Job Scheduling Algorithms

Introduction

This handout shows how the various job scheduling algorithms work.

First Come, First Serve (FCFS)

This policy services jobs in the order they arrive.

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	10	10	0	1.0
B	1	29	10	39	38	9	1.3
C	2	3	39	42	40	37	13.3
D	3	7	42	49	46	39	6.6
E	4	12	49	61	57	45	4.8
mean					38	26	5.4

Shortest Job Next (SJN)

This policy services the shortest job next.

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	10	10	0	1.0
B	1	29	32	61	60	31	2.1
C	2	3	10	13	11	8	3.7
D	3	7	13	20	17	10	2.4
E	4	12	20	32	28	16	2.3
mean					25	13	2.3

Pre-emptive Shortest Job Next (PSJN)

This policy services the shortest job next, pre-emptively.

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	2	*pre-empted by C*		
		8	12	20	20	10	2.0
B	1	29	32	61	60	31	2.1
C	2	3	2	5	3	0	1.0
D	3	7	5	12	9	2	1.3
E	4	12	20	32	28	16	2.3
mean					24	12	1.7

Highest Response Ratio Next (HRN)

This policy services the job with the highest response ratio next.

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	10	10	0	1.0
B	1	29	32	61	60	31	2.1
C	2	3	10	13	11	8	3.7
D	3	7	13	20	17	10	2.4
E	4	12	20	32	28	16	2.3
mean					25	13	2.3

Round Robin (RR)

This policy services jobs for a fixed quantum (here, 5).

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	5	*end of quantum; B starts*		
		5	23	28	28	18	2.8
B	1	29	5	10	*end of quantum; C starts*		
		24	28	33	*end of quantum; D starts*		
		19	40	45	*end of quantum; E starts*		
		14	47	61	60	31	2.1
C	2	3	10	13	11	8	3.7
D	3	7	13	18	*end of quantum; E starts*		
		2	33	35	32	25	4.6
E	4	12	18	23	*end of quantum; A starts*		
		7	35	40	*end of quantum; B starts*		
		2	45	47	43	31	3.5
mean					35	23	3.3

Selfish Round Robin (SRR)

This policy services jobs for a fixed quantum (here, 1). The priority of new processes increases at a rate of 3 per quantum, of accepted processes at a rate of 2 per quantum. Note that new process promotions from the new queue to the ready queue precede quanta expirations.

time	*job running*	*ready queue (at end of interval)*	*new queue (at end of interval)*
0-1	A	A(2)	B(0)
1-2	A	A(4)	B(3), C(0)
2-3	A	B(6), A(6)	C(3), D(0)
3-4	B	A(8), B(8)	C(6), D(3), E(0)
4-5	A	B(10),A(10)	C(9), D(6), E(3)
5-6	B	A(12), C(12), B(12)	D(9), E(6)
6-7	A	C(14), B(14), A(14)	D(12), E(9)
7-8	C	B(16), A(16), C(16)	D(15), E(12)
8-9	B	A(18), C(18), D(18), B(18)	E(15)
9-10	A	C(20), D(20), B(20), A(20)	E(18)
10-11	C	D(22), B(22), A(22), C(22)	E(21)
11-12	D	B(24), A(24), C(24), E(24), D(24)	

… round robin from here on …

The relevant numbers (ignoring start and finish time) are:

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	…	…	27	17	2.7
B	1	29	…	…	60	31	2.1
C	2	3	…	…	15	12	5.0
D	3	7	…	…	33	26	4.7
E	4	12	…	…	44	32	3.7
mean					35.8	23.6	3.6

Multilevel Feedback (MLFB)

The variant of this class of scheduling algorithms uses three levels:

- processes at level 1 are scheduled round robin; the relevant quantum is 2, and when a quantum expires the job is moved to level 2.
- processes at level 2 are scheduled round robin; the quantum is 4, and processes are allowed 2 quanta before being moved to level 3.
- processes at level 3 are serviced first come first serve.

The jobs A, B, C, D, and E have been augmented by F, a 1-second job arriving at time 13, and G, an 11-second job arriving at time 50. These are to demonstrate that quanta are usually **not** interrupted.
In what follows, the number in parentheses in the comment field is the remaining service time for the job.

time	level 1	level 2	level 3	comments
0	A	—	—	A(10) arrives, runs
1	AB	—	—	B(29) arrives, A continues quantum
2	BC	A	—	C(3) arrives, A's quantum expires (8), moves to level 2, B runs
3	BCD	A	—	D(7) arrives, B continues quantum
4	CDE	AB	—	E(12) arrives, B's quantum expires (27), moves down, C runs
6	DE	ABC	—	C's quantum expires (1), moves down, D runs
8	E	ABCD	—	D's quantum expires (5), moves down, E runs
10	—	ABCDE	—	E's quantum expires (10), moves down, A runs from level 2 (level 1 is empty)
13	F	ABCDE	—	F(1) arrives, A's quantum continues
14	F	ABCDE	—	A's quantum expires (4), F runs (at level 1)
15	—	ABCDE	—	F finishes, B runs from level 2 (level 1 is empty)
19	—	ABCDE	—	B's quantum expires (23), C runs
20	—	ABDE	—	C finishes, D runs
24	—	ABDE	—	D's quantum expires (1), E runs
28	—	ABDE	—	E's quantum expires (6), A runs
32	—	BDE	—	A finishes, B runs
36	—	DE	B	B's quantum expires (19), moves down, D runs
37	—	E	B	D finishes, E runs
41	—	—	BE	E's quantum expires (2), moves down, B runs from level 3 (since there is nothing in higher levels)
50	G	—	BE	G arrives(11), B continues to run
60	G	—	E	B finishes, G runs (since it is in the highest level)
62	—	G	E	G's quantum expires (9), moves down, G runs from level 2
66	—	G	E	G's quantum expires (5), G runs
70	—	—	EG	G's quantum expires (1), moves down, E runs
72	—	—	G	E finishes, G runs
73	—	—	—	G finishes

The relevant numbers (ignoring start and finish time) are:

job name	*arrival time*	*service time*	*start time*	*finish time*	*turnaround time*	*waiting time*	*response ratio*
A	0	10	0	2	*preempted by B*		
		8	10	14	*preempted by F*		
		4	28	32	32	22	3.2
B	1	29	2	4	*preempted by C*		
		27	15	19	*preempted by C*		
		23	32	36	*preempted by D*		
		19	41	60	59	30	2.0
C	2	3	4	6	*preempted by D*		
		1	19	20	18	15	6.0
D	3	7	6	8	*preempted by E*		
		5	20	24	*preempted by E*		
		1	36	37	34	27	4.9
E	4	12	8	10	*preempted by A*		
		10	24	28	*preempted by A*		
		6	37	41	*preempted by B*		
		2	70	72	68	56	5.7
F	13	1	14	15	2	1	2.0
G	50	11	60	70	*preempted by E*		
		1	72	73	23	12	2.1
mean					33.7	23.3	3.7