OS HW 3 Simulating Page Replacement Algorithms Final Report

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With complete reference to the details logged in the logfile.log described below is the working and the conclusion of the Simulation:

CONCLUSION

From the Simulation, the metrics show that LRU performs the best compared to all the other algorithms. Followed by MFU that performs reasonably well compared to LFU and FIFO.. And lastly we have Random that performs with lowest hitrates.

This sequence of performance is highly influenced by the locality of reference algorithm. As described the algorithm will generate references to the same or adjacent pages 70% of the time. This means either the same page could be accessed multiple times or sequential pages might be referenced.
This logic of reference page generation works very well in favor of the behavior supported by LRU, MFU, LFU and FIFO Algorithms and hence we should notice high performance from them.

In comparison to all LRU is strongly influenced and works best with such locality of reference algorithms as it maintains the list of recently used pages. Thus we should expect to see LRU perform the best.

Secondly since the algorithm has a high chance of referencing the same page again over a short period of time MFU plays to its strength and performs well compared to LFU which lacks in such scenarios.

Also since there are high chances of sequential page references FIFO is seen to perform very well.

Lastly since randomPick does not have any intellectual logic embedded nor tracks history of pages and hence if the page reference is random they are bound to suffer in terms of the hit rate.

There could be chances where randomPick might perform better but that would be non deterministic in nature as opposed to the other algorithms performing well all the time in a deterministic manner due to their logic and affinity to locality of reference.

Hence theoretically expected LRU > MFU >LFU > FIFO > RandomPick or LRU > MFU > FIFO >LFU > RandomPick

In the below simulations we see LRU, MFU and FIFO performing better in the first simulation, However since the random reference differs in each run we do see MFU, LRU and LFU competing in other runs.

LRU does well in most of the cases.

Due to just 4 frame, we notice high miss rate than hit rate hence the values are < = 15%

Hence, Simulations were conducted with higher frames, to observe the behavior and we get a better hit ratio from 15 ~= 30-40 % as shown in the simulations below.

Run 1
SIMULATION RESULTS:
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 11.236211389254866
Algorithm LRUHitRatio 13.627815275414005
Algorithm LFUHitRatio 2.2509803921568627
Algorithm MFUHitRatio 13.453779553779555
Algorithm RandomHitRatio 7.569242865837292

Run 2
SIMULATION RESULTS:
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 6.910331948854925
Algorithm LRUHitRatio 15.159575961843421
Algorithm LFUHitRatio 13.97947045485868
Algorithm MFUHitRatio 14.297409467524378
Algorithm RandomHitRatio 7.243956641535297

Run 3
Algorithm FIFOHitRatio 8.182354464609713
Algorithm LRUHitRatio 12.525806042725995
Algorithm LFUHitRatio 13.26366383695689
Algorithm MFUHitRatio 13.740181237585864
Algorithm RandomHitRatio 7.8045923278448495

Run 4
SIMULATION RESULTS:
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 9.679903330737698
Algorithm LRUHitRatio 15.078069934337316
Algorithm LFUHitRatio 12.567153177300545
Algorithm MFUHitRatio 12.511261383901603
Algorithm RandomHitRatio 8.51822302475773

With higher frames 6, we get better hit ratio

Run 1
SIMULATION RESULTS:
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 25.208604474723135
Algorithm LRUHitRatio 34.42274936892808
Algorithm LFUHitRatio 42.57296827559363
Algorithm MFUHitRatio 43.75796384701791
Algorithm RandomHitRatio 33.588350204777434

Run 2
SIMULATION RESULTS:
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 23.91088634277707
Algorithm LRUHitRatio 35.26871279995534
Algorithm LFUHitRatio 34.31175039158178
Algorithm MFUHitRatio 34.22593646048641
Algorithm RandomHitRatio 23.616744908406798

Run 3
The average Hit Ratios for each algorithm are:
Algorithm FIFOHitRatio 22.168396835940122
Algorithm LRUHitRatio 37.0181871771105
Algorithm LFUHitRatio 34.12487580685335
Algorithm MFUHitRatio 35.727717011358806
Algorithm RandomHitRatio 24.1157028914398

WORKING
The details of the logfile and working are explained below:

The below lines show the creation of processes and Freelist linkedlist

Dec 02, 2023 10:27:10 PM JobQueue printQueue
INFO: P22
Dec 02, 2023 10:27:10 PM JobQueue printQueue
INFO: P5
Dec 02, 2023 10:27:10 PM JobQueue printQueue
INFO: P0

```
Dec 02, 2023 10:27:10 PM FreePageList printList
INFO: 1024 -->
Dec 02, 2023 10:27:10 PM FreePageList printList
INFO: 1024 -->
Dec 02, 2023 10:27:10 PM FreePageList printList
INFO: 1024 -->
Dec 02, 2023 10:27:10 PM FreePageList printList
INFO: 1024 -->
```

Next you will notice the schedule process allocating free frames to multiple processes and their witness their concurrent execution. The free pages count is also noted after each allocation.

```
Dec 02, 2023 10:27:10 PM Simulation main
INFO: Algorithm FIFO
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P149 allocated 5 pages  Service duration 8000, freePages=
96
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P146 allocated 31 pages  Service duration 1000,
freePages= 92
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P127 allocated 31 pages  Service duration 1000, freePages=
88
Dec 02, 2023 10:27:10 PM Process run
INFO:  Strategy FIFO
Dec 02, 2023 10:27:10 PM Process run
INFO:  Strategy FIFO
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P126 allocated 31 pages  Service duration 1000,
freePages= 84
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P120 allocated 17 pages  Service duration 4000,
freePages= 80
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: Enter P115 allocated 5 pages  Service duration 8000, freePages=
76
```

You will then notice free pages reducing to 0 and paralleling the concurrent processing referencing random pages every 100 milliseconds while keeping a track of their service duration

```
INFO: Time 0: Process P92 referenced page 4 Page@29deaf66 remaining
time 1000
Dec 02, 2023 10:27:10 PM Process run
INFO:  Working P8311 6000
```

Dec 02, 2023 10:27:10 PM Process run
INFO: Time 0: **Process P83 referenced page 5 Page@141ce1c5 remaining time 6000**
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: **Enter P77 allocated 17 pages Service duration 5000, freePages= 4**
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@141ce1c5
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@641883a0
Dec 02, 2023 10:27:10 PM Process run
INFO: Strategy FIFO
Dec 02, 2023 10:27:10 PM Process run
INFO: Working P1075 7000
Dec 02, 2023 10:27:10 PM Process run
INFO: Time 0: **Process P122 referenced page 4 Page@4fd22672 remaining time 7000**
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@29deaf66
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@4fd22672
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: **Enter P70 allocated 31 pages Service duration 3000, freePages= 0**
Dec 02, 2023 10:27:10 PM Process run
INFO: Working P7717 5000
Dec 02, 2023 10:27:10 PM Process run
INFO: **Time 0: Process P107 referenced page 4 Page@76d0057d remaining time 7000**
Dec 02, 2023 10:27:10 PM Process run
INFO: **Time 0: Process P77 referenced page 0 Page@49edc963 remaining time 5000**
Dec 02, 2023 10:27:10 PM Process run
INFO: Strategy FIFO

You can see pages incurring a hit or a miss regularly

INFO: Miss for Page Page@76d0057d
Dec 02, 2023 10:27:10 PM ScheduleJobList scheduleProcesses
INFO: LENGTH OF PROCESSLIST 25
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@49edc963
Dec 02, 2023 10:27:10 PM Process run
INFO: Working P7031 3000
Dec 02, 2023 10:27:10 PM Process run

INFO: Hit for Page Page@429e5d0b
INFO: Time 0: Process P70 referenced page 5 Page@d6e6dc2 remaining time 3000
Dec 02, 2023 10:27:10 PM FIFOCache referencePage
INFO: Miss for Page Page@d6e6dc2

You will notice processes waiting to be given freeframes once the freepages have been exhausted and list of 25 processes running at a given moment.

INFO: Process P53 Waiting for 31 pages
Dec 02, 2023 10:27:19 PM ScheduleJobList scheduleProcesses
INFO: process p Thread-146
Dec 02, 2023 10:27:19 PM ScheduleJobList scheduleProcesses
INFO: Exit P146 31 1000 freepages 4 hitRatio 6.666666666666666
Dec 02, 2023 10:27:19 PM ScheduleJobList scheduleProcesses
INFO: **Enter P53 allocated 31 pages Service duration 1000, freePages= 0**
Dec 02, 2023 10:27:19 PM ScheduleJobList scheduleProcesses
INFO: LENGTH OF PROCESSLIST 25

When an interaction for an algorithm is done the number of iterations are printed

Dec 02, 2023 10:28:04 PM Simulation main
INFO: --------------- FIFO 1 times ----------------
Dec 02, 2023 10:28:04 PM JobQueue printQueue