Page Replacement Algorithms

1. Least Recently used (LRU)

In this case, the page which is least recently used is replaced with the new page.

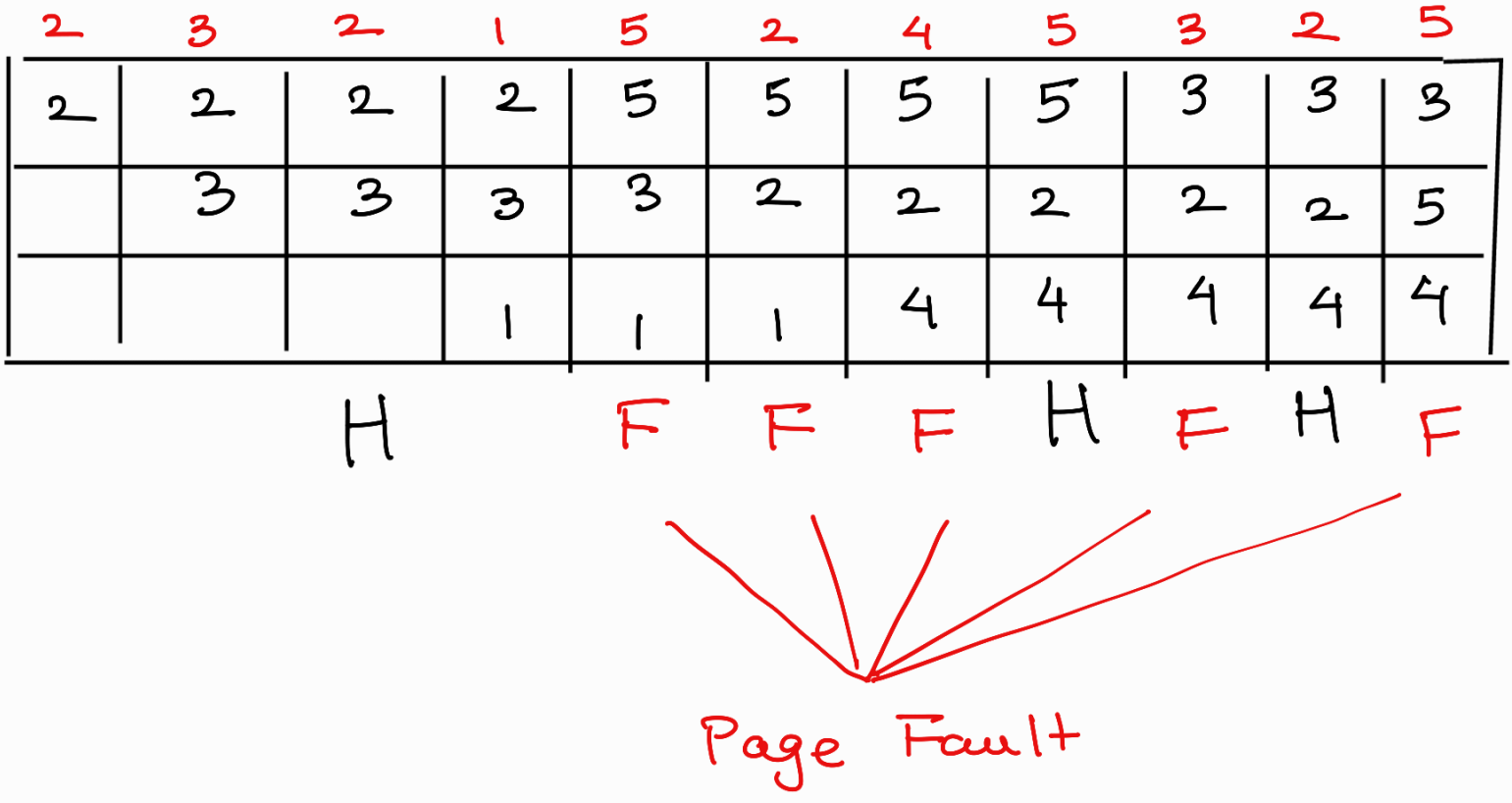
2. First In First Out (FIFO)

In this case, the page which was brought into the cache/memory first is replaced first. Thus the page which has stayed for the longest time is replaced.

3. Least Frequently Used (LFU)

In this case, the page which is used for the least number of times is replaced first.

FIFO



For the following string, simulate using FIFO & LRU.

6 0 12 0 30 4 2 30 32 1 20 15

(Page Size = 3)

6	0	12	0	30	4	2	30	32	1	20	15
6	6	6	6	30	30	30	30	32	32	32	15
	0	0	0	0	4	4	4	4	1	1	1
		12	12	12	12	2	2	2	2	20	20
			H	F	F	F	H	F	F	F	F

FIFO

No. of Page Faults ⇒ 7

6	0	12	0	30	4	2	30	32	1	20	15
6	6	6	6	30	30	30	30	30	30	20	20
	0	0	0	0	0	2	2	2	1	1	1
		12	12	12	4	4	4	32	32	32	15
			H	F	F	F	H	F	F	F	F

LRU

No. of Page Faults = 7

Q. Find out page fault for following string using LFU method. Consider page frame size = 3.

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

Cost & Performance Measurement

(2-Level Memory Hierarchy)

Parameters considered for performance Analysis

1. Average Cost (C)
2. Hit Ratio (H)
3. Average Access Time (t_A)
4. Efficiency (η)

Any 2-Level memory has to be analysed with it's performance characteristics.

The different group of 2 Level memories can be cache memory & main memory, main memory & virtual memory, internal & external cache memory, etc.

1. Average Cost (C)

$$= \frac{C_1 S_1 + C_2 S_2}{S_1 + S_2}$$

where C_1 & C_2 are the costs per bit of memory 1 (faster memory) & memory 2 (slower memory)

S_1 & S_2 are the sizes of memory 1 and memory 2 respectively.

2. Hit Ratio (H) $= \frac{N_1}{N_1 + N_2}$

where N_1 is the no. of hits & N_2 is the number of misses.

3. Average Access Time (t_A)

$$= H t_{A1} + (1 - H) t_{A2}$$

where t_{A1} & t_{A2} are the time taken to access memory 1 & memory 2 respectively.

$$t_A = H t_{A1} + (1 - H) t_{A2}$$

$$= H t_{A1} + (1 - H)(t_{A1} + t_B)$$

where,

$$t_{A2} = t_{A1} + t_B$$

$$= t_{A1} + (1 - H) t_B$$

4. Efficiency $(\eta) = \frac{t_{A1}}{t_A}$

$$= \frac{t_{A1}}{H t_{A_1} + (1-H)\, t_{A2}}$$

$$= \frac{1}{H + (1-H)\, r}$$

where $r = \frac{t_{A2}}{t_{A1}}$ = Speed Ratio