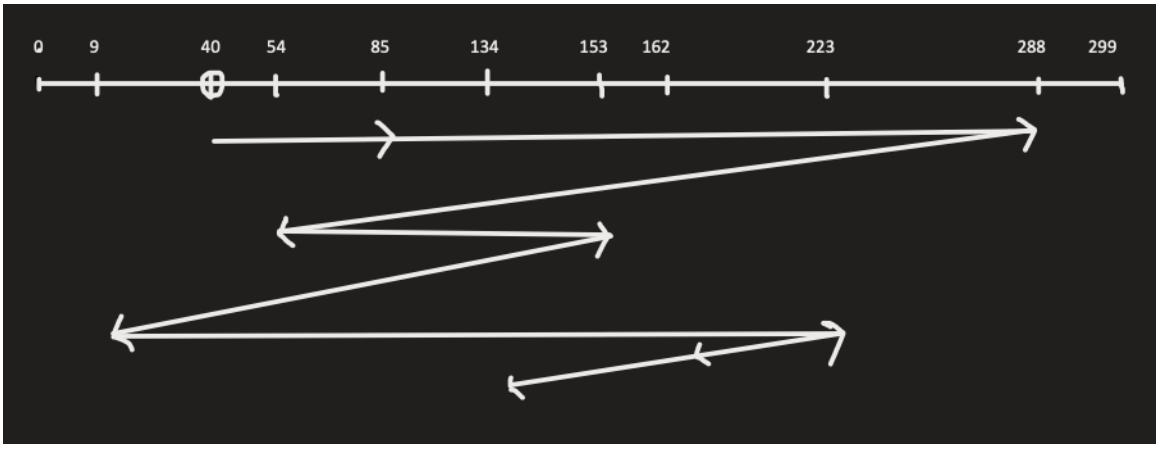
COMP 7500/7506 Advanced Operating Systems
Homework 2: Storage Systems

1. **[20 points] Suppose we apply the SSTF scheduling algorithm (shortest seek time first) to schedule disk requests. Which type of cylinders does SSTF favor? You must justify your answer. Hint: There are three types of cylinders, namely, middle cylinders, innermost cylinders, and outermost cylinders.**

Ans: SSTF favors middle cylinders over the innermost and outermost cylinders. Because the center of the disk has the smallest average distance to all other tracks. Thus, the disk head tends to shift from the corner of the disk toward middle cylinders. For example, the current point of the head isolates the cylinders into two groups. If the head is away from center of the disk and a new request arrives, the new request is more likely from the group that includes the center of the disk. Therefore, the head is more expected to move in that direction.

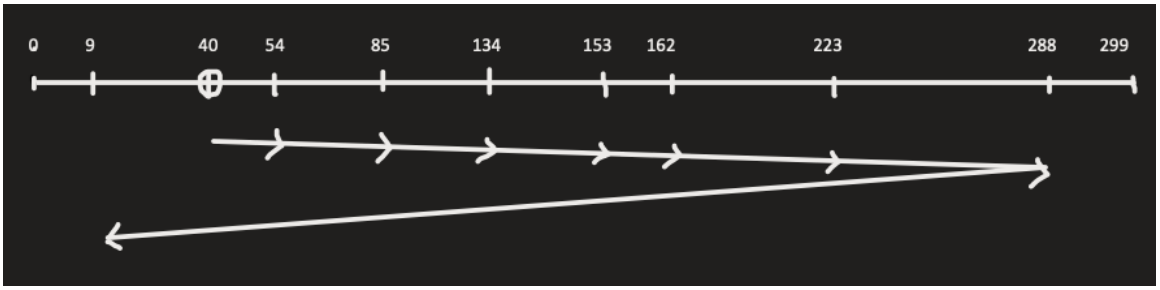
2. [50 points] Let's consider the following disk request queue: 85, 288, 54, 153, 9, 223, 162, 134 with the disk head initially at the track 40 and the tail track being at 299.

2.1 [10 points] What is the total head movement if the FCFS algorithm (i.e., first-come, first-served) is employed to schedule these disk requests?



Total Head movement = 45+203+234+99+144+214+61+28
= 1028

2.2 [10 points] What is the total head movement if the SSTF algorithm (i.e., Shortest Seek Time First) is employed to schedule these disk requests?

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Total Head movement = 14+31+49+19+9+61+65+274
                    = 527
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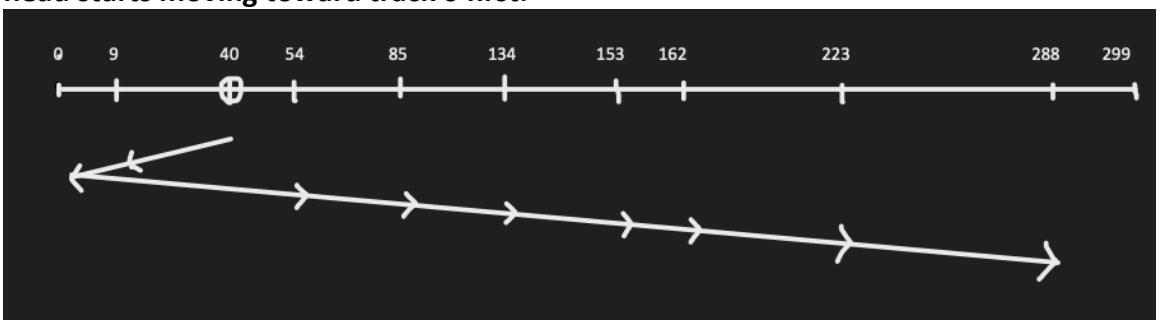
2.3 [10 points] What is the total head movement if the SCAN algorithm (i.e., Elevator) is employed to schedule these disk requests? Assumption: We assume that the disk head starts moving toward track 0 first.

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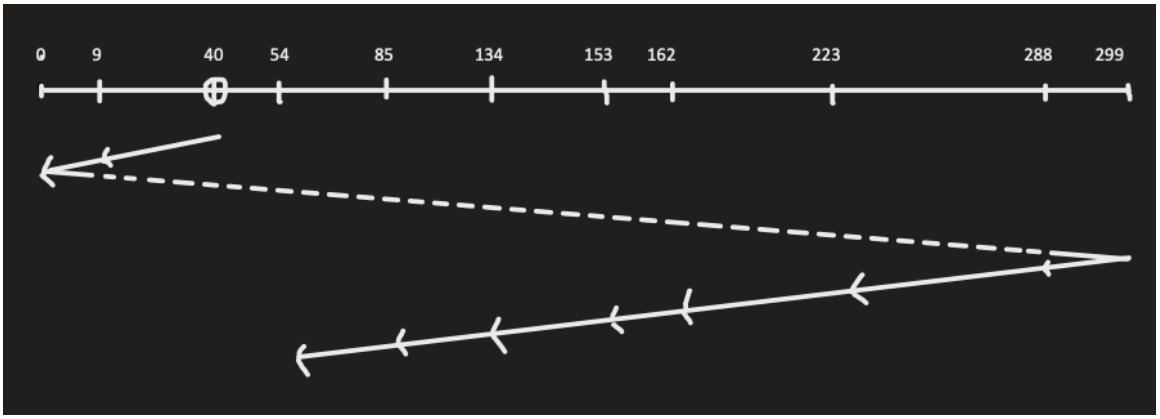
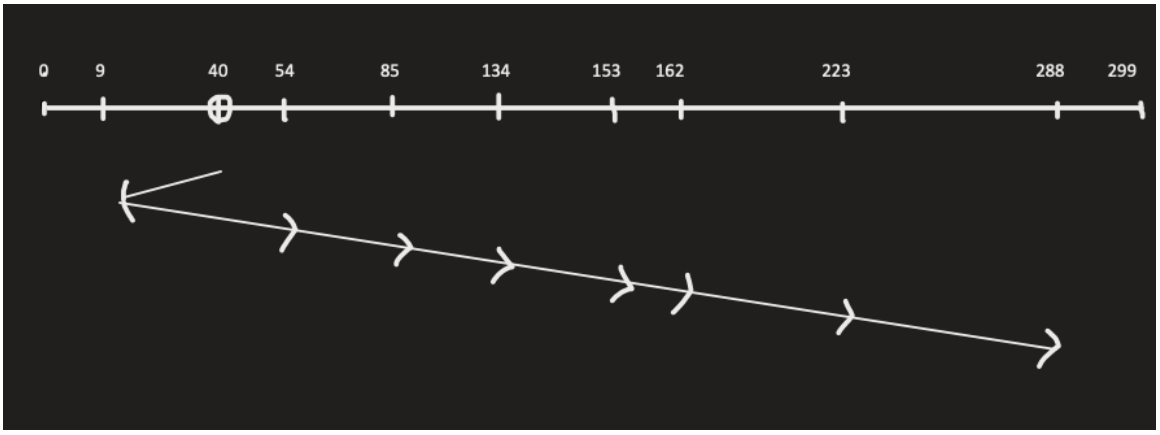
Total Head movement = 31+9+54+31+49+19+9+61+65
                    = 328
```

2.4 [10 points] What is the total head movement if the C-SCAN algorithm (i.e., Circular Scanning) is employed to schedule these disk requests? Assumption: We assume that the disk head starts moving toward track 0 first. We also assume that the big jump from track 0 to track 299 isn't counted as head movement.




```
Total Head movement = 31+9+11+65+61+9+19+49+31
                    = 285
```

2.5 [10 points] What is the total head movement if the LOOK algorithm (i.e., Advanced SCAN) is employed to schedule these disk requests? Assumption: We assume that the disk head starts moving toward track 0 first.




```
Total Head movement = 31+45+31+49+19+9+61+65
                    = 310
```

3. [15 points] Let's compare two RAID systems (i.e., a RAID-0 system and its RAID-1 counterpart), which share the same number of disks.

3.1 [5 points] Can you explain why in normal cases the RAID-0 system outperforms the RAID-1 system in terms of read performance?

Ans: RAID-0 and RAID-1 both provide faster read access. However, RAID-0 shows more efficient read performance than RAID-1. In RAID-0, data is assigned uniformly in multiple disks. So, data can be read synchronously from multiple strips at the same time. On the other hand, RAID 1 uses mirroring strategy to copy the same data into 2 or more disks. So, only single set of data can be read simultaneously from any of the disk.

3.2 [10 points] Please describe a scenario in which RAID-1 may be superior to RAID-0.

Ans: RAID-1 offers redundancy through mirroring whereas RAID-0 offers no redundancy. For example, In RAID-1, data is written identically to two drives which is redundant. Whereas, RAID-0 uses striping (data is split and assigned uniformly in multiple disks). But, RAID-1 may be superior to RAID-0 by offering fault tolerance. RAID-0 offers no fault tolerance; if any of the basic drives fails, the RAID unit fails. but in RAID-1 if any of the basic drives fails the data can be easily recovered because of the mirroring of the drives.

4. [15 points] Rebuilding a failed RAID-5 system requires reading data from all surviving disks. Please describe a potential problem during the read-intensive RAID-5 rebuilding process.

Ans: In RAID-5, the parity information is distributed among the drives. Also, if one (and only one) of the drives fails but the others are working, everything will continue to operate successfully with no data loss.
However, serious disaster can strike during rebuilding process. When we build the disk array, the lifespan of each disk is more likely same because they come from same vendor. That means, if one disk fails, other survival disks may fail in the same time. If intensive read is done from other survival disks, it is more likely we may get second failed disk. That means, during the data reconstruction process we would be unable to recover the data because of second disk

fail thus, the loss of an entire array. Because, in RAID-5 storage system, only 1 simultaneous disk failure the RAID-5 system can endure.