Solution : TD N°3: Scheduling

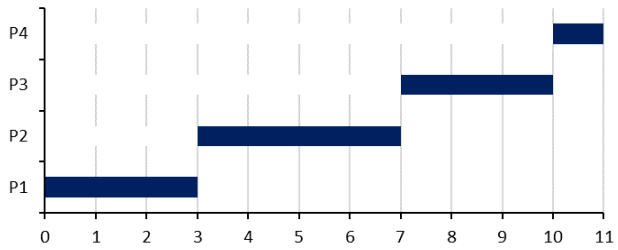
Exercise n°1

We consider 4 processes P_1, P_2, P_3, and P_4, whose execution time and arrival date are given in the following table:

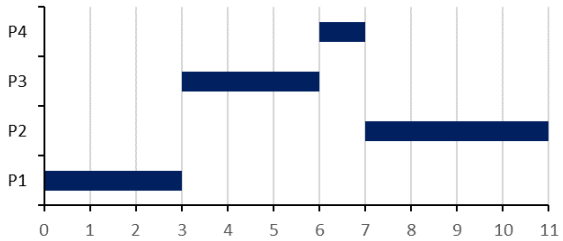
Process	Execution time	Arrival date
P_1	3	0
P_2	4	1
P_3	3	3
P_4	1	4

1) Give the Gantt diagram (the execution diagram) for these 4 processes according to the following schedules:

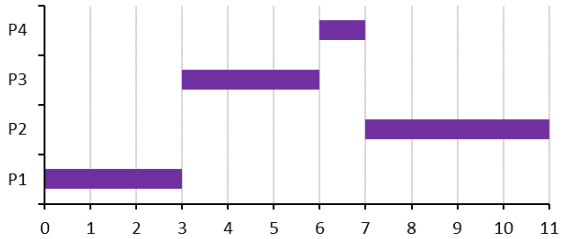
a) FCFS scheduling (First Come, First Served).



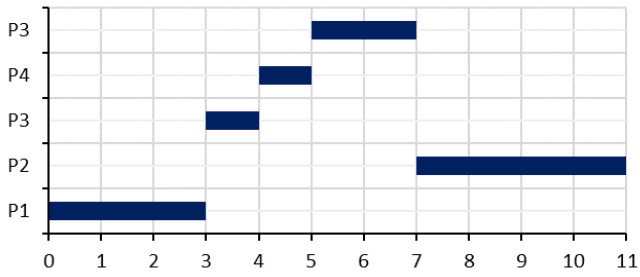
b) LIFO scheduling (First In, First Out).



c) SJF scheduling (Shortest Job First).



d) SRTF scheduling (Shortest Remaining Time First).



2) Calculate the average response time and the average waiting time for the 4 types of scheduling: FCFS, LIFO, SRTF and SJF.

FCFS

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	3	3	0
P2	1	4	7	6	2
P3	3	3	10	7	4
P4	4	1	11	7	6

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{3+6+7+7}{4} = \frac{23}{4} = 5.75$$

$$Avg_{WaitTime} = \frac{\sum_{i=1} WaitTime_i}{n} = \frac{0+2+4+6}{4} = \frac{12}{4} = 3$$

LIFO

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	3	3	0
P2	1	4	11	10	6
P3	3	3	6	3	0
P4	4	1	7	3	2

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{3+10+3+3}{4} = \frac{19}{4} = 4.75$$

$$Avg_{WaitTime} = \frac{\sum_{i=1} WaitTime_i}{n} = \frac{0+6+0+2}{4} = \frac{8}{4} = 2$$

SJF

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	3	3	0
P2	1	4	11	10	6
P3	3	3	6	3	0
P4	4	1	7	3	2

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{3+10+3+3}{4} = \frac{19}{4} = 4.75$$

$$Avg_{WaitTime} = \frac{\sum_{i=1} WaitTime_i}{n} = \frac{0+6+0+2}{4} = \frac{8}{4} = 2$$

SRTF

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	3	3	0
P2	1	4	11	10	6
P3	3	3	7	4	1
P4	4	1	5	1	0

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{3+10+4+1}{4} = \frac{18}{4} = 4.5$$

$$Avg_{WaitTime} = \frac{\sum_{i=1} WaitTime_i}{n} = \frac{0+6+1+0}{4} = \frac{7}{4} = 1.75$$

Exercise n°2

Three processes P_1, P_2 and P_3 were loaded into a data processing system on the dates shown below:

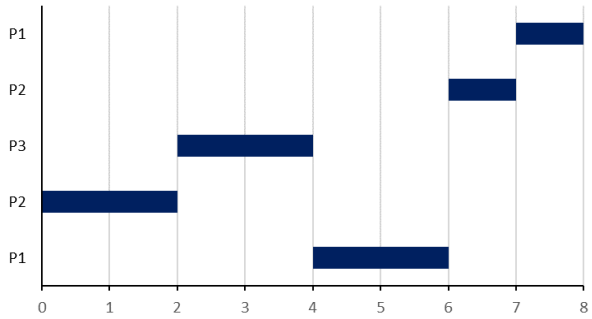
Processus	Execution time	Arrival date	Static priority
P_1	3	0	3
P_2	3	0	1
P_3	2	2	2

1) Give the Gantt diagram (the execution diagram) for these processes using the following scheduling algorithms:

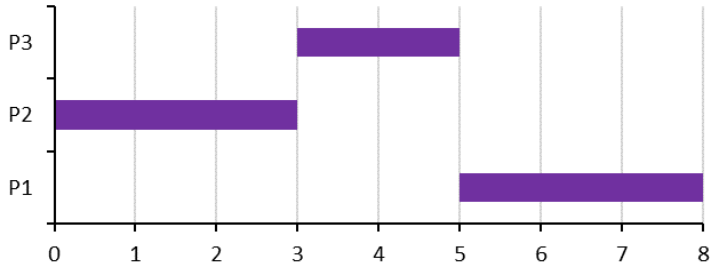
   a) R-R (round robin) with quantum = 2.

   L'ordonnanceur consulte la file ***Queue_Ready*** après chaque 2 unités de temps (par exemple chaque 2 secondes) et sélectionne le processus le plus prioritaire parmi les processus qui ne sont pas encore passés par le processeur de telle que l'ordre d'exécution des processus soit cyclique. Dans cette partie, la priorité est utilisée pour départager entre les processus qui ne sont pas passés par le processeur.

   Exemple : au temps 0, l'ordonnanceur trouvera P_1 et P_2 dans la file d'attente ***Queue_Ready*** il choisira P_2 car il a une priorité supérieure à celle de P_1. Après 2 unité de temps, l'ordonnanceur consulte la file ***Queue_Ready*** il trouvera les processus P_1 et P_3, et dans ce cas il prendra en charge P_3 car il n'est pas encore passé d'une part (d'après le cycle de round robin) et d'autre part il a une priorité supérieure que celle de P_1.



   b) Static priority (priority is given to the process with a low priority value).



2) Calculate the average response time for these 2 types of scheduling.

Round Robin (RR)

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	8	8	5
P2	0	3	7	7	4
P3	2	2	4	2	0

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{8+7+2}{3} = \frac{17}{3} = 5.66$$

Fixed priority

Process	Arrival Time	Execution time	End date	Resp Time	Waiting Time
P1	0	3	8	8	5
P2	0	3	3	3	0
P3	2	2	5	3	1

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{8+3+3}{3} = \frac{14}{3} = 4.66$$

3) Compare them according to the response time criterion.

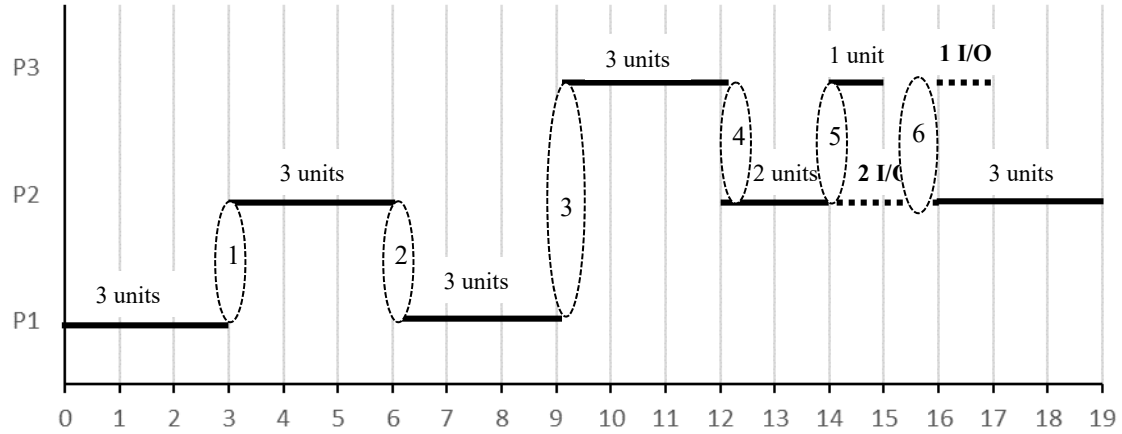
L'algorithme d'ordonnancement avec priorité statique est meilleur que celui de round robin en termes de temps de réponse. En outre, il présente un nombre de commutations de contexte inférieur que celui de round robin.

Exercise n°3

Consider three processes P1, P2 and P3, whose execution time and arrival date are given in the following table:

Processus	**Execution time**	**Arrival date**
P1	6 cpu	0
P2	5 cpu + 2 I/O + 3 cpu	3
P3	4 cpu + 1 I/O	5

1) Give the execution diagram (Gantt diagram) of these processes according to the following scheduling algorithm: R-R (round robin) with a quantum = 3 units and a context switch = 1 unit.



2) Indicate the number of context switches.

Le nombre de changements de contexte est : 6

3) Calculate the average response time.

Process	Arrival Time	End date	Resp Time
P1	0	9	9
P2	3	19	16
P3	5	17	12

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{9+16+12}{3} = \frac{37}{3} = 12.33$$

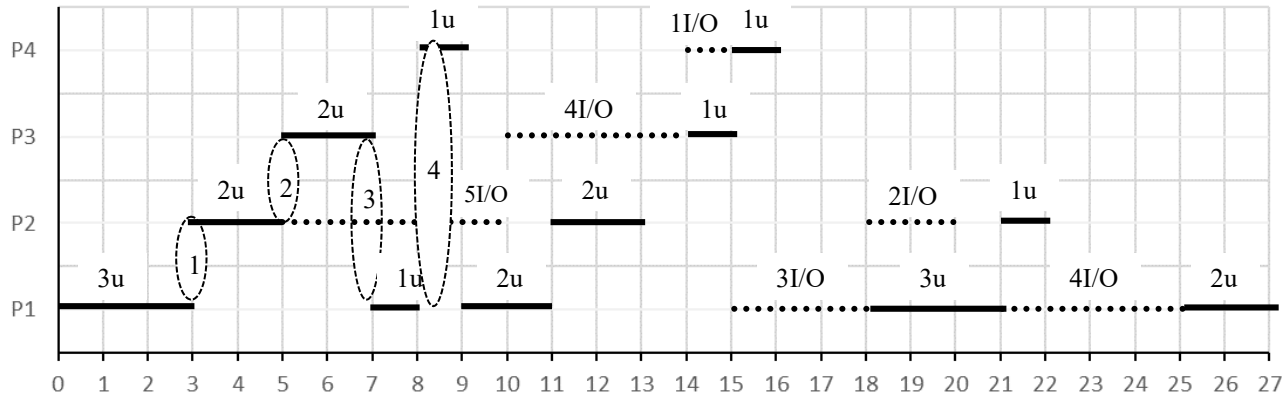
Exercise n°4

Consider a single-processor architecture on which you wish to run a set of 4 programs whose behaviour is defined as follows:

Process	Time cpu + time I/O	Arrival date
P_1	6cpu + 3 I/O + 3cpu + 4 I/O + 2cpu	0
P_2	2cpu + 5 I/O + 2cpu + 2 I/O + 1cpu	3
P_3	2 cpu + 4 I/O + 1 cpu	5
P_4	1cpu + 1 I/O + 1cpu	8

It is assumed that a single channel is available to manage a disk, and that the order of service of input/output (I/O) requests for this disk is based on an FCFS policy. Scheduling on the processor is done using an SRTF (Shortest Remaining Time First) strategy.

1) For each program, complete the Gantt diagrams shown below:



For process P_1

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27
I/O																x	x	x				x	x	x	x		
Waiting												x	x	x	x												
Ready				x	x	x	x		x																		
Running	x	x	x					x		x	x								x	x	x					x	x

For process P_2

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27
I/O						x	x	x	x	x									x	x							
Waiting														x	x	x	x	x									
Ready											x										x						
Running				x	x							x	x									x					

For process P3

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27
I/O											x	x	x	x													
Waiting								x	x	x																	
Ready																											
Running						x	x								x												

For process P4

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27
I/O															x												
Waiting										x	x	x	x	x													
Ready																											
Running									x							x											

2) Calculate:

a) The number of context switches:

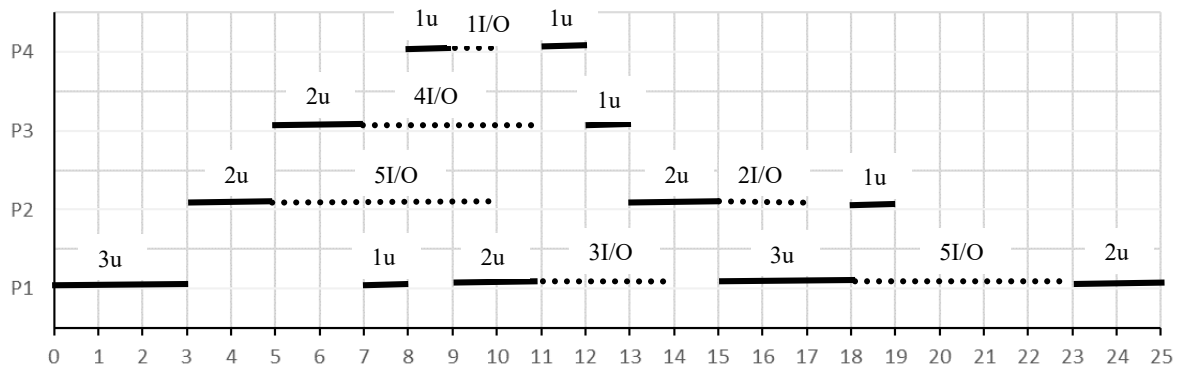
Le nombre de changements de contexte est : 11

b) The response time of each program and the average response time.

Process	Arrival Time	End date	Resp Time
P1	0	27	27
P2	3	22	19
P3	5	15	10
P4	8	16	8

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{27+19+10+8}{4} = \frac{64}{4} = 16$$

Dans le cas il existe plusieurs canaux au niveau des E/S c'est-à-dire qu'on pourra faire des opérations d'E/S simultanées.



Process	Arrival Time	End date	Resp Time
P_1	0	25	25
P_2	3	19	16
P_3	5	13	8
P_4	8	12	4

$$Avg_{ResTime} = \frac{\sum_{i=1} ResTime_i}{n} = \frac{25+16+8+4}{4} = \frac{53}{4} = \mathbf{13,25}$$