CSC3002F: Operating Systems

Practical Assignment : Memory Management

Department of Computer Science
University of Cape Town, South Africa

DUE: 20th of April, 2022, 10.00 AM

Assignment Description

Write a Python program that implements the *FIFO*, *LRU*, and *optimal* page replacement algorithms presented in *Chapter 9: Virtual Memory* of Silberschatz et al. [Silberschatz et al., 2018].

First, generate a random page-reference string where page numbers range from 0 to 9. Apply the random page-reference string to each algorithm, and record the number of page faults incurred by each algorithm.

Implement the *FIFO*, *LRU*, and *optimal* (OPT) replacement algorithms so that the number of page frames can vary from 1 to 7. Assume that *demand paging* is used. The *main* function should include the following.:

```
def main():
    #...TODO...
    size = int(sys.argv[1])
    print 'FIFO', FIFO(size,pages), 'page faults.'
    print 'LRU', LRU(size,pages), 'page faults.'
    print 'OPT', OPT(size,pages), 'page faults.'

if __name__ == "__main__":
     if len(sys.argv) != 2:
        print 'Usage: python paging.py [number of pages]'
     else:
          main()
```

Implement these FIFO, LRU and OPT algorithms as functions within one file called *paging.py*, making sure that you clearly identify yourself (name and student number) in comments at the top of the file.

The total assignment mark (100) will be calculated as follows.:

1. Correct implementation and functioning of FIFO. **(30%)**
2. Correct implementation and functioning of LRU. **(30%)**
3. Correct implementation and functioning of OPT. **(40%)**

NOTE: Values in bold parentheses are the percentage weighting of each question as a portion of the total assignment mark.

Assignment Instructions and Notes

- Note that the assignment will be manually marked − Hence it is important that your code compiles and runs so as the tutors can test that the algorithms are actually functioning properly. Your code must run on the *nightmare.cs.uct.ac.za* server. You can use SSH and STP to test it.

- You must implement this assignment in Python − All algorithms should be in the same *.py* file − the main function is given in the above assignment description.

- For each algorithm (LRU, $FIFO$, OPT): You do not need to use real virtual memory to test your algorithms, but rather a *simulation* of referenced pages. This is just an array of N integers to test N page references. For example.: the array: [8, 5, 6]: could test page numbers: 8, 5, 6. Page numbers must be values in the range of 0 to 9 (also stated in the assignment description). Reference arrays of N such page numbers can then be (randomly) generated.

- Each algorithm must also the *frames* parameter, i.e. how many pages can be in memory at any one time. Your LRU, $FIFO$, OPT algorithms should work with any frame size, but you can test each algorithm with frame sizes between 1 and 7 (as stated in assignment description).

- Be sure to test your algorithms with various page reference sizes (e.g. 8 pages, 16 pages, 24 pages, and 32 pages) with some set frame-size (e.g. = 3), to be sure that the algorithms are working correctly.

- For reference look at the associated reading: *A Comparison of Three Page Replacement Algorithms: FIFO, LRU and Optimal* [CSC3002F, 2022], which presents an example test run done for each algorithm and output given for number of pages = 8, 16, 24, and 32. Testing of your own FIFO, OPT and LRU algorithms should do something similar, but with more pages! (e.g. $N > 32$).

- NOTE: You DO NOT have to show your testing results (this is just for your own testing purposes). You only need to hand in the .py file with the src for your FIFO, OPT and LRU functions.

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References

[CSC3002F, 2022] CSC3002F (2022). *A Comparison of Three Page Replacement Algorithms: FIFO, LRU and Optimal.* Department of Computer Science, University of Cape Town, South Africa.

[Silberschatz et al., 2018] Silberschatz, A., Galvin, P., and Gagne, G. (2018). *Operating System Concepts - 10th Edition.* John Wiley & Sons, New York, USA.