CS 342
Operating Systems
Homework 1

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Dilay Yiğit

21602059

◉ **My System Information and How I download Ubuntu:**

First of all, my operating system is the following, macOS Monterey version 12.1. I am familiar with the Linux system as I have been using Linux Mint for many years. In addition to this, I have never use virtual machine. I did a quick research and chose a virtual machine suitable for my system which is UTM. I did not choose VirtualBox as it is mentioned in the homework, because VirtualBox is not compatible with MacBook with M1 chip. Ubuntu 20.04 was already exist in UTM's market called gallery. So that, I downloaded Ubuntu 20.04 LTS from UTM's gallery and install it by following the step by step instructions I found on the UTM's official website.

◉ **10 Basic Linux Commands and How I learn and test commands:**

As I mentioned before, I had knowledge about basic commands due to my previous experience of using Linux. In addition to what I know, I also got help from some websites like "askubuntu.com".

➡ **sudo:** This command means that SuperUser DO. It is for running instructions as an administrator. You cannot change files as a normal user. If you use sudo at the beginning of the instructions, you need to enter your password to reach admin user. For example;

```
dilay@dilay:~$ sudo apt-get update
[sudo] password for dilay:
```

➡ **ls:** This command is the same with "dir" instruction that shows all files in the current directory.

➡ **cd ..:** This command takes you one directory back.

➡ **mkdir:** This command creates new directory.

➡ **rmdir:** This command deletes an existing directory.

```
dilay@dilay:~/Desktop$ ls
dilay@dilay:~/Desktop$ cd ..
dilay@dilay:~$ ls
Desktop  Documents  Downloads  Music  Pictures  Public  Templates  Videos
dilay@dilay:~$ cd Desktop
dilay@dilay:~/Desktop$ mkdir testFile
dilay@dilay:~/Desktop$ ls
testFile
dilay@dilay:~/Desktop$ rmdir testFile
dilay@dilay:~/Desktop$ ls
```

➡ **ls > .txt:** By using this command, user can create new .txt file. When I install Ubuntu, Vim was exist by default. So, it can also done by **vi/ vim** command.

➡ **cat:** This command prints the content of a file.

➡ **echo:** This command puts the data into text file.

➡ **cp:** This command copies the first file and saves it to the second file.

```
dilay@dilay:~/Desktop$ ls > first.txt
dilay@dilay:~/Desktop$ ls > second.txt
dilay@dilay:~/Desktop$ ls
first.txt  second.txt
dilay@dilay:~/Desktop$ echo "This is first test" > first.txt
dilay@dilay:~/Desktop$ echo "This is second test" > second.txt
dilay@dilay:~/Desktop$ cat first.txt
This is first test
dilay@dilay:~/Desktop$ cat second.txt
This is second test
dilay@dilay:~/Desktop$ cp first.txt second.txt
dilay@dilay:~/Desktop$ cat first.txt
This is first test
dilay@dilay:~/Desktop$ cat second.txt
This is first test
dilay@dilay:~/Desktop$
```

➡ **history:** This command prints previous commands that user wrote.

```
dilay@dilay:~/Desktop$ history
    1  sudo apt update
    2  sudo apt install ubuntu-desktop
    3  sudo reboot
    4  sudo apt-get update
    5  ls
    6  cd Desktop
    7  ls
    8  mkdir /testFolder
    9  mkdir testFolder
   10  ls
   11  cd ..
   12  ls
   13  cd Desktop
   14  mkdir newTestFile
   15  ls
   16  rm testFolder
   17  rm /Desktop/testFolder
   18  rm Desktop/testFolder
   19  rmdir testFolder
   20  ls
   21  rmdir newTestFile
   22  ls
   23  cd ..
   24  ls
   25  cd Desktop
   26  mkdir testFile
   27  ls
   28  rmdir testFile
   29  ls
   30  history
   31  vim dilay.txt
   32  ls
   33  cat dilay.txt
```

- **Kernel Version and Executable File:**

The kernel executable file is located in the /boot directory. With the information I got from the internet (howtogeek.com), I learned that the kernel executable format is “vmlinuz-*version*". I used uname -r command to learn the kernel version.

- ➡ Kernel version: 5.4.0-97-generic
- ➡ Kernel executable: /boot/vmlinuz-5.4.0-97-generic

```
dilay@dilay:/boot$ ls
config-5.4.0-97-generic  initrd.img-5.4.0-97-generic  vmlinuz
efi                      initrd.img.old                vmlinuz-5.4.0-97-generic
grub                     lost+found                    vmlinuz.old
initrd.img               System.map-5.4.0-97-generic
dilay@dilay:/boot$ uname -r
5.4.0-97-generic
```

- **Subdirectories of Downloaded the Source of the Linux Kernel:**

I downloaded Linux-5.4.177 version of kernel source code, and subdirectories of this file are the following:

- ➡ arch
- ➡ fs
- ➡ net
- ➡ security
- ➡ virt
- ➡ block
- ➡ crypto
- ➡ include
- ➡ sound
- ➡ certs
- ➡ Documentation
- ➡ init
- ➡ kernel
- ➡ samples

➡ tools

➡ drivers

➡ ipc

➡ lib

➡ mm

➡ scripts

➡ usr

◉ **Syscall Table in Kernel Source File:**

Pathname of the system call table is;

/linux-5.4.177/arch/x86/entry/syscalls/syscall_64.tbl

➡ Syscall 3: close

➡ Syscall 35: nanosleep

➡ Syscall 110: getppid

➡ Syscall 210: io_cancel

◉ **Using Strace Command of Linux:**

dilay@dilay:~$ strace ls

```
execve("/usr/bin/ls", ["ls"], 0xfffffb16cb50 /* 49 vars */) = 0
brk(NULL)                               = 0xaaaae599f000
faccessat(AT_FDCWD, "/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=67283, ...}) = 0
mmap(NULL, 67283, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff87615000
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-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\267\0\1\0\0\0 e\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=154872, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0xffff87653000
mmap(NULL, 227800, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff875dd000
mprotect(0xffff87602000, 61440, PROT_NONE) = 0
mmap(0xffff87611000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x24000) = 0xffff87611000
```

```
mmap(0xffff87613000, 6616, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff87613000
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\350A\2\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=1449992, ...}) = 0
mmap(NULL, 1518672, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff8746a000
mprotect(0xffff875c4000, 65536, PROT_NONE) = 0
mmap(0xffff875d4000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x15a000) = 0xffff875d4000
mmap(0xffff875da000, 11344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff875da000
close(3)                        = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libpcre2-8.so.0", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\"\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=514504, ...}) = 0
mmap(NULL, 578176, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff873dc000
mprotect(0xffff87458000, 65536, PROT_NONE) = 0
mmap(0xffff87468000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x7c000) = 0xffff87468000
close(3)                        = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libdl.so.2", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\21\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=14528, ...}) = 0
mmap(NULL, 78080, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff873c8000
mprotect(0xffff873cb000, 61440, PROT_NONE) = 0
mmap(0xffff873da000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x2000) = 0xffff873da000
close(3)                        = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libpthread.so.0", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\240p\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=158008, ...}) = 0
mmap(NULL, 193512, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff87398000
mprotect(0xffff873b2000, 65536, PROT_NONE) = 0
mmap(0xffff873c2000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x1a000) = 0xffff873c2000
mmap(0xffff873c4000, 13288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff873c4000
close(3)                        = 0
```

```
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0xffff87651000
mprotect(0xffff875d4000, 12288, PROT_READ) = 0
mprotect(0xffff873c2000, 4096, PROT_READ) = 0
mprotect(0xffff873da000, 4096, PROT_READ) = 0
mprotect(0xffff87468000, 4096, PROT_READ) = 0
mprotect(0xffff87611000, 4096, PROT_READ) = 0
mprotect(0xaaaaac075000, 8192, PROT_READ) = 0
mprotect(0xffff87657000, 4096, PROT_READ) = 0
munmap(0xffff87615000, 67283)           = 0
set_tid_address(0xffff876516e0)         = 3262
set_robust_list(0xffff876516f0, 24)     = 0
rt_sigaction(SIGRTMIN, {sa_handler=0xffff8739eb28, sa_mask=[], sa_flags=SA_SIGINFO},
NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0xffff8739ebe8, sa_mask=[], sa_flags=SA_RESTART|
SA_SIGINFO}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
statfs("/sys/fs/selinux", 0xffffd43a7cb0) = -1 ENOENT (No such file or directory)
statfs("/selinux", 0xffffd43a7cb0)      = -1 ENOENT (No such file or directory)
brk(NULL)                               = 0xaaaae599f000
brk(0xaaaae59c0000)                     = 0xaaaae59c0000
openat(AT_FDCWD, "/proc/filesystems", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0444, st_size=0, ...}) = 0
read(3, "nodev\tsysfs\nnodev\ttmpfs\nnodev\tbd"..., 1024) = 382
read(3, "", 1024)                       = 0
close(3)                                = 0
faccessat(AT_FDCWD, "/etc/selinux/config", F_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/lib/locale/locale-archive", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=3035952, ...}) = 0
mmap(NULL, 3035952, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff870b2000
close(3)                                = 0
ioctl(1, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(1, TIOCGWINSZ, {ws_row=29, ws_col=85, ws_xpixel=0, ws_ypixel=0}) = 0
openat(AT_FDCWD, ".", O_RDONLY|O_NONBLOCK|O_CLOEXEC|O_DIRECTORY) = 3
fstat(3, {st_mode=S_IFDIR|0755, st_size=4096, ...}) = 0
getdents64(3, /* 23 entries */, 32768)  = 736
getdents64(3, /* 0 entries */, 32768)   = 0
close(3)                                = 0
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0
write(1, "Desktop  Documents  Downloads  M"..., 72Desktop  Documents  Downloads  Music
Pictures            Public   Templates  Videos
) = 72
close(1)                                = 0
```

```
close(2)                                = 0
exit_group(0)                           = ?
+++ exited with 0 +++
```

dilay@dilay:~$ strace cp

```
execve("/usr/bin/cp", ["cp"], 0xffffef11fc40 /* 49 vars */) = 0
brk(NULL)                               = 0xaaaaead36000
faccessat(AT_FDCWD, "/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=67283, ...}) = 0
mmap(NULL, 67283, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff9a23e000
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-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\267\0\1\0\0\0 e\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=154872, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0xffff9a27c000
mmap(NULL, 227800, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff9a206000
mprotect(0xffff9a22b000, 61440, PROT_NONE) = 0
mmap(0xffff9a23a000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x24000) = 0xffff9a23a000
mmap(0xffff9a23c000, 6616, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff9a23c000
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libacl.so.1", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0P\31\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=34720, ...}) = 0
mmap(NULL, 98416, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff9a1ed000
mprotect(0xffff9a1f4000, 65536, PROT_NONE) = 0
mmap(0xffff9a204000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x7000) = 0xffff9a204000
close(3)                                = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libattr.so.1", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0000\24\0\0\0\0\0\0"..., 832) =
832
fstat(3, {st_mode=S_IFREG|0644, st_size=22376, ...}) = 0
mmap(NULL, 86040, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff9a1d7000
mprotect(0xffff9a1db000, 65536, PROT_NONE) = 0
mmap(0xffff9a1eb000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x4000) = 0xffff9a1eb000
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\350A\2\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=1449992, ...}) = 0
mmap(NULL, 1518672, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff9a064000
mprotect(0xffff9a1be000, 65536, PROT_NONE) = 0
mmap(0xffff9a1ce000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x15a000) = 0xffff9a1ce000
mmap(0xffff9a1d4000, 11344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff9a1d4000
close(3)                        = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libpcre2-8.so.0", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\"\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=514504, ...}) = 0
mmap(NULL, 578176, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff99fd6000
mprotect(0xffff9a052000, 65536, PROT_NONE) = 0
mmap(0xffff9a062000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x7c000) = 0xffff9a062000
close(3)                        = 0
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libdl.so.2", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\21\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=14528, ...}) = 0
mmap(NULL, 78080, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff99fc2000
mprotect(0xffff99fc5000, 61440, PROT_NONE) = 0
mmap(0xffff99fd4000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x2000) = 0xffff99fd4000
close(3)                        = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0xffff9a27a000
openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libpthread.so.0", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\240p\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=158008, ...}) = 0
mmap(NULL, 193512, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0xffff99f92000
mprotect(0xffff99fac000, 65536, PROT_NONE) = 0
mmap(0xffff99fbc000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_DENYWRITE, 3, 0x1a000) = 0xffff99fbc000
mmap(0xffff99fbe000, 13288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|
MAP_ANONYMOUS, -1, 0) = 0xffff99fbe000
close(3)                        = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0xffff9a278000
```

```
mprotect(0xffff9a1ce000, 12288, PROT_READ) = 0
mprotect(0xffff99fbc000, 4096, PROT_READ) = 0
mprotect(0xffff99fd4000, 4096, PROT_READ) = 0
mprotect(0xffff9a062000, 4096, PROT_READ) = 0
mprotect(0xffff9a1eb000, 4096, PROT_READ) = 0
mprotect(0xffff9a204000, 4096, PROT_READ) = 0
mprotect(0xffff9a23a000, 4096, PROT_READ) = 0
mprotect(0xaaaacc41d000, 4096, PROT_READ) = 0
mprotect(0xffff9a280000, 4096, PROT_READ) = 0
munmap(0xffff9a23e000, 67283)           = 0
set_tid_address(0xffff9a2780e0)         = 3387
set_robust_list(0xffff9a2780f0, 24)     = 0
rt_sigaction(SIGRTMIN, {sa_handler=0xffff99f98b28, sa_mask=[], sa_flags=SA_SIGINFO},
NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0xffff99f98be8, sa_mask=[], sa_flags=SA_RESTART|
SA_SIGINFO}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
statfs("/sys/fs/selinux", 0xffffd25a5a10) = -1 ENOENT (No such file or directory)
statfs("/selinux", 0xffffd25a5a10)      = -1 ENOENT (No such file or directory)
brk(NULL)                               = 0xaaaaaead36000
brk(0xaaaaaead57000)                    = 0xaaaaaead57000
openat(AT_FDCWD, "/proc/filesystems", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0444, st_size=0, ...}) = 0
read(3, "nodev\tsysfs\nnodev\ttmpfs\nnodev\tbd"..., 1024) = 382
read(3, "", 1024)                       = 0
close(3)                                = 0
faccessat(AT_FDCWD, "/etc/selinux/config", F_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/lib/locale/locale-archive", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=3035952, ...}) = 0
mmap(NULL, 3035952, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff99cac000
close(3)                                = 0
geteuid()                               = 1000
openat(AT_FDCWD, "/usr/share/locale/locale.alias", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=2996, ...}) = 0
read(3, "# Locale name alias data base.\n#"..., 4096) = 2996
read(3, "", 4096)                       = 0
close(3)                                = 0
openat(AT_FDCWD, "/usr/share/locale/en_US.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY)
= -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en_US.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) =
-1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en_US/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1
ENOENT (No such file or directory)
```

```
openat(AT_FDCWD, "/usr/share/locale/en.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1
ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1
ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1
ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US.UTF-8/LC_MESSAGES/coreutils.mo",
O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US.utf8/LC_MESSAGES/coreutils.mo",
O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US/LC_MESSAGES/coreutils.mo",
O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en.UTF-8/LC_MESSAGES/coreutils.mo",
O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en.utf8/LC_MESSAGES/coreutils.mo",
O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en/LC_MESSAGES/coreutils.mo", O_RDONLY)
= -1 ENOENT (No such file or directory)
write(2, "cp: ", 4cp: )                 = 4
write(2, "missing file operand", 20missing file operand)    = 20
write(2, "\n", 1
)                  = 1
write(2, "Try 'cp --help' for more informa"..., 38Try 'cp --help' for more information.
) = 38
lseek(0, 0, SEEK_CUR)               = -1 ESPIPE (Illegal seek)
close(0)                            = 0
close(1)                            = 0
close(2)                            = 0
exit_group(1)                         = ?
+++ exited with 1 +++
```

- **Using time command of Linux:**

```
dilay@dilay:~$ time ls
Desktop  Documents  Downloads  Music  Pictures  Public  Templates  Videos

real    0m0.006s
user    0m0.001s
sys     0m0.005s
```

```
dilay@dilay:~$ time date
Wed 09 Feb 2022 08:17:42 AM UTC

real    0m0.003s
user    0m0.003s
sys     0m0.000s
```

```
dilay@dilay:~/Desktop$ time uname -r
5.4.0-97-generic

real    0m0.002s
user    0m0.002s
sys     0m0.000s
```

```
dilay@dilay:~/Desktop$ time ls > test.txt

real    0m0.003s
user    0m0.004s
sys     0m0.000s
```

```
dilay@dilay:~/Desktop$ time echo "dilay" > test.txt

real    0m0.000s
user    0m0.000s
sys     0m0.000s
```

```
dilay@dilay:~/Desktop$ time cat test.txt
dilay

real    0m0.001s
user    0m0.000s
sys     0m0.001s
```

When I enter the time command, I searched the internet for these 3 different time results. I got help from "geeksforgeeks.com" about this.

- **Real:** Real is the total execution time of the command.
- **User:** User indicates how many seconds the CPU has been running in user mode for the specific command.
- **Sys:** Sys indicates how many seconds the CPU has been running in kernel mode for the specific command.

- **C program "list.c" that implements a linked list of integers:**

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <sys/time.h>
struct Node {
   int data;
   struct Node* next;
};
int main() {
   struct timeval start, end;
   gettimeofday(&start, NULL);
   struct Node* head = (struct Node*)malloc(sizeof(struct Node));
```

```
    head->data = rand() % 100 + 1;
    head->next = NULL;

    struct Node* cur = head;
    for(int i = 0; i < 10000; i++) {
        cur->next = malloc(sizeof(struct Node));
        cur = cur->next;
        cur->data = rand() % 100 + 1;
    }

    gettimeofday(&end, NULL);
    printf("%ld\n", (end.tv_sec - start.tv_sec) * 1000000 + (end.tv_usec - start.tv_usec));

    return 0;
}
```

- **Makefile of list.c:**

```
all: list
list: list.c
	gcc -Wall -g -o list list.c
clean:
	rm -fr list list.o *~
```

- **Example output of the time to insert numbers into linked list:**

```
dilay@dilay:~/Desktop/hw1$ make
gcc -Wall -g -o list list.c
dilay@dilay:~/Desktop/hw1$ ./list
787
dilay@dilay:~/Desktop/hw1$ ./list
800
dilay@dilay:~/Desktop/hw1$ ./list
806
dilay@dilay:~/Desktop/hw1$ ./list
785
dilay@dilay:~/Desktop/hw1$ ./list
927
dilay@dilay:~/Desktop/hw1$
```