Smt. Chandibai Himathmal Mansukhani College

USCSP301 : USCS303 - Operating System (OS)

Contents

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USCS3P01:USCS303 – Operating System (OS) Practical_09

Practical Date: 31st August 2021

Practical Aim: Page Replacement Algorithm : LRU

Page Replacement Algorithm : LRU

- **Content**: In page replacement algorithm the page that has not been used for the longest Period of the time is chosen and replaced.
- **Process**: Implement LRU algorithm and find out page hits and page faults.
- **Prior Knowledge**: Page Replacement Algorithm.

Page Replacement Algorithm

- In demand paging memory management technique, if a page demanded for execution is not present in main memory, then a page fault occurs.
- To load the page in demand into main memory, a free page frame is search in main memory and allocated.
- If no page frame is free, Memory Manager has to free a frame by swapping its content to secondary storage and thus make room for the required page.
- To swap pages many screens of strategies are used.

Least Recently Used (LRU)

- The Least Recently used (LRU) algorithm replaces the page that has not been used for the longest period of time.
- It is based on the observation that pages that have not been used for the long time with probably remain unused for the longest time and are to be replaced.

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Solved Example:

- Apply the LRU replacement algorithms for the following page-reference strings :7,0 , 1 , 2 ,0 , 3 ,0 , 4 ,2 ,3 ,0 ,3 ,2 .
- Indicate the number of page faults for LRU you algorithm assuming demand paging with four frames.
- Find the number of hits, number of faults and hit ratio.

Page-Reference String :7,0 , 1 , 2 ,0 , 3 ,0 , 4 ,2 ,3 ,0 ,3 ,2

Demand Paging or Number of Frames: 4

7		7		7		7		7		3		3		3		3		3		3		3	
-1		0		0		0		0		0		0		0		0		0		0		0	
-1		-1		1		1		1		1		4		4		4		4		4		4	
-1		-1		-1		2		2		2		2		2		2		2		2		2	

7	0	1	2	0	3	0	4	2	3	0	3	2
W	W	W	W	R	W	R	W	R	R	R	R	R

Number of Hits: count of number replacements = 7

Number of faults: count of replacements = 6 [R]

Hit Ratio: Number of hits / len(Ref string)= 7/13 = 0.53846157 [W]

Do it Yourself 1 :

Consider the following example 3 frames with 1 ,3 ,0 ,3 ,5 ,6 ,3 page-reference strings.

Find the number of hits, number of faults and hit ratio using page using LRU Page Replacement Algorithm.

Do it Yourself 2 :

Consider the following example 3 frames with 7 ,0 ,1 ,2 ,0 ,3 ,0 ,4 ,2 ,3 ,0 ,3 ,2 ,1 ,2 ,0 ,1 ,7 ,0 ,1 page-reference strings.

Find the number of hits, number of faults and hit ratio using page using LRU Page Replacement Algorithm

Question:

Write a Java Program that implements the LRU page-replacement algorithm.

Implementation

```
// Name: Gaurang Sanyasi
// Batch: B2
// PRN: 2020016400785461
// Date: 31st August, 2021
// Prac-08: Page Replacement Algorithm LRU

import java.io.*;
import java.util.*;
public class P9_PR_LRU_GS
{
public static void main(String[] args) throws IOException
{
Scanner scan = new Scanner(System.in);
int frames,pointer = 0,hit = 0,fault = 0,ref_len;
Boolean isFull = false;
int buffer[];
```

```
ArrayList<Integer> stack = new ArrayList<Integer>();
int reference[];
int mem_layout[][];
System.out.print("Please enter the number of frames:");
frames = scan.nextInt();
System.out.print("Please enter the length ofReference string: ");
ref_len = scan.nextInt();
reference = new int[ref_len];
mem_layout = new int [ref_len][frames];
buffer = new int[frames];
for(int j=0;j<frames;j++)
buffer[j] = -1;
System.out.println("Please enter the reference string:");
for(int i = 0;i<ref_len;i++)
{
reference[i] = scan.nextInt();
}
System.out.println();
for (int i=0;i<ref_len;i++)
{
if(stack.contains(reference[i]))
{
stack.remove(stack.indexOf(reference[i]));
}
stack.add(reference[i]);
int search = -1;
for(int j =0;j<frames;j++)
{
if(buffer[j]==reference[i])
{
search = j;
hit++;
break;
}
}
if(search==-1)
{
if(isFull)
{
int min_loc = ref_len;
for(int j = 0;j<frames;j++)
{
if(stack.contains(buffer[j]))
```

```
{
int temp=stack.indexOf(buffer[j]);
if(temp<min_loc)
{
min_loc=temp;
pointer=j;
}
}
}
}
buffer[pointer]=reference[i];
fault++;
pointer++;
if(pointer==frames)
{
pointer=0;
isFull=true;
}
}
for(int j=0;j<frames;j++)
mem_layout[i][j] = buffer[j];
}
for(int i=0;i<frames;i++)
{
for(int j=0;j<ref_len;j++)
System.out.printf("%3d",mem_layout[j][i]);
System.out.println();
}
System.out.println("The number of Hits:" +hit);
System.out.println("HitRatio:"+(float)((float)hit/ref_len));
System.out.println("The number of faults:"+fault);
}
}
```

Input:

```
E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>javac P9_PR_LRU_GS.java

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>java P9_PR_LRU_GS
Please enter the number of frames:4
Please enter the length ofReference string: 13
Please enter the reference string:
7 0 1 2 0 3 0 4 2 3 0 3 2
```

Output:

```
  7  7  7  7  7  3  3  3  3  3  3  3  3
 -1  0  0  0  0  0  0  0  0  0  0  0  0
 -1 -1  1  1  1  1  1  4  4  4  4  4  4
 -1 -1 -1  2  2  2  2  2  2  2  2  2  2
The number of Hits:7
HitRatio:0.53846157
The number of faults:6
```

Sample Output01:

```
E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>javac P9_PR_LRU_GS.java

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>java P9_PR_LRU_GS
Please enter the number of frames:4
Please enter the length ofReference string: 13
Please enter the reference string:
7 0 1 2 0 3 0 4 2 3 0 3 2

  7  7  7  7  7  3  3  3  3  3  3  3  3
 -1  0  0  0  0  0  0  0  0  0  0  0  0
 -1 -1  1  1  1  1  1  4  4  4  4  4  4
 -1 -1 -1  2  2  2  2  2  2  2  2  2  2
The number of Hits:7
HitRatio:0.53846157
The number of faults:6

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>
```

Input2:

```
E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>javac P9_PR_LRU_GS.java

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>java P9_PR_LRU_GS
Please enter the number of frames:3
Please enter the length ofReference string: 7
Please enter the reference string:
1 3 0 3 5 6 3
```

Output2:

```
  1  1  1  1  5  5  5
 -1  3  3  3  3  3  3
 -1 -1  0  0  0  6  6
The number of Hits:2
HitRatio:0.2857143
The number of faults:5
```

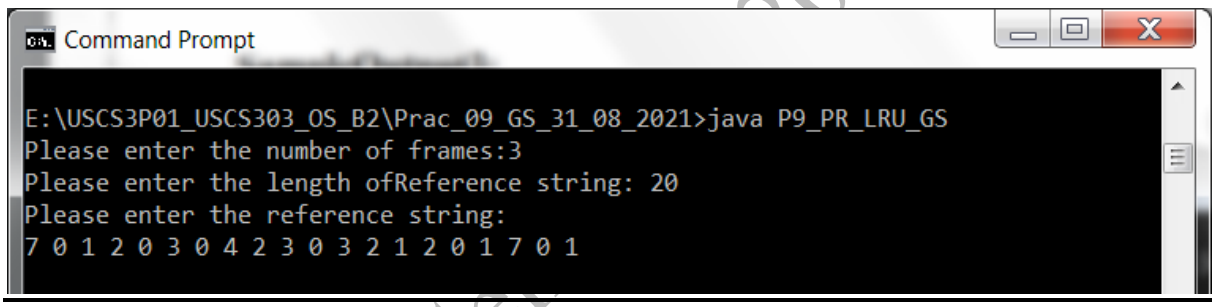
Sample Output02:

```
E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>javac P9_PR_LRU_GS.java

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>java P9_PR_LRU_GS
Please enter the number of frames:3
Please enter the length ofReference string: 7
Please enter the reference string:
1 3 0 3 5 6 3

  1  1  1  1  5  5  5
 -1  3  3  3  3  3  3
 -1 -1  0  0  0  6  6
The number of Hits:2
HitRatio:0.2857143
The number of faults:5
```

Input:



Output:

```
 7  7  7  2  2  2  2  4  4  4  0  0  0  1  1  1  1  1  1  1
-1  0  0  0  0  0  0  0  0  3  3  3  3  3  3  0  0  0  0  0
-1 -1  1  1  1  3  3  3  2  2  2  2  2  2  2  2  2  7  7  7
The number of Hits:8
HitRatio:0.4
The number of faults:12
```

SampleOutput3:

```
E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>java P9_PR_LRU_GS
Please enter the number of frames:3
Please enter the length ofReference string: 20
Please enter the reference string:
7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 0 1 7 0 1

  7  7  7  2  2  2  2  4  4  4  0  0  0  1  1  1  1  1  1  1
 -1  0  0  0  0  0  0  0  0  3  3  3  3  3  3  0  0  0  0  0
 -1 -1  1  1  1  3  3  3  2  2  2  2  2  2  2  2  7  7  7
The number of Hits:8
HitRatio:0.4
The number of faults:12

E:\USCS3P01_USCS303_OS_B2\Prac_09_GS_31_08_2021>
```