Virtual Memory I
CSE 351 Winter 2024

Instructor:
Justin Hsia

Teaching Assistants:
Adithi Raghavan
Aman Mohammed
Connie Chen
Eyoel Gebre
Jiawei Huang
Malak Zaki
Naama Amiel
Nathan Khuat
Nikolas McNamee
Pedro Amarante
Will Robertson

Hey macOS, I need some memory!

But... Do you really need all those processes running?

Yes! Yes we do.

PRETENDS TO BE DRAWING | PTBD.JWELS.BERLIN
https://ptbd.jwels.berlin/comic/21/
Relevant Course Information

❖ HW21 due tonight, HW22 due Monday, HW23 due Wednesday
❖ Lab 4 due tonight
❖ Lab 5 due next Friday (3/8)
  ▪ The most significant amount of C programming you will do in this class – combines lots of topics from this class: pointers, bit manipulation, structs, examining memory
  ▪ Understanding the concepts first and efficient debugging will save you lots of time
  ▪ Light style grading
  ▪ Only 1 late day can be used for Lab 5

❖ No lessons for Lectures 25 and 26 – “normal” lectures
Take-Home Final Exam

❖ First three days of Finals Week (3/11-13)
  ▪ Structure will be very similar to the midterm
  ▪ Not cumulative: focused on post-midterm material
  ▪ Hybrid final review session planned for 3/8 (room TBD)
  ▪ Justin will hold virtual support hours on 3/12 and 3/13
  ▪ Regrade requests Monday, 3/18
Virtual Memory I
Lesson Summary (1/2)

- **Virtual memory** is software’s perspective (e.g., memory layout), **physical memory** is hardware’s perspective (e.g., memory hierarchy)

- Virtual memory manages the memory for multiple concurrently running processes (implements protection and sharing)
  - Each process has its own virtual address space that gets mapped into parts of the physical address space
  - When run out of physical address space, put least recently used data in disk
Lesson Summary (2/2)

❖ Can think of physical memory as a cache of virtual memory
  • Data is transferred between physical memory and swap space (disk) in *pages*
  • Physical memory has caching parameters and properties
    • Large page size, fully associative, write-back, replacement policy
  • Caveats: virtual pages may not exist, data doesn’t have to exist in both physical memory and disk

![Diagram showing virtual memory and physical memory with unallocated and empty physical pages]
Lesson Q&A

❖ Learning Objectives:
  ▪ Explain the benefits behind why virtual memory is used instead of only physical memory address space.
  ▪ Describe the relationships between virtual memory parameters and policies.

❖ What lingering questions do you have from the lesson?
  ▪ Chat with your neighbors about the lesson for a few minutes to come up with questions
Virtual Memory I – Practice
Polling Questions (1/2)

❖ On a 64-bit machine currently running 8 processes, how much virtual memory is currently available?

❖ True or False: A 32-bit machine with 8 GiB of RAM installed would never use all of it (in theory).
Polling Questions (2/2)

❖ How many bits wide are the following fields?
  - 16 KiB pages
  - 48-bit virtual addresses
  - 16 GiB physical memory

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Group Work Time

❖ During this time, you are encouraged to work on the following:

1) If desired, continue your discussion
2) Work on the homework problems
3) Work on the lab (if applicable)

❖ Resources:

- You can revisit the lesson material
- Work together in groups and help each other out
- Course staff will circle around to provide support