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# Page Replacement Algorithms

# Why Page Replacement Algorithms?

- The total amount of memory required by all processes in the systems is often much more than capacity of RAM
- Keeping all processes in the memory all the time requires a huge amount of RAM and may be impossible

- Solution: Virtual Memory

# Virtual Memory

- An application is both in the RAM and disk
- For each page access, if there is unmmap between virtual address and physical address, there is Page Fault
- If there is Page Fault and memory is full
  - OS has to select a page to remove and to make room for the incoming page
  - Which page will be removed ?

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*That depends on Page Replacement Algorithms*

# Simulation scenarios

- Problem 36, Chapter 3, textbook
  - A computer has four page frames. The time of loading, time of last access, and the R&M bits for each page area as shown below (the times are in clock ticks)

| Page | Loaded | Last ref. | R | M |
|---|---|---|---|---|
| 0 | 126 | 280 | 1 | 0 |
| 1 | 230 | 265 | 0 | 1 |
| 2 | 140 | 270 | 0 | 0 |
| 3 | 110 | 285 | 1 | 1 |

(a) Which page will NRU replace?

(b) Which page will FIFO replace?

(c) Which page will LRU replace?

(d) Which page will second chance replace?

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# First-in-First-out (FIFO)

# FIFO

- Ideas
  - Replace the page that has been in memory for the longest time

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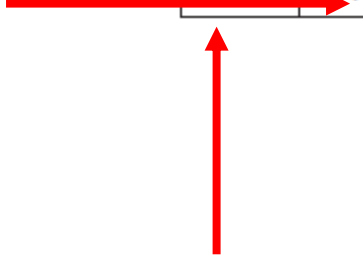

*Page to be removed is 3*

# The Least Recently Used (LRU)

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# The Least Recently Used (LRU)

- Ideas:
  - Keep track of when a page is used
  - The page that has been used least recently is evicted

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*Find page with smallest value in the column*

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*This page*

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*This page*

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*Find page with smallest value in the column*

*Page 1 will be removed*


Q&A