...for a complete human being

Texas

International College

**Lab No: 2** **Date: 2082/**

**Title: Write a program to calculate the number of page fault for user input reference string and frame size using OPR page replacement algorithm.**

Optimal Page Replacement replaces the page that will not be used for the longest time in the future. It yields the minimum possible page faults for a given reference string, so it's mainly used as a theoretical benchmark (not practical in real systems because the future isn't known).

Algorithm:

Step 1: Initialize frames as empty.

Step 2: Read the reference string.

Step 3: For each page request:

- If page is in frame → Page Hit.
- If not in frame → Page Fault:
    - If free space → insert page.
    - Else → find the page in frame that will be used farthest in the future (or not used again) and replace it.

Step 4: Update page hit/fault count.

Step 5: Repeat until all pages are processed and display results.

**Language**: C++

**IDE**: VS Code

**Code:**

```
#include <iostream>

#include <vector>

#include <iomanip>

using namespace std;

void optimalPageReplacement(const string &referenceString, int frameSize) {

    vector<char> frames;

    int pageFaults = 0, pageHits = 0;

    int refLen = referenceString.length();

    cout << "\nStep-by-step Table (Optimal Page Replacement):\n";

    cout << "------------------------------------------------------------\n";

    cout << setw(10) << "Page"

         << setw(20) << "Frames"

         << setw(15) << "Page Fault"

         << setw(15) << "Page Hit\n";

    cout << "------------------------------------------------------------\n";

    for (int i = 0; i < refLen; ++i) {

        char currentPage = referenceString[i];

        bool found = false;

        // Check if current page is already in frame

        for (char f : frames) {

            if (f == currentPage) {

                found = true;

                break;

            }
```

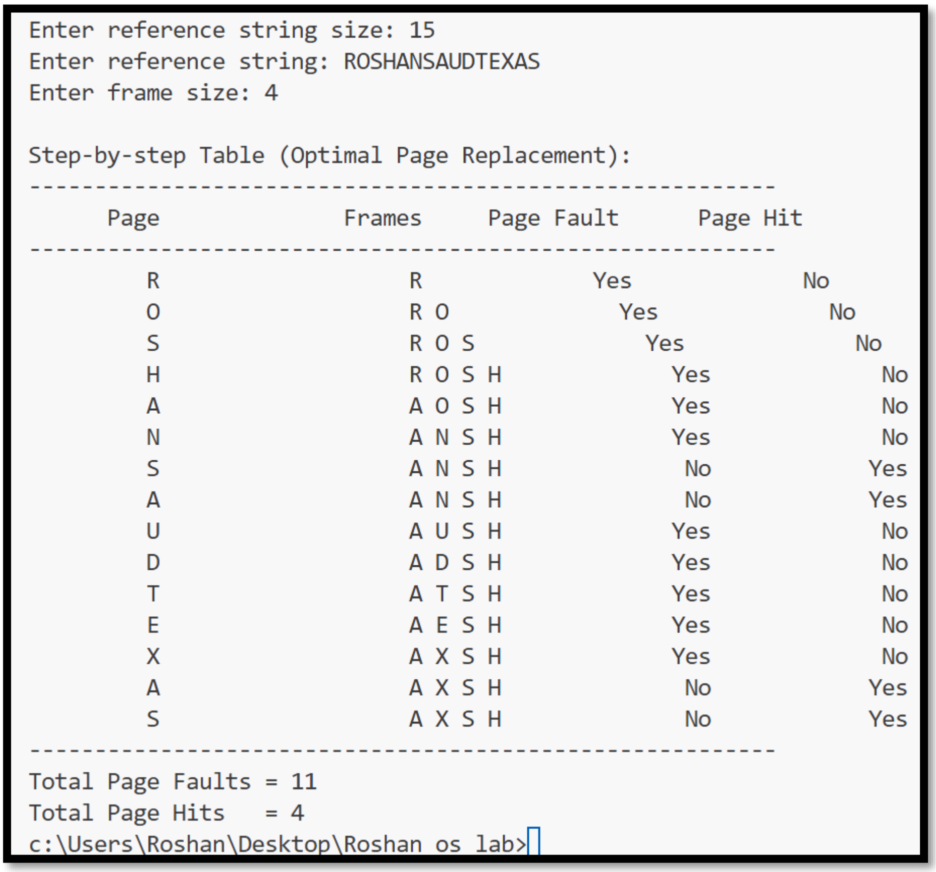
```
}
if (!found) { // Page fault
    if ((int)frames.size() < frameSize) {
        frames.push_back(currentPage);
    } else {
        // Find the page in frames that will not be used for the longest time
        int indexToReplace = -1;
        int farthest = -1;
        for (int j = 0; j < frameSize; ++j) {
            int k;
            for (k = i + 1; k < refLen; ++k) {
                if (referenceString[k] == frames[j])
                    break;
            }
            if (k > farthest) {
                farthest = k;
                indexToReplace = j;
            }
        }
        // Replace the chosen page
        frames[indexToReplace] = currentPage;
    }
    pageFaults++;
} else {
    pageHits++;
```

```
        }
        // Print current step
        cout << setw(10) << currentPage << setw(20);
        for (char f : frames) cout << f << " ";
        cout << setw(15) << (found ? "No" : "Yes")
             << setw(15) << (found ? "Yes" : "No") << "\n";
    }
    cout << "------------------------------------------------------------\n";
    cout << "Total Page Faults = " << pageFaults << endl;
    cout << "Total Page Hits   = " << pageHits;
}
int main() {
    int refSize;
    string referenceString;
    int frameSize;
    cout << "Enter reference string size: ";
    cin >> refSize;
    cout << "Enter reference string: ";
    for (int i = 0; i < refSize; ++i) {
        char page;
        cin >> page;
        referenceString += page;
    }
    cout << "Enter frame size: ";
    cin >> frameSize;
    optimalPageReplacement(referenceString, frameSize);

    return 0;

}
```

**Output:**



```
Enter reference string size: 15
Enter reference string: ROSHANSAUDTEXAS
Enter frame size: 4

Step-by-step Table (Optimal Page Replacement):
---------------------------------------------------------
      Page              Frames     Page Fault      Page Hit
---------------------------------------------------------
         R                   R             Yes             No
         O                   R O             Yes             No
         S                   R O S             Yes             No
         H                   R O S H             Yes             No
         A                   A O S H             Yes             No
         N                   A N S H             Yes             No
         S                   A N S H              No            Yes
         A                   A N S H              No            Yes
         U                   A U S H             Yes             No
         D                   A D S H             Yes             No
         T                   A T S H             Yes             No
         E                   A E S H             Yes             No
         X                   A X S H             Yes             No
         A                   A X S H              No            Yes
         S                   A X S H              No            Yes
---------------------------------------------------------
Total Page Faults = 11
Total Page Hits   = 4
c:\Users\Roshan\Desktop\Roshan os lab>
```

**Conclusion:**

The OPR gives the lowest possible page faults and never exhibits Belady’s anomaly, making it the gold-standard benchmark for evaluating other algorithms. However, it’s not implementable in practice because it requires future knowledge of references; hence systems use approximations like LRU instead.