

FIFO Page Replacement: 15 page faults! : Adding more frames can cause more page faults!! :! Belady's Anomaly!

reference string																				
7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1	
7	7	7	2		2	2	4	4	4	0			0	0			7	7	7	
	0	0	0		3	3	3	2	2	2			1	1			1	0	0	
		1	1		1	0	0	0	3	3			3	2			2	2	1	
page frames																				

Optimal Algorithm:

- Optimal Page replacement –

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, 3, with 4 page frame. Find number of page fault.

Page reference	7,0,1,2,0,3,0,4,2,3,0,3,2,3														No. of Page frame - 4	
7	0	1	2	0	3	0	4	2	3	0	3	2	3			
			2	2	2	2	2	2	2	2	2	2	2			
		1	1	1	1	1	4	4	4	4	4	4	4			
	0	0	0	0	0	0	0	0	0	0	0	0	0			
7	7	7	7	7	3	3	3	3	3	3	3	3	3			
Miss	Miss	Miss	Miss	Hit	Miss	Hit	Miss	Hit	Hit	Hit	Hit	Hit	Hit			
Total Page Fault = 6																

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.

In operating systems, whenever a new page is referred and not present in memory, page fault occurs and Operating System replaces one of the existing pages with newly needed page. Different page replacement algorithms suggest different ways to decide which page to replace. The target for all algorithms is to reduce number of page faults.

Replace page that will not be used for longest period of time! ● 9 is optimal page faults:

reference string																			
7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1
7	7	7	2		2		2			2			2				7		
	0	0	0		0		4			0			0				0		
		1	1		3		3			3			1				1		
page frames																			

Least Recently Used (LRU) Algorithm : 12 is the LRU page faults

reference string																			
7	0	1	2	0	3	0	4	2	3	0	3	2	1	2	0	1	7	0	1
7	7	7	2		2		4	4	4	0			1			1			
	0	0	0		0		0	0	3	3			3			0			
		1	1		3		3	2	2	2			2			2			7
page frames																			

LRU Algorithm

- Use past knowledge rather than future!
- Replace page that has not been used in the most amount of time!
- Associate time of last use with each page