ICS 332 Fall 2021

Homework Assignment #11 – Page Faults [50 pts]

You are expected to do your own work on all homework assignments. (See the statement of Academic Dishonesty on the Syllabus.)

Check the Syllabus for the late assignment policy for this course.

How to turn in?

Assignments need to be turned in via Laulima. Check the Syllabus for the late assignment policy for the course.

What to turn in?

You should turn in single **plain text** file named `README.txt` with your answers to the assignment's questions. Your file must be readable "as is" and points will be removed if the report is not readable.

Exercise #1 [42 pts]

Consider a system with four page frames and a program that uses eight pages. Consider the reference string **0 1 7 2 0 3 1 7 0 1 7** and assume that all four page frames are initially empty. Consider the three following algorithms:

- **a. [14 pts]** Optimal page replacement
- **b. [14 pts]** FIFO page replacement
- **c. [14 pts]** LRU page replacement

In each cases show a diagram (ASCII art recommended) that shows which pages are in which frames throughout time, and page faults at the bottom. For instance:

```
  | 0  1  7  2  . . .
------------------------
0 | 0  0  0  0  . . .
1 | -  1  1  1  . . .
2 | -  -  7  7  . . .
3 | -  -  -  2  . . .
------------------------
f | X  X  X  X  . . .
```

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when and thus infer the number of page faults.

The first 4 steps are ALWAYS the same, as above (i.e., just fill the four frames, with one page fault each time)

Exercise #2 [8 pts]

Consider a system that implements demand paging without a TLB. The single-level page table is held in memory, and we assume that there are no free frames. Each memory access requires 100 **nanoseconds**. It takes 6 additional **milliseconds** to handle a page fault if the victim page is not “dirty” or 12 additional **milliseconds** if the victim page is “dirty”.

Experiments show that the probability of page faulting is 0.00003 (i.e., 0.003% chance) and that the average memory access time is 400ns.

What is the percent chance that a page is dirty at the time it is evicted?

Hint: Call the “being dirty” probability *d* and write a simple equation that gives the average data access time as a function of *d*. Solve for *d* (the result should be a number between 0 and 1, which you then convert to a percentage).