

CS443 – Lab 4

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 + gap size) * blocks per track
 $(512 + 128) * 20 = 12,800$ bytes

Useful Capacity of track: block size * blocks per track
 $512 * 20 = 10,240$ bytes

- (b) How many cylinders are there?

Each cylinder consists of one track from each surface $\therefore 400$ cylinders

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

Since it is double sided $15 * 2 = 30$

Total capacity of cylinder: 30 * Total Capacity of track
 $30 * 12,800 = 384,000$ bytes

Useful capacity of cylinder: 30 * Useful Capacity of track
 $30 * 10,240 = 307,200$ bytes

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

Total disk pack capacity: Tracks per surface * Total cylinder capacity
 $400 * 384,000 = 153,600,000$ bytes

Useful disk pack capacity: Tracks per surface * useful cylinder capacity
 $400 * 307,200 = 122,880,000$ 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
 $12,800 * \frac{60 * 1,000}{2,400} = 512$ bytes/msec

Block transfer time: Block size / Transfer rate
 $512 / 512 = 1$ msec

Average rotational delay: $60 * 1,000 / 2 * \text{rpm}$
 $60 * 1,000 / 2 * 2,400 = 12.5$ msec

Bulk transfer rate: $\text{Block size} / (\text{Block size} + \text{Gap size}) * \text{Transfer rate}$
 $(512 / (512 + 128)) * 512 = 409.6 \text{ bytes / ms}$

- (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?

Seek time + Rotational delay + Block transfer time
 $30 + 12.5 + 1 = 43.5 \text{ msec}$

- (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).

Average time: $\text{Number of blocks} * (\text{Seek time} + \text{Rotational delay} + \text{Block transfer time})$
 $20 * 43.5 = 870 \text{ msec}$

Time: $\text{Seek time} + \text{Rotational delay} + (\text{Number of blocks} * \text{Block transfer time})$
 $(30) + (12.5) + (20 * 1) = 62.5 \text{ msec}$

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.

Record size: $\text{Name} + \text{SSN} + \text{ADDRESS} + \text{PHONE} + \text{BIRTHDATE} + \text{SEX} + \text{MAJORDEPTCODE} + \text{MINORDEPTCODE} + \text{CLASSCODE} + \text{DEGREEPROGRAM} + 1$
 $30 + 9 + 40 + 10 + 8 + 1 + 4 + 4 + 4 + 3 + 1 = 114 \text{ bytes}$

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

Blocking factor: $\text{floor}(\text{Block size} / \text{Record size})$
 $\text{floor}(512 / 114) = \text{floor}(4.49) = 4$

Number of file blocks: $\text{Number of records} / \text{Blocking factor}$
 $200,000 / 4 = 50,000 \text{ blocks}$

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

Contiguously: Seek time + Rotational delay + (File blocks/2 * Block transfer time)

$$30 + 12.5 + (50,000 / 2) * 1 = \mathbf{25,042.5 \text{ msec}}$$

2. if the file blocks are not stored contiguously.

Not Contiguously: (Seek time + Rotational delay + Block transfer time) * (File blocks/2)

$$(50,000 / 2) * (30 + 12.5 + 1) = \mathbf{1,087,500 \text{ msec}}$$

- (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.

Time: \log_2 Number of blocks * (Seek time + Rotational delay + Block transfer time)

$$15.6 * (30 + 12.5 + 1) = \mathbf{696 \text{ msec}}$$