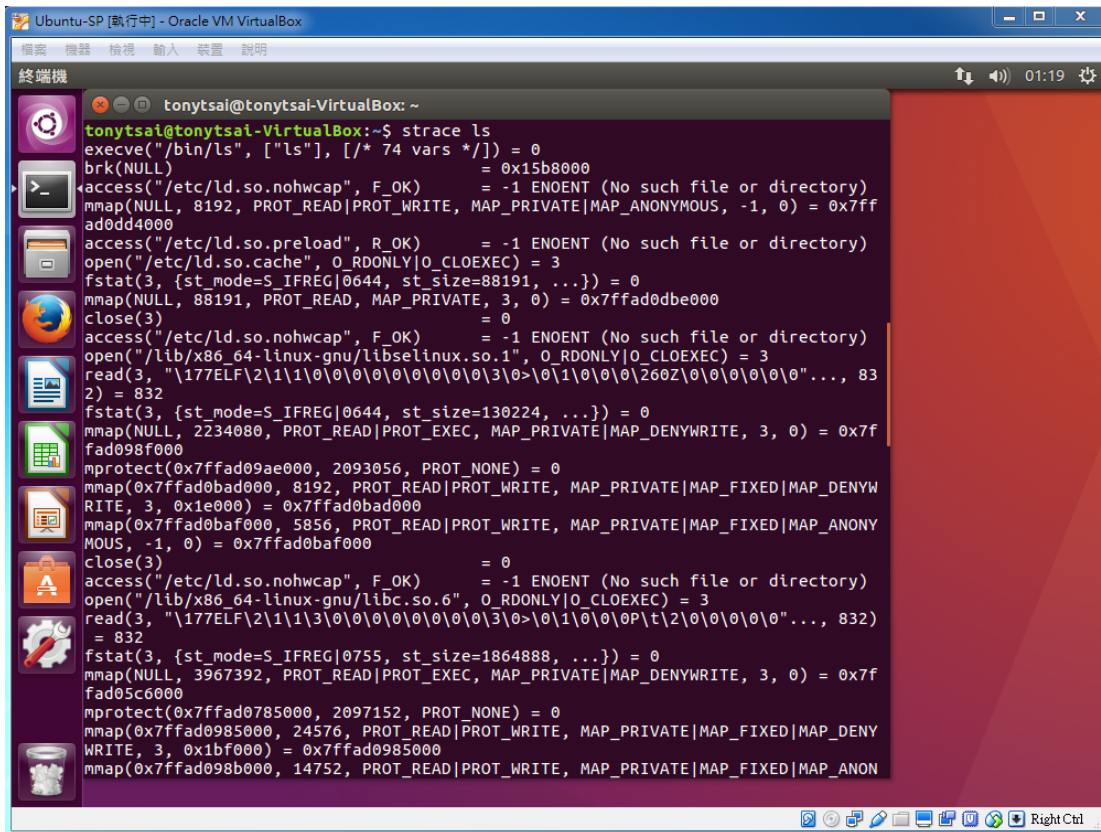


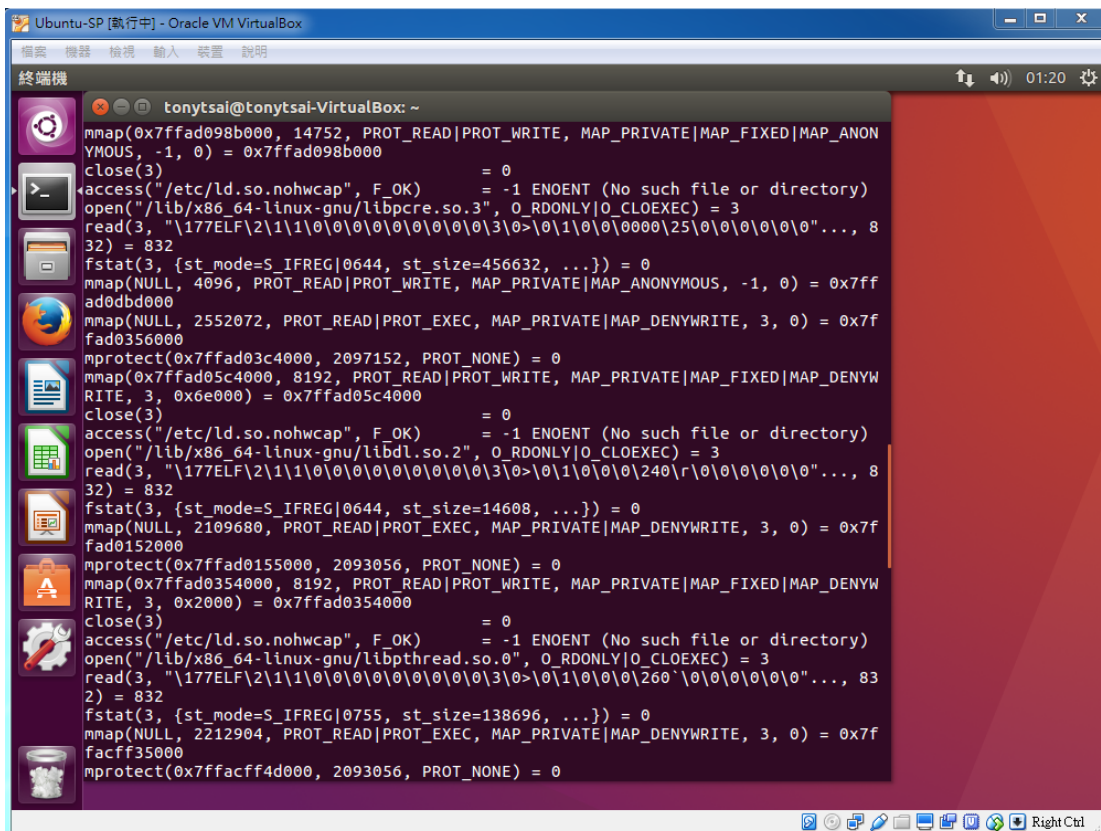
# 系統程式作業三

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## 1. Ls 呼叫的 system call



```
tonytsai@tonytsai-VirtualBox: ~  
tonytsai@tonytsai-VirtualBox:~$ strace ls  
execve("/bin/ls", ["ls"], [/* 74 vars */]) = 0  
brk(NULL) = 0x15b8000  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7ffad0dd4000  
access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)  
open("/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3  
fstat(3, {st_mode=S_IFREG|0644, st_size=88191, ...}) = 0  
mmap(NULL, 88191, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7ffad0dbe000  
close(3) = 0  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
open("/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\260Z\0\0\0\0\0...", 832) = 832  
fstat(3, {st_mode=S_IFREG|0644, st_size=130224, ...}) = 0  
mmap(NULL, 2234080, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ffad098f000  
mprotect(0x7ffad09ae000, 2093056, PROT_NONE) = 0  
mmap(0x7ffad0bad000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e000) = 0x7ffad0bad000  
mmap(0x7ffad0baf000, 5856, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7ffad0baf000  
close(3) = 0  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
open("/lib/x86_64-linux-gnu/libc.so.6", 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\0P\2\0\0\0\0...", 832) = 832  
fstat(3, {st_mode=S_IFREG|0755, st_size=1864888, ...}) = 0  
mmap(NULL, 3967392, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ffad05c6000  
mprotect(0x7ffad0785000, 2097152, PROT_NONE) = 0  
mmap(0x7ffad0985000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1bf000) = 0x7ffad0985000  
mmap(0x7ffad098b000, 14752, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANON
```

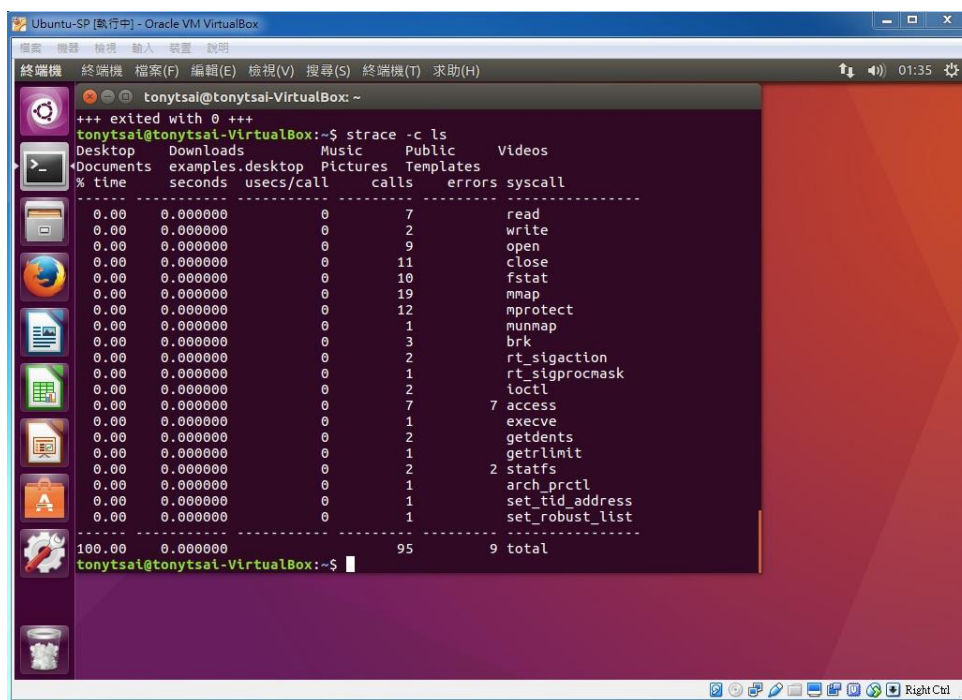


```
YMOUS, -1, 0) = 0x7ffad098b000  
close(3) = 0  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
open("/lib/x86_64-linux-gnu/libpcre.so.3", O_RDONLY|O_CLOEXEC) = 3  
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\000\25\0\0\0\0\0...", 832) = 832  
fstat(3, {st_mode=S_IFREG|0644, st_size=456632, ...}) = 0  
mmap(NULL, 4096, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7ffad0dbd000  
mmap(NULL, 2552072, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ffad0356000  
mprotect(0x7ffad03c4000, 2097152, PROT_NONE) = 0  
mmap(0x7ffad05c4000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6e000) = 0x7ffad05c4000  
close(3) = 0  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
open("/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\240r\0\0\0\0\0...", 832) = 832  
fstat(3, {st_mode=S_IFREG|0644, st_size=14608, ...}) = 0  
mmap(NULL, 2109680, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ffad0152000  
mprotect(0x7ffad0155000, 2093056, PROT_NONE) = 0  
mmap(0x7ffad0354000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7ffad0354000  
close(3) = 0  
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)  
open("/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\260`\0\0\0\0\0...", 832) = 832  
fstat(3, {st_mode=S_IFREG|0755, st_size=138696, ...}) = 0  
mmap(NULL, 2212904, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ffacff35000  
mprotect(0x7ffacff4d000, 2093056, PROT_NONE) = 0
```





若加上 `-c` 可以看到更多資料內容包含時間與次數，最右邊呼叫到的 system call



```
tonytsai@tonytsai-VirtualBox:~$ strace -c ls
Desktop Downloads Music Public Videos
Documents examples.desktop Pictures Templates
% time seconds usecs/call calls errors syscall
-----
0.00 0.000000 0 7 read
0.00 0.000000 0 2 write
0.00 0.000000 0 9 open
0.00 0.000000 0 11 close
0.00 0.000000 0 10 fstat
0.00 0.000000 0 19 mmap
0.00 0.000000 0 12 mprotect
0.00 0.000000 0 1 munmap
0.00 0.000000 0 3 brk
0.00 0.000000 0 2 rt_sigaction
0.00 0.000000 0 1 rt_sigprocmask
0.00 0.000000 0 2 ioctl
0.00 0.000000 0 7 access
0.00 0.000000 0 1 execve
0.00 0.000000 0 2 getdents
0.00 0.000000 0 1 getrlimit
0.00 0.000000 0 2 statfs
0.00 0.000000 0 1 arch_prctl
0.00 0.000000 0 1 set_tid_address
0.00 0.000000 0 1 set_robust_list
-----
100.00 0.000000 95 9 total
tonytsai@tonytsai-VirtualBox:~$
```

2. 拿掉 `ch02` 的 `table` 的 `symbol table`，觀察檔案大小的變化

```
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02$ ls -l table
-rwxrwxr-x 1 tonytsai tonytsai 9352 16 15:50 table
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02$ strip table
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02$ ls -l table
-rwxrwxr-x 1 tonytsai tonytsai 6288 30 01:42 table
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02$
```

3. 使用 `objdump -R` 觀察 `ls` 連結哪些函數庫

```
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02
tonytsai@tonytsai-VirtualBox:~/Downloads/課程大綱及ch00-ch06/ch02$ objdump -R /bin/ls

/bin/ls:      file format elf64-x86-64

DYNAMIC RELOCATION RECORDS
OFFSET      TYPE          VALUE
0000000000061dff8 R_X86_64_GLOB_DAT __gmon_start__
0000000000061e000 R_X86_64_COPY     __progname@@GLIBC_2.2.5
0000000000061e008 R_X86_64_COPY     stdout@@GLIBC_2.2.5
0000000000061e010 R_X86_64_COPY     optind@@GLIBC_2.2.5
0000000000061e018 R_X86_64_COPY     optarg@@GLIBC_2.2.5
0000000000061e020 R_X86_64_COPY     __progname_full@@GLIBC_2.2.5
0000000000061e040 R_X86_64_COPY     stderr@@GLIBC_2.2.5
0000000000061e018 R_X86_64_JUMP_SLOT __ctype_toupper_loc@GLIBC_2.3
0000000000061e020 R_X86_64_JUMP_SLOT __uflow@GLIBC_2.2.5
0000000000061e028 R_X86_64_JUMP_SLOT getenv@GLIBC_2.2.5
0000000000061e030 R_X86_64_JUMP_SLOT sigprocmask@GLIBC_2.2.5
0000000000061e038 R_X86_64_JUMP_SLOT raise@GLIBC_2.2.5
0000000000061e040 R_X86_64_JUMP_SLOT free@GLIBC_2.2.5
0000000000061e048 R_X86_64_JUMP_SLOT localtime@GLIBC_2.2.5
0000000000061e050 R_X86_64_JUMP_SLOT __mempcpy_chk@GLIBC_2.3.4
0000000000061e058 R_X86_64_JUMP_SLOT abort@GLIBC_2.2.5
0000000000061e060 R_X86_64_JUMP_SLOT __errno_location@GLIBC_2.2.5
0000000000061e068 R_X86_64_JUMP_SLOT strncmp@GLIBC_2.2.5
0000000000061e070 R_X86_64_JUMP_SLOT localtime_r@GLIBC_2.2.5
0000000000061e078 R_X86_64_JUMP_SLOT _exit@GLIBC_2.2.5
0000000000061e080 R_X86_64_JUMP_SLOT strcpy@GLIBC_2.2.5
0000000000061e088 R_X86_64_JUMP_SLOT _fpending@GLIBC_2.2.5
0000000000061e090 R_X86_64_JUMP_SLOT isatty@GLIBC_2.2.5
0000000000061e098 R_X86_64_JUMP_SLOT sigaction@GLIBC_2.2.5
0000000000061e0a0 R_X86_64_JUMP_SLOT iswcntrl@GLIBC_2.2.5
0000000000061e0a8 R_X86_64_JUMP_SLOT wcswidth@GLIBC_2.2.5
```



```
tonytsai@tonytsai-VirtualBox: ~/Downloads/課程大綱及ch00-ch06/ch02
000000000061e0a8 R_X86_64_JUMP_SLOT wcswidth@GLIBC_2.2.5
000000000061e0b0 R_X86_64_JUMP_SLOT localeconv@GLIBC_2.2.5
000000000061e0b8 R_X86_64_JUMP_SLOT mbstowcs@GLIBC_2.2.5
000000000061e0c0 R_X86_64_JUMP_SLOT readlink@GLIBC_2.2.5
000000000061e0c8 R_X86_64_JUMP_SLOT clock_gettime@GLIBC_2.17
000000000061e0d0 R_X86_64_JUMP_SLOT setenv@GLIBC_2.2.5
000000000061e0d8 R_X86_64_JUMP_SLOT textdomain@GLIBC_2.2.5
000000000061e0e0 R_X86_64_JUMP_SLOT fclose@GLIBC_2.2.5
000000000061e0e8 R_X86_64_JUMP_SLOT opendir@GLIBC_2.2.5
000000000061e0f0 R_X86_64_JUMP_SLOT getpwuid@GLIBC_2.2.5
000000000061e0f8 R_X86_64_JUMP_SLOT bindtextdomain@GLIBC_2.2.5
000000000061e100 R_X86_64_JUMP_SLOT stpcpy@GLIBC_2.2.5
000000000061e108 R_X86_64_JUMP_SLOT dcgettext@GLIBC_2.2.5
000000000061e110 R_X86_64_JUMP_SLOT __ctype_get_mb_cur_max@GLIBC_2.2.5
000000000061e118 R_X86_64_JUMP_SLOT strlen@GLIBC_2.2.5
000000000061e120 R_X86_64_JUMP_SLOT __lxstat@GLIBC_2.2.5
000000000061e128 R_X86_64_JUMP_SLOT __stack_chk_fail@GLIBC_2.4
000000000061e130 R_X86_64_JUMP_SLOT getopt_long@GLIBC_2.2.5
000000000061e138 R_X86_64_JUMP_SLOT mbrtowc@GLIBC_2.2.5
000000000061e140 R_X86_64_JUMP_SLOT strchr@GLIBC_2.2.5
000000000061e148 R_X86_64_JUMP_SLOT getgrgid@GLIBC_2.2.5
000000000061e150 R_X86_64_JUMP_SLOT __overflow@GLIBC_2.2.5
000000000061e158 R_X86_64_JUMP_SLOT strrchr@GLIBC_2.2.5
000000000061e160 R_X86_64_JUMP_SLOT fgetfilecon
000000000061e168 R_X86_64_JUMP_SLOT gmtime_r@GLIBC_2.2.5
000000000061e170 R_X86_64_JUMP_SLOT lseek@GLIBC_2.2.5
000000000061e178 R_X86_64_JUMP_SLOT gettimeofday@GLIBC_2.2.5
000000000061e180 R_X86_64_JUMP_SLOT __assert_fail@GLIBC_2.2.5
000000000061e188 R_X86_64_JUMP_SLOT __strtoul_internal@GLIBC_2.2.5
000000000061e190 R_X86_64_JUMP_SLOT fnmatch@GLIBC_2.2.5
000000000061e198 R_X86_64_JUMP_SLOT memset@GLIBC_2.2.5
000000000061e1a0 R_X86_64_JUMP_SLOT fscanf@GLIBC_2.2.5
```

```
tonytsai@tonytsai-VirtualBox: ~/Downloads/課程大綱及ch00-ch06/ch02
000000000061e1a0 R_X86_64_JUMP_SLOT fscanf@GLIBC_2.2.5
000000000061e1a8 R_X86_64_JUMP_SLOT ioctl@GLIBC_2.2.5
000000000061e1b0 R_X86_64_JUMP_SLOT close@GLIBC_2.2.5
000000000061e1b8 R_X86_64_JUMP_SLOT closedir@GLIBC_2.2.5
000000000061e1c0 R_X86_64_JUMP_SLOT __libc_start_main@GLIBC_2.2.5
000000000061e1c8 R_X86_64_JUMP_SLOT memcmp@GLIBC_2.2.5
000000000061e1d0 R_X86_64_JUMP_SLOT _setjmp@GLIBC_2.2.5
000000000061e1d8 R_X86_64_JUMP_SLOT fputs_unlocked@GLIBC_2.2.5
000000000061e1e0 R_X86_64_JUMP_SLOT calloc@GLIBC_2.2.5
000000000061e1e8 R_X86_64_JUMP_SLOT lgetfilecon
000000000061e1f0 R_X86_64_JUMP_SLOT strcmp@GLIBC_2.2.5
000000000061e1f8 R_X86_64_JUMP_SLOT signal@GLIBC_2.2.5
000000000061e200 R_X86_64_JUMP_SLOT dirfd@GLIBC_2.2.5
000000000061e208 R_X86_64_JUMP_SLOT getpwnam@GLIBC_2.2.5
000000000061e210 R_X86_64_JUMP_SLOT __memcpy_chk@GLIBC_2.3.4
000000000061e218 R_X86_64_JUMP_SLOT sigemptyset@GLIBC_2.2.5
000000000061e220 R_X86_64_JUMP_SLOT memcpy@GLIBC_2.14
000000000061e228 R_X86_64_JUMP_SLOT getgrnam@GLIBC_2.2.5
000000000061e230 R_X86_64_JUMP_SLOT getfilecon
000000000061e238 R_X86_64_JUMP_SLOT tzset@GLIBC_2.2.5
000000000061e240 R_X86_64_JUMP_SLOT fileno@GLIBC_2.2.5
000000000061e248 R_X86_64_JUMP_SLOT tcgetpgrp@GLIBC_2.2.5
000000000061e250 R_X86_64_JUMP_SLOT __xstat@GLIBC_2.2.5
000000000061e258 R_X86_64_JUMP_SLOT readdir@GLIBC_2.2.5
000000000061e260 R_X86_64_JUMP_SLOT wcwidth@GLIBC_2.2.5
000000000061e268 R_X86_64_JUMP_SLOT malloc@GLIBC_2.2.5
000000000061e270 R_X86_64_JUMP_SLOT fflush@GLIBC_2.2.5
000000000061e278 R_X86_64_JUMP_SLOT nl_langinfo@GLIBC_2.2.5
000000000061e280 R_X86_64_JUMP_SLOT ungetc@GLIBC_2.2.5
000000000061e288 R_X86_64_JUMP_SLOT __fxstat@GLIBC_2.2.5
000000000061e290 R_X86_64_JUMP_SLOT strcoll@GLIBC_2.2.5
000000000061e298 R_X86_64_JUMP_SLOT __freading@GLIBC_2.2.5
```

```
tonytsai@tonytsai-VirtualBox: ~/Downloads/課程大綱及ch00-ch06/ch02
000000000061e298 R_X86_64_JUMP_SLOT __freanding@GLIBC_2.2.5
000000000061e2a0 R_X86_64_JUMP_SLOT fwrite_unlocked@GLIBC_2.2.5
000000000061e2a8 R_X86_64_JUMP_SLOT realloc@GLIBC_2.2.5
000000000061e2b0 R_X86_64_JUMP_SLOT stpncpy@GLIBC_2.2.5
000000000061e2b8 R_X86_64_JUMP_SLOT fdopen@GLIBC_2.2.5
000000000061e2c0 R_X86_64_JUMP_SLOT setlocale@GLIBC_2.2.5
000000000061e2c8 R_X86_64_JUMP_SLOT __printf_chk@GLIBC_2.3.4
000000000061e2d0 R_X86_64_JUMP_SLOT timegm@GLIBC_2.2.5
000000000061e2d8 R_X86_64_JUMP_SLOT strftime@GLIBC_2.2.5
000000000061e2e0 R_X86_64_JUMP_SLOT memcpy@GLIBC_2.2.5
000000000061e2e8 R_X86_64_JUMP_SLOT memmove@GLIBC_2.2.5
000000000061e2f0 R_X86_64_JUMP_SLOT error@GLIBC_2.2.5
000000000061e2f8 R_X86_64_JUMP_SLOT open@GLIBC_2.2.5
000000000061e300 R_X86_64_JUMP_SLOT fseeko@GLIBC_2.2.5
000000000061e308 R_X86_64_JUMP_SLOT unsetenv@GLIBC_2.2.5
000000000061e310 R_X86_64_JUMP_SLOT strtoul@GLIBC_2.2.5
000000000061e318 R_X86_64_JUMP_SLOT __cxa_atexit@GLIBC_2.2.5
000000000061e320 R_X86_64_JUMP_SLOT wcstombs@GLIBC_2.2.5
000000000061e328 R_X86_64_JUMP_SLOT getxattr@GLIBC_2.3
000000000061e330 R_X86_64_JUMP_SLOT freecon
000000000061e338 R_X86_64_JUMP_SLOT sigismember@GLIBC_2.2.5
000000000061e340 R_X86_64_JUMP_SLOT exit@GLIBC_2.2.5
000000000061e348 R_X86_64_JUMP_SLOT fwrite@GLIBC_2.2.5
000000000061e350 R_X86_64_JUMP_SLOT __fprintf_chk@GLIBC_2.3.4
000000000061e358 R_X86_64_JUMP_SLOT fflush_unlocked@GLIBC_2.2.5
000000000061e360 R_X86_64_JUMP_SLOT mbsinit@GLIBC_2.2.5
000000000061e368 R_X86_64_JUMP_SLOT iswprint@GLIBC_2.2.5
000000000061e370 R_X86_64_JUMP_SLOT sigaddset@GLIBC_2.2.5
000000000061e378 R_X86_64_JUMP_SLOT strstr@GLIBC_2.2.5
000000000061e380 R_X86_64_JUMP_SLOT __ctype_tolower_loc@GLIBC_2.3
000000000061e388 R_X86_64_JUMP_SLOT __ctype_b_loc@GLIBC_2.3
000000000061e390 R_X86_64_JUMP_SLOT __sprintf_chk@GLIBC_2.3.4
```