COEN-383
Advanced Operating System
Project 4 Report
Group 4

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Objective :

The objective of this project is to gain hands-on experience in exploring the various memory management algorithms for swapping and paging. This will be achieved by using a C program to operate various page replacement algorithms such as First-In-First-Out (FIFO), Least Recently Used (LRU), Least Frequently Used (LFU), Most Frequently Used (MFU), and Random Pick. The project involves generating random processes with varied sizes and durations, and organizing them into a Job Queue based on arrival time. The program will also manage the physical memory frames and disk pages, allocating memory to processes from the free pages list. Additionally, the program will generate the appropriate record whenever a job starts or completes. The key aspect of the project is the implementation of the chosen page replacement algorithm to select a victim page to evict, so that the needed page can be brought into memory. The program will track the hit and miss statistics for every run, and calculate the average number of processes successfully swapped-in for each replacement algorithm over multiple runs, and print the results. By completing this project, the student will gain valuable hands-on experience in understanding and implementing memory management algorithms, which are essential in the field of operating systems and computer architecture.

Theory:

In understanding the dynamics of page replacement algorithms, it's crucial to delve into the distinct strategies they employ. The FCFS Algorithm, standing for First-Come-First-Served, adheres strictly to the principle of chronology, opting to replace the page that arrived earliest. Conversely, the LRU Algorithm, which stands for Least Recently Used, operates on the principle of recency, choosing to replace the page that has remained untouched for the longest duration. The LFU Algorithm, denoting Least Frequently Used, prioritizes the replacement of pages with the least number of references, aiming to optimize memory usage by eliminating infrequently accessed pages. In contrast, the MFU Algorithm, or Most Frequently Used, targets pages that have been referenced most often, favoring those with higher utilization rates to maintain

efficiency. Lastly, the R Algorithm introduces an element of randomness into the replacement process, selecting pages for eviction arbitrarily. Each of these algorithms offers a unique approach to managing memory resources, catering to various scenarios and optimizing system performance accordingly.

Each process does start at page-0 then every 100 msec it references a random page from its own address space.

- Locality of reference, after referencing a page i, there is a 70% probability that the next reference will be to page i, i-1, or i+1. It wraps around from 10 to 0. In other words, there is a 70% probability that for a given i, Δi will be -1, 0, or +1. Otherwise, $|\Delta i| > 1$.
- We will be generating 150 jobs.
- Sort the random jobs generation based on arrival time and have them structured as a linked list.
- Processes have randomly and evenly distributed sizes of 5, 11, 17, and 31 MB.
- Processes have randomly and evenly distributed service durations of 1, 2, 3, 4, or 5 seconds.

Code Execution

- A Makefile has been created to compile all the files and showcase the output. To execute the code, use the following command

#code execution:

make run

- To remove the object files and clean up the project directory, employ the command

#code clean:

make clean

Result & Conclusion:

The Swapping and Paging Simulation project offers insightful information about how different page replacement methods impact an operating system's memory management and page swapping. Through a series of simulations using various

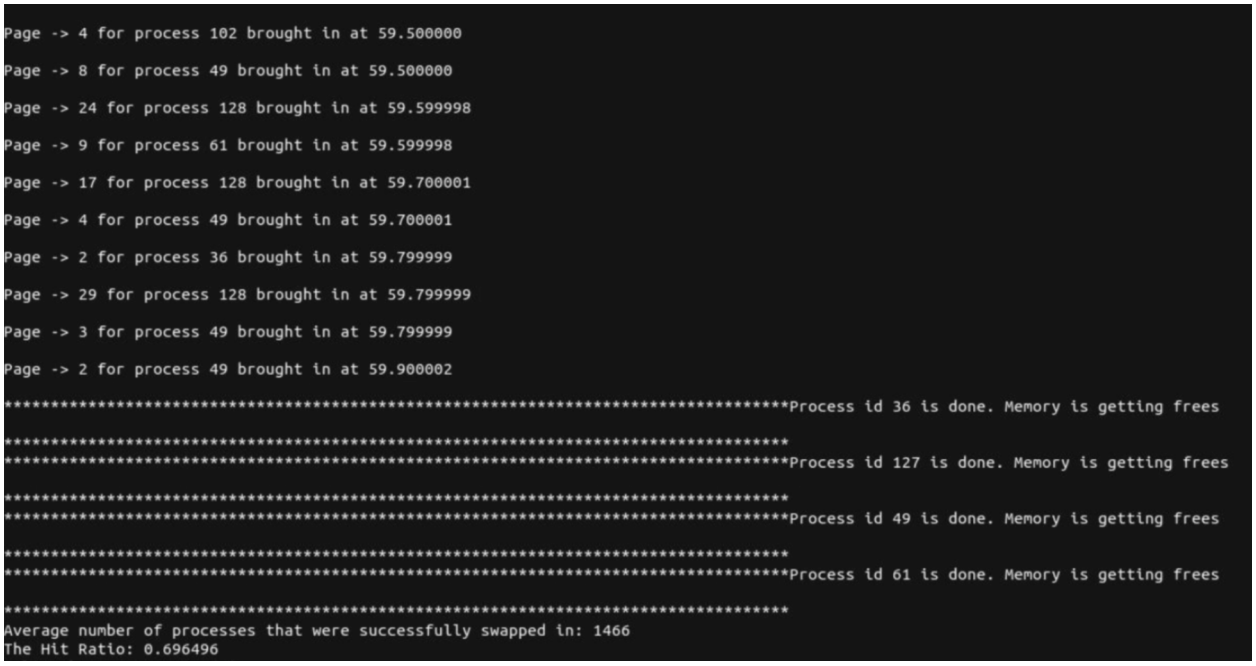
methods, the code facilitates performance comparison and analysis. The best performance in terms of Hit Ratio - we get is Least Recently Used Algorithm.

Algorithm	Hit Ratio	Pages Swapped
FCFS	0.6964	1466
LFU	0.6561	1648
LRU	0.6935	1485
MFU	0.6701	1587
Random	0.6945	1517

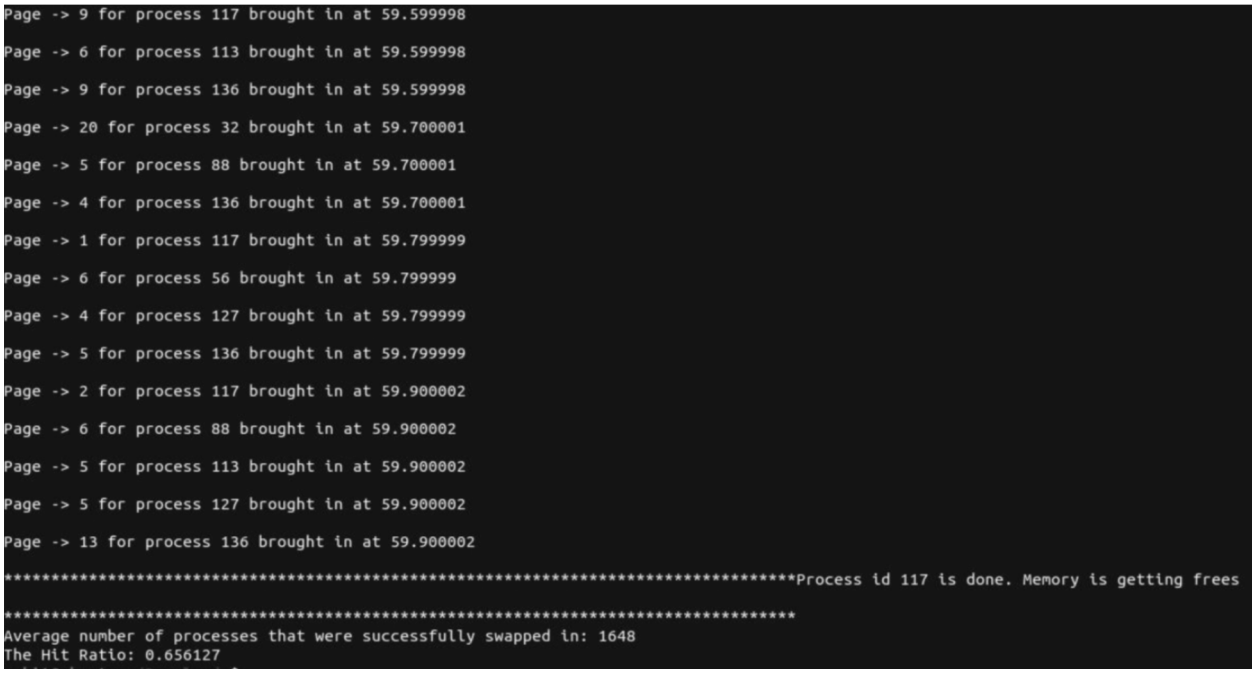
Outputs:

Screenshots from a Run on a Linux Machine:

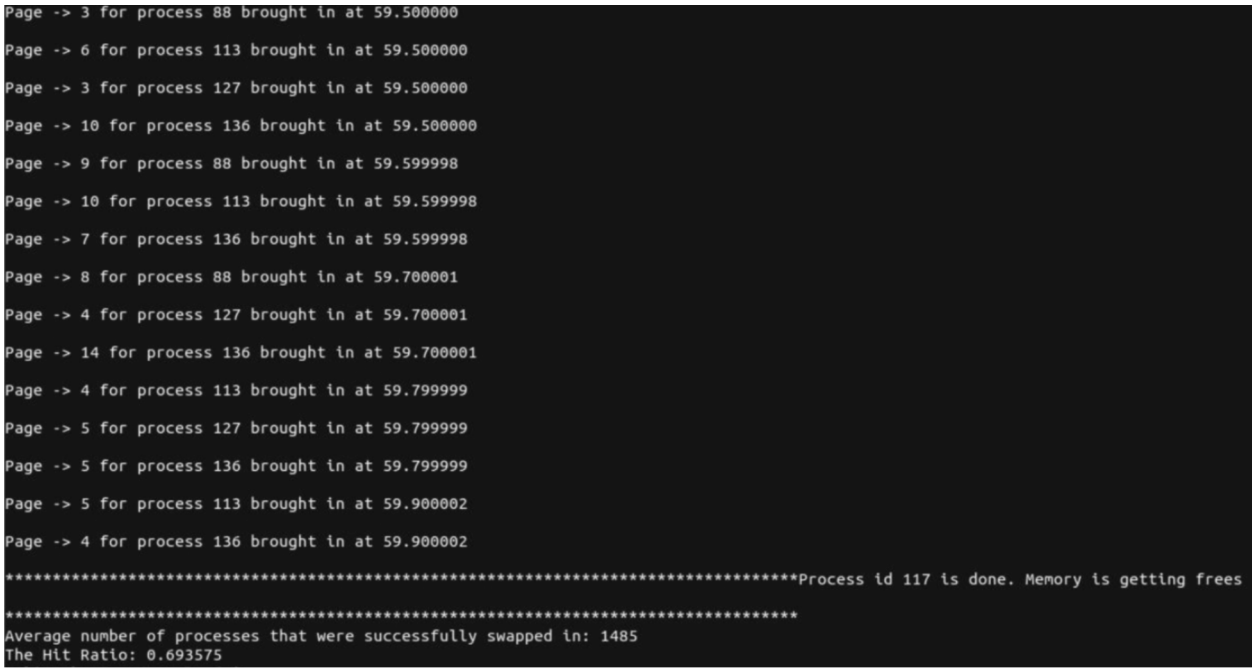
First Come First Serve



Least Frequently Used



Least Recently Used



Most Frequently Used

```
Page -> 3 for process 88 brought in at 59.500000

Page -> 9 for process 117 brought in at 59.599998

Page -> 6 for process 113 brought in at 59.599998

Page -> 9 for process 136 brought in at 59.599998

Page -> 20 for process 32 brought in at 59.700001

Page -> 5 for process 88 brought in at 59.700001

Page -> 4 for process 136 brought in at 59.700001

Page -> 6 for process 56 brought in at 59.799999

Page -> 4 for process 127 brought in at 59.799999

Page -> 5 for process 136 brought in at 59.799999

Page -> 2 for process 44 brought in at 59.900002

Page -> 6 for process 88 brought in at 59.900002

Page -> 5 for process 113 brought in at 59.900002

Page -> 5 for process 127 brought in at 59.900002

Page -> 13 for process 136 brought in at 59.900002

********************************************************************************Process id 117 is done. Memory is getting frees

********************************************************************************
Average number of processes that were successfully swapped in: 1587
The Hit Ratio: 0.670170
```

Random

```
Page -> 9 for process 70 brought in at 59.500000

Page -> 28 for process 138 brought in at 59.599998

Page -> 5 for process 144 brought in at 59.599998

Page -> 8 for process 70 brought in at 59.599998

Page -> 4 for process 70 brought in at 59.700001

Page -> 4 for process 22 brought in at 59.799999

Page -> 2 for process 11 brought in at 59.900002

Page -> 3 for process 22 brought in at 59.900002

Page -> 14 for process 70 brought in at 59.900002

********************************************************************************Process id 138 is done. Memory is getting frees

********************************************************************************
********************************************************************************Process id 11 is done. Memory is getting frees

********************************************************************************
********************************************************************************Process id 32 is done. Memory is getting frees

********************************************************************************
********************************************************************************Process id 144 is done. Memory is getting frees

********************************************************************************
********************************************************************************Process id 103 is done. Memory is getting frees

********************************************************************************
Average number of processes that were successfully swapped in: 1517
The Hit Ratio: 0.694551
```