



Pune District Education Association's
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EXPERIMENT NO

Title : write a program to simulate Page replacement algorithm.

Objectives :

- To understand Page replacement policies
- To understand paging concept
- To understand concept of page fault, page hit, miss, hit ratio etc

Problem statement :

write a java program to implement Page Replacement Policies FIFO, Optimal and LRU

Outcomes :

- knowledge of Page Replacement Policies in OS
- Implemented LRU, FIFO and OPT Page replacement Policies.
- Understood concept of paging

Software Requirement :

latest jdk, Eclipse, Python

Hardware requirements :

- m/c lenovo Think center M700 Ci3, 6100, 6th Gen, H81, 4GB RAM, 500 GB HDD

Theory concepts :

Paging : In paging, operating system divides each incoming programs into pages of equal size. The sections of a disk are called block or sectors. The sections of main memory are called page frames. One sector will hold one page of job instructions and fit into one page frame of memory.

- In paging, logical address space of a program can be noncontiguous. It solves external fragmentation problem.

	Page	Block	Address	Value	Job
0					
10		0 5	1000 1500	Job 1	
2000		1 6	2000 2500	Job 2	
Page			2518	lead 2108	Pages
1000	load 12108	0 2	3000		
9000		1 4	4000	Free	page 2
3000	015571	2 7	5000		Page 1
			6000		Page 0
0			7000	015571	
10		0 8	2000		Page 2
Job 3	Page map		9000		Page 0
Address spaces	tables		10000	Free	

Page Replacement Algorithm :

Page replacement algorithms are the techniques using which an operating system decides which memory pages to swap out, write to disk when a page of memory needs to be allocated. Paging happens whenever a page fault occurs and a



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free page cannot be used for allocation purpose accounting to reason that pages are not available of the number of free pages is lower than required pages

~~Page fault :~~

A page fault is a type of exception raised by computing hardware when a running program accesses a memory page that is not currently mapped by the memory management unit into the virtual address space of a process.

~~Page hit : Pune District Education Association~~

A hit is request to a web server for a file, like a web page, image, JavaScript or cascading style sheet. When a web page is downloaded from a server the number of hits or page hits is equal to the number of files requested.

~~Page frame :~~

The page frame is the storage unit whereas the page is the contents that you would store in the storage unit ie that page frame

~~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.

1. First In first out (FIFO) algorithm :

- oldest page in main memory is the one which will be selected for replacement
- Easy to implement, keep a list, replace pages from the tail and add new pages at the head

Reference String : 0, 2, 1, 1, 6, 1, 4, 1, 0, 1, 1, 0, 1, 3, 1, 1, 2, 1

0	4	4	4	4	4	4	2	
2	→ 4	2	→ 0	0	→ 3	0	→ 2	0
1	1	1	1	3	3	3	3	
6	6	6	6	6	1	1	1	

$$\text{Fault Rate} = \frac{9}{12} = 0.75$$

Page reference Stream :

1	2	3	2	1	5	2	1	6	2	5	6	3	1	3	6	1	2	4	3
1	1	1	1	1	2	2	3	5	1	6	6	2	5	5	3	3	1	6	2
2	2	2	2	3	3	5	1	6	2	2	5	3	3	1	1	6	2	4	
3	3	3	5	5	1	6	2	5	5	3	1	1	6	6	2	4	3	*	

FIFO

Total 14 page faults

Advantage of FIFO

1. FIFO is very simple and easy to implement

Disadvantage of FIFO

1. It suffers from Belady's anomaly
2. It is not very effective
3. System needs to keep track of each frame



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2. Optimal Page algorithm :

- An optimal page-replacement algorithm has the lowest page fault rate of all algorithm. An optimal page-replacement algorithm exists, and has been called OPT or MIN.
- Replace the page that will not be used for the longest period of time use the time when a page is to be used.

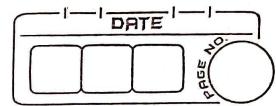
Reference string : 0, 1, 1, 6, 4, 0, 1, 0, 3, 1, 2, 1

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	0	0	3
2	4	2	2
1		1	1
6		4	4

$$\text{Fault Rate} = \frac{6}{12} = 0.50$$

1	2	3	4	1	2	5	1	2	3	4	5
1	1	1	1	1	1	1	1	1	3	3	3
	2	2	2	2	2	2	2	2	2	4	4
	3	4	4	4	5	5	5	5	5	5	5
F	F	F	F	✓	✓	F	✓	✓	F	F	✓
				HIT	HIT		HIT	HIT			HIT

Total no of page fault = 7



Advantages of OPTIMAL

1. It has lowest page fault rate
2. Optimal never suffers from Belady's anomaly
3. Used for comparison studies

Disadvantages :

1. Difficult to implement
2. It requires future reference string

3. least Recently used (LRU) :

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

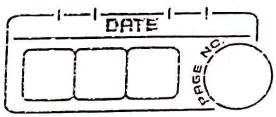
1. Start traversing the pages
 - i) If set holds less pages than capacity
 - a) Insert page into the set one by one until the size of set reaches capacity or all page requests are processed.
 - b) Simultaneously maintain the recent occurred index of each page in a map called indexes
 - c) Increment page fault

If current page is present in set do nothing
ELSE

- a) find the page in the set that was least recently used. we find it using index array we basically need to replace the page with minimum index
- b) Replace the found page with current page
- c) Increment page faults
- d) Update index of current page.

2. Return page faults

Example Consider the following page reference string 1,2,3,4,1,1,2,5,1,2,3,4,5 for a memory with 3 frames. How many page fault would occur for following page replacement algo



←

1	2	3	4	1	2	5	1	2	3	4	5
1	1	1	4	4	4	5	5	5	5	5	5
	2	2	2	1	1	1	1	1	3	3	3
		3	3	3	2	2	2	2	2	4	4
F	F	F	F	F	F	F	F	F	F	F	F

Total no of page fault = 9

Advantages :

1. It is quite good algorithm
2. It is amenable to full statistical analysis
3. Never suffers from Belady's anomaly

Disadvantages :

1. Problem is how to implement
2. It requires hardware assistance

Conclusion :-

बहुजन हिताय, बहुजन सुखाय।

Thus, I have implemented page replacement policies
FIFO, LRU and OPT.