CMPT 454 Fall 2017
Assignment 1

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Total points: 94 (10% of final grade)
Due date: Midnight of September 27, 2017

1 Hard Disks [27 points]

Question 1.1 [18 points] Consider a disk with the following statistics:

- Sector size: 1024 bytes
- Sectors per track: 40
- Number of cylinders: 10,000
- Block size: 2 sectors
- Number of platters: 5 double-sided
- RPM: 20,000
- Time for the disk head to move from the innermost to outermost track: 20ms
- Cylinders are labeled 1 to 10,000, with 1 being the outermost and 10,000 the innermost
- Platters are labeled 1 to 5, and their surfaces are labeled I and II
- Blocks on each track are labeled by the sequence of A, B, C, $\cdots$

a) How many disk heads does the disk head array contain? [1 point]

b) What is the storage capacity of the disk (in bytes)? [2 points]

c) What is the size in bytes of the largest data file that could be read without having to move the disk head? Please explain. [3 points]

d) What is the *maximum* time to read a single block (roughly as discussed in class)? How about the *minimum* time? Please show the value for each component. [4 points]

e) What is the *maximum* time to read two blocks in a desired sequence, that is, one must be read before the other one (roughly as discussed in class)? How about the *minimum* time? Please explain for each scenario. [8 points]

Question 1.2 [9 points] Suppose we have an ordered table containing 5,000 records of 100 bytes each is to be stored in the above disk such that no record is allowed to span two blocks.

a) How many records can fit onto a block? [2 points]

b) How many blocks are required to store the entire file? [2 points]

c) Suppose the 1st block of this table is stored on disk 1, surface I, track 10,000, block A. Where to store the next block to optimize the access efficiency? Explain where to store the rest to optimize the access efficiency of the table? [5 points]

2 RAID [40 points]

Suppose there is a data whose blocks are numbered as:

0	1	2	3	$\cdots$

Consider the following requests:

- Read blocks 0 to 15
- Read blocks 1, 4, 10, 15
- Read blocks 0, 6, 10, 20
- Write blocks 0 to 15
- Write blocks 1, 4, 10, 15
- Write blocks 0, 6, 10, 20

Request	Single Disk	RAID 0	RAID 1	RAID 0+1	RAID 4	RAID 5
Read 0 to 15	16					
Read 1,4,10,15						
Read 0,6,10,20						
Write 0 to 15						
Write 1,4,10,15						
Write 0,6,10,20						
Disk Cost	1					

Calculate the I/O cost (one read/write is one I/O cost; two reads/writes at the same time is one I/O cost) and disk cost (how many disks needed in total)

for each system by complete the above table. RAID systems contain 4 data disks and additional disks containing redundant data. For example, single disk needs only 1 disk, and thus the disk cost for single disk is 1 as in table. To read 0 to 15 blocks, single disk require one I/O cost for each block, and thus 16 as in table.

3 Buffer Manager: Page Replacement Policy [27 points]

Given page request string as [1,2,3,4,2,1,5,6,2,1,2,3] and suppose we have 3 frames in main memory, show the main memory after each step for LRU, FIFO, and MRU. For example, 3 policies show the same main memory placement for the 1st 3 requests as in table. Fill the rest requests.

Request String	1	2	3	4	2	1	5	6	2	1	2	3
LRU	1	1	1									
		2	2									
			3									
FIFO	1	1	1									
		2	2									
			3									
MRU	1	1	1									
		2	2									
			3									