COMP 2432 Operating Systems

Tutorial 10

1. **Virtual Memory Page Replacement.**

   Consider the following reference string generated by a process for which *3 memory frames* are allocated for the process. *Indicate* the content of the frames after each page indicated by the reference string is accessed, including the *page fault*. *How many* page faults are generated from the reference string? Answer the question based on different page replacement algorithms: (*a*) FIFO, (*b*) Optimal, and (*c*) LRU.

   0 1 2 3 0 2 3 4 0 1 2 3 4 2 3

2. **Virtual Memory Page Replacement.**

   Consider the following reference string generated by a process for which *3 memory frames* are allocated for the process. *Indicate* the content of the frames after each page indicated by the reference string is accessed, including the *page fault*. *How many* page faults are generated from the reference string? Answer the question based on different page replacement algorithms: (*a*) FIFO, (*b*) Optimal, (*c*) LRU based on counter approach, and (*d*) LRU based on stack approach. Repeat the question with *4 memory frames*.

   0 1 2 3 4 0 2 3 4 5 0 1 3 5 4 3 2 1 2 3

3. **Virtual Memory Page Replacement.**

   Consider the following reference string generated by a process for which *3 memory frames* are allocated for the process. *Indicate* the content of the frames after each page indicated by the reference string is accessed, including the *page fault*. *How many* page faults are generated from the reference string? Answer the question based on different page replacement algorithms: (*a*) FIFO, (*b*) Optimal, and (*c*) LRU. Repeat the question with *4 memory frames* and then *5 memory frames*. You may want to see how many possible answers there are in Optimal.

   0 1 2 3 4 1 2 1 4 3 5 1 3 1 2 3 1 3 5 0 2 4 2 4

   Do you have any observation on the *number of page faults* with respect to the *number of frames*?

4. **Virtual Memory Page Replacement.**

   Consider the following reference string, which is highly similar to that in **Question 3**, with just one different reference as highlighted. *Using 3 memory frames*, answer the question for the three algorithms. Do you have any interesting observation on the number of page faults?

   0 1 2 **1** 4 1 2 1 4 3 5 1 3 1 2 3 1 3 5 0 2 4 2 4

   Again, compare your results with those from **Question 3** with the following modified reference string on the three algorithms, *using 3 memory frames*. Do you have any interesting observation on the number of page faults?

   0 1 2 3 4 **0** 2 1 4 3 5 1 3 1 2 3 1 3 5 0 2 4 2 4

5. **Virtual Memory Page Replacement.**

   Compare your results with those from **Question 3** with the following "longer" reference string on the three algorithms *using 3 memory frames*. Here there is an additional reference to page 2 inserted somewhere in the *middle*. Do you have any interesting observation with respect to the number of page faults?

   0 **3** 1 2 3 4 1 2 1 4 3 5 1 3 1 2 3 1 3 5 0 2 4 2 4

   Again, compare your results with those from **Question 3** with the following "shorter" reference string on the three algorithms *using 4 memory frames*. Here the indicated reference to page 1 in the *middle* is removed. Do you have any interesting observation with respect to the number of page faults?

   0 1 2 3 4 1 2 ~~1~~ 4 3 5 1 3 1 2 3 1 3 5 0 2 4 2 4