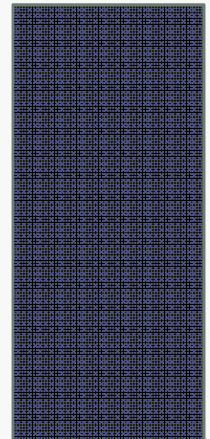
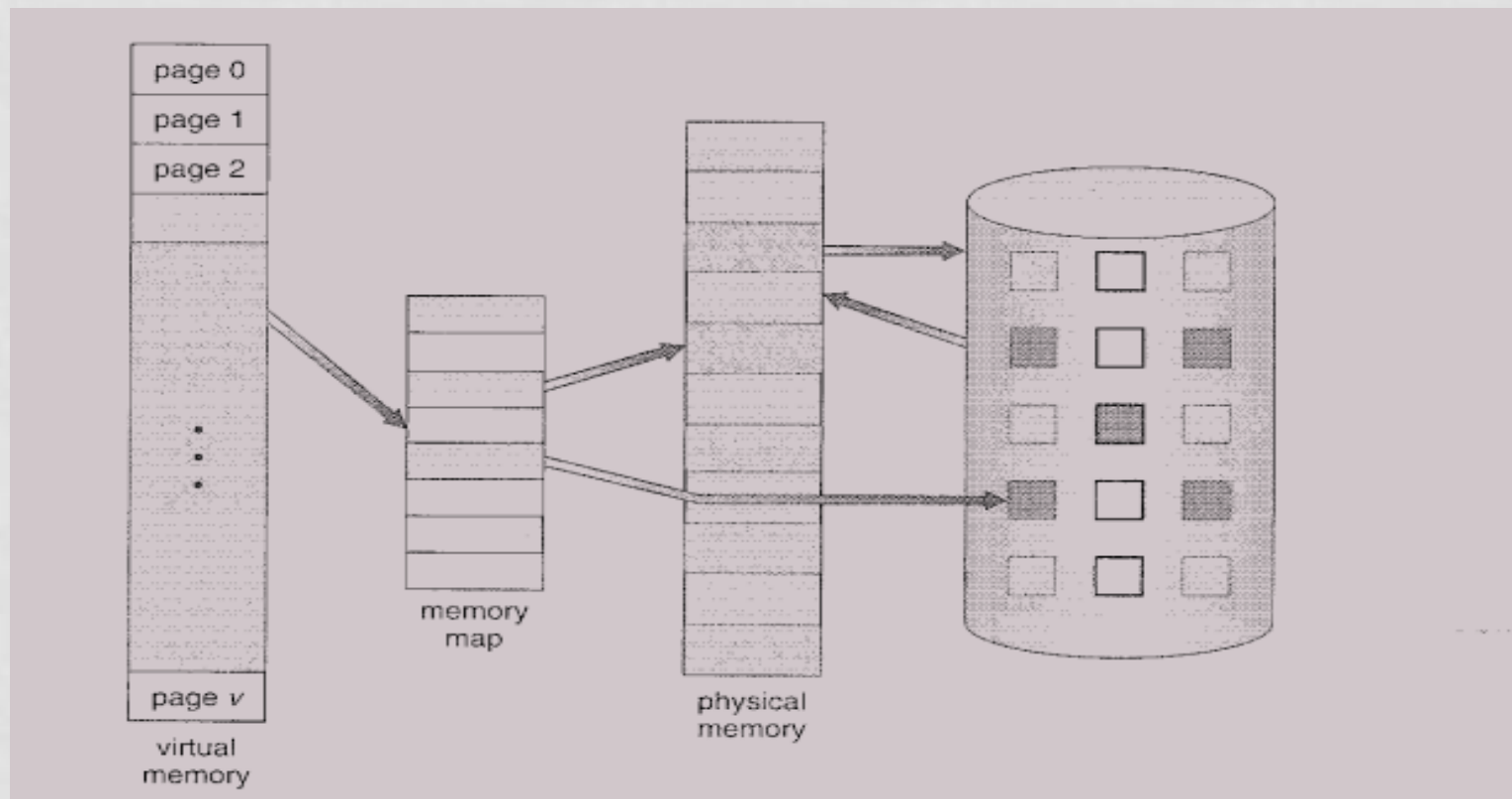


# VIRTUAL MEMORY

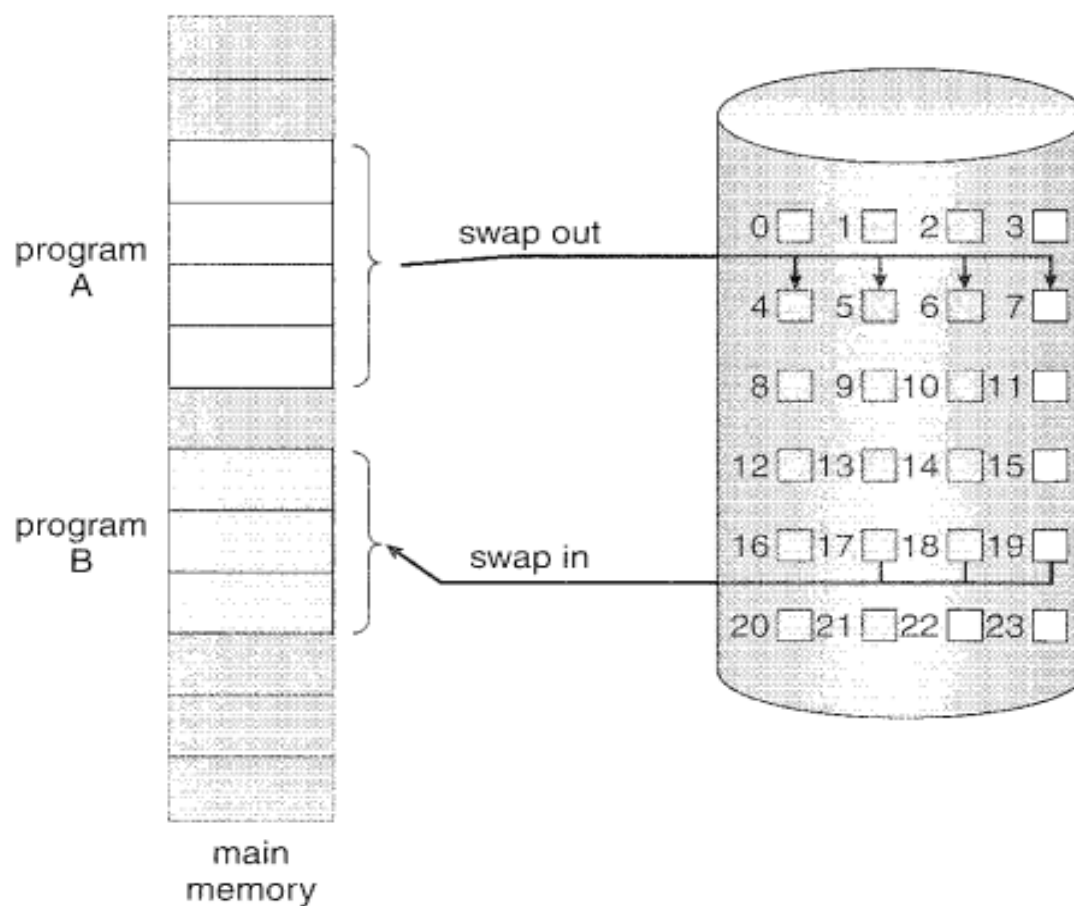
*DR. PADMAJA JOSHI*



- *What is virtual memory?*

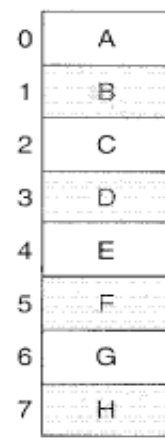


# DEMAND PAGING

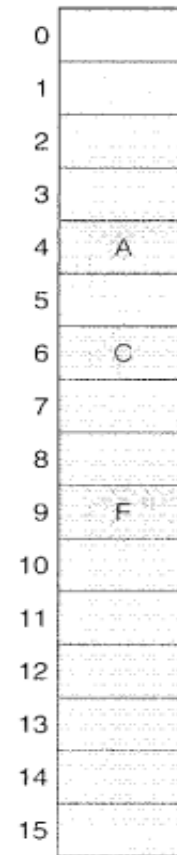
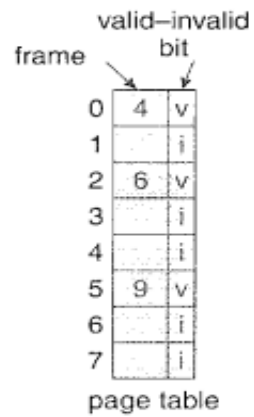


# DEMAND PAGING

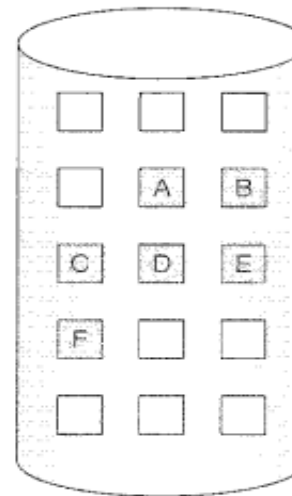
- *Lazy swapper*



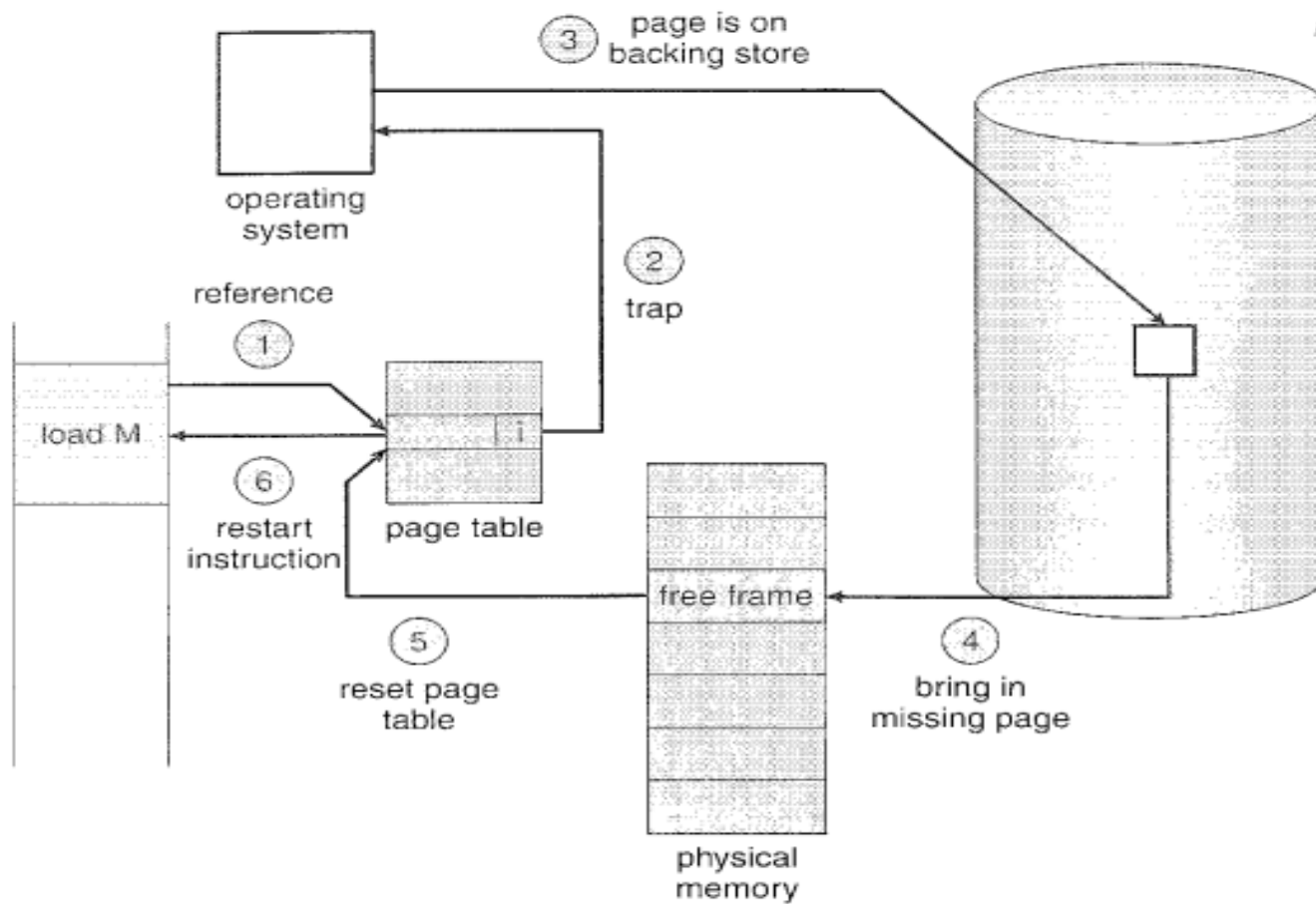
logical  
memory



physical memory



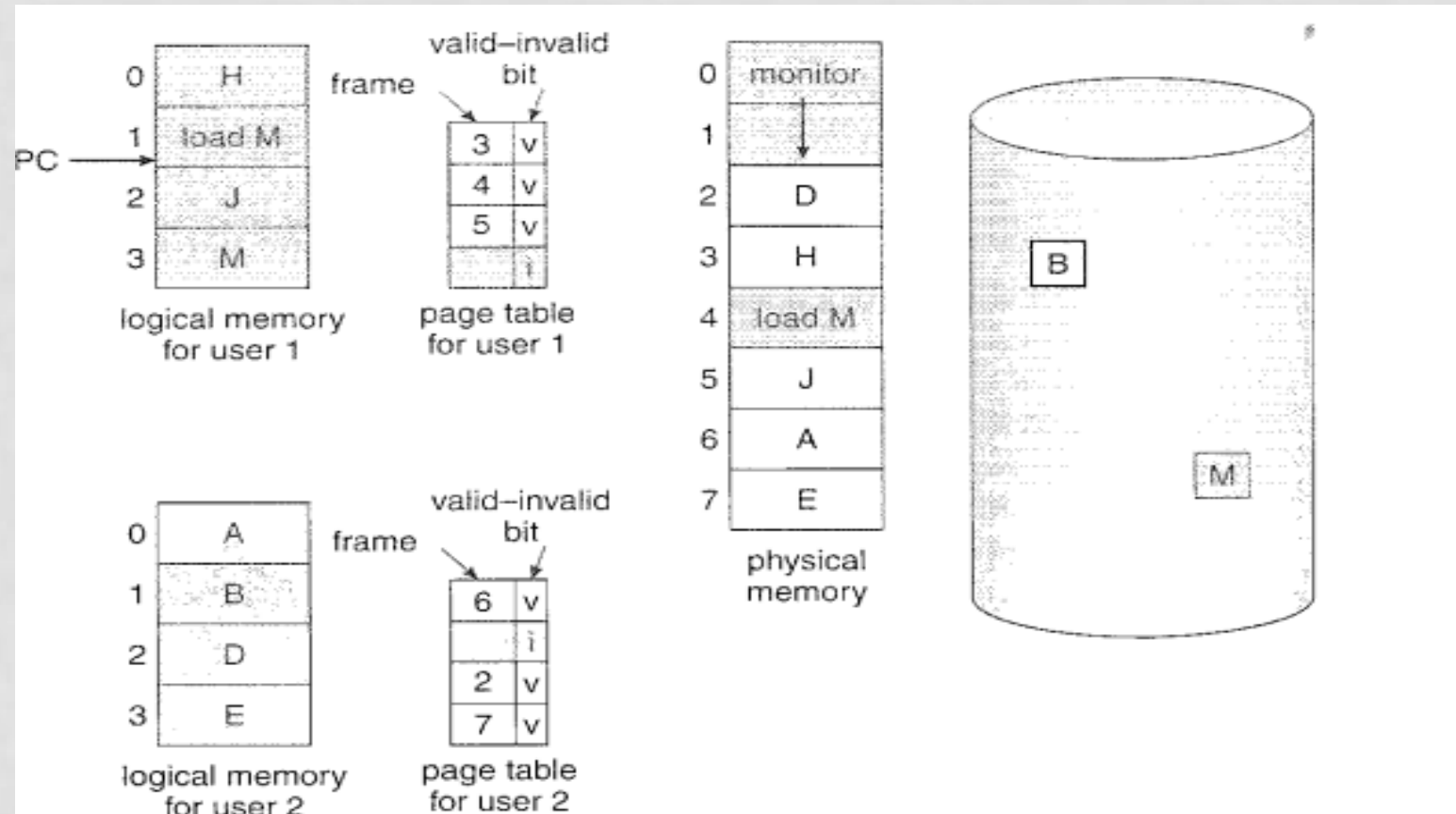
# PAGE FAULT



# PERFORMANCE OF DEMAND PAGING

- $p$  : *probability of page fault*
- *Effective access time =  $(1-p) \times ma + p \times \text{page fault time}$*
- $EAT \propto p$

# NEED FOR PAGE REPLACEMENT

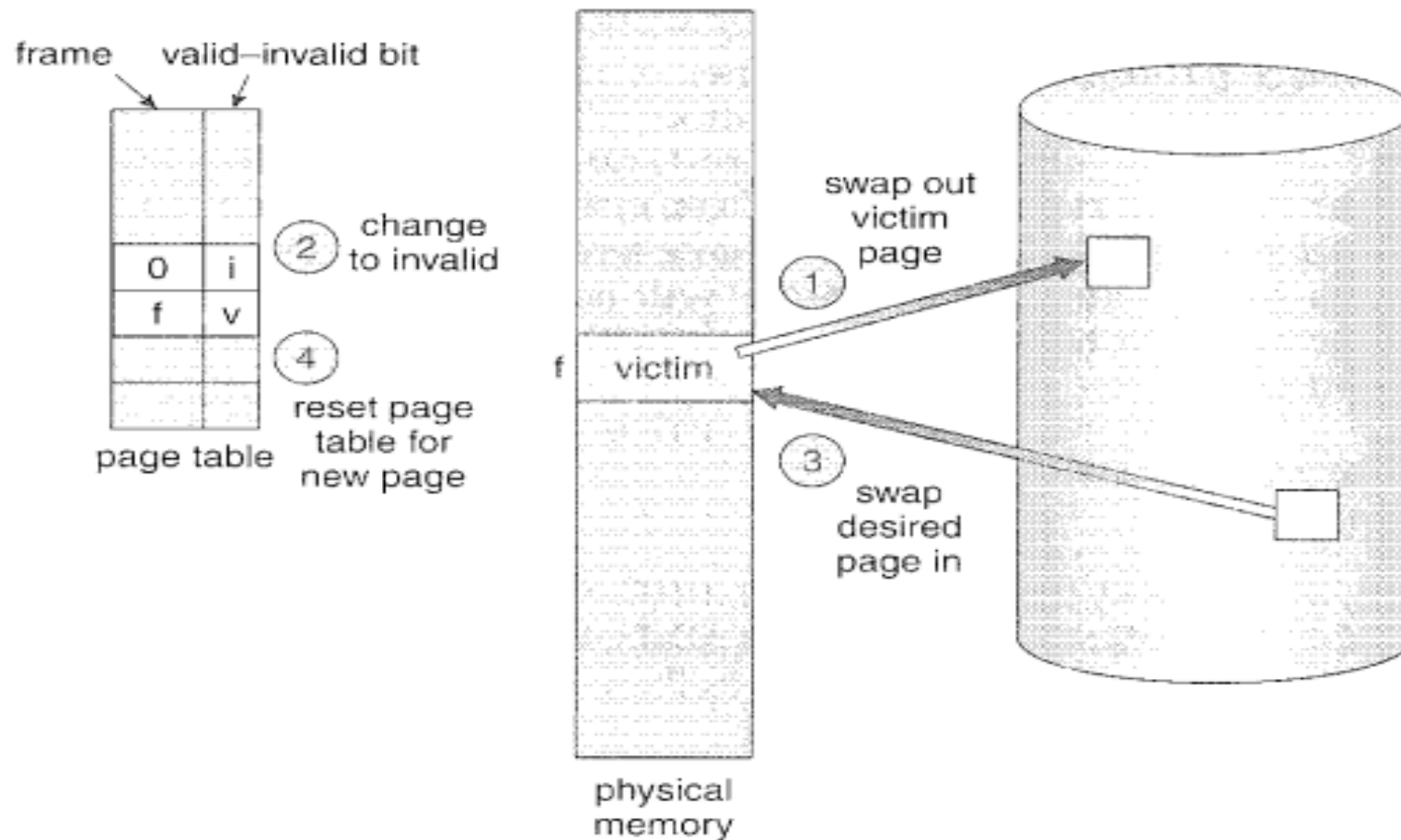




# PAGE REPLACEMENT

- *Dirty bit*

# PAGE REPLACEMENT WITH DIRTY BIT



# FIFO

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																
	0	0	0																
		1	1																

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

0	0																		
1	1																		
3	2																		

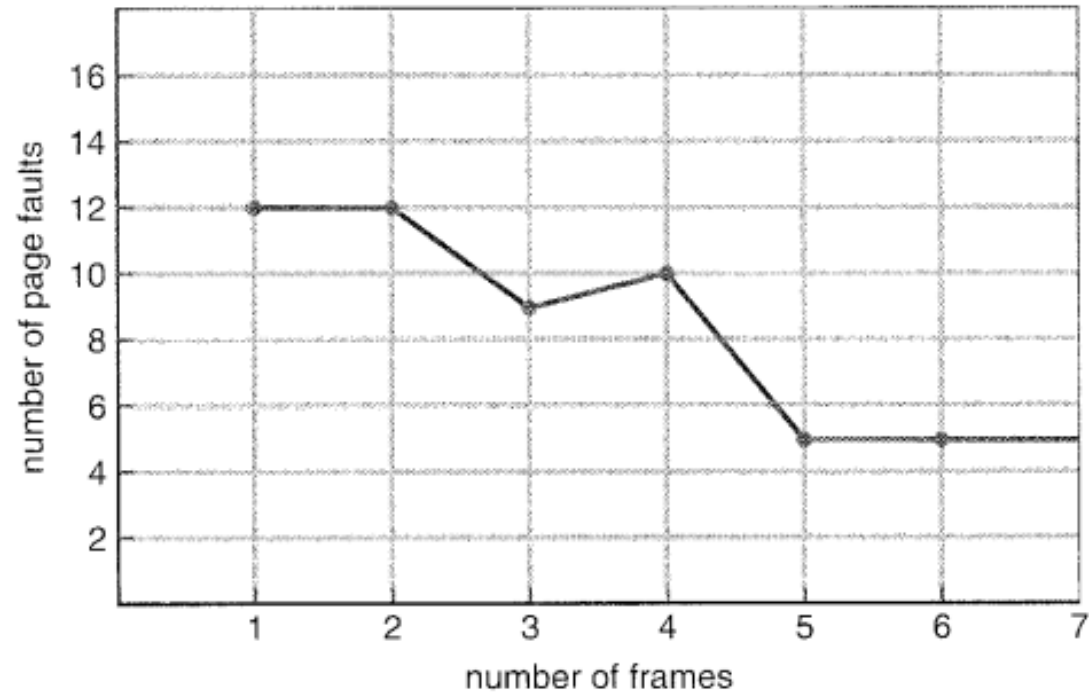
7	7	7																	
1	0	0																	
2	2	1																	

page frames

# BELADY'S ANOMALY

- *1,2,3,4,1,2,5,1,2,3,4,5*
- *Page replacement with 3 frames and 4 frames*

### 5.4 Page Replacement 555



# OPTIMAL PAGE REPLACEMENT

- Replace the page that will not be used for longest period of time*

reference string

7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1



page frames

# LEAST RECENTLY USED (LRU)

reference string

7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1

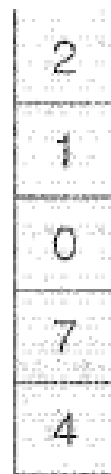
7	7	7	2																
	0	0	0																
		1	1																

page frames

# LRU USING STACKS

reference string

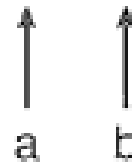
4 7 0 7 1 0 1 2 1 2 7 1 2



stack  
before  
a



stack  
after  
b





# SECOND CHANCE REPLACEMENT

- *Additional bits are maintained to keep the information about the chance*

# COUNTING BASED ALGORITHMS

- *Least frequently used*
- *Most frequently used*

# PAGE BUFFERING ALGORITHMS

- *Desired page is read into the free frames*

# THRASHING

- *High paging activity is called “Thrashing”*
- *Process is thrashed if it is spending more time in paging than executing*

*THANK YOU*