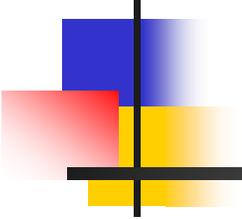
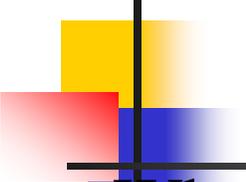
A decorative vertical bar on the left side of the slide. It consists of a dark teal background with a white dotted vertical line running through its center. To the right of this bar, there are five orange circles of varying sizes, arranged in a cluster. The largest circle is at the top, with four smaller circles below it. The text 'PRINCIPLES OF OPERATING SYSTEMS' is centered horizontally across the slide, overlapping the decorative bar.

PRINCIPLES OF OPERATING SYSTEMS



LECTURE 17

PAGE REPLACEMENT ALGORITHMS

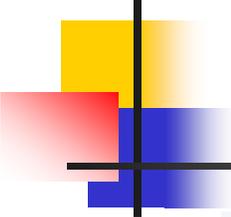


Page Replacement

- What if there is no free frame?

- **PAGE REPLACEMENT APPROACH:**

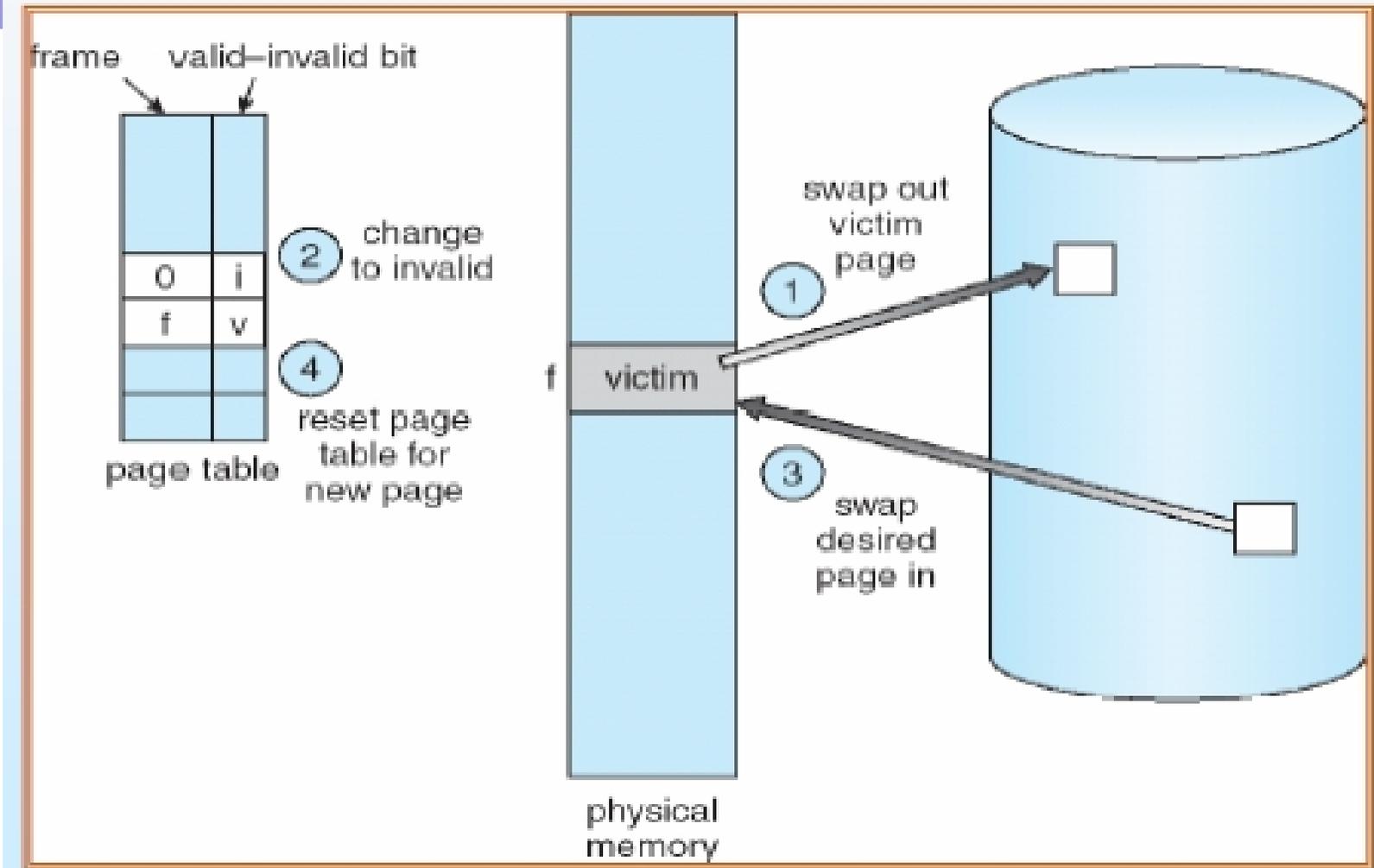
If no frame is free, we find one that is not currently being used and free it. We can free a frame by writing its contents to swap space and changing the page table to indicate that this page is no longer in memory.

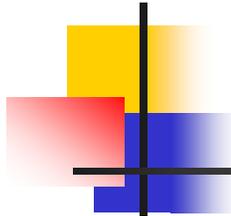


Basic Page Replacement

1. Find the location of the desired page on disk
2. Find a free frame:
 - If there is a free frame, use it
 - If there is no free frame, use a page replacement algorithm to select a **victim** frame
3. Bring the desired page into the (newly) free frame; update the page and frame tables
4. Restart the process

Page Replacement





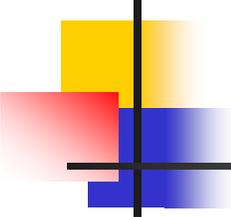
FIFO Algorithm

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



Page Replacement(FIFO)Algorithms

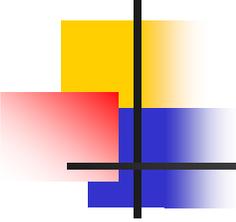
- **Goal:**

Want lowest page-fault rate

Evaluate algorithm by running it on a particular string of memory references (reference string) and computing the number of page faults on that string

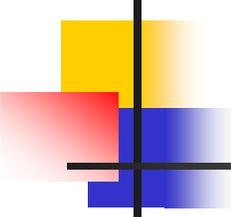
- In all our examples, the reference string is

1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5



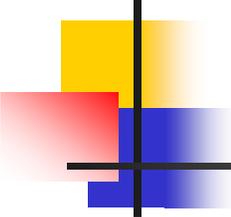
FIFO

- When a page must be replaced, the oldest page is chosen
- In all our examples, the reference string is
1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5
- 3 frame (9 page faults)
- 4 frame (10 page faults)
- Notice that the number of faults for 4 frames is greater than the number of faults for 3 frames!! This unexpected result is known as **Belady's anomaly**



Optimal Page-Replacement Algorithm

- Replace page that will not be used for longest period of time
- This is a design to guarantee the lowest page-fault rate for a fixed number of frames



Optimal Page-Replacement Algorithm

4 frames example

1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5



4

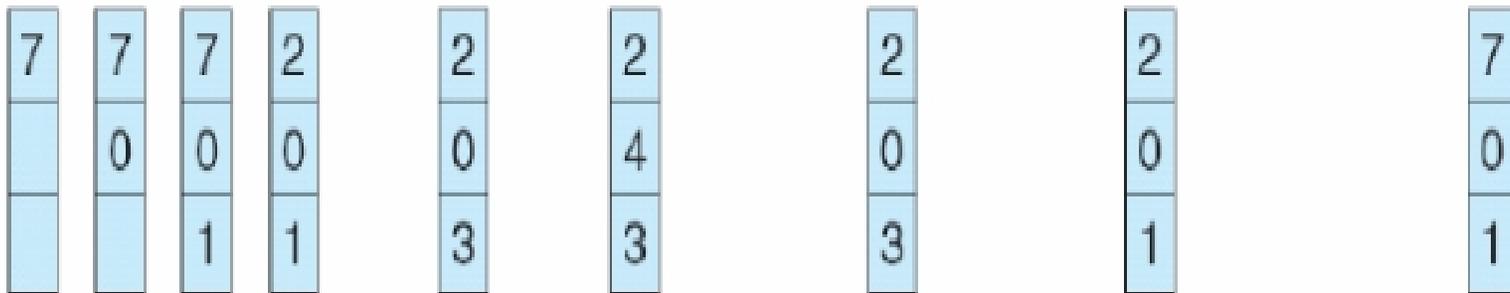
6 page faults

5

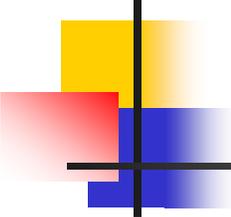
Optimal Page-Replacement Algorithm

reference string

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



page frames



Optimal Page-Replacement Algorithm

- Unfortunately, the optimal page-replacement is difficult to implement, because it requires future knowledge of the reference string