

Stack Replacement Algorithms

ECE595

Feb 27

Y. Charlie Hu

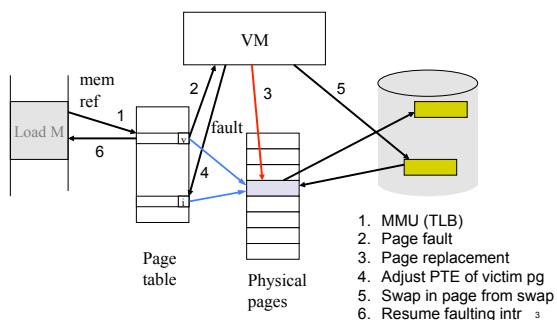
1

[week7] Virtual Memory

- Definition: *Virtual memory* permits a process to run with only some of its virtual address space loaded into physical memory
- Objective:
 - To produce the illusion of memory as big as necessary
- Virtual address space translated to either
 - Physical memory (small, fast) or
 - Disk (backing store), large but slow

2

Page Fault Handling in demand paging



Page replacement algorithms: Summary

- Optimal
- FIFO
- Random
- FIFO with 2nd chance
- Clock: a simple FIFO with 2nd chance
- Enhanced FIFO with 2nd chance
- Approximate LRU

4

“Deep thinking”

- For a fixed replacement algorithm, more page frames → fewer page faults?

10

More Page Frames → Fewer Page Faults?

- Consider the following reference string with 4 physical pages
 - FIFO replacement
 - 1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5
 - How many page faults?
- Consider the same reference string with 3 physical pages
 - FIFO replacement
 - 1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5
 - How many page faults?
- This is called *Belady's anomaly*

11

Stack algorithms

- **Definition:** a page replacement algorithm in which it can be shown that the set of pages that would be in memory for n physical pages is *always a subset* of the set of pages that would be in memory for $n+1$ physical pages
- **Implication:** hit rate of stack algorithms never decreases when number of physical pages grows
 - Proof?
- Examples: OPT? LRU? FIFO? LFU?

12

OPT is a stack algorithm

- Proof by induction:
 - Given
 - A mem X of N physical pages
 - A mem Y of $N+1$ physical pages
 - A sequence of virtual page accesses
 - The claim is true after i accesses;
 - On the $(i+1)$ th access of x . Show after replacement, claim is still true

13

OPT is a stack algorithm

- Is there a one-sentence argument?



15

The BIG picture

- We've talked about single evictions
- Most computers are multiprogrammed
 - Single eviction decision still needed
 - New concern – processes compete for resources
 - How to be “fair enough” and achieve good overall throughput



16

Possible replacement strategies

- Global replacement:
 - All pages from all processes are lumped into a single replacement pool
 - Most flexibility, least “pig protection”
- Local replacement
 - Per-process replacement:
 - Each process has a separate pool of pages
 - Per-user replacement:
 - Lump all processes for a given user into a single pool
- In local replacement, must have a mechanism for (slowly) changing the allocations to each pool



17

Reading

- Chapter 9



18