Fall 2015 COMP 3511 Homework Assignment #4 Solution

Handout Date: November 16, 2015 Due Date: December 2, 2015

Name: _____ ID: _____

E-Mail: _____Section: _____

Please read the following instructions carefully before answering the questions:

- You should finish the homework assignment **individually**.
- There are a total of **4** questions.
- When you write your answers, please try to be precise and concise.
- Fill in your name, student ID, email and Section number at the top of each page.
- Please fill in your answers in the space provided, or you can type your answers in the MS Word file.

- **Homework Collection:** the hardcopy is required and the homework is collected in **collection box #16** (for **L1**) and **collection box #17** (for **L2**). The collection boxes are located outside **Room 4210**, near **Lift 21** (there are labels on the boxes)

1. (20 points) Multiple choices

   1) Which of the following is a benefit of allowing a program that is only partially in memory to execute?
   A) Programs can be written to use more memory than is available in physical memory.
   B) CPU utilization and throughput is increased.
   C) Less I/O is needed to load or swap each user program into memory.
   D) All of the above
   Answer: D

   2) Belady's anomaly states that ____.
   A) giving more memory to a process will improve its performance
   B) as the number of allocated frames increases, the page-fault rate may decrease for all page replacement algorithms
   C) for some page replacement algorithms, the page-fault rate may decrease as the number of allocated frames increases
   D) for some page replacement algorithms, the page-fault rate may increase as the number of allocated frames increases
   Answer: D

   3) Optimal page replacement ____.
   A) is the page-replacement algorithm most often implemented
   B) is used mostly for comparison with other page-replacement schemes
   C) can suffer from Belady's anomaly
   D) requires that the system keep track of previously used pages
   Answer: B

   4) The ____ is the number of entries in the TLB multiplied by the page size.
   A) TLB cache

B) page resolution
C) TLB reach
D) hit ratio
Answer: C

5) Suppose we have the following page accesses: 1 2 3 4 2 3 4 1 2 1 1 3 1 4 and that there are three frames within our system. Using the FIFO replacement algorithm, what is the number of page faults for the given reference string?
A) 14
B) 8
C) 13
D) 10
Answer: B

6) Given the reference string of page accesses: 1 2 3 4 2 3 4 1 2 1 1 3 1 4 and a system with three page frames, what is the final configuration of the three frames after the LRU algorithm is applied?
A) 1, 3, 4
B) 3, 1, 4
C) 4, 1, 2
D) 1, 2, 3
Answer: B

7) Suppose that the operating system uses two internal tables to keep track of open files. Process A has two files open and process B has three files open. Two files are shared between the two processes. How many entries are in the per-process table of process A, the per-process table of process B, and the system-wide tables, respectively?
A) 5, 5, 5
B) 2, 3, 3
C) 2, 3, 5
D) 2, 3, 1
Answer: B

8) Which of the following is true of the tree-structured directory structure?
A) Users cannot create their own subdirectories.
B) Users cannot acquire permission to access the files of other users.
C) Directories can share subdirectories and files.
D) It is the most common directory structure.
Answer: D

9) Order the following file system layers in order of lowest level to highest level.
[1] I/O control
[2] logical file system
[3] basic file system
[4] file-organization module

[5] devices
A) 1, 3, 5, 4, 2
B) 5, 1, 3, 2, 4
C) 1, 5, 3, 4, 2
D) 5, 1, 3, 4, 2
Answer: D

10) _____ includes all of the file system structure, minus the actual contents of files.
A) Metadata
B) Logical file system
C) Basic file system
D) File-organization module
Answer: A

2. (30 points) Please answer the following questions in a few sentences

1) (5 points) Please highlight the sequence of events that takes place when a page-fault occurs.

Answer: When a page-fault occurs. (1) to find the page on the disk, (2) to locate a free frame in the memory, or replace a page to free up one frame. (3) A disk operation is then scheduled to read the page into the frame. (4) update the page table, and (5) restart the instruction that was interrupted because of the page fault..

2) (5 points) What is the benefit and cost associated with a pre-paging scheme?

Answer: Paging schemes, such as pure demand paging, result in large amounts of initial page faults as the process is started. Prepaging is an attempt to prevent this high level of initial paging by bringing into memory (3 points), yet, not necessarily all of the pages brought in will be that will be needed by the process, resulting in waster of memory and I/O.

3) (5 points) Can any of the replacement algorithms we discussed (FIFO, OPT, LRU and its approximation) solve the problem of thrashing if a process has entered thrashing? Please justify your answer.

Answer: No, it cannot (1 points). The cause for a process to enter thrashing is lack of sufficient number of frames allocated to this process (2 points), any replacement algorithm does not increase the total number of frames allocated to the process, thus cannot resolve the problem of thrashing (2 points)

4) (5 points) Consider a demand-paging system with page fault rate 1% and the page fault service time is 1 milliseconds. Suppose a one-level page table is used for address translation, and memory access time is 200 nanoseconds. We further

assume that a TLB is used with TLB hit rate 90% and TLB access time is 20 nanoseconds, and those pages within TLB reach do not result in any page fault. Please calculate the effective memory access time.

Answer: 0.9x(20+200)+0.09x(20+200+200)+0.01(20+200+200+1,000,000) = 10240 ns.

5) (4 points) Please briefly describe the four commonly used in-memory structures that are used to implement a file system.

Answer: An in-memory mount table contains information about each mounted volume. An in-memory directory-structure cache holds the directory information of recently accessed directories. The system-wide open-file table contains a copy of the FCB of each open file. The per-process open-file table contains a pointer to the appropriate entry in the system-wide open-file table. (1 points each)

6) (6 points) Consider a UNIX file system that uses inodes to represent files. The logical address has 32 bits, and disk block size is 4KB. The combined scheme is used for disk allocation, with 10 direct disk blocks, plus one single, one double, and one triple indirect disk blocks. What is the maximum file size that can be supported in this file system?

Answer: With a 32-bit address, each pointer needs 32 bit or 4 bytes. So one block with 4KB has 1,024 pointers (2 points). The maximum file size is

10x4KB + 1,024x4KB+1,024x1,024x4KB + 1,024x1,024x1,024x4KB

This is roughly 4 TB. (40KB + 4MB + 4GB + 4TB)

3. (30 points) Consider the following page reference string:

7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.

Assuming demand paging with **three** frames allocated to a process with local allocation scheme used. Please illustrate **each step** that the following replacement algorithms work for this reference string and compute the page faults in each algorithm.

1) FIFO replacement

2) LRU replacement

3) Optimal replacement

Answer:

1) FIFO

7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
7	7	7	1		1		1	6	6		6	0	0	0	6	6	6	0	0
	2	2	2		5		5	5	7		7	7	5	5	5	2	2	2	1
		3	3		3		4	4	4		1	1	1	4	4	4	3	3	3

Page faults: 17

2) LRU

7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
7	7	7	1		1	3	3	3	7		7	7	5	5	5	2	2	2	1
	2	2	2		2	2	4	4	4		1	1	1	4	4	4	3	3	3
		3	3		5	5	5	6	6		6	0	0	0	6	6	6	0	0

Page faults: 18.

3) Optimal:

7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
7	7	7	1		1		1	1	1			1		1	1	1	1		
	2	2	2		5		5	5	5			5		4	6	2	3		
		3	3		3		4	6	7			0		0	0	0	0		

Page faults: 13

4. (20 points) Disk scheduling problem

Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 2150, and the previous request was at cylinder 1805. The queue of pending requests, in FIFO order, is:

2069, 1212, 2296, 2800, 544, 1618, 346, 1523, 4975, 3681

What is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk-scheduling algorithms?

a) FCFS

b) SSTF

c) SCAN

d) C-SCAN

e) LOOK

f) C-LOOK

Answer:

a) The FCFS schedule is 2150, 2069, 1212, 2296, 2800, 544, 1618, 346, 1523, 4975, 3681. The total seek distance is 13,051.

b) The SSTF schedule is 2150, 2069, 2296, 2800, 3681, 4975, 1618, 1523, 1212, 544, 346. The total seek distance is 7616.

c) The SCAN schedule is 2150, 2296, 2800, 3681, 4975, 2069, 1618, 1523, 1212, 544, 346. The total seek distance is 7502.

d) The C-SCAN schedule is 2150, 2296, 2800, 3681, 4975, 346, 544, 1212, 1523, 1618, 2069. The total seek distance is 9917.

e) The LOOK schedule is 2150, 2296, 2800, 3681, 4975, 2069, 1618, 1523, 1212, 544, 346. The total seek distance is 7454.

f) The C-LOOK schedule is 2150, 2296, 2800, 3681, 4975, 346, 544, 1212, 1523, 1618, 2069. The total seek distance is 9177.