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03/10/2021

CS342 Operating Systems - Fall 2021
Homework #1

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1. In the Asus Rog Strix series, I first downloaded the latest updated iso file of Ubuntu Desktop (**20.04.3 LTS**) to my computer with Windows x64 operating system. Then I downloaded VirtualBox **(6.1.26 platform packages)** from the windows host option from Oracle's site. In VirtualBox, which is a virtualization software, I installed another operating system (Linux) to supplement the one in my computer. One of the main reasons I prefer VirtualBox is that there is no download cost and the security of the system is kept very high.

   In Virtual Box, I had to decide the memory size according to your computer, I chose the VDI (virtualBox disk image) option and determined the memory size as 6129MB. I paired Ubuntu and the Virtual machine by pressing the Start option. Since there is more space on the HDD on my computer, I installed both files on D:/. I did not encounter any problems during the installation, the interface was very user-friendly.

   10 Linux commands: *ls, cp, pwd, cd, mv, mkdir, sudo, find, diff, tar*

2.
   a. Kernel executable root is found on **/boot**.
   b. Running version that is found by using the the texture “uname -r” is **5.11.0-37-generic**

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3. I have downloaded version **(5.14.9)** as it was the latest release in *kernel.org.* After that I check the subdirectories as given:
   a. arch
   b. block
   c. certs
   d. crypto
   e. Documentation
   f. drivers
   g. fs
   h. include
   i. init

j. kernel
k. lib
l. LICENCES
m. mm
n. net
o. samples
p. scripts
q. security
r. sound
s. tools
t. usr
u. virt

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4. *System call numbers* for specifically given numbers **3, 35, 110, 210**;
Pattern: ~/Desktop/linux-5.14.9/arch/x86/entry/syscalls/syscall_64.tbl

3 : close **35:** nanosleep **110:** getppid **210:** io_cancel

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5. The output for the ***"strace ls"*** command

```
execve("/usr/bin/ls", ["ls"], 0x7fff618eb7b0 /* 57 vars */) = 0
brk(NULL)                               = 0x55d5617e7000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffe3e6cd830) = -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=64418, ...}) = 0
mmap(NULL, 64418, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7efc8c4d1000
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) = 0x7efc8c4cf000
mmap(NULL, 174600, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7efc8c4a4000
mprotect(0x7efc8c4aa000, 135168, PROT_NONE) = 0
mmap(0x7efc8c4aa000, 102400, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6000) = 0x7efc8c4aa000
mmap(0x7efc8c4c3000, 28672, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1f000) = 0x7efc8c4c3000
mmap(0x7efc8c4cb000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7efc8c4cb000
```

```
mmap(0x7efc8c4cd000, 6664, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7efc8c4cd000
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\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"..., 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\0", 32,
848) = 32
pread64(3,
"\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\204\276X>\
263"..., 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"..., 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\0", 32,
848) = 32
pread64(3,
"\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\204\276X>\
263"..., 68, 880) = 68
mmap(NULL, 2036952, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7efc8c2b2000
mprotect(0x7efc8c2d7000, 1847296, PROT_NONE) = 0
mmap(0x7efc8c2d7000, 1540096, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7efc8c2d7000
mmap(0x7efc8c44f000, 303104, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0x7efc8c44f000
mmap(0x7efc8c49a000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7efc8c49a000
mmap(0x7efc8c4a0000, 13528, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7efc8c4a0000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-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\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) =
0x7efc8c222000
mmap(0x7efc8c224000, 409600, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7efc8c224000
```

```
mmap(0x7efc8c288000, 163840, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x66000) = 0x7efc8c288000
mmap(0x7efc8c2b0000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8d000) = 0x7efc8c2b0000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libdl.so.2", 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 \22\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=18816, ...}) = 0
mmap(NULL, 20752, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7efc8c21c000
mmap(0x7efc8c21d000, 8192, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7efc8c21d000
mmap(0x7efc8c21f000, 4096, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7efc8c21f000
mmap(0x7efc8c220000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7efc8c220000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpthread.so.0",
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\220\201\0\0\0\0\0\0"..., 832) =
832
pread64(3,
"\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68,
824) = 68
fstat(3, {st_mode=S_IFREG|0755, st_size=157224, ...}) = 0
pread64(3,
"\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68,
824) = 68
mmap(NULL, 140408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7efc8c1f9000
mmap(0x7efc8c200000, 69632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x7000) = 0x7efc8c200000
mmap(0x7efc8c211000, 20480, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x18000) = 0x7efc8c211000
mmap(0x7efc8c216000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1c000) = 0x7efc8c216000
mmap(0x7efc8c218000, 13432, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7efc8c218000
close(3)                                = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7efc8c1f7000
arch_prctl(ARCH_SET_FS, 0x7efc8c1f8400) = 0
```

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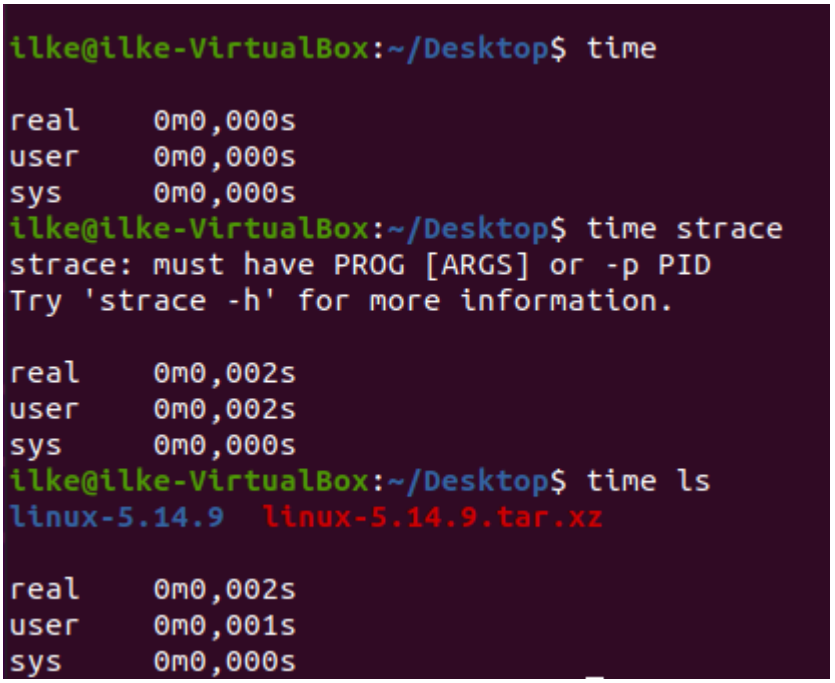
```
mprotect(0x7efc8c49a000, 12288, PROT_READ) = 0
mprotect(0x7efc8c216000, 4096, PROT_READ) = 0
mprotect(0x7efc8c220000, 4096, PROT_READ) = 0
mprotect(0x7efc8c2b0000, 4096, PROT_READ) = 0
mprotect(0x7efc8c4cb000, 4096, PROT_READ) = 0
mprotect(0x55d56105f000, 4096, PROT_READ) = 0
mprotect(0x7efc8c50e000, 4096, PROT_READ) = 0
munmap(0x7efc8c4d1000, 64418)           = 0
set_tid_address(0x7efc8c1f86d0)         = 2929
set_robust_list(0x7efc8c1f86e0, 24)     = 0
rt_sigaction(SIGRTMIN, {sa_handler=0x7efc8c200bf0, sa_mask=[],
sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0x7efc8c20e3c0}, NULL, 8) =
0
rt_sigaction(SIGRT_1, {sa_handler=0x7efc8c200c90, sa_mask=[],
sa_flags=SA_RESTORER|SA_RESTART|SA_SIGINFO,
sa_restorer=0x7efc8c20e3c0}, 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", 0x7ffe3e6cd780) = -1 ENOENT (No such file or directory)
statfs("/selinux", 0x7ffe3e6cd780)      = -1 ENOENT (No such file or directory)
brk(NULL)                               = 0x55d5617e7000
brk(0x55d561808000)                     = 0x55d561808000
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) = 360
read(3, "", 1024)                       = 0
close(3)                                = 0
access("/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=17339232, ...}) = 0
mmap(NULL, 17339232, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7efc8b16d000
close(3)                                = 0
ioctl(1, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(1, TIOCGWINSZ, {ws_row=24, ws_col=80, 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, /* 4 entries */, 32768)   = 120
getdents64(3, /* 0 entries */, 32768)   = 0
close(3)                                = 0
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0
write(1, "linux-5.14.9  linux-5.14.9.tar.x"..., 34linux-5.14.9  linux-5.14.9.tar.xz
```

```
) = 34
close(1)                        = 0
close(2)                        = 0
exit_group(0)                     = ?
+++ exited with 0 +++
```

---

6. The time command for different times such as real time, user time, sys time given below:



```
ilke@ilke-VirtualBox:~/Desktop$ time

real    0m0,000s
user    0m0,000s
sys     0m0,000s
ilke@ilke-VirtualBox:~/Desktop$ time strace
strace: must have PROG [ARGS] or -p PID
Try 'strace -h' for more information.

real    0m0,002s
user    0m0,002s
sys     0m0,000s
ilke@ilke-VirtualBox:~/Desktop$ time ls
linux-5.14.9  linux-5.14.9.tar.xz

real    0m0,002s
user    0m0,001s
sys     0m0,000s
```

---

7. The code of C language

```c
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <sys/time.h>

struct linkedListNode
{
    int data;                           //Data of the node
    struct linkedListNode *nextptr;     //Address of the next node
};

struct linkedListNode * addresNextnode = NULL;
```

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```
void generateLinkedList(int randomNumber); // function to create the
list

int main()
{
    printf("*****************\n");
    printf("\n          Random Numbers are downloading...\n");
    printf("*****************\n");
    int number = 0;
    struct timeval timeBefore;
    gettimeofday(&timeBefore, NULL);
    while( number < 1000){
        generateLinkedList(rand());
        number++;
    }
    struct timeval timeAfter;
    gettimeofday(&timeAfter, NULL);
    printf("The difference after insertion into linked list is: \n
micro seconds : %ld\n seconds : %ld \n",(timeAfter.tv_usec -
timeBefore.tv_usec), (timeAfter.tv_sec - timeBefore.tv_sec)  );
    return 0;
}

void generateLinkedList(int randomNumber)
{
    struct linkedListNode *temprorayNode;
    temprorayNode = (struct linkedListNode *) malloc(sizeof(struct
linkedListNode));
    if(temprorayNode == NULL) //checking node is empty cut the program
without memory allocation
    {
        printf(" No Memory Allocation");
    }
    else
    {
        temprorayNode -> data= randomNumber;
        temprorayNode -> nextptr= addresNextnode;
        addresNextnode = temprorayNode;
    }
}
```

The output:

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```
******************
Random Numbers are downloading...
******************
The difference after insertion into linked list is:
 micro seconds : 91
 seconds : 0
```

MakeFile:

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