openat
16.83      0.000052      5         10         0 close
16.83      0.000052     26          2         2 access
16.18      0.000050      5         10         0 newfstatat
12.30      0.000038      1         23         0 mmap
7.44       0.000023      2          8         0 read
5.50       0.000017     17          1         0 write
2.91       0.000009      9          1         0 futex
0.00       0.000000      0          9         0 mprotect
0.00       0.000000      0          1         0 munmap
0.00       0.000000      0          3         0 brk
0.00       0.000000      0          4         0 pread64
0.00       0.000000      0          1         0 execve
0.00       0.000000      0          2         2 statfs
0.00       0.000000      0          2         1 arch_prctl
0.00       0.000000      0          1         0 set_tid_address
0.00       0.000000      0          1         0 set_robust_list
0.00       0.000000      0          1         0 prlimit64
0.00       0.000000      0          1         0 getrandom
0.00       0.000000      0          1         0 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,
cp, rsync		cp, rsync	cp,
diff, cmp		diff, cmp	diff,
sort, uniq		sort, uniq	sort,
grep, sed		grep, sed	grep,