IT253 - Operating Systems

# VIRTUAL MEMORY MANAGEMENT SIMULATOR

Team Members

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## Introduction and Objective

- This project deals with the creation of a Virtual Memory Management Simulator by utilising the various concepts of Virtual memory such as different fetch policies and page replacement algorithms.
- Fetch policy determines when a page should be brought into main memory. In our virtual memory management simulator, the following policies have been implemented:
  - Demand paging
  - Prepaging
- Page replacement algorithms are used to select the page that is to be replaced when the main memory is full and a new page has been requested.

# Introduction and Objective (Cont...)

- The following page replacement algorithms will be implemented in our virtual memory management simulator
    - FIFO  (FIrst In First Out)
    - LRU   (Least Recently Used)
    - Clock
- The entire simulation of Virtual memory management will be then displayed through a GUI.

## Literature Survey

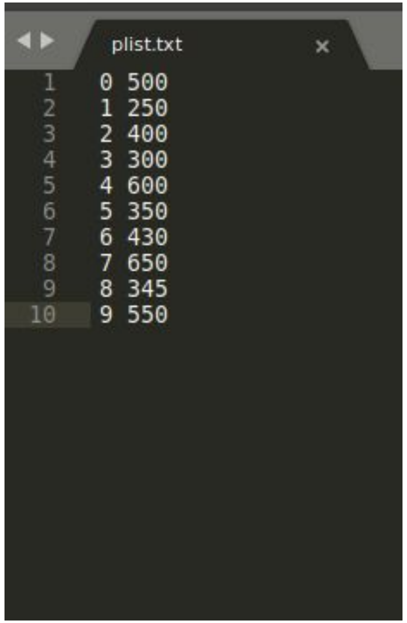
- In a paper, the virtual memory management system is simulated and its properties were verified with MSVL which is a parallel programming language.
- The system mentioned above manages the virtual memory by handling the pages and uses the aging algorithm to find a page to swap out when a page fault occurs and there is no idle page.
- Another study had modified the MOSS simulator and developed a virtual memory simulator which allowed the user to switch between different page replacement algorithms and analyse and compare the number of page faults that occur in each of the algorithms.
- The results in the above model showed that the optimal algorithm produces the least number of page faults and that LRU is generally better than FIFO.

## Implementation

- Backend - C++
  - Input page size, fetching policy and replacement algorithm
  - Reading Plist and Ptrace
  - Calculating the number of page faults
- Frontend - Python + Tkinter
  - Getting data from backend using subprocess call
  - Running simulation for alternative algorithms
  - Generating statistics
  - Rendering GUI using Tkinter

# Input Format

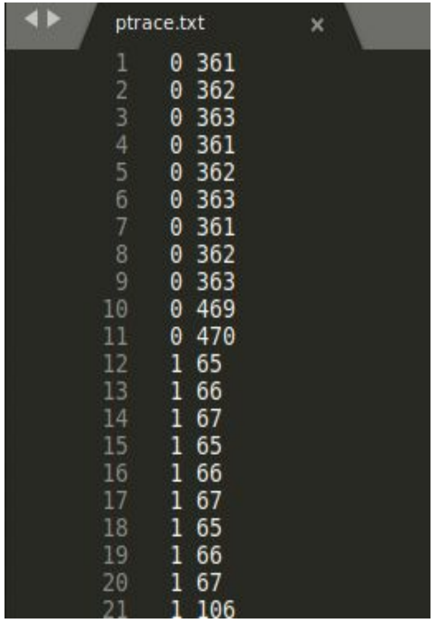
Process List


plist.txt

```
0 500
1 250
2 400
3 300
4 600
5 350
6 430
7 650
8 345
9 550
```

Each line has the format
(process_id, total # of memory locations)

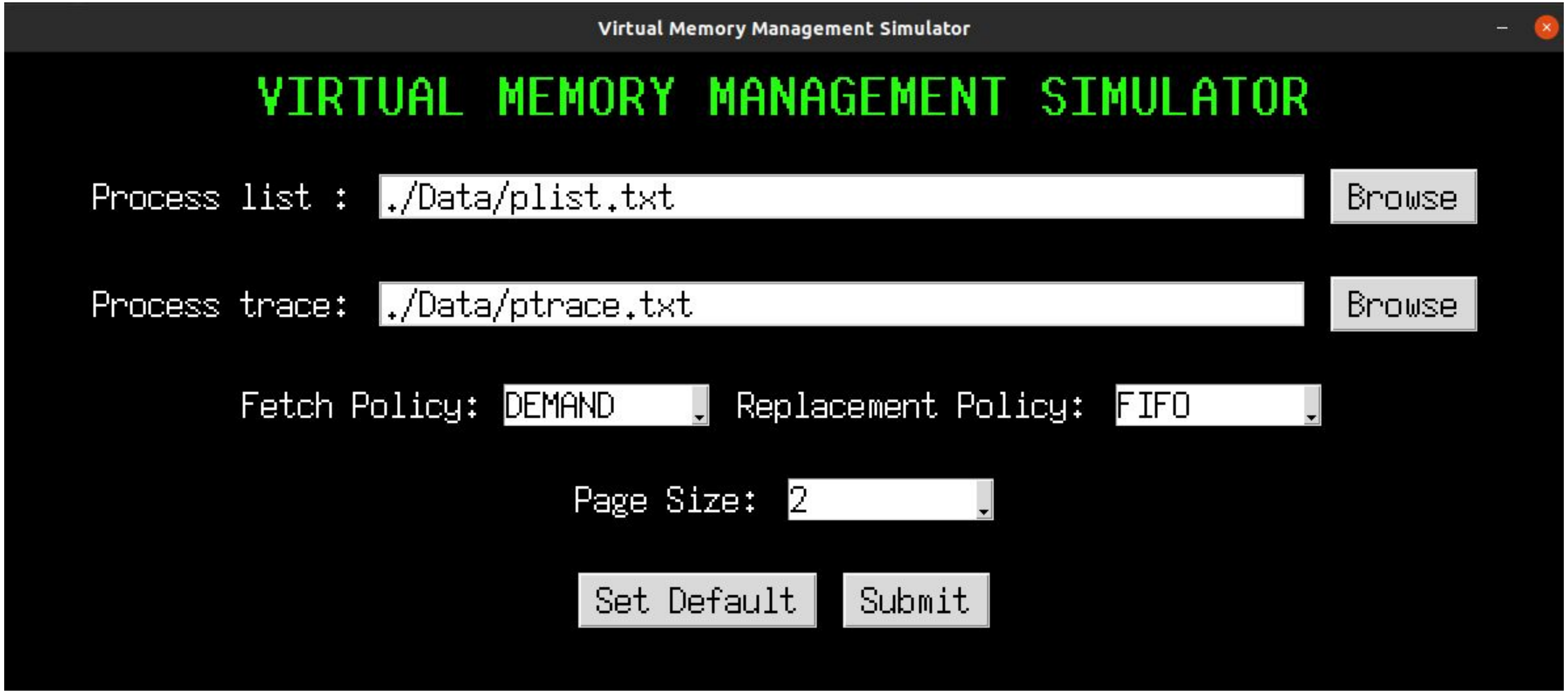
Process Trace


ptrace.txt

```
0 361
0 362
0 363
0 361
0 362
0 363
0 361
0 362
0 363
0 469
0 470
1 65
1 66
1 67
1 65
1 66
1 67
1 65
1 66
1 67
1 106
```

Each line has the format
(process_id, referenced memory location)

# Sample Input



Virtual Memory Management Simulator

VIRTUAL MEMORY MANAGEMENT SIMULATOR

Process list : ./Data/plist.txt

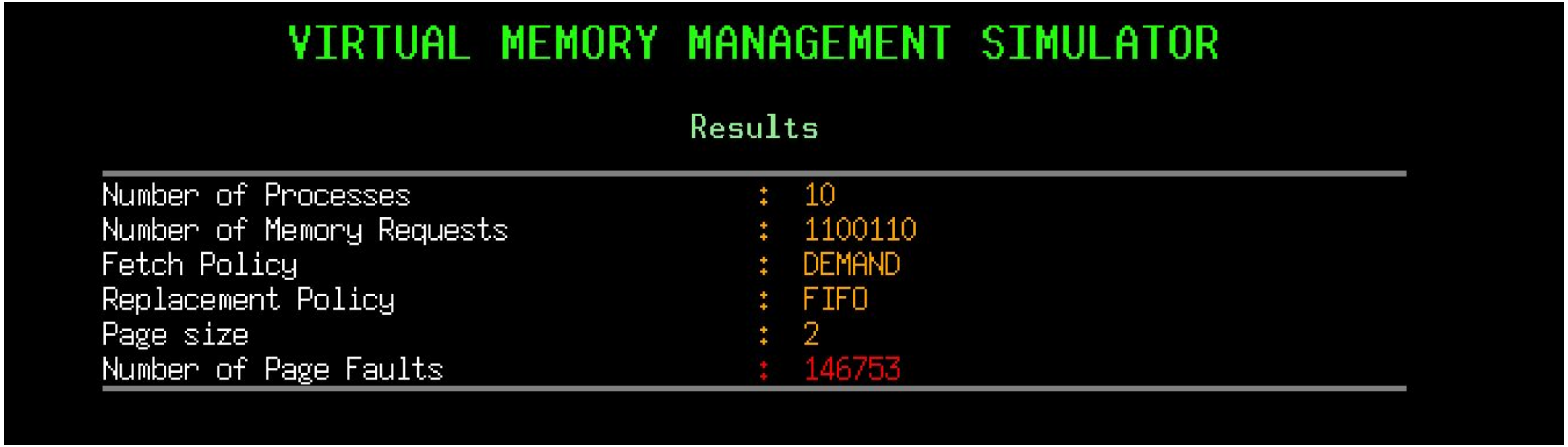
Process trace: ./Data/ptrace.txt

Fetch Policy: DEMAND

Replacement Policy: FIFO

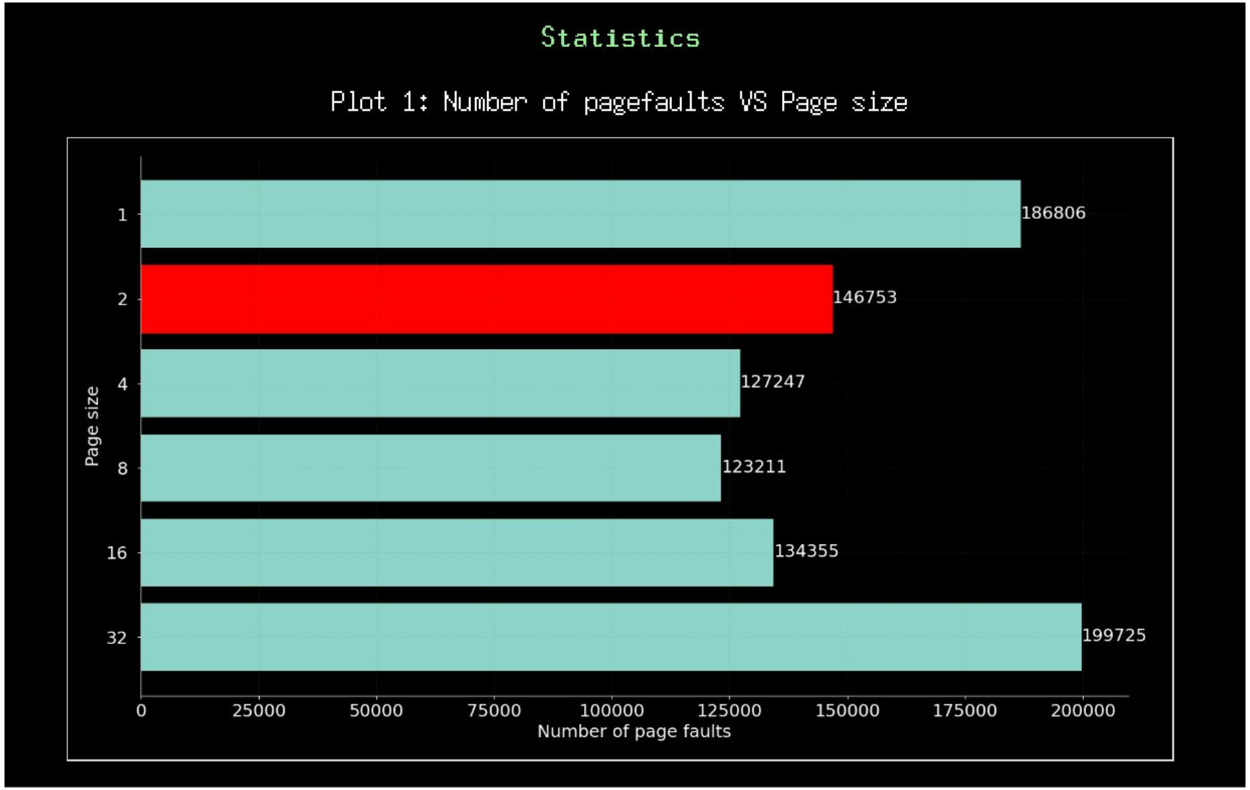
Page Size: 2

## Sample Output

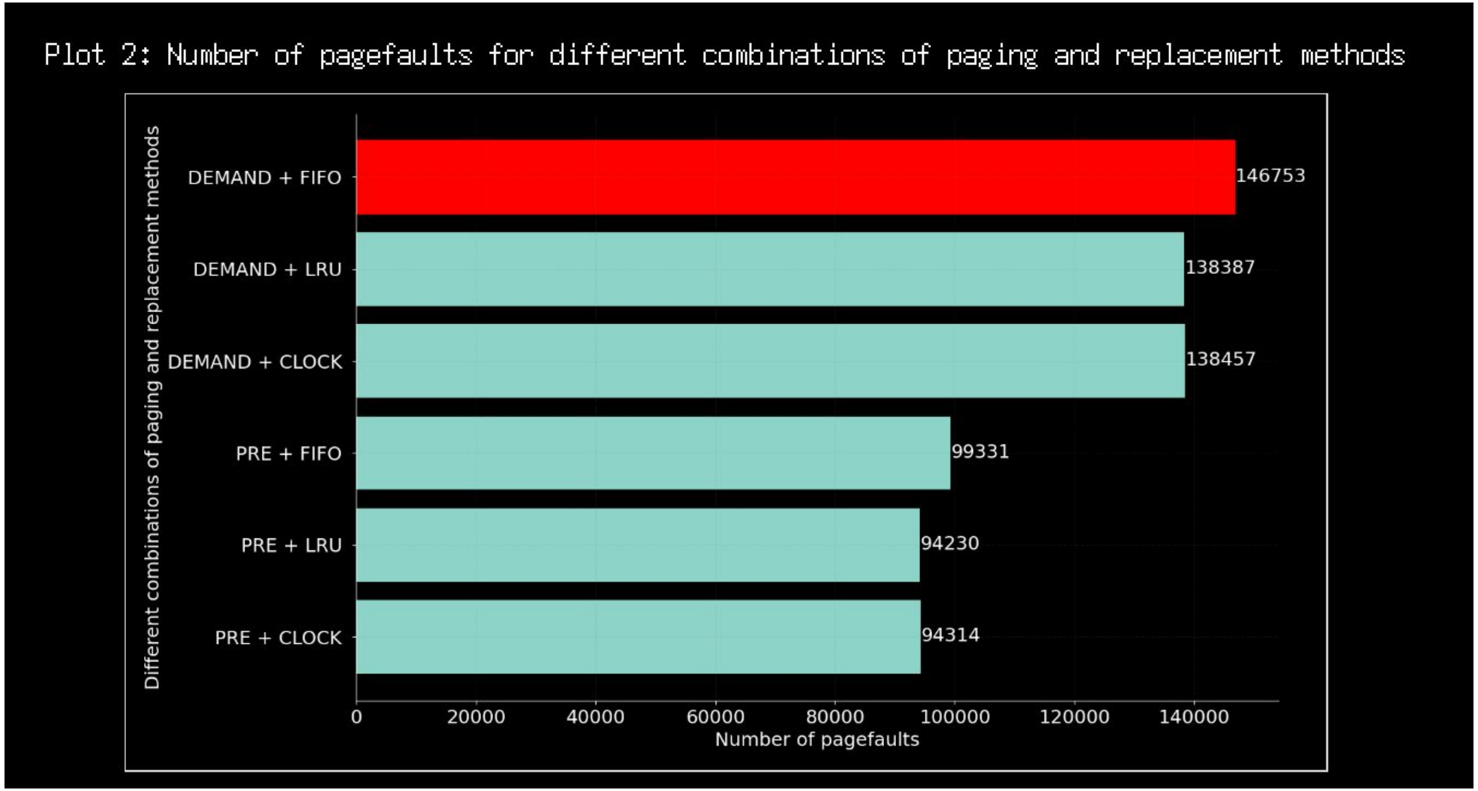


```
VIRTUAL MEMORY MANAGEMENT SIMULATOR

              Results

Number of Processes              :  10
Number of Memory Requests        :  1100110
Fetch Policy                     :  DEMAND
Replacement Policy               :  FIFO
Page size                        :  2
Number of Page Faults            :  146753
```

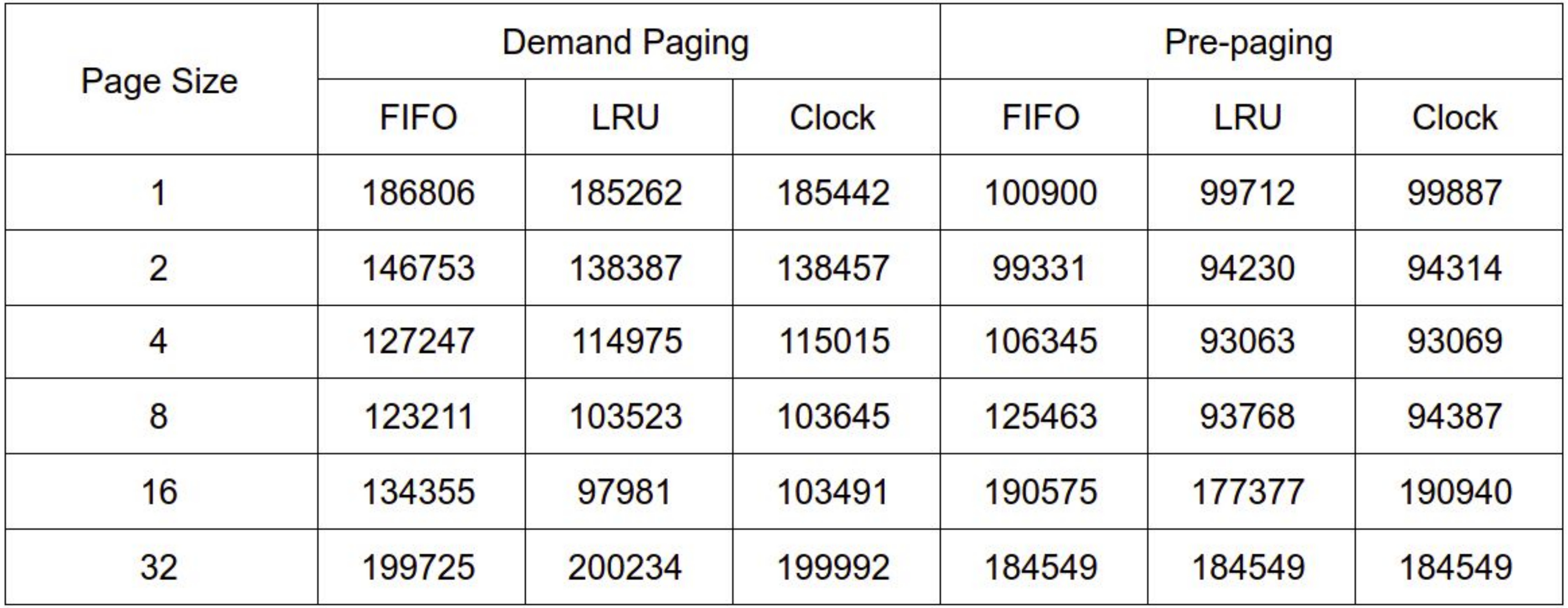
# Sample Output - Plot 1



# Sample Output - Plot 2



# Experimentation and Analysis



| Page Size | Demand Paging | | | Pre-paging | | |
|---|---|---|---|---|---|---|
| | FIFO | LRU | Clock | FIFO | LRU | Clock |
| 1 | 186806 | 185262 | 185442 | 100900 | 99712 | 99887 |
| 2 | 146753 | 138387 | 138457 | 99331 | 94230 | 94314 |
| 4 | 127247 | 114975 | 115015 | 106345 | 93063 | 93069 |
| 8 | 123211 | 103523 | 103645 | 125463 | 93768 | 94387 |
| 16 | 134355 | 97981 | 103491 | 190575 | 177377 | 190940 |
| 32 | 199725 | 200234 | 199992 | 184549 | 184549 | 184549 |

Fig. Number of page faults for different combinations of fetch policies and replacement algorithms

## Experimentation and Analysis

- When the page size is extreme, i.e. too high or too low, then, usually all the replacement policies show similar behavior, for a given page fetch policy. Observing the collected statistics for page sizes 1 and 32, it is evident that the number of page faults is almost close for each of the page replacement policies for a given page fetch policy.

- Further, when the page size is small, it can be observed that, generally, pre-paging produces much better performance as compared to demand paging.

- Also, when the page size becomes too large, the performance of pre-paging reduces and in some cases it is out-performed by demand paging.

## Experimentation and Analysis

- When the page size is intermediate, i.e. neither too high nor too low, then, it can be observed that FIFO replacement policy produces the maximum number of page faults whereas Clock and LRU generally produce a lesser number of page faults. Although the number of page faults produced by both Clock and LRU replacement policies is both close, generally, LRU produces a lesser number of page faults as compared to Clock. This shows that in most cases, LRU performs the best, closely followed by Clock whereas FIFO generally gives the worst performance.

- Also, in case of intermediate page size, again pre-paging usually produces better results as compared to demand paging as the number of page faults produced for pre-paging for a given replacement algorithm is generally lesser than the number of page faults produced by demand paging.

- Further, for a given combination of page fetch policy and page replacement policy, it is observed that as the page size increases, the number of page faults initially decreases and then increases (Fig 1 - 6). When page size is very small, then the number of page faults is quite high. The number of page faults decreases as the page size is increased till a certain point, after which, the number of page faults again increases.

Thank You