CS 537
Lecture 10
Swapping

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Group grading

- The project grade is:
  - 50% functionality
  - 30% code and write-up
  - 20% group grade
- The group grade:
  - We distribute the rest of the grade among the group
  - Example:
    - if you get 100% grades for functionality and code/write-up, you can distribute a 100% grade for the group (60 points total among 3 people)
    - If you get 66% grade on the results, you distribute 40 points through your group
- How should we assign this?
  - Evenly: split in 3 ways
  - You assign to your peers

Example of assigning

- Person a,b,c report what their peers do:
  - a: b did 33%, c did 33%
  - b: a did 50%, c did 0%
  - c: b did 50%, a did 20%
- Totals:
  - a got 50/50+20/70 = 1.28
  - b got 33/66+50/70 = 1.21
  - c got 33/66+0/50 = 0.5
- So group grade =
  - percentage on project (xx/80) X
  - 20 possible points X
  - your score from your peers: if project was perfect, A gets a 105, B gets 104, C gets 90

Swapping Pages

- In this lecture:
  - When do pages get swapped
  - Where do they get put on disk?

When to swap

- The OS may write pages to disk and free memory two times
  - in the background, to make sure there are free pages in the future
  - on demand, when there is memory available
- Why have both?

Background swapping

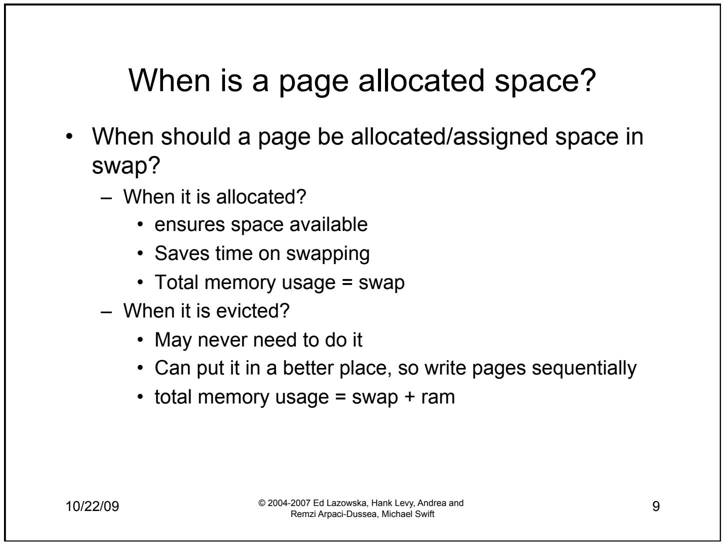
- **Swap Daemon** (a kernel process) periodically wakes up and scans pages
  - Runs clock algorithm or adjusts working set sizes
  - Moves pages from “active” list – in use - to “inactive list” – candidate for eviction
- Clean and dirty pages treated differently
  - If a page is clean, it can be reused immediately
    - can put on free list
  - If a page is dirty, is must be written back first
    - swap daemon tries to write sets of pages at a time

Page fault to an inactive / free page

- What happens if a program references a page that is in the process of being written?
  - It can still use it without delay; page still contains data
- When should the OS clear the contents of a page?
  - When put on free list: don’t have to clear it before returning it
  - When returned from allocator: can still use data on page fault to original virtual address

Where do pages go on disk?

- Kernel organizes regions of virtual memory as “areas” or segments according to how they are swapped
  - Data that gets swapped to the same file all goes to a segment
  - Multiple memory areas can get swapped to the same file in different places, or to anywhere in a “swap file” or “swap partition”
- How do you find a place to swap a page in the swap file?
  - Swap daemon maintains a “**swap map**” of
    - Which blocks on disk are in use
    - Which virtual pages are stored in those blocks



When is a page allocated space?

- When should a page be allocated/assigned space in swap?
  - When it is allocated?
    - ensures space available
    - Saves time on swapping
    - Total memory usage = swap
  - When it is evicted?
    - May never need to do it
    - Can put it in a better place, so write pages sequentially
    - total memory usage = swap + ram