Scheduling

מערכות הפעלה תרגול 6

Exercise 1: CPU utilization

A given system runs a single process, which waits for I/O for 40% of the time (avg.).

Q: What is the approximate CPU utilization?

Exercise 1: CPU utilization

A given system runs a single process, which waits for I/O for 40% of the time (avg.).

Q: What is the approximate CPU utilization?

A: 0.6

Exercise 1: CPU utilization

A given system runs a single process, which waits for I/O for 40% of the time (avg.).

Q: What is the approximate CPU utilization?

A: 0.6

Q: What is the approximate CPU utilization with **three** processes running?

Exercise 1: CPU utilization

A given system runs a single process, which waits for I/O for 40% of the time (avg.).

Q: What is the approximate CPU utilization?

A: 0.6

Q: What is the approximate CPU utilization with **three** processes running?

A: At a given moment, the probability that all three processes are blocking on I/O is 0.6^3

That means that the CPU utilization is $1-0.6^3$

Exercise 2: FCFS vs. SJF

- The following is a list of processes which require scheduling:

  P_A – 6 TU (time units)

  P_B – 3 TU

  P_C – 1 TU

  P_D – 7 TU

Determine the turnaround with FCFS and SJF

Exercise 2: FCFS vs. SJF - Solution

- FCFS: (6,3,1,7) -> 6+9+10+17=42 TU
- SJF: (1,3,6,7) -> 1+4+10+17=32 TU

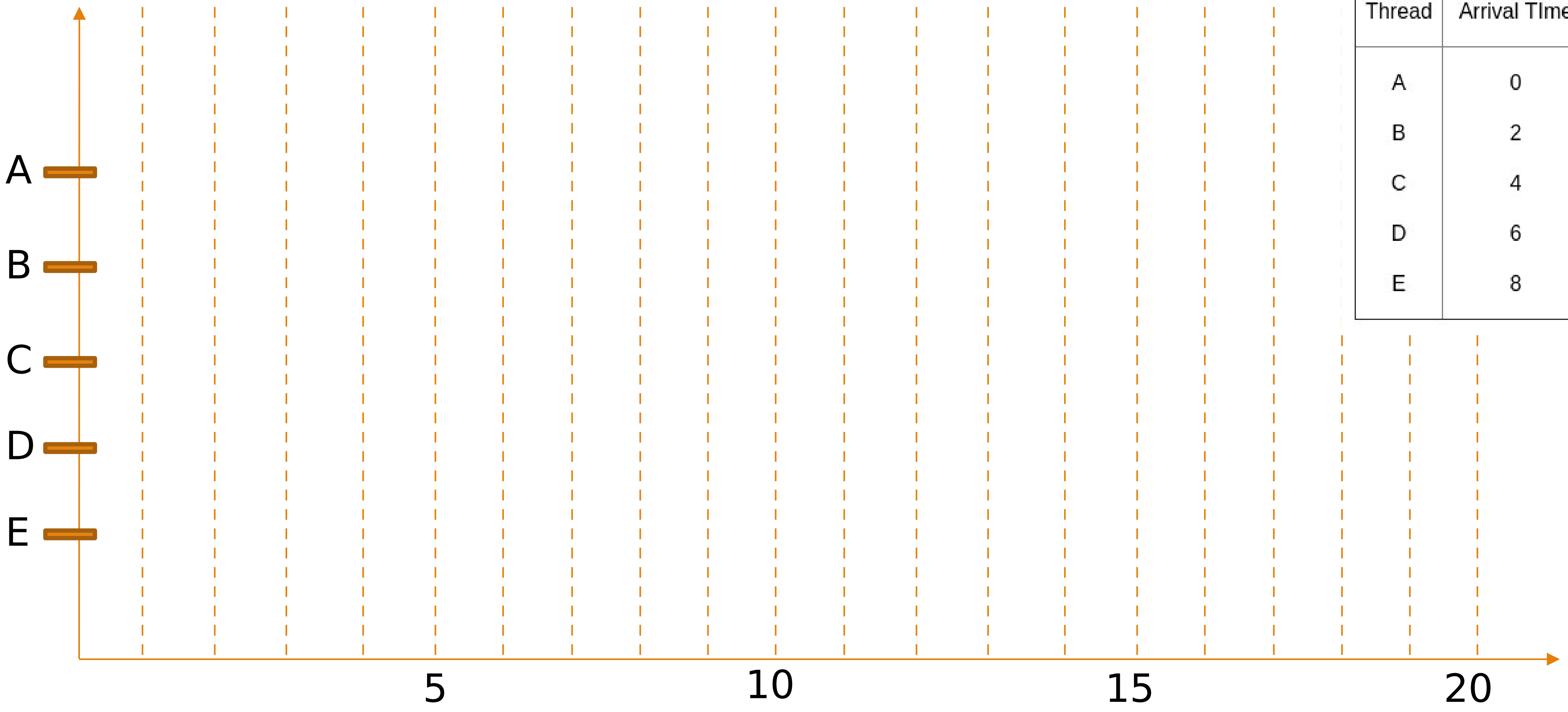
Exercise 3: HRRN

What is the order of the processes running?

Thread	Arrival TIme	CPU Burst Length
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2

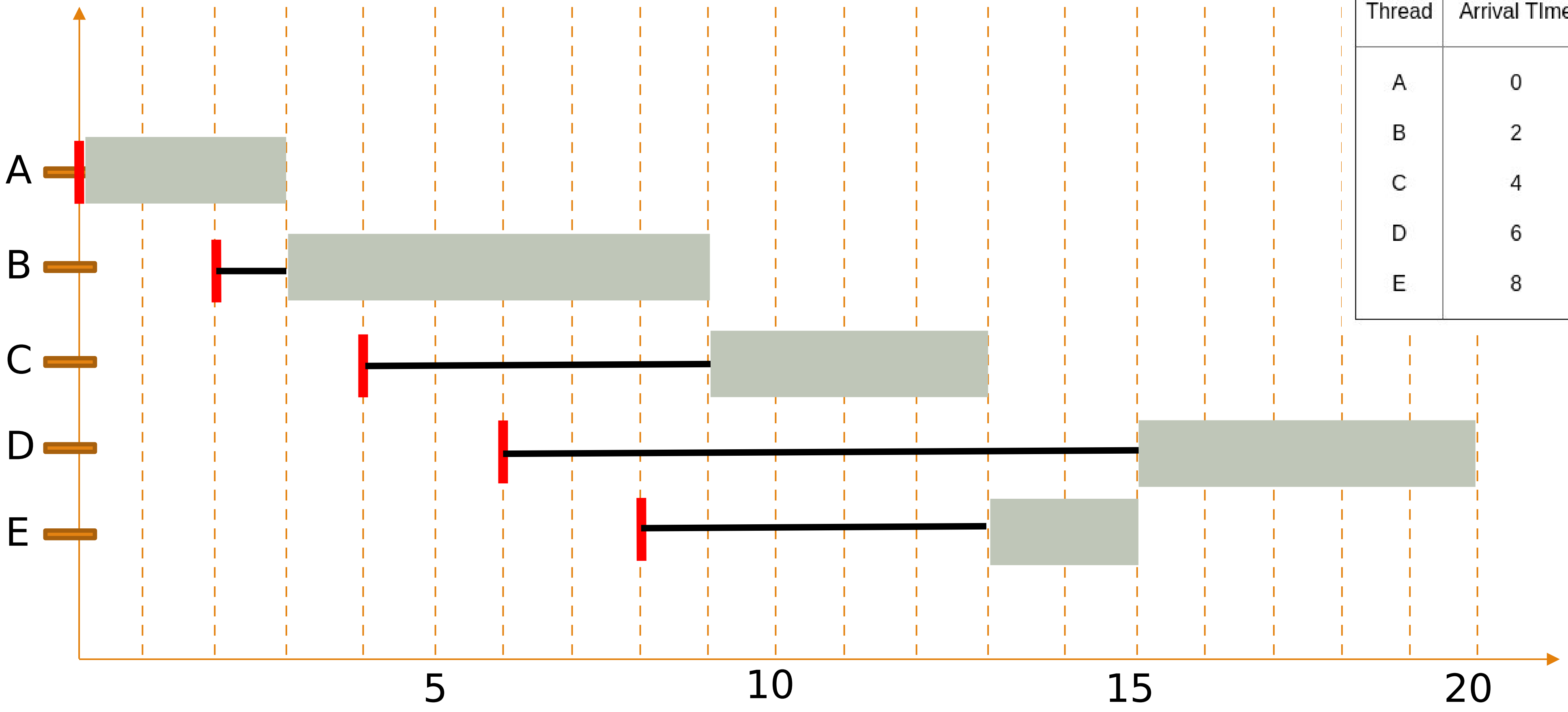
$$Priority = \frac{waiting\ time + estimated\ run\ time}{estimated\ run\ time} = 1 + \frac{waiting\ time}{estimated\ run\ time}$$

Exercise 3: HRRN - Solution



Thread	Arrival TIme	CPU Burst Length
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2

Exercise 3: HRRN - Solution



Thread	Arrival TIme	CPU Burst Length
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2

Exercise 4: Round Robin

- The following is a list of processes which require scheduling:

  P_A – 6 TU (time units)

  P_B – 3 TU

  P_C – 1 TU

  P_D – 7 TU

- What is the optimal quanta size when scheduling with RR to achieve minimal average turnaround time? (assume 0 cost context switches, and that all processes are in the 'ready' queue)

Exercise 4: Round Robin

$P_A=6$, $P_B=3$, $P_C=1$, $P_D=7$

Quanta =

17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Quanta=1:

Quanta=2:

Quanta=3:

Quanta=4:

Quanta=5:

Quanta=6:

Quanta=7:

Exercise 4: Round Robin - Solution

$P_A=6$, $P_B=3$, $P_C=1$, $P_D=7$

Quanta =1 15+9+3+17=44 /4=11

17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
D	D	A	D	A	D	A	D	B	A	D	B	A	D	C	B	A

Quanta =2 14+10+5+17=46 /4=11.5

17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
D	D	D	A	A	D	D	B	A	A	D	D	C	B	B	A	A

Quanta=3: 13+6+7+17=43 /4=10.75

Quanta=4: 14+7+8+17=46 /4=11.5

Quanta=5: 15+8+9+17=49 /4=12.25

Quanta=6,7: 6+9+10+17=42 /4=10.5

Exercise 5: Preemptive Dynamic Priorities

(Taken from Silberschatz, 5-9)

- Consider the following preemptive priority scheduling algorithm
  - Larger numbers imply higher priority
  - The initial priority of every process is 0
  - When a process is waiting for the CPU in the ready Q, its priority changes at rate **α**; when it is running, its priority changes at rate **β**.
  - **α** and **β** can be set

Exercise 5: Preemptive Dynamic Priorities

What is the best ratio between and ?

Consider the following example: P_1, P_2, P_3 arrive one after the other and last for 3 TU

9	8	7	6	5	4	3	2	1	
								0	P1
							0		P2
						0			P3

Exercise 5: Example

What is the algorithm that results from $\beta > \alpha > 0$?

Consider the following example: P_1, P_2, P_3 arrive one after the other and last for 3 TU

Let $\alpha = 1, \beta = 2$

9	8	7	6	5	4	3	2	1	
						4	**2**	**0**	P1
			6	**4**	**2**	1	0		P2
8	**6**	**4**	3	2	1	0			P3

The resulting schedule is a non-preemptive ***FCFS***

Exercise 5: Example

- What is the algorithm that results from $\alpha < \beta < 0$?

Consider an identical example as before, but now α=-2, β=-1

9	8	7	6	5	4	3	2	1	
14-	**13-**	11-	9-	7-	5-	3-	1-	**0**	P1
		8-	**7-**	5-	3-	1-	**0**		P2
				2-	**1-**	**0**			P3

The resulting schedule is ***LIFO***

Exercise 6: Multilevel queue

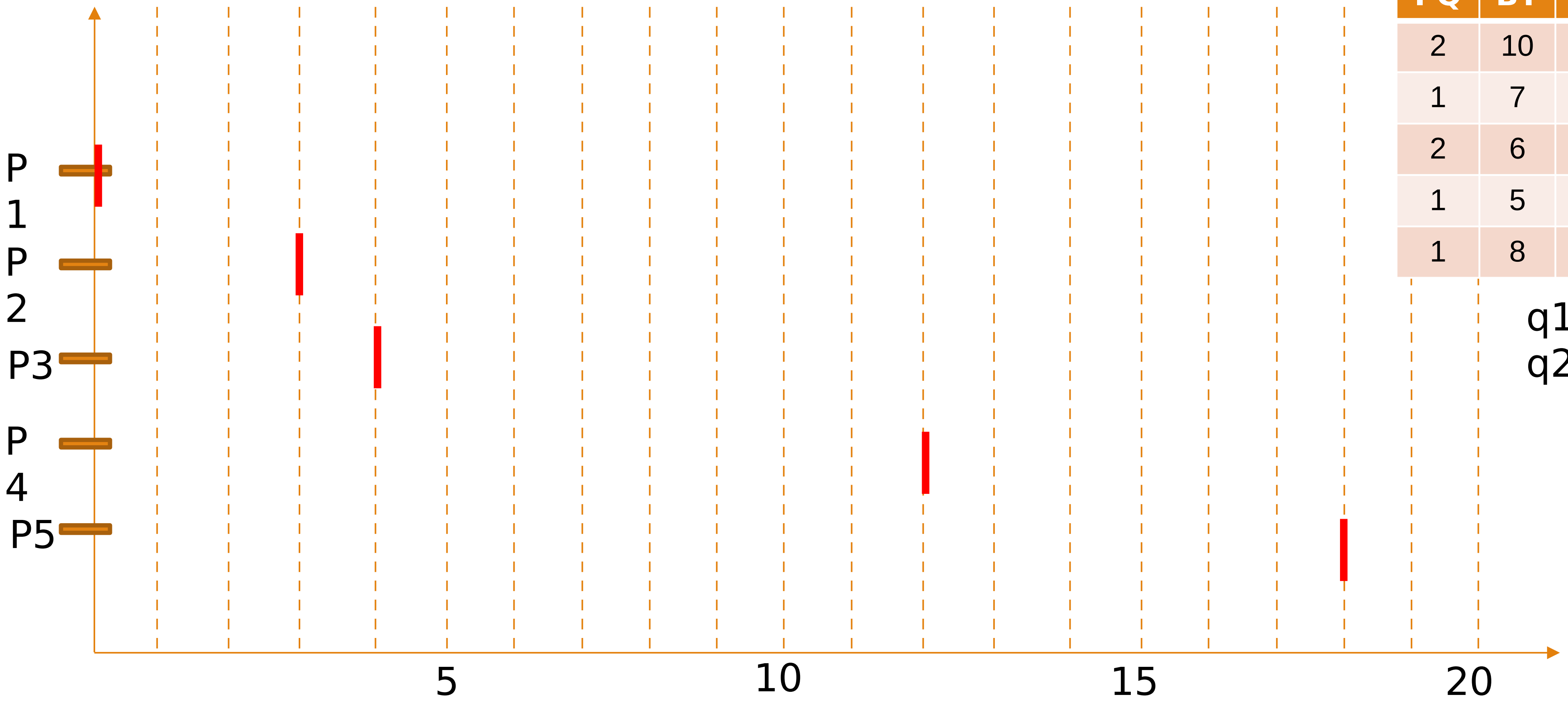
- The following is a list of processes which require scheduling:

PQ	BT	AT	
2	10	0	P1
1	7	3	P2
2	6	4	P3
1	5	12	P4
1	8	18	p5

AT – Arrival time
BT – Burst (working) time

- Both queues use RR scheduling with:
  - Proirity q 1: quanta=4
  - Priority q 2: quanta=3
- What is the turnaround avg such that q1 has higher priority over q2?

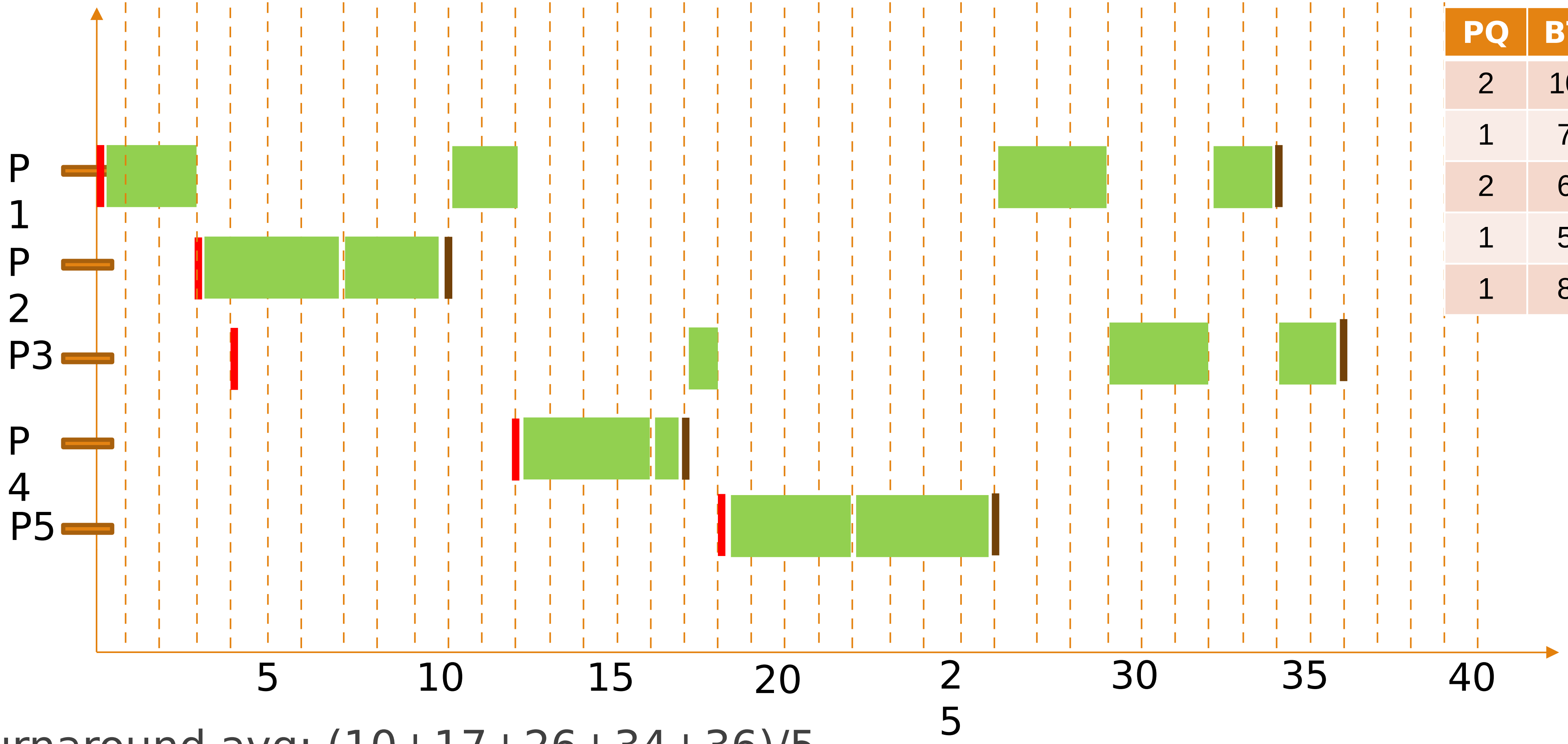
Exercise 6: Multilevel queue



PQ	BT	AT	
2	10	0	P1
1	7	3	P2
2	6	4	P3
1	5	12	P4
1	8	18	p5

q1: quanta=4
q2: quanta=3

Exercise 6: Multilevel queue - solution



PQ	BT	AT	
2	10	0	P1
1	7	3	P2
2	6	4	P3
1	5	12	P4
1	8	18	p5

q1: quanta=4
q2: quanta=3

Turnaround avg: (10+17+26+34+36)/5

Exercise 7: Guaranteed Scheduling

- What is the running order of the next processes by guaranteed priority?

Ratio (BT/ Period)	Period (AT/n)	BT	AT	
		8	2	P1
		6	4	P2
		10	6	P3
		4	8	P4

Exercise 7: Guaranteed Scheduling

- What is the running order of the next processes by guaranteed priority?

Ratio (BT/Period)	Period (AT/n)	BT	AT	
16	0.5	8	2	P1
6	1	6	4	P2
6.7	1.5	10	6	P3
2	2	4	8	P4

Order: P4,P2,P3,P1