

CS443 - Assignment 7

Question 1:

Consider a disk with the following characteristics: block size $B=512$ bytes, interblock gap size $G=128$ bytes, number of blocks per track=20, number of tracks per surface=400. A disk pack consists of 15 double-sided disks.

- (a) What is the total capacity of a track and what is its useful capacity (excluding interblock gaps)?

Total capacity of track = (block size + interblock size) * blocks per track

Total capacity of track = (512 + 128) * 20 = **12800 bytes**

Useful capacity = block size * blocks per track

Useful capacity = 512 * 20 = **10240 bytes**

- (b) How many cylinders are there?

400 cylinders in total since it is similar to the number of tracks per surface

- (c) What is the total capacity and the useful capacity of a cylinder?

Total capacity of cylinder = 30 * total capacity of track

Total capacity of cylinder = 30 * 12800 = **384000 bytes**

Useful cylinder capacity = 30 * useful track capacity

Useful cylinder capacity = 30 * 10240 = **307200 bytes**

- (d) What is the total capacity and the useful capacity of a disk pack?

Total disk pack capacity = 400 * total cylinder capacity

Total disk pack capacity = 400 * 307200 = **122880000 bytes**

- (e) Suppose the disk drive rotates the disk pack at a speed of 2400 rpm (revolutions per minute); what is the transfer rate (tr) in bytes/msec and the block transfer time (btt) in msec? What is the average rotational delay (rd) in msec? What is the bulk transfer rate (btr)?

Transfer rate = size of each track / time of one revolution

Transfer rate = (total capacity) / ((60 * 1000) / disk pack)

Transfer rate = 12800 / ((60 * 1000) / 2400) = **512 bytes / msec**

Block transfer time = block size / transfer rate

Block transfer time = 512 / 512 = **1 msec**

Average rotational delay = (60 * 1000) / (2 * 2400) = **12.5 msec**

Bulk transfer rate = (block size / (block size + gap size)) * transfer rate

Bulk transfer rate = (512 / (512 + 128)) * 512 = **409.6 bytes / msec**

- (f) Suppose the average seek time is 30 msec. How much time does it take (on the average) in msec to locate and transfer a single block given its block address?

s → seek time
rd → rotational time
btt → block transfer time

$$s + rd + btt \\ 30 + 12.5 + 1 = \mathbf{43.5 \text{ msec}}$$

- (g) Calculate the average time it would take to transfer 20 random blocks (may not be on the same cylinder) and compare it with the time it would take to transfer 20 consecutive blocks (all in on cylinder).

s → seek time
rd → rotational time
btt → block transfer time
k → number of blocks

$$s + rd + (k * btt) \\ 30 + 12.5 + (20 * 1) = \mathbf{62.5 \text{ msec}}$$

Question 2:

A file has $r=200000$ STUDENT records of fixed-length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), ADDRESS (40 bytes), PHONE (10 bytes), BIRTHDATE (8 bytes), SEX (1 byte), MAJORDEPTCODE (4 bytes), MINORDEPTCODE (4 bytes), CLASSCODE (4 bytes, integer), and DEGREEPROGRAM (3 bytes). An additional byte is used as a deletion marker. The file is stored on the disk whose parameters are given in Question 1.

- (a) Calculate the record size R in bytes.

$$R = 30 + 9 + 40 + 10 + 8 + 1 + 4 + 4 + 4 + 3 + 1 = \mathbf{114 \text{ bytes}}$$

- (b) Calculate the blocking factor (bfr) and the number of file blocks b assuming an unspanned organization.

B → block size
R → record size

$$\begin{aligned} \text{bfr} &= \text{FLOOR} [B / R] \\ \text{bfr} &= 512 / 114 \\ \text{bfr} &= 4.49 \rightarrow \mathbf{4} \end{aligned}$$

$$\begin{aligned} b &= \text{number of records} / \text{blocking factor} \\ b &= r / \text{bfr} \\ b &= 200000 / 4 \\ b &= \mathbf{50000 \text{ blocks}} \end{aligned}$$

- (c) Calculate the average time it takes to find a record by doing a linear search on the file if
1. the file blocks are stored contiguously, and

k → b / 2
s → seek time
rd → rotational time
btt → block transfer time

$$\begin{aligned}\text{Contiguously} &= s + rd (k * btt) \\ \text{Contiguously} &= 30 + 12.5 + ((50000 / 2) * 1) \\ \text{Contiguously} &= \mathbf{25042.5 \text{ msec}}\end{aligned}$$

2. if the file blocks are not stored contiguously.

$$\begin{aligned}k &\rightarrow b / 2 \\ s &\rightarrow \text{seek time} \\ rd &\rightarrow \text{rotational time} \\ btt &\rightarrow \text{block transfer time}\end{aligned}$$

$$\begin{aligned}\text{Not stored contiguously} &= k * (s + rd + btt) \\ \text{Not stored contiguously} &= (50000 / 2) * (30 + 12.5 + 1) = \mathbf{1087500 \text{ msec}}\end{aligned}$$

(d) Assume the file is ordered by SSN; calculate the time it takes to search for a record given its SSN value by doing a binary search.

$$\begin{aligned}k &\rightarrow b / 2 \\ s &\rightarrow \text{seek time} \\ rd &\rightarrow \text{rotational time} \\ btt &\rightarrow \text{block transfer time}\end{aligned}$$

$$\begin{aligned}\text{Not contiguous} &= k * (s + rd + btt) \\ \text{Not contiguous} &= (\log_2 50000) * (30 + 12.5 + 1) = \mathbf{679.02 \text{ msec}}\end{aligned}$$