

### Problem 1

1. The first similarity between fixed sized partitioning and paging is both the size of memory is fixed and cannot be changed dynamically.
2. The fixed sized partitioning and paging both have the internal fragmentation problem.

### Problem 2

1. The first similarity between variable sized partitioning and segmentation is both the size of memory part is variable.
2. The variable sized partitioning and segmentation both have the external fragmentation problem.

### Problem 3

1. The first difference between paging and segmentation is, in paging program is divided into fixed or mounted size pages while in segmentation the program is divided into variable size sections.
2. The second difference between paging and segmentation is, paging could result in internal fragmentation problem while segmentation could result in external fragmentation problem.
3. Another difference between paging and segmentation is, the page size is determined by the hardware while the section size in segmentation may varied by the user program.

## Problem 4

The screenshot of command line, files and code is listed below.

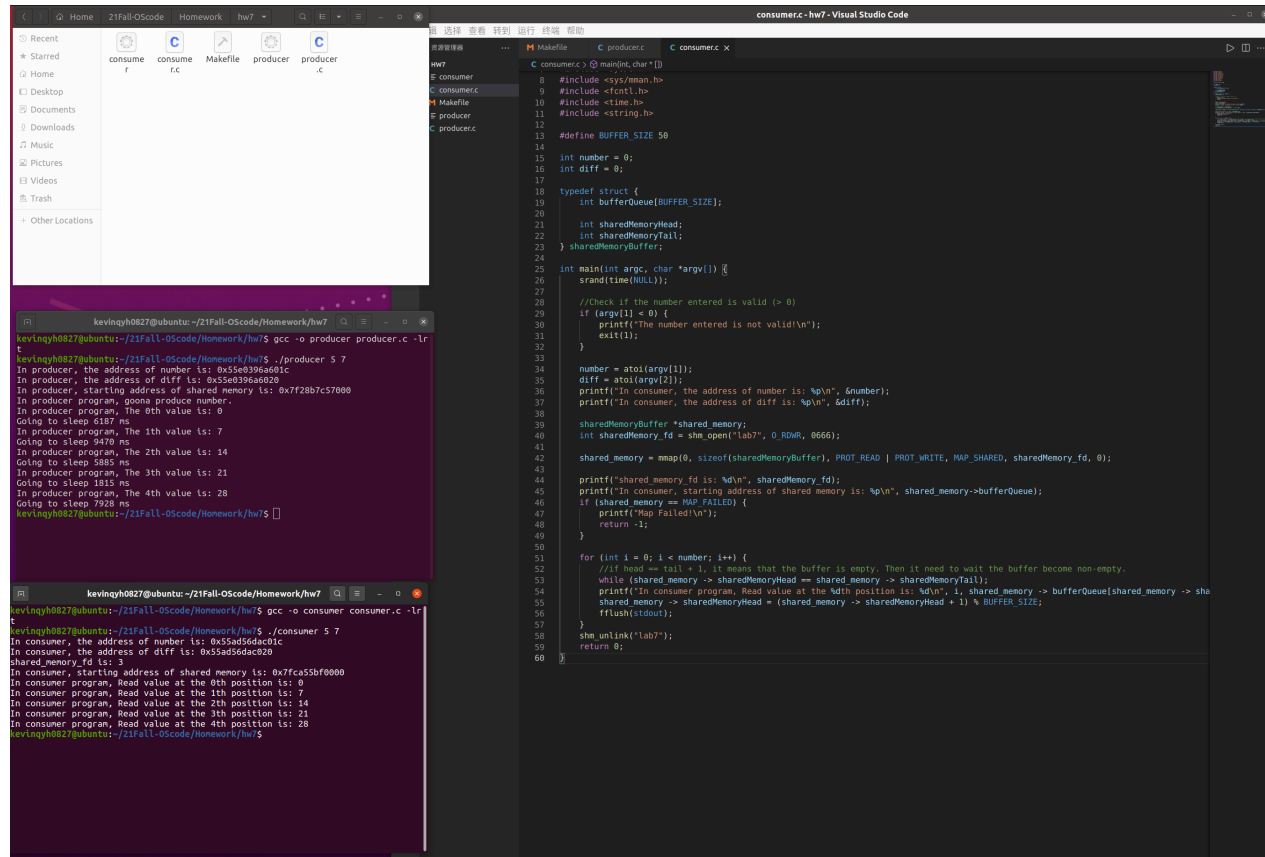


Figure 1: Screenshot of command line and files.

```
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7
kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$ gcc -o producer producer.c -l
t
kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$ ./producer 5 7
In producer, the address of number is: 0x55e0396a601c
In producer, the address of diff is: 0x55e0396a6020
In producer, starting address of shared memory is: 0x7f28b7c57000
In producer program, goona produce number.
In producer program, The 0th value is: 0
Going to sleep 6187 ms
In producer program, The 1th value is: 7
Going to sleep 9470 ms
In producer program, The 2th value is: 14
Going to sleep 5885 ms
In producer program, The 3th value is: 21
Going to sleep 1815 ms
In producer program, The 4th value is: 28
Going to sleep 7928 ms
kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$

kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$ gcc -o consumer consumer.c -l
t
kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$ ./consumer 5 7
In consumer, the address of number is: 0x55ad56dac01c
In consumer, the address of diff is: 0x55ad56dac020
shared_memory_fd is: 3
In consumer, starting address of shared memory is: 0x7fca555bf000
In consumer program, Read value at the 0th position is: 0
In consumer program, Read value at the 1th position is: 7
In consumer program, Read value at the 2th position is: 14
In consumer program, Read value at the 3th position is: 21
In consumer program, Read value at the 4th position is: 28
kevinqyh0827@ubuntu:~/21Fall-OScode/Homework/hw7$
```

Figure 2: Screenshot of starting address of shared memory in different running processes.

- a.
  - i. The printed address of the start address of the shared buffer is not similar from both process. Because of the MMU (Memory management unit), the printed value of a pointer in C language is always the virtual memory address. Since each process has its independent virtual memory space, this printed value of starting address of the shared buffer is different with each other.
  - ii. The printed address is virtual memory address.

```
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7
IBC_
57: 0000000000000000 0 FUNC GLOBAL DEFAULT UND srand@@GLIBC_2.2.5
58: 0000000000000400 0 NOTYPE GLOBAL DEFAULT 25 __data_start
59: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __gmon_start__
60: 0000000000000408 0 OBJECT GLOBAL HIDDEN 25 __dso_handle
61: 0000000000000200 4 OBJECT GLOBAL DEFAULT 18 __IO_stdin_used
62: 0000000000000000 0 FUNC GLOBAL DEFAULT UND time@@GLIBC_2.2.5
63: 00000000000001420 101 FUNC GLOBAL DEFAULT 16 __libc_csu_init
64: 0000000000000000 0 FUNC GLOBAL DEFAULT UND fflush@@GLIBC_2.2.5
65: 0000000000000401c 4 OBJECT GLOBAL DEFAULT 26 number
66: 00000000000004020 0 NOTYPE GLOBAL DEFAULT 26 __end
67: 00000000000001160 47 FUNC GLOBAL DEFAULT 16 __start
68: 00000000000004010 0 NOTYPE GLOBAL DEFAULT 26 __bss_start
69: 00000000000001249 465 FUNC GLOBAL DEFAULT 16 main
70: 0000000000000000 0 FUNC GLOBAL DEFAULT UND shm_unlink@@GLIBC_2.2
.5
71: 0000000000000000 0 FUNC GLOBAL DEFAULT UND atoi@@GLIBC_2.2.5
72: 00000000000004010 0 OBJECT GLOBAL HIDDEN 25 __TMC_END__
73: 0000000000000000 0 NOTYPE WEAK DEFAULT UND __ITM_registerTMCloneT
able
74: 0000000000000000 0 FUNC WEAK DEFAULT UND __cxa_finalize@@GLIBC
_2.2
75: 00000000000004020 4 OBJECT GLOBAL DEFAULT 26 diff
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7$
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7$ gcc -o consumer consumer.c -lr
t
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7$ ./consumer 5 7
In consumer, the address of number is: 0x55ad56dac01c
In consumer, the address of diff is: 0x55ad56dac020
shared_memory_fd is: 3
In consumer, starting address of shared memory is: 0x7fca55bf0000
In consumer program, Read value at the 0th position is: 0
In consumer program, Read value at the 1th position is: 7
In consumer program, Read value at the 2th position is: 14
In consumer program, Read value at the 3th position is: 21
In consumer program, Read value at the 4th position is: 28
kevinqyh0827@ubuntu: ~/21Fall-OScode/Homework/hw7$ ./consumer 5 7
In consumer, the address of number is: 0x55ccdb76e01c
In consumer, the address of diff is: 0x55ccdb76e020
shared_memory_fd is: 3
In consumer, starting address of shared memory is: 0x7fe4d0dc0000
In consumer program, Read value at the 0th position is: 0
In consumer program, Read value at the 1th position is: 7
In consumer program, Read value at the 2th position is: 14
In consumer program, Read value at the 3th position is: 21
In consumer program, Read value at the 4th position is: 28
```

Figure 3: Screenshot of address in absolute module and virtual memory of running process.

- b.
  - i. The address of variable “number” and “diff” is not matched in running program and in the absolute module. But the relative offset of these two variables keeps same in absolute module and running process.
  - ii. The reason is when the absolute module is loaded to the main memory, it typically be remapped to a physical address which is not necessarily be matched with the address in absolute module.