

# Problem Set 20

CS 411

Due at the beginning of class on the first class day of the following week.  
Sections 9.4–6

1. Consider the following page reference string:

7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.

Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms? Show work.

- (a) LRU replacement
  - (b) FIFO replacement
  - (c) Optimal replacement
2. Assume that you are monitoring the rate at which the pointer in the clock algorithm (which indicates the candidate page for replacement) moves. What can you say about the system if you notice the following behavior:
    - (a) pointer is moving fast
    - (b) pointer is moving slow
  3. Consider a demand-paging system with the following time-measured utilizations:

CPU utilization: 20%  
Paging disk: 97.7%  
Other I/O devices: 5%

For each of the following, say whether it will (or is likely to) improve CPU utilization. Explain your answers.

- (a) Install a faster CPU.
- (b) Install a bigger paging disk.
- (c) Increase the degree of multiprogramming.
- (d) Decrease the degree of multiprogramming.
- (e) Install more main memory.
- (f) Install a faster hard disk or multiple controllers with multiple hard disks.
- (g) Add prepaging to the page fetch algorithms.
- (h) Increase the page size.