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SE Comps A-3

OPERATING SYSTEMS
EXPERIMENT - 9

AIM:
To write a program to implement the following page replacement policies :-
1. First In First Out [FIFO]
2. Least Recently Used [LRU]
3. Optimal Page Replacement [OPR]

DESCRIPTION:
Page Replacement Algorithm decides which page to remove, also called swap out when a new page needs to be loaded into the main memory. Page Replacement happens when a requested page is not present in the main memory and the available space is not sufficient for allocation to the requested page.

TERMS USED:
1. Page - A page is a fixed-length contiguous block of virtual memory, described by a single entry in the page table

2. Frame - A frame is the smallest fixed-length contiguous block of physical memory into which memory pages are mapped by the operating system

3. Paging - Paging is a memory management scheme that eliminates the need for contiguous allocation of physical memory

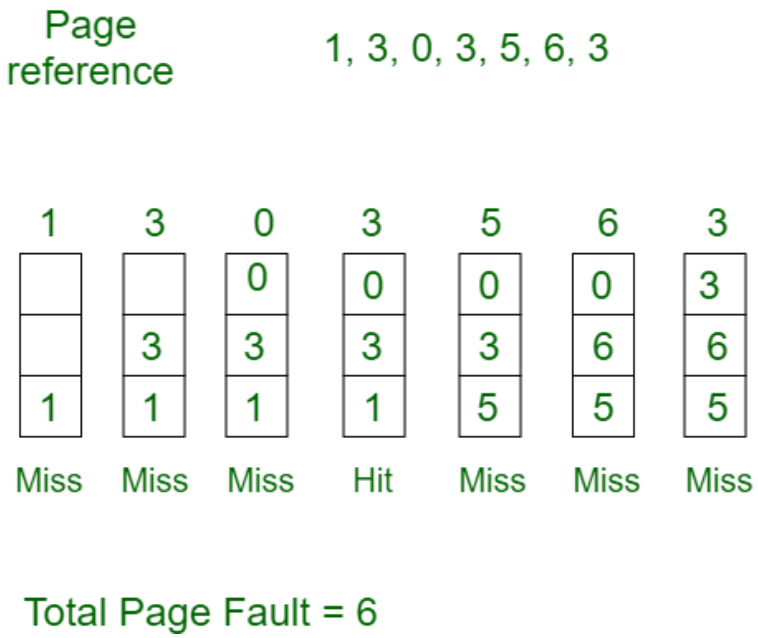
4. Page Table - A page table is the data structure used by a virtual memory system in a computer operating system to store the mapping between virtual addresses and physical addresses

5. Page Fault - A page fault happens when a running program accesses a memory page that is mapped into the virtual address space but not loaded in physical memory

FIRST IN FIRST OUT (FIFO):

This is the simplest page replacement algorithm. In this algorithm, the operating system keeps track of all pages in the memory in a queue, the oldest page is in the front of the queue. When a page needs to be replaced page in the front of the queue is selected for removal.

Example-1 Consider page reference string 1, 3, 0, 3, 5, 6 with 3 page frames.Find number of page faults.



Initially all slots are empty, so when 1, 3, 0 came they are allocated to the empty slots —> **3 Page Faults.**

when 3 comes, it is already in memory so —> **0 Page Faults.**

Then 5 comes, it is not available in memory so it replaces the oldest page slot i.e 1. —>**1 Page Fault.**

6 comes, it is also not available in memory so it replaces the oldest page slot i.e 3 —>**1 Page Fault.**

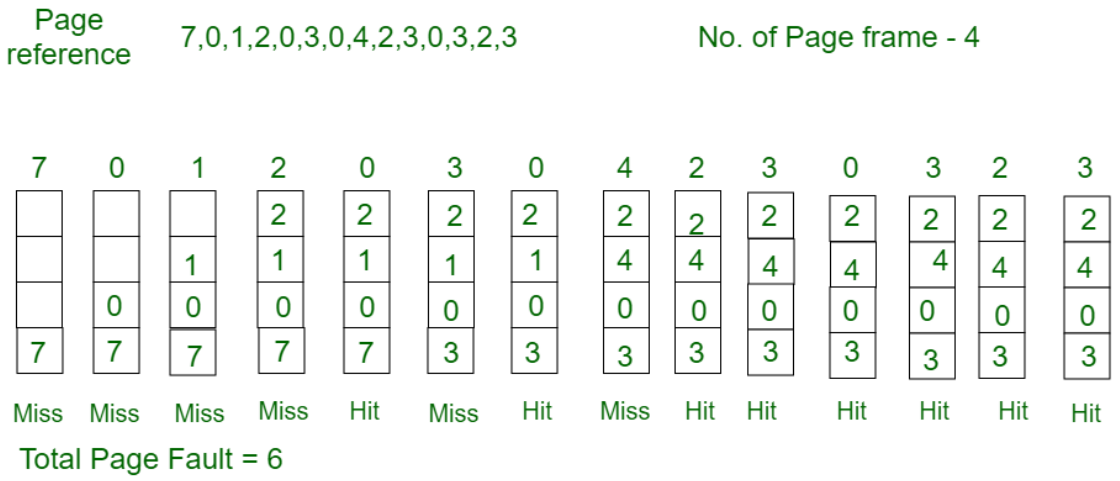
Finally when 3 come it is not available so it replaces 0 **1 page fault**

- Advantages –
    1. It is simple and easy to understand & implement.
- Disadvantages –
    1. The process effectiveness is low.
    2. When we increase the number of frames while using FIFO, we are giving more memory to processes. So, page fault should decrease, but here the page faults are increasing. This problem is called Belady's Anomaly.
    3. Every frame needs to be taken into account off.

LEAST RECENTLY USED (LRU):

In this algorithm page will be replaced which is least recently used.

Example-3 Consider the page reference string 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2 with 4 page frames.Find number of page faults.



Here LRU has same number of page fault as optimal but it may differ according to question.

Initially all slots are empty, so when 7 0 1 2 are allocated to the empty slots –> **4 Page faults**

0 is already their so –> **0 Page fault.**

when 3 came it will take the place of 7 because it is least recently used –>**1 Page fault**

0 is already in memory so –> **0 Page fault**.

4 will takes place of 1 –> **1 Page Fault**

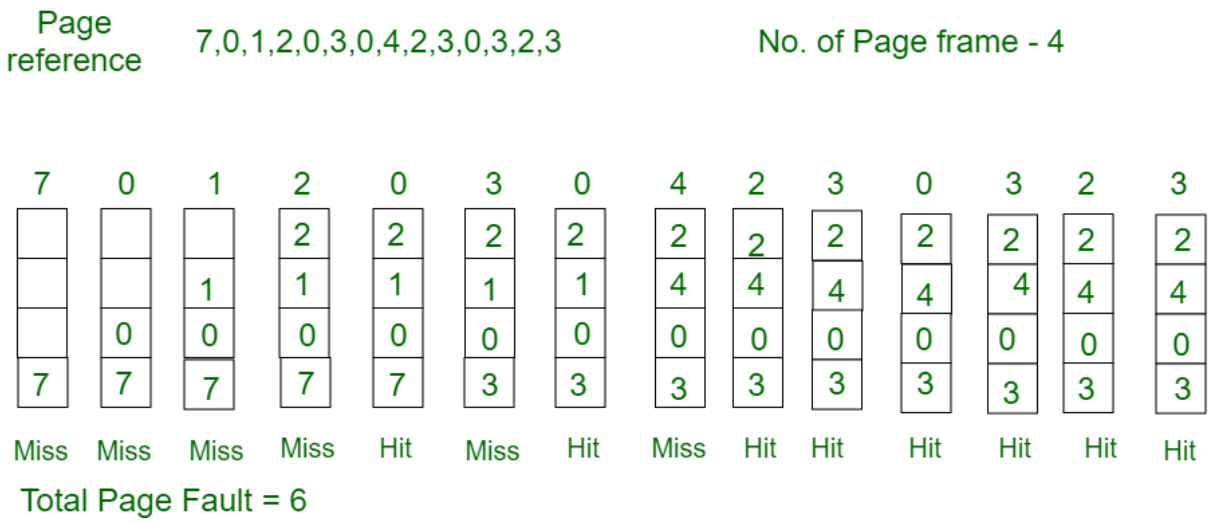
Now for the further page reference string –> **0 Page fault** because they are already available in the memory.

- Advantages –
    1. It is open for full analysis.
    2. In this, we replace the page which is least recently used, thus free from Belady’s Anomaly.
    3. Easy to choose page which has faulted and hasn’t been used for a long time.
- Disadvantages –
    1. It requires additional Data Structure to be implemented.
    2. Hardware assistance is high.

OPTIMAL PAGE REPLACEMENT (OPR):

In this algorithm, pages are replaced which would not be used for the longest duration of time in the future.

Example-2:Consider the page references 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, with 4 page frame. Find number of page fault.



Initially all slots are empty, so when 7 0 1 2 are allocated to the empty slots —> 4 Page faults

0 is already there so —> 0 Page fault.

when 3 came it will take the place of 7 because it is not used for the longest duration of time in the future.—>1 Page fault.

0 is already there so —> 0 Page fault..

4 will takes place of 1 —> 1 Page Fault.

Now for the further page reference string —> 0 Page fault because they are already available in the memory.

Optimal page replacement is perfect, but not possible in practice as the operating system cannot know future requests. The use of Optimal Page replacement is to set up a benchmark so that other replacement algorithms can be analyzed against it.

- Advantages –
    1. Complexity is less and easy to implement.
    2. Assistance needed is low i.e Data Structure used are easy and light.
- Disadvantages –
    1. OPR is perfect, but not possible in practice as the operating system cannot know future requests.
    2. Error handling is tough.

CONCLUSION:

We have implemented various page replacement policies and have tested them on standard input. This helps to highlight their strengths and weaknesses thus allowing us to differentiate between them. We have learned about the ‘Optimal’ policy which cannot be implemented in real systems as it requires knowledge of future events and its use as a comparative baseline for evaluating other policies.