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A case study that implements the FIFO, LRU, and Optimal(OPT) page-replacement algorithms

Page Replacement Algorithms

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Introduction

Virtual memory enables computers to compensate for physical memory shortages by temporarily transferring pages of data from RAM to disk storage. Page replacement algorithms decide which pages to evict when new pages need to be loaded into memory. This case study presents a simulation of three key page replacement algorithms: FIFO, LRU, and OPT using Python and Tkinter for a graphical interface.

Algorithms Overview

FIFO (First-In, First-Out)
- Replaces the page that has been in memory the longest.
- Simple and easy to implement.
- May not always produce the best performance.

LRU (Least Recently Used)
- Replaces the page that hasn't been used for the longest period of time.
- More intelligent than FIFO as it considers usage history.
- Requires tracking past usage.

OPT (Optimal Page Replacement)

- Replaces the page that will not be used for the longest time in the future.
- Ideal and theoretical – used for comparison.
- Requires knowledge of future page requests.

Implementation Details

Programming Language: Python 3
GUI Library: Tkinter
Input:
Number of frames (set to 4 in code)
Page reference string of length 13, randomly generated with values from 0–99
Output:
Visual display of page loading into frames and how each algorithm handles page faults.

How to Use the Program

1. Run the program using:

Bash

python page_replacement_gui.py

2. The GUI displays:

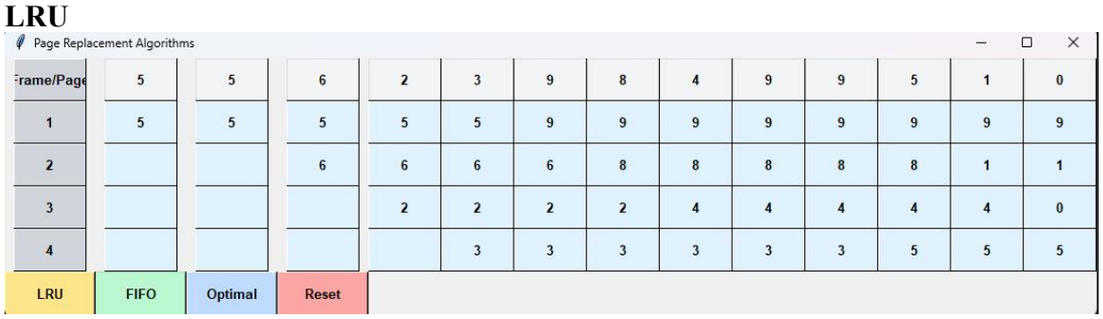
A row with randomly generated reference string
Four rows representing page frames

3. Buttons:

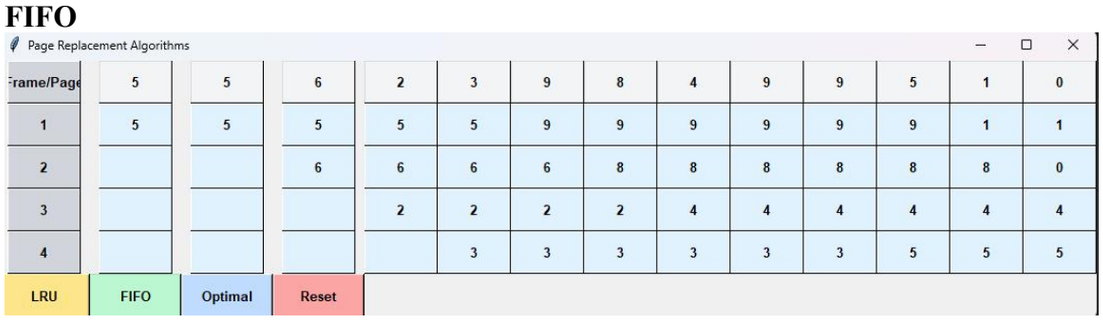
FIFO: Simulate FIFO algorithm
LRU: Simulate LRU algorithm
Optimal: Simulate OPT algorithm
Réinitialiser: Reset and generate a new reference string

Screen Captures

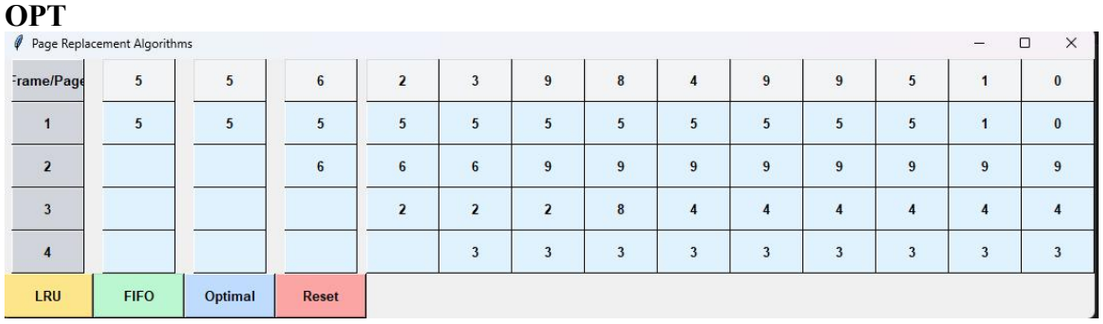
LRU



FIFO



OPT



Conclusion

This GUI-based simulator effectively demonstrates the operational logic and performance differences among FIFO, LRU, and OPT algorithms. It serves as an educational tool for understanding virtual memory management through interactive visualization.

Recommendations for Future Enhancements

- Add a live counter for page faults.
- Allow users to input custom reference strings.
- Save simulation results to files.
- Add dark mode or theming options.
- Include step-by-step animation of the replacement process.