Planning Document

Course: Operating Systems   **Course Faculty: Dr Suresh Kumar K**
Activity -Visible Quiz

Teaching Unit/Point: Unit 3 – Broad Topic – Memory Management
                                Sub. Topic – Page Replacement Algorithm

Learning Objective: *At the end of the lecture, students will understand various page replacement algorithms.*

Purpose of the Page Replacement

- A page replacement algorithm is required to decide which page need to be replaced with a minimum page fault.
- To study how pages are replaced in various replacement algorithms like FIFO, LRU, OPT.

Purpose of the Activity

- To identify the understanding of various page replacement algorithms by students.
- Similarly, identifying the student familiarity to find the number of page faults in each algorithm for the reference string with different frame sizes.
- Though the concept seems easy to understand, the students should practice solving the problem quickly.
- This activity enhances peer learning through productive discussion.

Page Replacement Algorithms

Page Fault in OS

- A page fault occurs when the CPU references a page that is not present in the Primary Memory.
- The essential page needs to be fetched from the secondary memory into the Primary memory.
- A page needs to be replaced if all the frames of the main memory are already occupied.

Page Replacement

Page replacement algorithms are the methods by which an Operating System decides which memory pages to swap out and write to disk when a page of memory needs to be allocated.

Page replacement is required when-

- All the frames of the primary memory are occupied.
- Hence, a page has to be replaced to create room for the required page.

List of Page Replacement Algorithms

- **First in First Out (FIFO)**
- **Least Recently Used (LRU)**
- **Optical page Replacement (OR)**

Problem and Solution

FIFO Page Replacement Algorithm

- This algorithm work with the principle "**First in First out (FIFO)"**.
- This algorithm replaces the oldest page that has been present in the primary memory for the longest period.
- A queue is implemented to keep track of all the pages.
- **Example**


```
Page reference stream:
1 2 3 2 1 5 2 1 6 2 5 6 3 1 3 6 1 2 4 3

1 1 1 1 1 2 2 3 5 1 6 6 2 5 5 3 3 1 6 2
  2 2 2 2 3 3 5 1 6 2 2 5 3 3 1 1 6 2 4
    3 3 3 5 5 1 6 2 5 5 3 1 1 6 6 2 4 3
*  *  *        *     *  *  *  *     *  *        *        *  *  *
FIFO
Total 14 page faults
```

LRU Page Replacement Algorithm

- This algorithm work with the principle "**Least Recently Used(LRU)**".
- LRU replaces the page that is not referred to by the CPU for the longest time.
- **Example**


```
Page reference stream:
1 2 3 2 1 5 2 1 6 2 5 6 3 1 3 6 1 2 4 3

1 1 1 1 3 2 1 5 2 1 6 2 5 6 6 1 3 6 1 2
  2 2 3 2 1 5 2 1 6 2 5 6 3 1 3 6 1 2 4
    3 2 1 5 2 1 6 2 5 6 3 1 3 6 1 2 4 3
*  *  *        *           *        *           *  *                 *  *  *
LRU
Total 11 page faults
```

Optimal Page Replacement Algorithm

- OR algorithm replaces the page that the CPU will not refer to in future for the longest time.
- In practice, it is not possible to implement the OR algorithm.
- It cannot be predicted which page will not be used in future for the longest time. Still, it is known as the best algorithm which gives the least no of page faults.
- **Example**

```
Page reference stream:
1  2  3  2  1  5  2  1  6  2  5  6  3  1  3  6  1  2  4  3

1  1  1  1  1  1  1  1  6  6  6  6  6  6  6  6  6  2  2  2
   2  2  2  2  2  2  2  2  2  2  2  2  1  1  1  1  1  4  4
      3  3  3  5  5  5  5  5  5  5  5  3  3  3  3  3  3  3
*  *  *        *        *              *  *           *  *
Optimal
Total 9 page faults
```

The procedure followed in conducting the activity

To Create Teams

I have a class strength of 32, So I planned to divide the class into eight groups of 4 members in each group. The group is formed by asking each student to pick a chit from the box. The box contains exactly 32 chits, and each chit has a number between 1 to 8, and each number has four occurrences)

Step 1 – Students are divided into eight groups, and each group will have four students. A problem on page replacement algorithm will be shared with all the groups and ask them to solve the problem for all three methods (FIFO, LRU and OR).

Example Problem

Consider the page references 1,2,3,2,1,5,2,1,6,2,5,6,3,1,3,6,1,2,4,3 with 3 page frame. Find the number of page fault using FIFO, LRU, OR and find the best algorithm which gives least page fault.

Each group was instructed to raise their right hand if they get the FIFO algorithm as the best one, the left hand if LRU is best, and Both hands raised if the OR algorithm is best.

First In First Out	*Least Recently Used*	*Optimal Replacement*

Step 2 – Each group have to solve the problem within 20 minutes(5 min for each method (5 * 3 = 15 minutes) and an additional 5 minutes to cross-check the results within the teammates.

Step 3 – After the 20th minute, each group will be requested to raise their hands based on the result they obtained and disclose the number of page faults identified in each algorithm. Based on

the response received from each group, the instructor reveals which group(s) have given the correct answer. The instructor examines each group's results, and if the answer obtained by any group is correct, then the group members are requested to discuss their solution with all other groups. The instructor verifies the results obtained in each algorithm by each group, identifies and reacts based on each group's understanding of each method in the following case.

Case 1: If all the groups identify the no. of page fault in FIFO and LRU as 14 Page fault, 11-page fault, respectively. If only one or two groups have given the no of page fault as 9 for the OR method, the instructor can find some issues with understanding the OR algorithm and teach that topic.

Case 2: If there is a mix-up of the result, the instructor has to teach the topic again for better understanding.

Steps to implement the activity (Total duration Maximum of 2 hours)

1. A day before the activity, there will be a briefing session regarding the activity, which covers the following points   (10 Minutes)
   - The topic on which the activity is going to be.
   - The objective of the activity.
   - Duration of the activity, Time and Venue
   - The outcome of the activity.
2. During the activity, there will be a discussion on the topic, learning objectives, need for activity, and the outcome. (10 Minutes)
3. Group formation and briefing the activity.   (10 Minutes)
4. Visible quiz activity   (20 Minutes)
5. Assessment process   (10 Minutes)
6. Result announcement   (05 Minutes)
7. If the result comes under **case 1** then
   Discussion on the solution by group (Winner)   (15 Minutes)
   A second question can be given as the extended activity for better understanding
                                                                          (20 Minutes)
   Result announcement   (05 Minutes)
   Discussion on the solution by group (Winner)   (15 Minutes)
   Feedback Collection   (10 Minutes)

   Otherwise, the faculty will solve the problem   (20 Minutes)
   Redo the activity with a second question   (20 Minutes)
   Assessment process   (10 Minutes)
   Result announcement   (05 Minutes)
   Feedback Collection   (10 Minutes)