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CS 143
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Homework 5

1 Problem 1

The average time to read a random sector from the disk is 15.02ms.

Work:
Average time to read a random sector = average seek time + half disk rotation + transfer time

Average seek time = 10ms

$$\text{Half disk rotation} = \frac{6000 \text{ rotations}}{\text{minute}} \times \frac{1 \text{ minute}}{60 \text{ seconds}} = \frac{100 \text{ rotations}}{\text{second}} = \frac{0.01 \text{ seconds}}{\text{rotation}} \times 0.5$$
$$= 0.005 \text{ seconds} \times \frac{1000\text{ms}}{1\text{s}} = 5\text{ms}$$

$$\text{Transfer time} = \frac{0.01\text{seconds}}{500 \text{ sectors}} = 0.00002 \text{ seconds} \times \frac{1000\text{ms}}{1\text{s}} = 0.02\text{ms}$$

Average time to read a random sector = 10ms + 5ms + 0.02ms = 15.02ms

2 Problem 2

Assuming the disk blocks are unspanned, 72 disk blocks are needed to store the above table with 1,000 tuples.

Work:
one tuple = 2 + 4 + 4 + 4 + 4 + 4 + 30 + 20 = 72 bytes

1000 tuples = $72 \times 1000 = 72000$ bytes

1024 bytes per sector $\div$ 72 bytes per tuple = 14 tuples per sector

1000 tuples $\div$ 14 tuples per sector = 71.4285714286 sectors $\approx$ 72 sectors = 72 disk blocks

3 Problem 3

It will take 16.44ms to run the query.

Work:
Disk latency to scan entire table = one seek time + half disk rotation + (read one sector × sectors per block × blocks per table)

One seek time = 10ms

Half disk rotation = 5ms

read one sector × sectors per block × blocks per table = 0.02ms × 1 × 72 = 1.44ms

Disk latency to scan entire table = 10ms + 5ms + 1.44ms = 16.44ms

4 Problem 4

Assuming that we scan the entire table to execute the above query, it will take 361.44ms.

Work:
Disk latency to scan entire table = (average seek time + half disk rotation + transfer time of cluster) × 24 clusters

Average seek time = 10ms

Half disk rotation = 5ms

Transfer time of cluster = transfer time of one sector × number of blocks per cluster × number of sectors per block
= 0.02ms × 3 × 1 = 0.06ms

Disk latency to scan entire table = (10ms + 5ms + 0.06ms) × 24 clusters = 15.06ms × 24 = 361.44ms

5 Problem 5

The expected time to run the above query is 150.6ms. It is not helpful to create a non-clustering index to run this query, because with the non-clustering index, we have the potential for tuples of the same year to be in separate clusters if we index by this year attribute, which can slow down performance for a query on this attribute significantly due to poor locality.

Work:
Disk latency with non-clustering index = (average seek time + half disk rotation + transfer time of cluster) × 10 clusters
We have to scan 10 times since there are 10 classes offered every year and the worst case the 10 tuples are in 10 different blocks if they're not allocated in any order. We only need the transfer time of the cluster though, since we have the non-clustered index, so we do not have to scan the entire table, only those 10 clusters.

Average seek time = 10ms

Half disk rotation = 5ms

Transfer time of cluster = transfer time of one sector × number of blocks per cluster × number of sectors per block
= 0.02ms × 3 × 1 = 0.06ms

Disk latency with non-clustering index = (10ms + 5ms + 0.06ms) × 10 clusters = 15.06ms × 10 = 150.6ms