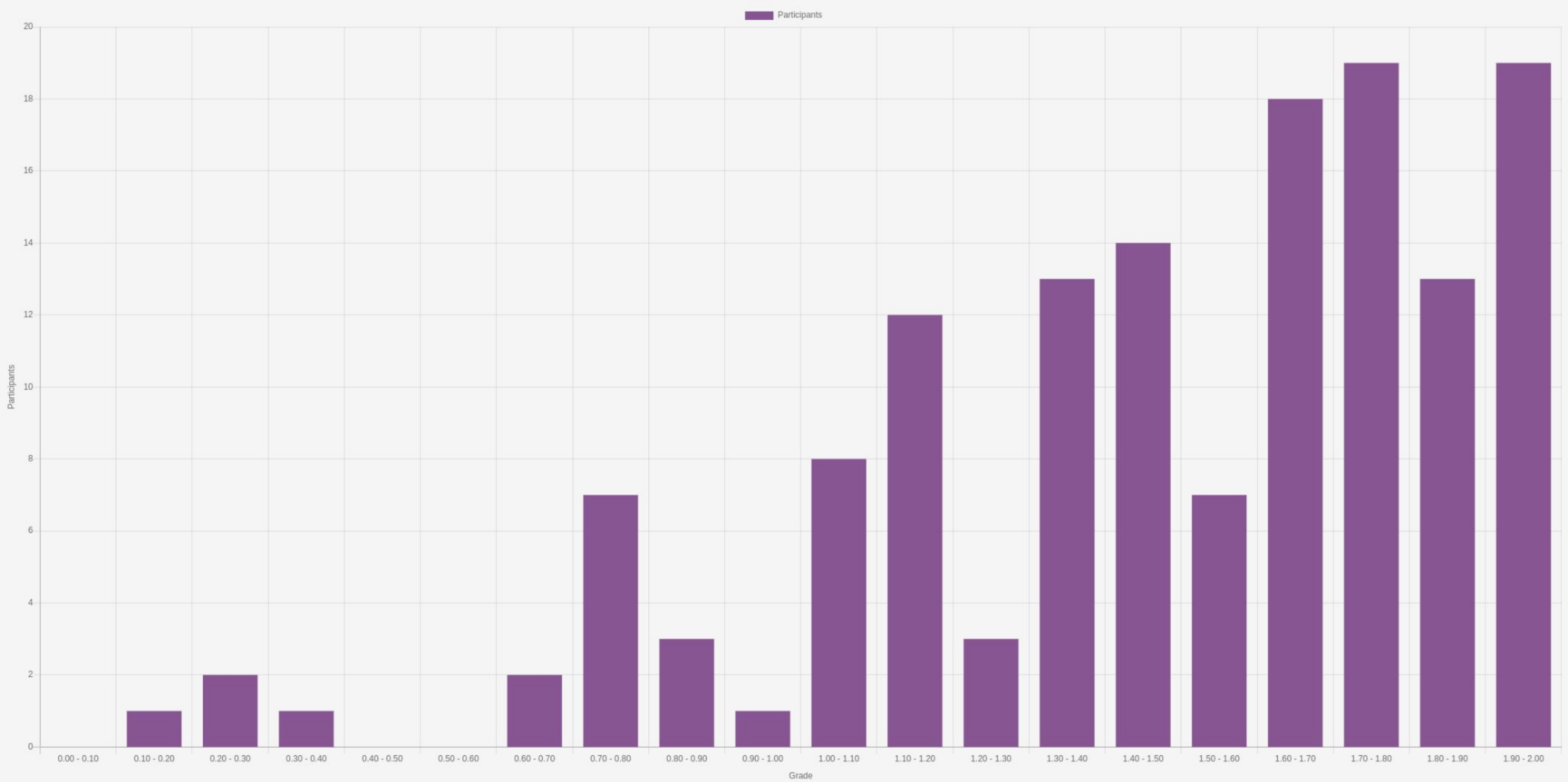
Database Technology

Exercise 1: Review



Participants
20
18
16
14
12
10
8
6
4
2
0
Participants
0.00 - 0.10
0.10 - 0.20
0.20 - 0.30
0.30 - 0.40
0.40 - 0.50
0.50 - 0.60
0.60 - 0.70
0.70 - 0.80
0.80 - 0.90
0.90 - 1.00
1.00 - 1.10
1.10 - 1.20
1.20 - 1.30
1.30 - 1.40
1.40 - 1.50
1.50 - 1.60
1.60 - 1.70
1.70 - 1.80
1.80 - 1.90
1.90 - 2.00
Grade

Q1: What level of the memory hierarchy can be accessed the fastest?

- SSD
- Main memory
- Hard disk
- Tertiary storage

Answer:

- Main memory

Q2: What level of the memory hierarchy can typically store the most data?

- Hard disk
- Main memory
- Cache
- Tertiary storage

Answer:

- Tertiary Storage

Q3: What is the overall of capacity of the disk in GiB (1 GiB = 1024^3 Bytes)?

Consider a hard disk with the following characteristics:

- 8 with 16 surfaces total
- 16384 tracks per surface
- 1024 sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 4096 bytes per sector
- 16384 bytes per block
- 10% of the tracks are used for gaps
- 10000 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 4000 cylinders that have to be passed by the read/write head

Answer:

$(16*16384*1024*4096)/(1024^3) = 1024$

Refer slide 38

Q4: Compute the average rotational latency in milliseconds.

Consider a hard disk with the following characteristics:

- 4 with 8 surfaces total
- 32768 (= 215) tracks per surface
- 256 (= 28) sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 2048 (= 211) bytes per sector
- 8192 (= 213) bytes per block
- 20% of the tracks are used for gaps
- 5400 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 6000 cylinders that have to be passed by the read/write head

Answer:

Average time for a single rotation = 60*1000/5400 ms/rotation = 11.1 ms/rotation

Average Rotational latency = 1/2 of total time to cover a track = 11.1/2 = 5.55 ms

Refer slide 45

Q5: Compute the average seek time in milliseconds.

Consider a hard disk with the following characteristics:

- 8 with 16 surfaces total
- 16384 tracks per surface
- 1024 sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 4096 bytes per sector
- 16384 bytes per block
- 10% of the tracks are used for gaps
- 10000 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 4000 cylinders that have to be passed by the read/write head

Answer:

Tracks/3 * time to access 1 track + time to start/stop write head = 16384/3 * 1/4000 +1 =2.36 ms

Refer slide 45

Q6: Compute the average transfer time per block in milliseconds. You can assume that the sectors of a block are laid out in sequence along a single track.

Consider a hard disk with the following characteristics:

- 4 with 8 surfaces total
- 32768 tracks per surface
- 256 sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 2048 bytes per sector
- 8192 bytes per block
- 20% of the tracks are used for gaps
- 5400 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 6000 cylinders that have to be passed by the read/write head

Answer:

((total sector per block * % covered by data) + (total gap per block * % covered by gap))/total sectors per track) * track rotation latency

((4*(1-0.2))+(3*0.2) /256) * ((60*1000)*5400) = 0.0148 * 11.1 = 0.164 ms

Refer slide 45

Q7: Specify the order by which the requests are services by the disk controller using the elevator algorithm and compute the completion time of each request.

Consider a hard disk with the following characteristics:

- The average transfer time for a block is 0.13 ms.
- The average rotational latency is 4.17 ms.
- It takes 0.5 ms to start and 0.5 ms to stop the read/write head.
- The read/write head can pass 4000 cylinders in 1 ms.

Initially, the read/write head is at cylinder 32000. The following requests arrive to the disk controller with the following request time stamps

(Start head + Seek Time + Stop Time + Avg. Rotational Latency + Transfer Time)

Request time (ms)	Cylinder	Order	Completion time (ms)
0	40000	1	0.5+2+0.5+4.17+0.13 = 7.3
10	20000	2	10+0.5+5+0.5+4.17+0.13= 20.3
15	12000	4	26.6+0.5+1+0.5+4.17+0.13 = 32.9
21	16000	3	20.3+0.5+1+0.5+4.17+0.13=26.6
24	60000	5	32.9+0.5+12+0.5+4.17+0.13 = 50.2
50	64000	6	50.2+0.5+1+0.5+4.17+0.13=56.5

Refer slide 56

Q8: How many milliseconds does it take to read 128 randomly distributed blocks? Assume that each block is on a different track and that we do not reorder the tracks to improve performance.

Consider a hard disk with the following characteristics:

- 6 with 12 surfaces total
- 8192 tracks per surface
- 512 sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 4096 bytes per sector
- 16384 bytes per block
- 20% of the tracks are used for gaps
- 7200 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 5000 cylinders that have to be passed by the read/write head

Answer:

(Average Transfer Time per Block + Average Seek Time + Average Rotational Latency) * 128 = 739

Refer slide 53

Q9: How many milliseconds does it take to read 64 sequentially distributed blocks? Assume that all blocks are on a single track and that we can read them in any order.

Consider a hard disk with the following characteristics:

- 8 with 16 surfaces total
- 16384 tracks per surface
- 256 sectors per track (this is a simplified model where all tracks have the same number of sectors)
- 2048 bytes per sector
- 8192 bytes per block
- 20% of the tracks are used for gaps
- 7200 rotations per minute
- 1 ms to start/stop the write head (1 for both operations together)
- 1 ms per 4000 cylinders that have to be passed by the read/write head

Answer:

(Average Transfer Time per block) * 64 + Average Seek time = 10.28

Refer slide 53

Q10: Spatial Locality Means?

True	False	
✓		... accessing data that is stored near previously accessed data.
	✗	... means actually pulling up the spatial data again and again from disk in a given short amount of time.
	✗	... accessing the same data more than once in a given short amount of time.
	✗	... accessing data that was last modified a short time ago.

Q11: RAID 0 improves the mean time to data loss (MTTDL).

Answer:

- No

Q12: RAID 5 improves the mean time to data loss (MTTDL).

Answer:

- Yes

Q13: Rate the different RAID levels with regard to the sequential throughput of the RAID array.

(1 – Highest throughput. If two RAID levels have the same throughput, give them the same rating and use only the ratings 1 to 3 in your answer. If three RAID levels have the same throughput, use only the ratings 1 and 2.)

RAID 0	1 (N*S)
RAID 1+0	3 (N/2*S)
RAID 4	2 (N-1 * S)
RAID 5	2 (N-1 * S)

Q14: Rate the different RAID levels with regard to the random read throughput of the RAID array.

(1 – Highest throughput. If two RAID levels have the same throughput, give them the same rating and use only the ratings 1 to 3 in your answer. If three RAID levels have the same throughput, use only the ratings 1 and 2.)

RAID 0	1 (N*R)
RAID 1+0	1 (N*R)
RAID 4	2 (N-1 * R)
RAID 5	1 (N*R)