

CSE 451 Homework #4

OUT: Tuesday, April 27th, 2004

IN: Monday, 11:00am, May 3rd, 2004

1. Consider the following page-reference string:

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

How many page faults would occur for the following replacement algorithms, assuming five frames?

- LRU replacement
- FIFO replacement
- Optimal replacement

2.a. When virtual memory is implemented in a computing system, it carries certain costs and certain benefits. List those costs and the benefits.

2.b. It is possible for the costs to exceed the benefits. Explain what measures you can take to ensure that this imbalance does not occur.

3. You have devised a new page-replacement algorithm that you think may be optimal. In some contorted test cases, Belady's anomaly occurs. Is the new algorithm optimal? Explain your answer.

4. Consider a demand-paging system with a paging disk that has an average access and transfer time of 20 milliseconds. Addresses are translated through a page table in main memory, with an access time of 1 microsecond per memory access. Thus, each memory reference through the page table takes two accesses. To improve this time, we have added an associative memory that reduces access time to one memory reference, if the page-table entry is in the associative memory.

Assume that 80 percent of the accesses are in the associative memory, and that, of the remaining, 10 percent (or 2 percent of the total) cause page faults. What is the effective memory access time? Show your work.

5.a. Newer versions of the x86 support something called "superpages" which are pages mapped in 2MB chunks, rather than the standard page size (IARM V3, S 3.7.2). Imagine you were the person at Intel in the early 90's who proposed the superpage. Describe the experiments you would run to demonstrate that superpages are a good idea, and that the "right" size for a superpage is 2MB. Make sure to explain the evaluation metric.

5.b. Now, using the infrastructure that you built for the last homework, compare the performance in terms of your metric for the Netscape program when using 4KB pages vs 2MB pages on a machine with a unified TLB having 72 entries. For purposes of comparison, you may assume that disk transfer time is zero.

5.c. Based on your measurements, what can you conclude about superpages and their use?