Lab 2 : Operating System Interfaces and Process Information

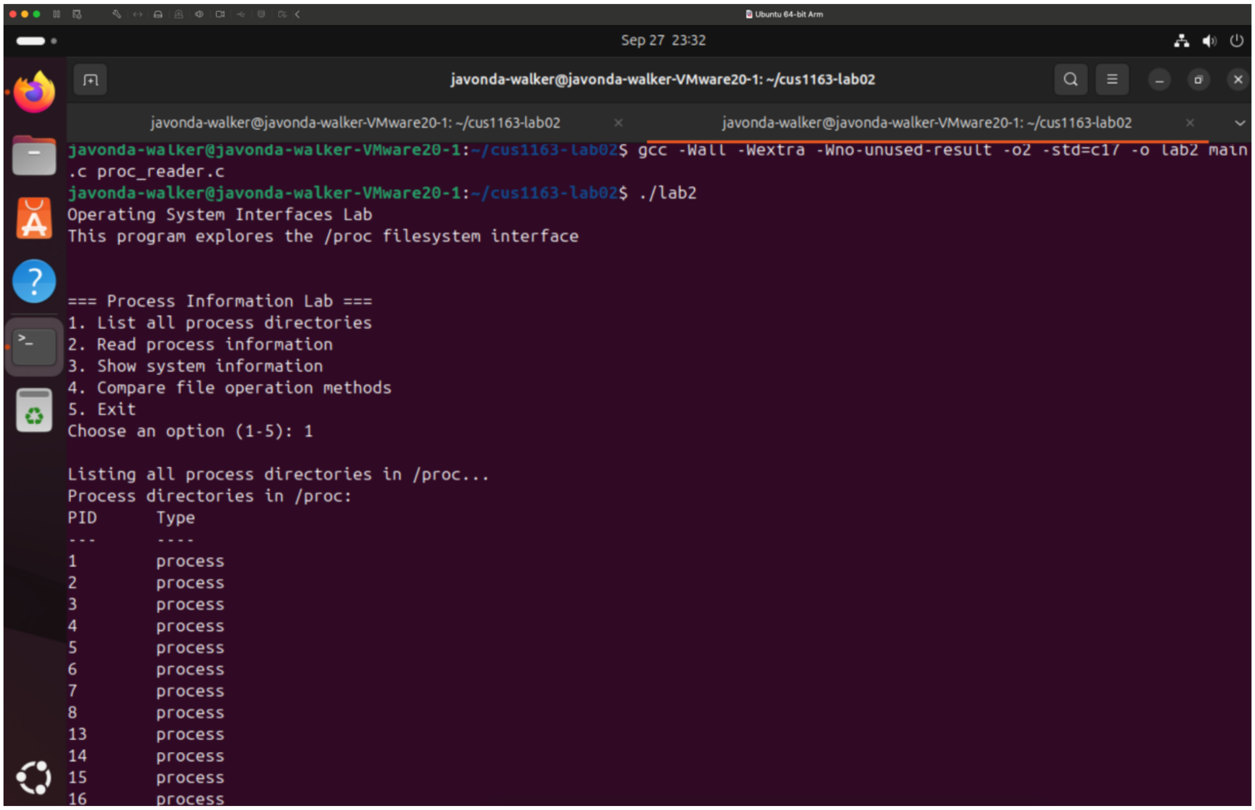
Javonda Walker

1.How many system calls?
When I ran option 4 and checked syscalls.txt, I saw about this many calls in total (both methods combined): openat=4, read=6, write=29, close=4. The library version ends up doing fewer read()calls because it reads bigger chunks at a time. The low-level version reads in smaller fixed chunks, so it would usually need more read()s to get the same data. The exact numbers can vary by machine, but the pattern is the same; fewer, larger reads with the library and more, smaller reads with raw syscalls.

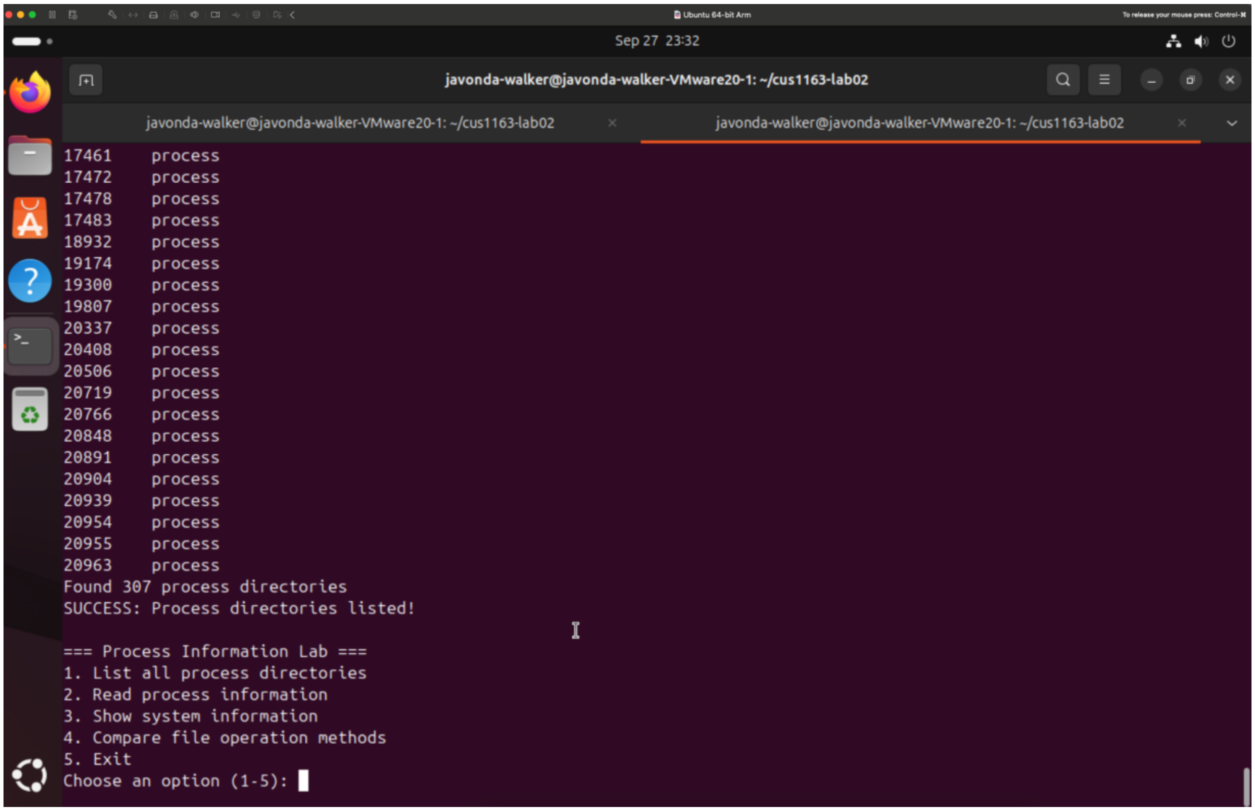
2.What’s the difference between open() and fopen()?
open() is the low-level system call that talks directly to the kernel and gives you an integer file descriptor. fopen() is the C library’s higher-level function that uses open() under the hood but returns a FILE* and sets up buffering. With fopen() you get helpers like fgets() and fprintf(), so the code is usually simpler to write.

3.Why does the library method make different calls?
Because of buffering. The stdio layer (fopen/fgets) keeps an in-memory buffer, so it can read a bigger chunk from the OS and then serve the program multiple lines from that buffer. That means fewer trips into the kernel (fewer read()syscalls). Also a couple of extra setup calls like fstat are seen, but overall there are fewer reads and that usually helps performance for straight sequential reading.

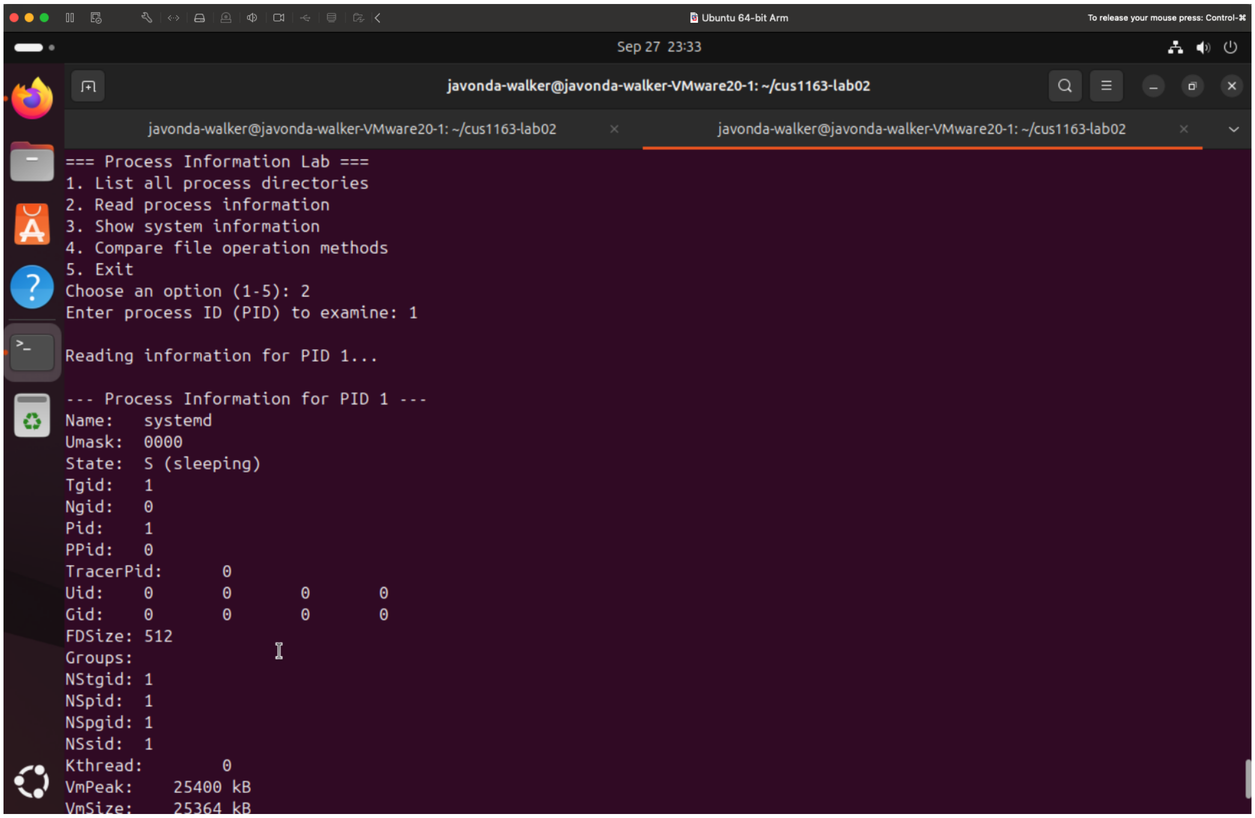
For this kind of sequential file read, the stdio approach tends to make fewer system calls and can be faster, while the raw syscall approach gives you tighter control over buffer sizes and exactly how reads/writes happen. In my trace, the stdio path reduced the number of read() calls, which matches what I expect from its buffering.


Ubuntu 64-bit Arm
Sep 27 23:32
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

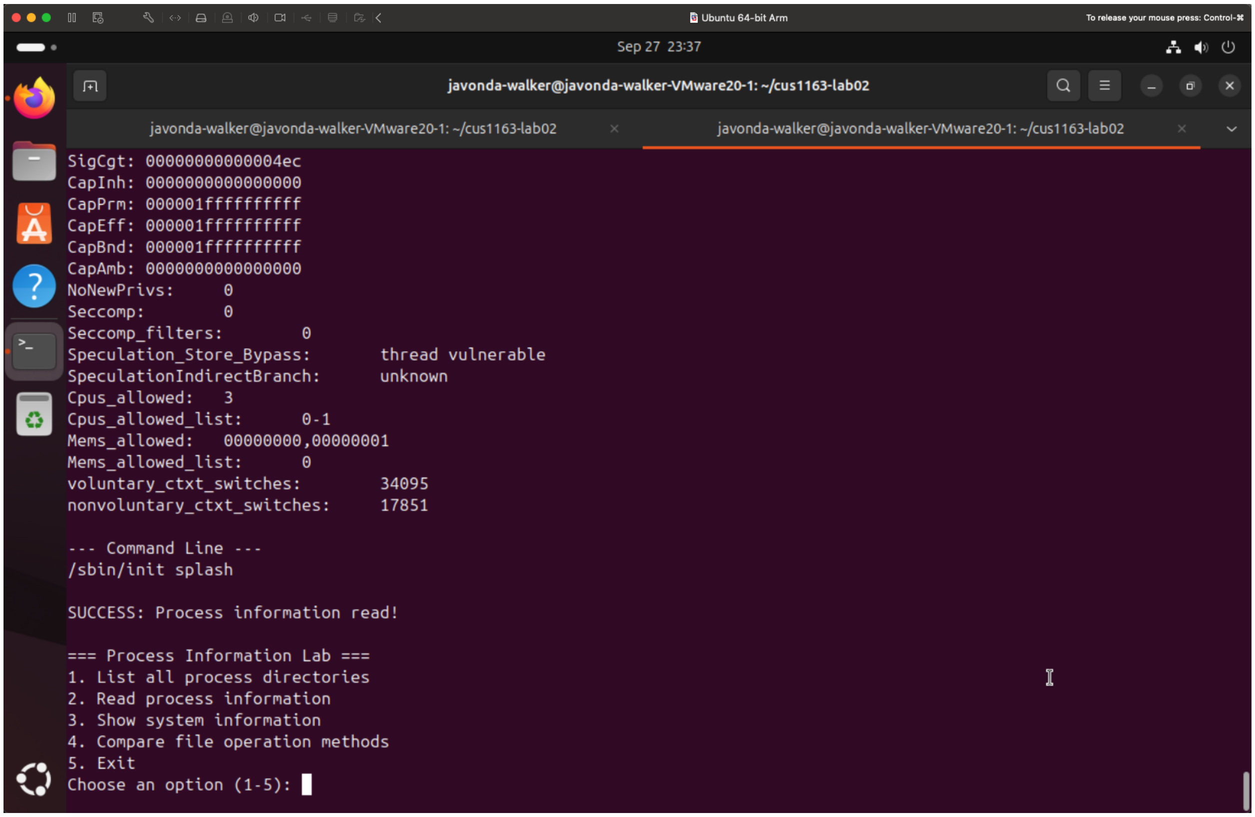
```
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ gcc -Wall -Wextra -Wno-unused-result -O2 -std=c17 -o lab2 main
.c proc_reader.c
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ ./lab2
Operating System Interfaces Lab
This program explores the /proc filesystem interface


=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 1

Listing all process directories in /proc...
Process directories in /proc:
PID      Type
---      ----
1        process
2        process
3        process
4        process
5        process
6        process
7        process
8        process
13       process
14       process
15       process
16       process
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 27 23:32
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

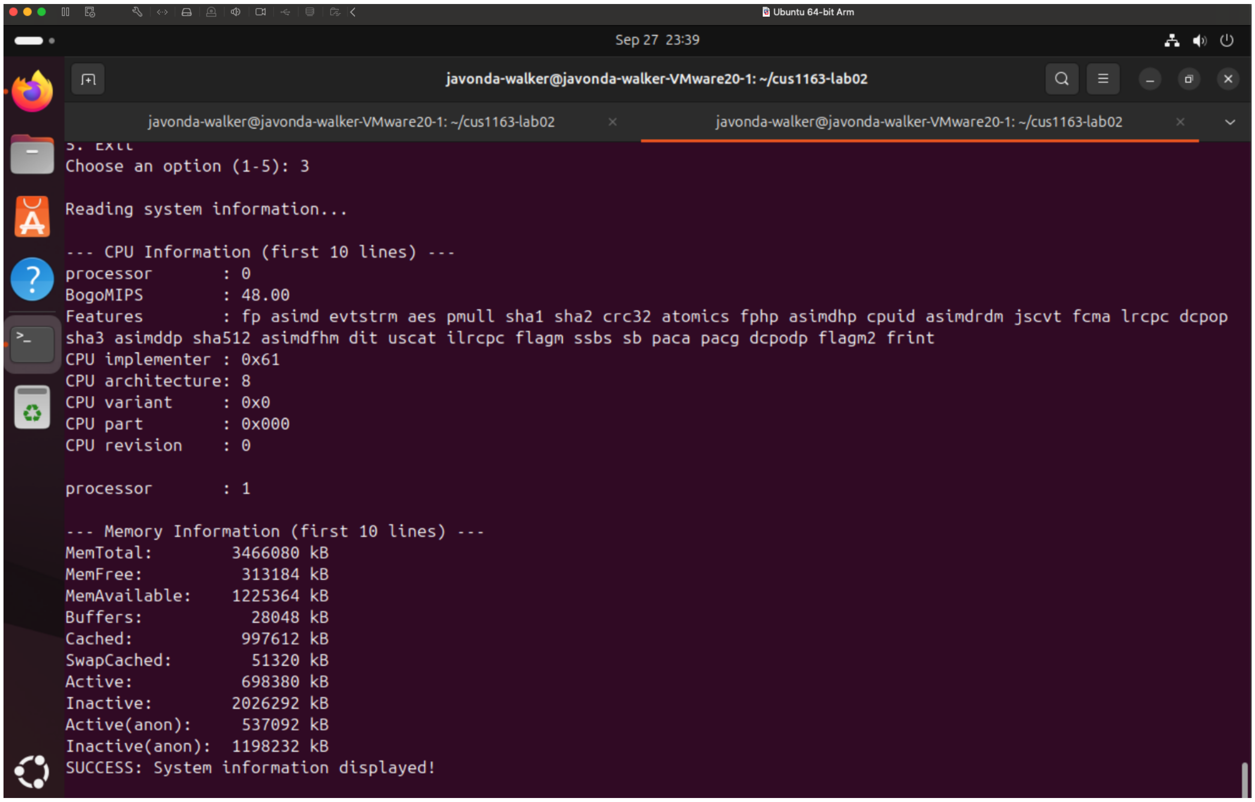
```
17461    process
17472    process
17478    process
17483    process
18932    process
19174    process
19300    process
19807    process
20337    process
20408    process
20506    process
20719    process
20766    process
20848    process
20891    process
20904    process
20939    process
20954    process
20955    process
20963    process
Found 307 process directories
SUCCESS: Process directories listed!

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5):
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 27 23:33
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

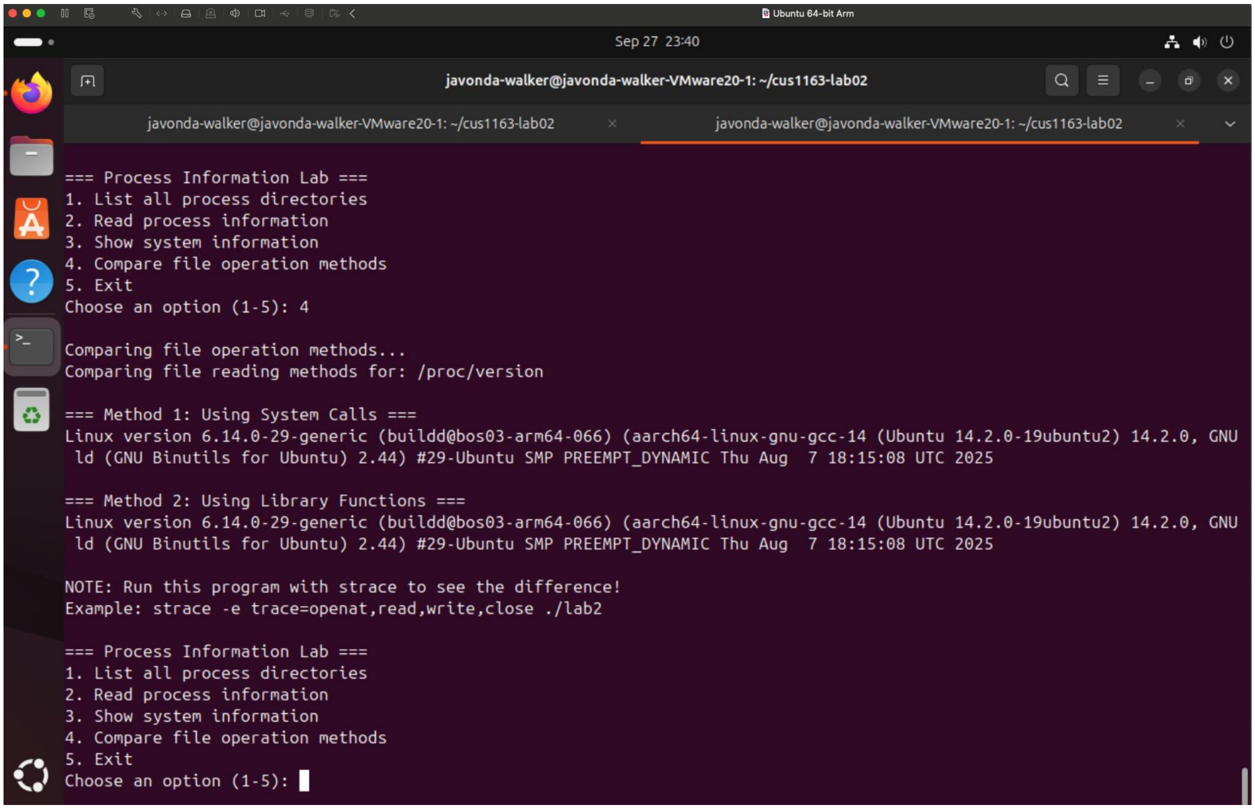
```
=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 2
Enter process ID (PID) to examine: 1

Reading information for PID 1...

--- Process Information for PID 1 ---
Name:   systemd
Umask:  0000
State:  S (sleeping)
Tgid:   1
Ngid:   0
Pid:    1
PPid:   0
TracerPid:      0
Uid:    0       0       0       0
Gid:    0       0       0       0
FDSize: 512
Groups:
NStgid: 1
NSpid:  1
NSpgid: 1
NSsid:  1
Kthread:        0
VmPeak:    25400 kB
VmSize:    25364 kB
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 27 23:37
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

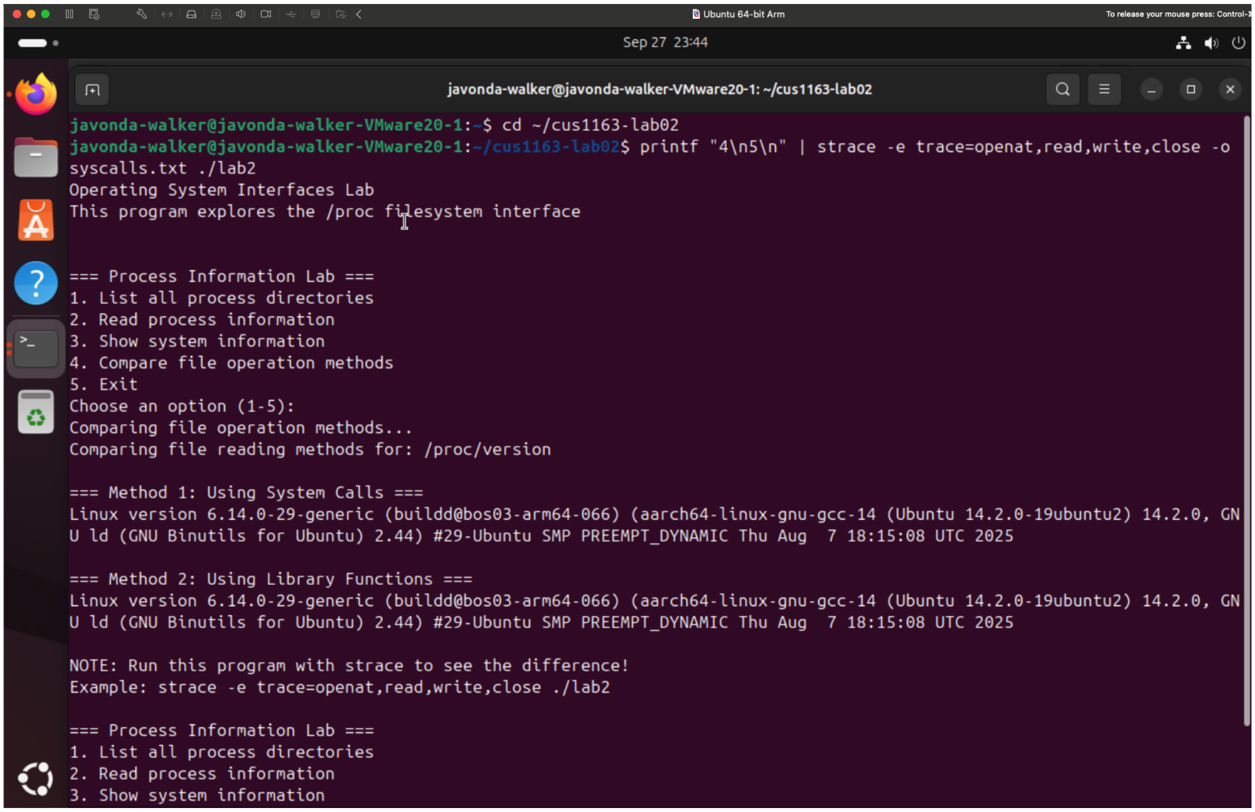
```
SigCgt: 00000000000004ec
CapInh: 0000000000000000
CapPrm: 000001ffffffffff
CapEff: 000001ffffffffff
CapBnd: 000001ffffffffff
CapAmb: 0000000000000000
NoNewPrivs:     0
Seccomp:        0
Seccomp_filters:        0
Speculation_Store_Bypass:       thread vulnerable
SpeculationIndirectBranch:      unknown
Cpus_allowed:   3
Cpus_allowed_list:      0-1
Mems_allowed:   00000000,00000001
Mems_allowed_list:      0
voluntary_ctxt_switches:        34095
nonvoluntary_ctxt_switches:     17851

--- Command Line ---
/sbin/init splash

SUCCESS: Process information read!

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 
```


Ubuntu 64-bit Arm
Sep 27 23:39
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

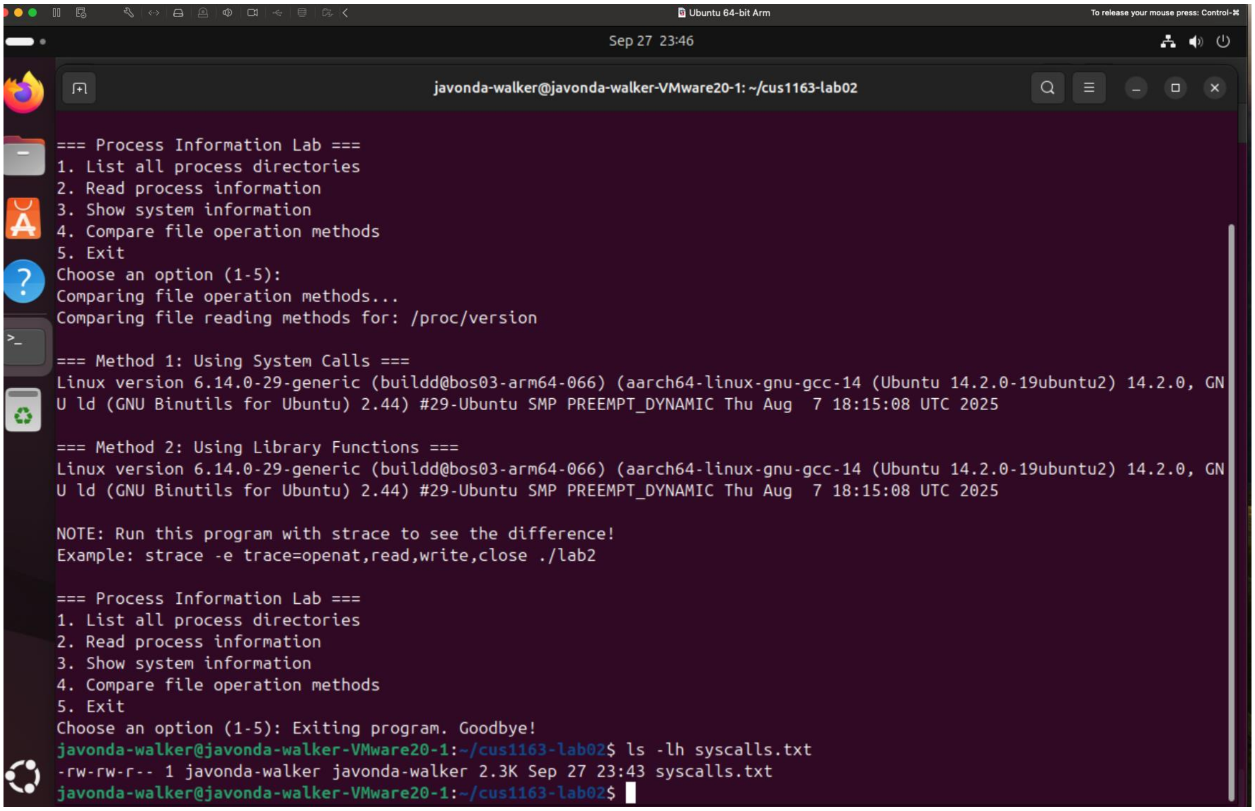
```
5. Exit
Choose an option (1-5): 3

Reading system information...

--- CPU Information (first 10 lines) ---
processor       : 0
BogoMIPS        : 48.00
Features        : fp asimd evtstrm aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid asimdrdm jscvt fcma lrcpc dcpop
sha3 asimddp sha512 asimdfhm dit uscat ilrcpc flagm ssbs sb paca pacg dcpodp flagm2 frint
CPU implementer : 0x61
CPU architecture: 8
CPU variant     : 0x0
CPU part        : 0x000
CPU revision    : 0

processor       : 1

--- Memory Information (first 10 lines) ---
MemTotal:        3466080 kB
MemFree:          313184 kB
MemAvailable:    1225364 kB
Buffers:           28048 kB
Cached:           997612 kB
SwapCached:        51320 kB
Active:           698380 kB
Inactive:        2026292 kB
Active(anon):     537092 kB
Inactive(anon):  1198232 kB
SUCCESS: System information displayed!
```


Ubuntu 64-bit Arm
Sep 27 23:40
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

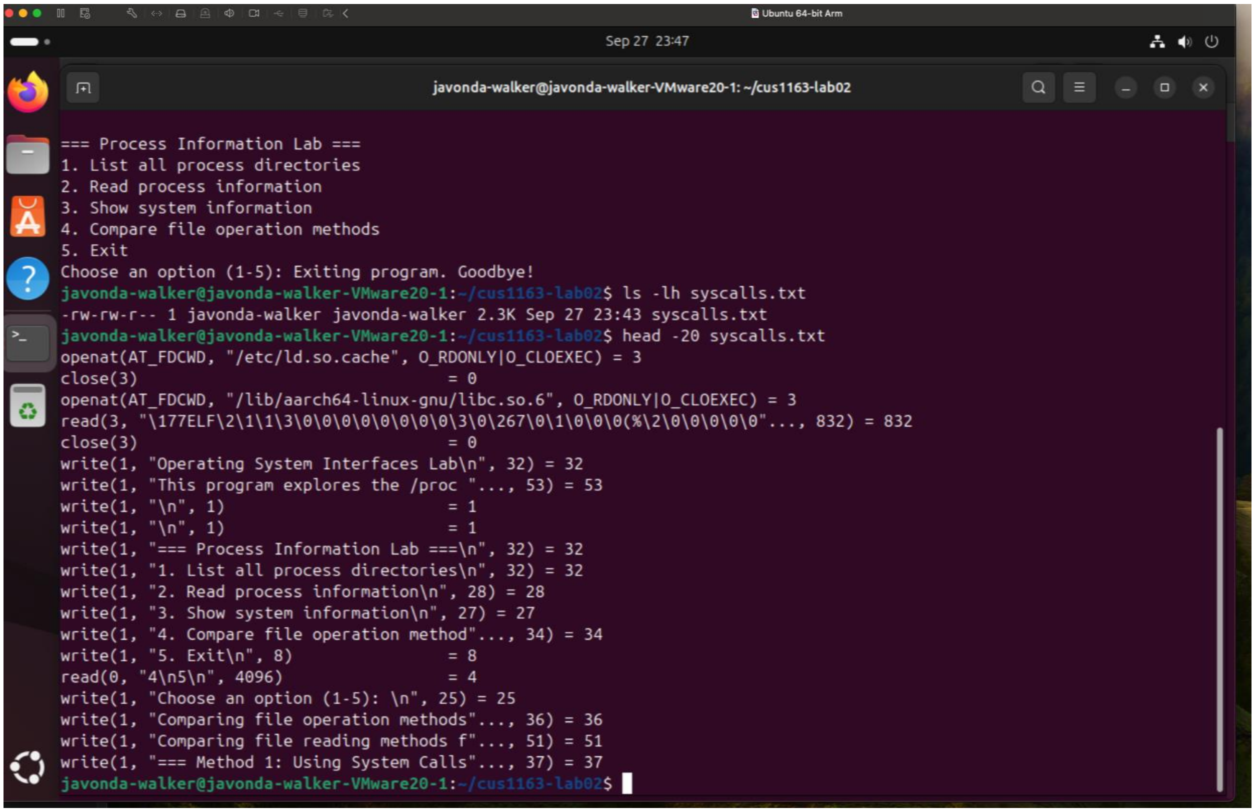
```
=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 4

Comparing file operation methods...
Comparing file reading methods for: /proc/version

=== Method 1: Using System Calls ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GNU
 ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

=== Method 2: Using Library Functions ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GNU
 ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

NOTE: Run this program with strace to see the difference!
Example: strace -e trace=openat,read,write,close ./lab2

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 27 23:44
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

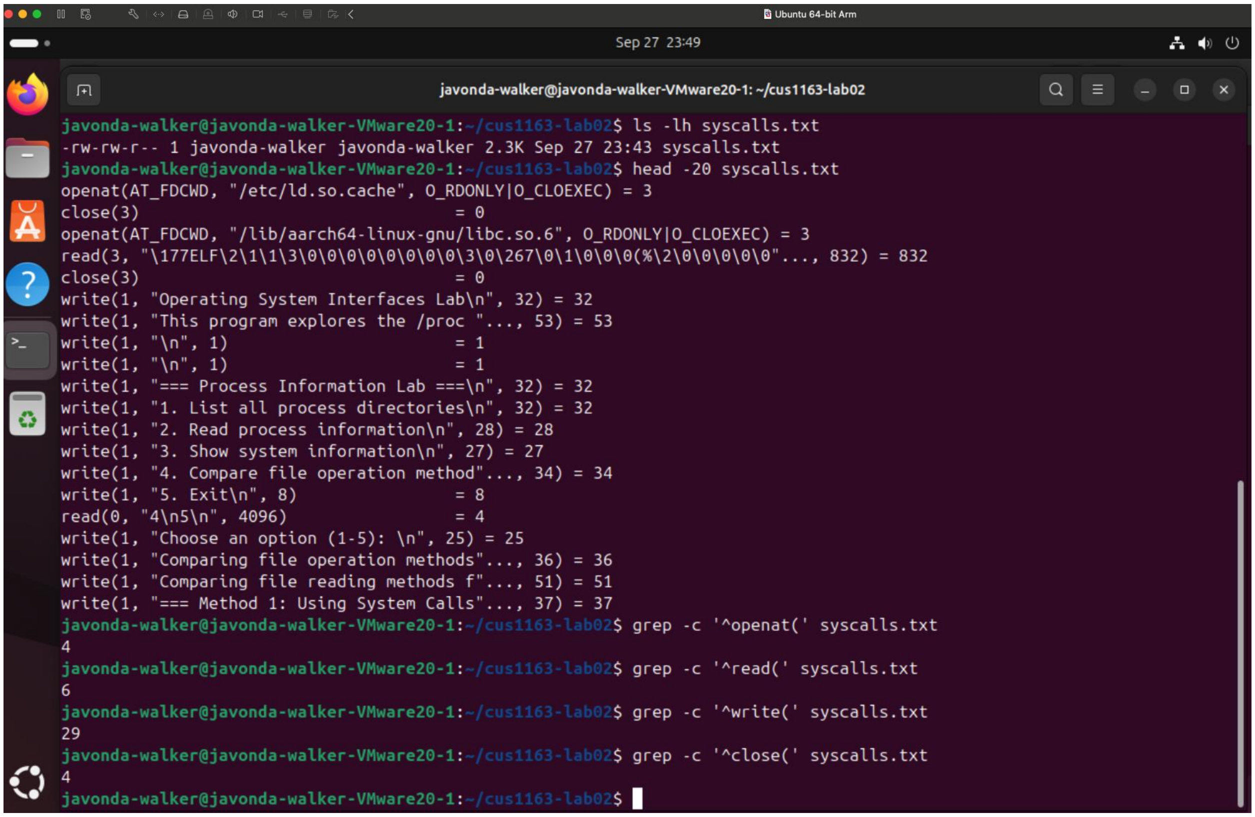
```
javonda-walker@javonda-walker-VMware20-1:~$ cd ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ printf "4\n5\n" | strace -e trace=openat,read,write,close -o
syscalls.txt ./lab2
Operating System Interfaces Lab
This program explores the /proc filesystem interface


=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5):
Comparing file operation methods...
Comparing file reading methods for: /proc/version

=== Method 1: Using System Calls ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GN
U ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

=== Method 2: Using Library Functions ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GN
U ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

NOTE: Run this program with strace to see the difference!
Example: strace -e trace=openat,read,write,close ./lab2

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 27 23:46
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

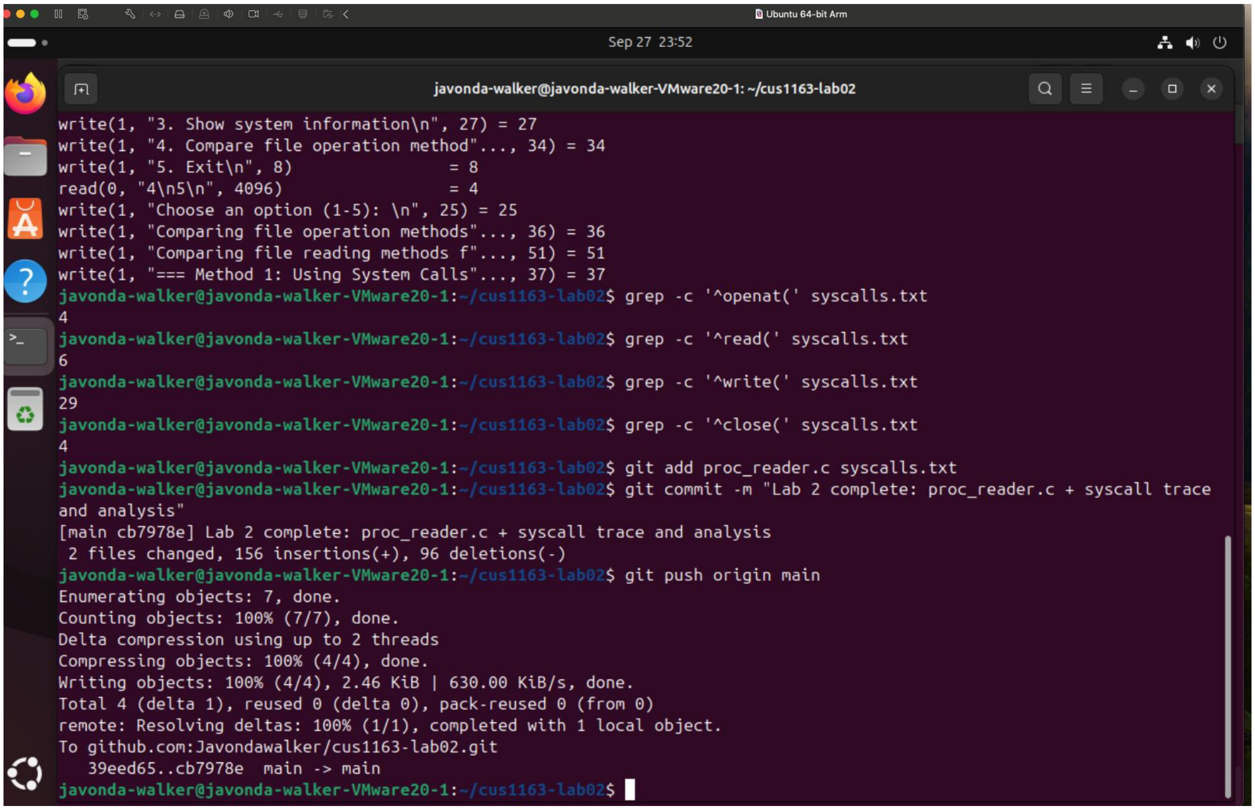
```
=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5):
Comparing file operation methods...
Comparing file reading methods for: /proc/version

=== Method 1: Using System Calls ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GN
U ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

=== Method 2: Using Library Functions ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GN
U ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

NOTE: Run this program with strace to see the difference!
Example: strace -e trace=openat,read,write,close ./lab2

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): Exiting program. Goodbye!
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ ls -lh syscalls.txt
-rw-rw-r-- 1 javonda-walker javonda-walker 2.3K Sep 27 23:43 syscalls.txt
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$
```



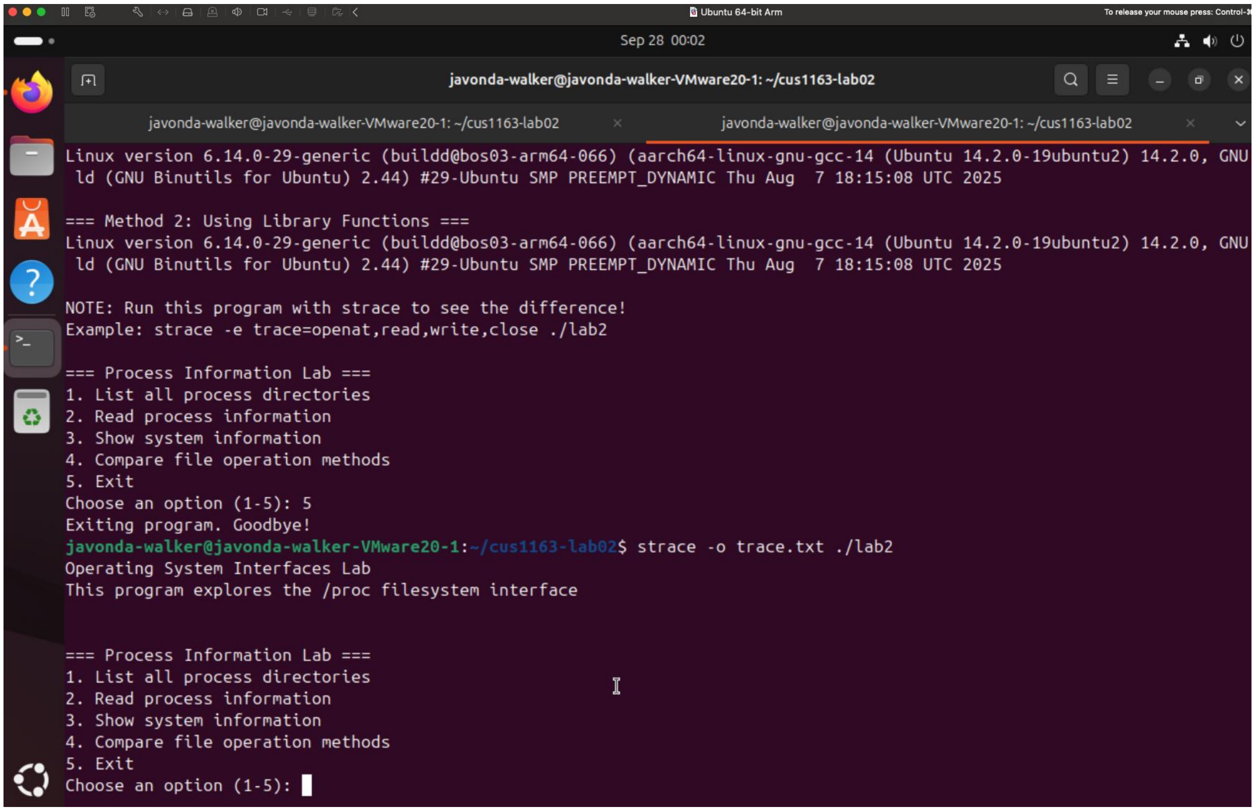
```
=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): Exiting program. Goodbye!
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ ls -lh syscalls.txt
-rw-rw-r-- 1 javonda-walker javonda-walker 2.3K Sep 27 23:43 syscalls.txt
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ head -20 syscalls.txt
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-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\3\0\267\0\1\0\0\0(%\2\0\0\0\0\0"..., 832) = 832
close(3)                                = 0
write(1, "Operating System Interfaces Lab\n", 32) = 32
write(1, "This program explores the /proc "..., 53) = 53
write(1, "\n", 1)                       = 1
write(1, "\n", 1)                       = 1
write(1, "=== Process Information Lab ===\n", 32) = 32
write(1, "1. List all process directories\n", 32) = 32
write(1, "2. Read process information\n", 28) = 28
write(1, "3. Show system information\n", 27) = 27
write(1, "4. Compare file operation method"..., 34) = 34
write(1, "5. Exit\n", 8)                = 8
read(0, "4\n5\n", 4096)                 = 4
write(1, "Choose an option (1-5): \n", 25) = 25
write(1, "Comparing file operation methods"..., 36) = 36
write(1, "Comparing file reading methods f"..., 51) = 51
write(1, "=== Method 1: Using System Calls"..., 37) = 37
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$
```



```
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ ls -lh syscalls.txt
-rw-rw-r-- 1 javonda-walker javonda-walker 2.3K Sep 27 23:43 syscalls.txt
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ head -20 syscalls.txt
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-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\3\0\267\0\1\0\0\0(%\2\0\0\0\0\0"..., 832) = 832
close(3)                                = 0
write(1, "Operating System Interfaces Lab\n", 32) = 32
write(1, "This program explores the /proc "..., 53) = 53
write(1, "\n", 1)                       = 1
write(1, "\n", 1)                       = 1
write(1, "=== Process Information Lab ===\n", 32) = 32
write(1, "1. List all process directories\n", 32) = 32
write(1, "2. Read process information\n", 28) = 28
write(1, "3. Show system information\n", 27) = 27
write(1, "4. Compare file operation method"..., 34) = 34
write(1, "5. Exit\n", 8)                = 8
read(0, "4\n5\n", 4096)                 = 4
write(1, "Choose an option (1-5): \n", 25) = 25
write(1, "Comparing file operation methods"..., 36) = 36
write(1, "Comparing file reading methods f"..., 51) = 51
write(1, "=== Method 1: Using System Calls"..., 37) = 37
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^openat(' syscalls.txt
4
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^read(' syscalls.txt
6
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^write(' syscalls.txt
29
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^close(' syscalls.txt
4
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$
```



```
write(1, "3. Show system information\n", 27) = 27
write(1, "4. Compare file operation method"..., 34) = 34
write(1, "5. Exit\n", 8)                = 8
read(0, "4\n5\n", 4096)                 = 4
write(1, "Choose an option (1-5): \n", 25) = 25
write(1, "Comparing file operation methods"..., 36) = 36
write(1, "Comparing file reading methods f"..., 51) = 51
write(1, "=== Method 1: Using System Calls"..., 37) = 37
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^openat(' syscalls.txt
4
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^read(' syscalls.txt
6
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^write(' syscalls.txt
29
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ grep -c '^close(' syscalls.txt
4
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ git add proc_reader.c syscalls.txt
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ git commit -m "Lab 2 complete: proc_reader.c + syscall trace
and analysis"
[main cb7978e] Lab 2 complete: proc_reader.c + syscall trace and analysis
 2 files changed, 156 insertions(+), 96 deletions(-)
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ git push origin main
Enumerating objects: 7, done.
Counting objects: 100% (7/7), done.
Delta compression using up to 2 threads
Compressing objects: 100% (4/4), done.
Writing objects: 100% (4/4), 2.46 KiB | 630.00 KiB/s, done.
Total 4 (delta 1), reused 0 (delta 0), pack-reused 0 (from 0)
remote: Resolving deltas: 100% (1/1), completed with 1 local object.
To github.com:Javondawalker/cus1163-lab02.git
   39eed65..cb7978e  main -> main
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$
```


Ubuntu 64-bit Arm
To release your mouse press: Control-⌘
Sep 28 00:02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02
javonda-walker@javonda-walker-VMware20-1: ~/cus1163-lab02

```
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GNU
 ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

=== Method 2: Using Library Functions ===
Linux version 6.14.0-29-generic (buildd@bos03-arm64-066) (aarch64-linux-gnu-gcc-14 (Ubuntu 14.2.0-19ubuntu2) 14.2.0, GNU
 ld (GNU Binutils for Ubuntu) 2.44) #29-Ubuntu SMP PREEMPT_DYNAMIC Thu Aug  7 18:15:08 UTC 2025

NOTE: Run this program with strace to see the difference!
Example: strace -e trace=openat,read,write,close ./lab2

=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5): 5
Exiting program. Goodbye!
javonda-walker@javonda-walker-VMware20-1:~/cus1163-lab02$ strace -o trace.txt ./lab2
Operating System Interfaces Lab
This program explores the /proc filesystem interface


=== Process Information Lab ===
1. List all process directories
2. Read process information
3. Show system information
4. Compare file operation methods
5. Exit
Choose an option (1-5):
```