# Operating System – Homework Assignment #4

Department of Political Economy
B096060041 YEN TE LEE
政經 113 李彥德

1. A computer has four-page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

| Page | Loaded | Last Reference | R | M |
|---|---|---|---|---|
| 0 | 126 | 279 | 0 | 0 |
| 1 | 230 | 260 | 1 | 1 |
| 2 | 120 | 272 | 1 | 1 |
| 3 | 160 | 280 | 1 | 1 |

   a. Which page will NRU replace?

      Page 0, since NRU picks from the RM bits set (0, 0), (0, 1), (1, 0), (1, 1).

   b. Which page will FIFO replace?

      Page 2, since it is the early one be loaded.

   c. Which page will LRU replace?

      Page 1, since its last reference time is 260, which is the oldest reference time.

   d. Which page will second chance replace?

      Page 0. Since its R bit is 0. However, if R would change from 1 to 0 and put it at the end of the list by FIFO replace schedule, the page 2's R bit will change to 0.

2. A small computer has 8-page frames, each containing a page. The Page frames contain virtual pages A, C, G, H, B, L, and D in that order. Their respective load times were 18, 23, 5, 7, 32, 19, 3, and 8. Their reference bits are 1, 0, 1, 1, 0, 1, 1, and 0 and their modified bits are 1, 1, 1, 0, 0, 0, 1, and 1, respectively. Which page will the second chance page replacement algorithm replace?

   Constructing the FIFO queue list and order:

| | N | G | H | D | A | L | C | B |
|---|---|---|---|---|---|---|---|---|
| Last Reference | 3 | 5 | 7 | 8 | 18 | 19 | 23 | 32 |
| R | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| M | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |

   Hence, the answer is Page D.

3. What is the difference between p physical address and a virtual address?

A virtual address is limited by the word length of the machine, which is refer to the virtual store viewed by the process or CPU's logic address. For instance, a 32-bits machine can address from 0 to $2^{32}$ - 1 in virtual address. However, the physical address is limited by the real memory size, which is refer to hardware address. For instance, the physical address can address from 0 to $2^{20}$ - 1 if there is a 1MB RAM. Moreover, the virtual address must be mapped into the physical address.

4. Are there any circumstances in which clock and second chance choose different pages to replace? If so, what are they?

It's same. Just in different perspective.

5. A small computer has four-page frames. At the first clock tick, the R bits are 0111 (page 0 is 0, the rest are 1). At subsequent clock ticks, the values are 1011, 1010, 1101, 0010, 1010, 1100, and 0001. If the aging algorithm is used with and 8-bits counter, give the values of the four counters after the last ticks.

| Page | Counter |
|---|---|
| Page 0 | 01101110 |
| Page 1 | 01001001 |
| Page 2 | 00110111 |
| Page 3 | 10001011 |