Oct 30, 2024

CS 350 DISCUSSION 8

Averages & Disk Scheduling

Making Predictions Using Averages

Simple Average

$$\overline{C}(n) = \frac{1}{n} \sum_{k=1}^{n} C_k$$

Sliding Window Average

$$\overline{C}(n) = \frac{1}{\omega} \sum_{k=n-\omega+1}^{n} C_k$$

Exponentially Weighted Moving Average

$$\overline{C}(n) = \alpha C_n + (1 - \alpha)\overline{C}(n-1)$$

Let's Practice

Exercise 1

Given your proven track record as an environmental scientist with a strong CS background, you have been deployed in Antarctica. Here, your job is to predict the day-by-day temperature of a specific ice cap. You design your experiments so that each day you collect 30 samples to be averaged, producing a single daily sample. Then, right before day x, you look at the history of the daily samples from day 0 until day $x-1$, and try to predict the temperature of the ice cap under analysis, before carrying out the measurement for day x. Assume that today is October 23, 2018, and that Day 0 was October 10, 2018. Table below depicts a list of daily samples collected starting from October 10, 2018.

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35

Date	Temperature (F)
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 1

How do you construct each daily sample? Specify how would you distribute your 30 measurements throughout each day, and how do you compute each of the final values reported in Table 1.

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 1

How do you construct each daily sample? Specify how would you distribute your 30 measurements throughout each day, and how do you compute each of the final values reported in Table 1.

Answer

The 30 measurements should be evenly distributed throughout a day.

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Produce predictions for the next 5 days, until October 28. For this purpose, proceed as follows. First, consider only samples from Oct. 10 until Oct. 23 to produce a prediction for the temperature on Oct. 24. Then, go out in the cold and measure the daily temperature for Oct. 24. Now, use samples from Oct. 10 through Oct. 24 to produce a prediction for Oct. 25 and so on. Do this using **simple averaging**, **sliding window averages** with w **= 4**, and **exponentially weighted averages** with α **= 0.6**.

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **simple averaging**.

Date	Est Temp (F)	Real Temp (F)
Oct. 24		-31
Oct. 25		-26
Oct. 26		-23
Oct. 27		-24
Oct. 28		-27

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **simple averaging**.

Answer

Date	Est Temp (F)	Real Temp (F)
Oct. 24	**-30**	-31
Oct. 25	**-30.07**	-26
Oct. 26	**-29.81**	-23
Oct. 27	**-29.41**	-24
Oct. 28	**-29.11**	-27

$$\overline{C}_{oct23} = (-31 + -25 + -24 + -23 + -27 + -28 + -34 + -35 + -35 + -34 + -32 + -31 + -31 + -30) \,/\, 14 = -30$$

$$\overline{C}_{oct24} = (\overline{C}_{oct23} \cdot 14 \; + -31) \,/\, 15 = -30.07$$

$$\overline{C}_{oct25} = (\overline{C}_{oct24} \cdot 15 \; + -26) \,/\, 16 = -29.81$$

$$\overline{C}_{oct26} = (\overline{C}_{oct25} \cdot 16 \; + -23) \,/\, 17 = -29.41$$

$$\overline{C}_{oct27} = (\overline{C}_{oct26} \cdot 17 \; + -24) \,/\, 18 = -29.11$$

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **sliding window averages** with w **= 4**.

Date	Est Temp (F)	Real Temp (F)
Oct. 24		-31
Oct. 25		-26
Oct. 26		-23
Oct. 27		-24
Oct. 28		-27

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **sliding window averages** with w **= 4**.

Answer

Date	Est Temp (F)	Real Temp (F)
Oct. 24	**-31**	-31
Oct. 25	**-30.75**	-26
Oct. 26	**-29.5**	-23
Oct. 27	**-27.5**	-24
Oct. 28	**-26**	-27

$$\overline{C}_{oct23} = (-32 + -31 + -31 + -30) \ / \ 4 = -31$$

$$\overline{C}_{oct24} = (-31 + -31 + -30 + -31) \ / \ 4 = -30.75$$

$$\overline{C}_{oct25} = (-31 + -30 + -31 + -26) \ / \ 4 = -29.5$$

$$\overline{C}_{oct26} = (-30 + -31 + -26 + -23) \ / \ 4 = -27.5$$

$$\overline{C}_{oct27} = (-31 + -26 + -23 + -24) \ / \ 4 = -26$$

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **exponentially weighted averages** with α **= 0.6**.

Date	Est Temp (F)	Real Temp (F)
Oct. 24		-31
Oct. 25		-26
Oct. 26		-23
Oct. 27		-24
Oct. 28		-27

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **exponentially weighted averages** with α = **0.6**.

Answer

Date	Est Temp (F)	Real Temp (F)
Oct. 24	**-30.52**	-31
Oct. 25		-26
Oct. 26		-23
Oct. 27		-24
Oct. 28		-27

$$\overline{C}_{oct23} = 0.6 \cdot (-30) + (1 - 0.6)\overline{C}_{oct22} = 0.6 \cdot (-30) + (1 - 0.6)(0.6 \cdot (-31) + (1 - 0.6)\overline{C}_{oct21}) = \ \ldots \ = -30.52$$

Problem 15.9 from the book

Let's Practice

Exercise 1

Date	Temperature (F)
Oct. 10	-31
Oct. 11	-25
Oct. 12	-24
Oct. 13	-23
Oct. 14	-27
Oct. 15	-28
Oct. 16	-34
Oct. 17	-35
Oct. 18	-35
Oct. 19	-34
Oct. 20	-32
Oct. 21	-31
Oct. 22	-31
Oct. 23	-30

Question 2

Predicting next 5 days using **exponentially weighted averages** with α = **0.6**.

Answer

Date	Est Temp (F)	Real Temp (F)
Oct. 24	**-30.52**	-31
Oct. 25	**-30.81**	-26
Oct. 26	**-27.92**	-23
Oct. 27	**-24.97**	-24
Oct. 28	**-24.39**	-27

$$\overline{C}_{oct23} = 0.6 \cdot (-30) + (1-0.6)\overline{C}_{oct22} = 0.6 \cdot (-30) + (1-0.6)(0.6 \cdot (-31) + (1-0.6)\overline{C}_{oct21}) = \ \ldots \ = -30.52$$

$$\overline{C}_{oct24} = 0.6 \cdot (-31) + (1-0.6)\overline{C}_{oct23} = -30.81$$

$$\overline{C}_{oct25} = 0.6 \cdot (-26) + (1-0.6)\overline{C}_{oct24} = -27.92$$

$$\overline{C}_{oct26} = 0.6 \cdot (-23) + (1-0.6)\overline{C}_{oct25} = -24.97$$

$$\overline{C}_{oct27} = 0.6 \cdot (-24) + (1-0.6)\overline{C}_{oct26} = -24.39$$

Problem 15.9 from the book

Let's Practice

Exercise 1

Question 3

Which one of the approaches above yields a smaller error when compared to the real temperature values? *(hint: you can compute the error as the absolute value of the difference between your day-by-day predictions and the daily measurements from Oct. 24-28).*

Simple Averages

Date	Est Temp (F)	Real Temp (F)
Oct. 24	-30	-31
Oct. 25	-30.07	-26
Oct. 26	-29.81	-23
Oct. 27	-29.41	-24
Oct. 28	-29.11	-27

Sliding Window

Date	Est Temp (F)	Real Temp (F)
Oct. 24	-31	-31
Oct. 25	-30.75	-26
Oct. 26	-29.5	-23
Oct. 27	-27.5	-24
Oct. 28	-26	-27

EWMA

Date	Est Temp (F)	Real Temp (F)
Oct. 24	-30.52	-31
Oct. 25	-30.81	-26
Oct. 26	-27.92	-23
Oct. 27	-24.97	-24
Oct. 28	-24.39	-27

Problem 15.9 from the book

Let's Practice

Exercise 1

Question 3

Which one of the approaches above yields a smaller error when compared to the real temperature values?

Simple Averages

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-30	-31	
Oct. 25	-30.07	-26	
Oct. 26	-29.81	-23	
Oct. 27	-29.41	-24	
Oct. 28	-29.11	-27	

Sliding Window

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-31	-31	
Oct. 25	-30.75	-26	
Oct. 26	-29.5	-23	
Oct. 27	-27.5	-24	
Oct. 28	-26	-27	

EWMA

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-30.52	-31	
Oct. 25	-30.81	-26	
Oct. 26	-27.92	-23	
Oct. 27	-24.97	-24	
Oct. 28	-24.39	-27	

Problem 15.9 from the book

Let's Practice

Exercise 1

Question 3

Which one of the approaches above yields a smaller error when compared to the real temperature values?

Answer

Simple Averages

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-30	-31	**1**
Oct. 25	-30.07	-26	**4.07**
Oct. 26	-29.81	-23	**6.81**
Oct. 27	-29.41	-24	**5.41**
Oct. 28	-29.11	-27	**2.11**

Average Error = 3.88

Sliding Window

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-31	-31	**0**
Oct. 25	-30.75	-26	**4.75**
Oct. 26	-29.5	-23	**6.5**
Oct. 27	-27.5	-24	**3.5**
Oct. 28	-26	-27	**1**

Average Error = 3.15

EWMA

Date	Est Temp (F)	Real Temp (F)	Error
Oct. 24	-30.52	-31	**0.48**
Oct. 25	-30.81	-26	**4.81**
Oct. 26	-27.92	-23	**4.92**
Oct. 27	-24.97	-24	**0.97**
Oct. 28	-24.39	-27	**2.61**

Average Error = 2.758 (SMALLEST)

Problem 15.9 from the book

Let’s Practice (Disk Scheduling)

Exercise 2

Consider a disk with 14 cylinders numbered from 0 to 13. Any disk operation is associated a cylinder number where the desired data is stored. Moreover, it is known that the mechanical head of the disk is capable of moving at the speed of exactly 1 cylinder per time unit. When the disk is idle, the position of the head remains that of the last request it served. Moreover, once in position, a read/write operation is performed very quickly, hence the time for actual reads/writes can be considered as negligible. Always assume that once picked, a request has to be served until completion (no preemption).

Initial state: at time zero, the disk has just finished serving a request at cylinder 2, and there are no other pending requests.

Request arrival: After time zero, new requests arrive with the arrival times and cylinder IDs as reported below.

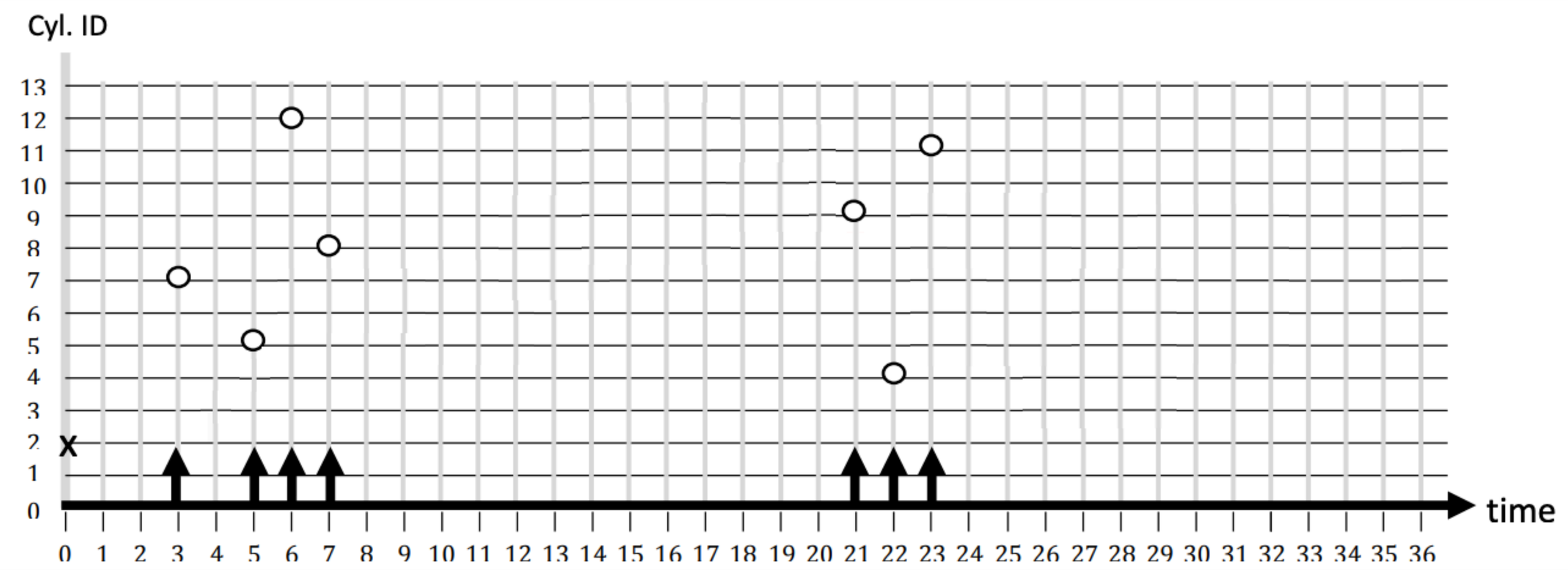
Request ID	Arrival Time	Cylinder ID
R1	3	7
R2	5	5
R3	6	12
R4	7	8
R5	21	9
R6	22	4
R7	23	11

Let's Practice (Disk Scheduling)

Exercise 2

Question 1

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **FIFO scheduler** is used by the disk. For simplicity, the initial position of the disk head (marked with an x), the cylinder ID (marked with an empty circle), and the arrival time (marked with an arrow) of each of the requests are depicted.



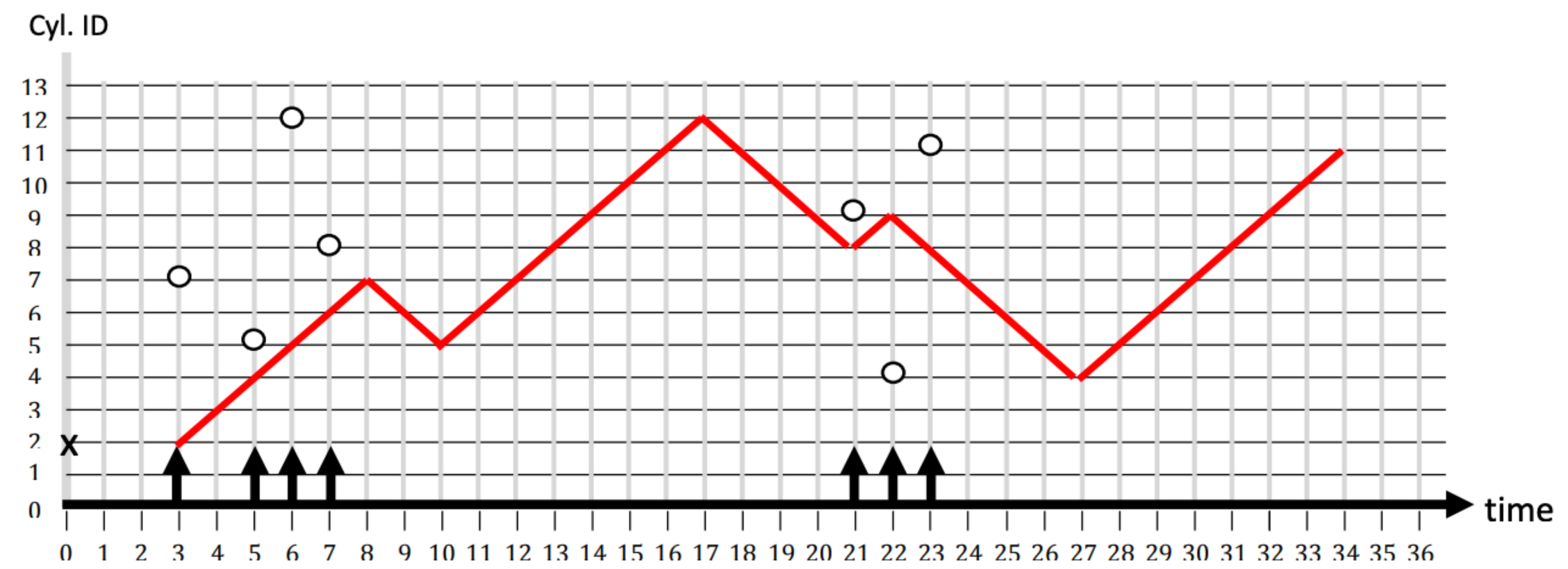
Let's Practice (Disk Scheduling)

Exercise 2

Question 1

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **FIFO scheduler** is used by the disk. For simplicity, the initial position of the disk head (marked with an x), the cylinder ID (marked with an empty circle), and the arrival time (marked with an arrow) of each of the requests are depicted.

Answer

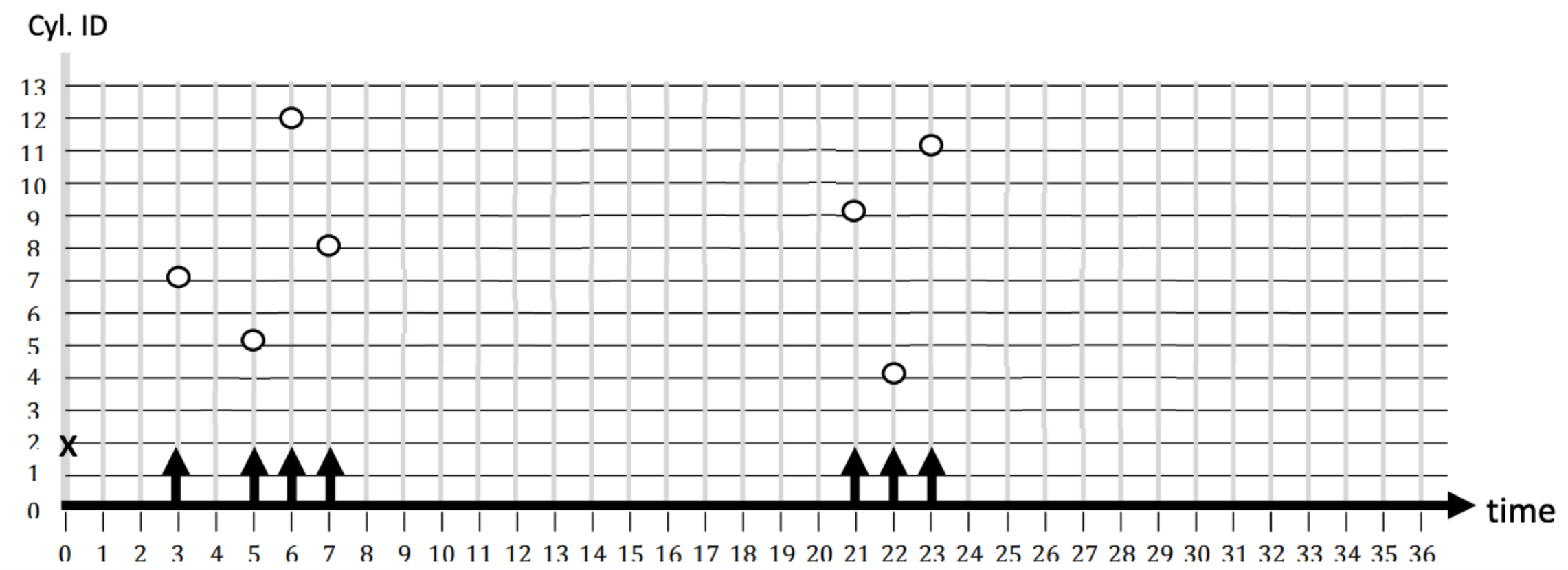


Let's Practice (Disk Scheduling)

Exercise 2

Question 2

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **SSF scheduler** is used by the disk. Once again, the initial position of the disk head, the cylinder ID, and the arrival of each of the requests are depicted.



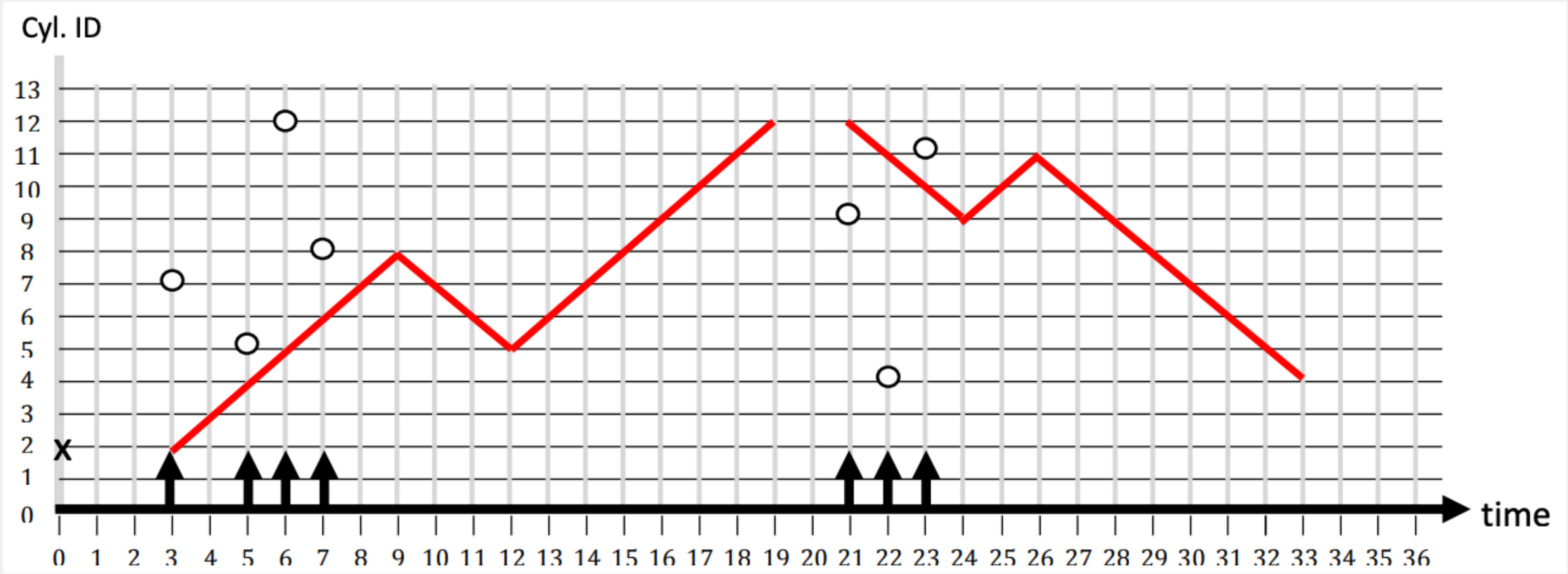
Let's Practice (Disk Scheduling)

Exercise 2

Question 2

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **SSF scheduler** is used by the disk. Once again, the initial position of the disk head, the cylinder ID, and the arrival of each of the requests are depicted.

Answer

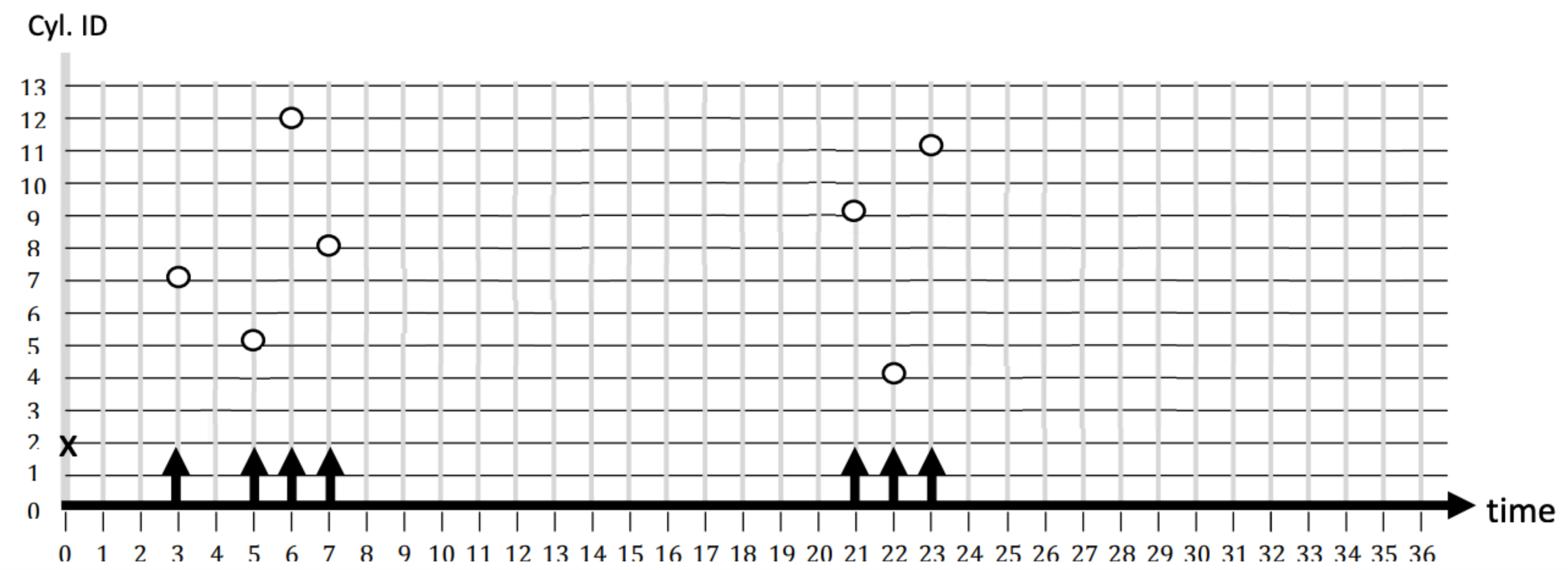


Let’s Practice (Disk Scheduling)

Exercise 2

Question 3

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **SCAN scheduler** is used by the disk. Once again, the initial position of the disk head, the cylinder ID, and the arrival of each of the requests are depicted.



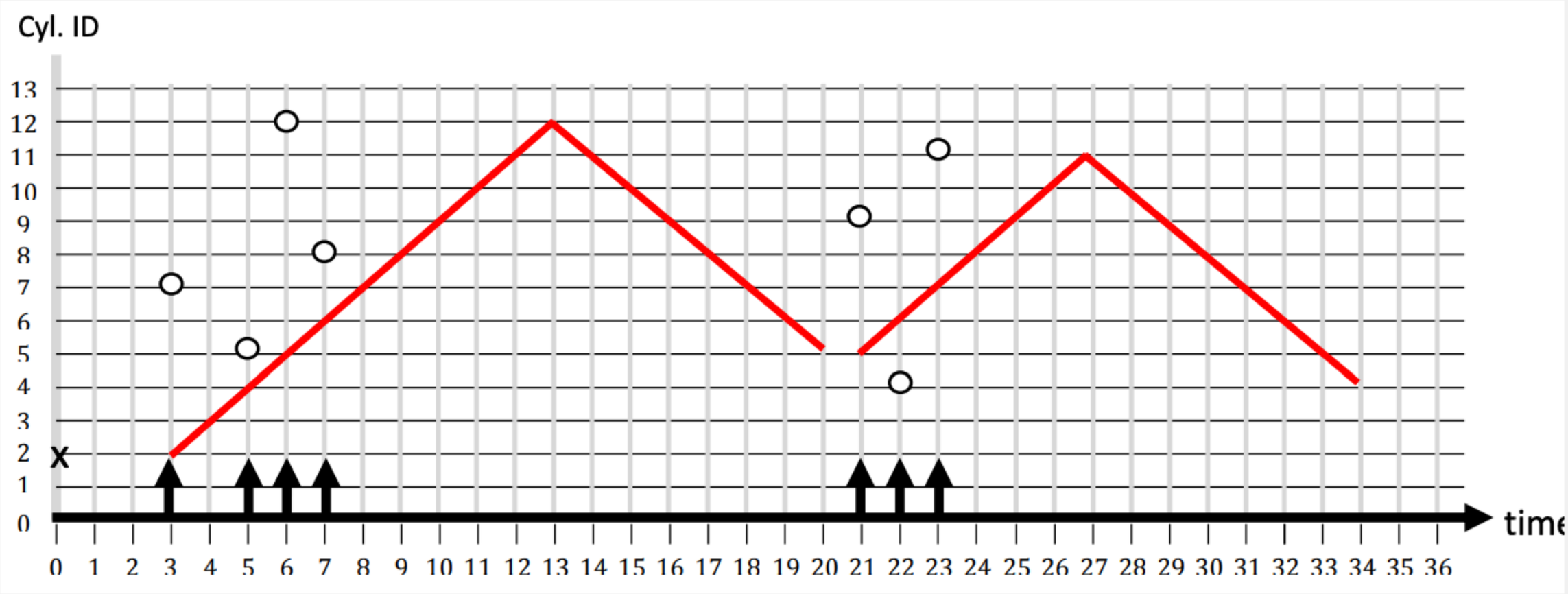
Let’s Practice (Disk Scheduling)

Exercise 2

Question 3

Use the grid below to produce the schedule and motion of the disk head until time 36 if a **SCAN scheduler** is used by the disk. Once again, the initial position of the disk head, the cylinder ID, and the arrival of each of the requests are depicted.

Answer



Let’s Practice (Disk Scheduling)

Exercise 2

Question 4

The disk remains idle if the queue of pending requests is empty. Draw a comparison of FIFO, SSN, and SCAN in terms of disk utilization over the considered time interval from 0 to 36. Based only on that, which scheduler is to be preferred?

Let’s Practice (Disk Scheduling)

Exercise 2

Question 4

The disk remains idle if the queue of pending requests is empty. Draw a comparison of FIFO, SSN, and SCAN in terms of disk utilization over the considered time interval from 0 to 36. Based only on that, which scheduler is to be preferred?

Answer

FIFO Utilization = (34 - 3) / 36 = **0.86**
SSN Utilization = ((33 - 21) + (19 - 3)) / 36 = **0.78** **←SMALLEST**
SCAN Utilization = ((34 - 21) + (20 - 3)) / 36 = **0.83**