LECTURE 14: TUTORIAL SCHEDULING ALGORITHM

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Round Robin CPU scheduling

Q1: Consider 4 processes A, B, C, D scheduled on a CPU in round robin fashion with a time quantum of 5-time units. The processes are assumed to have arrived in the order A, B, C and D, all at time T=0. There are exactly two context switching from A to B, one context switching from B to C, and no context switching from B to D and B to A. Which one of the following is possible as CPU bursts (in time units) of these processes?

(a) A= 9, B= 10, C=12, D=5 (b) A= 8, B= 9, C=3, D=4

(c) A= 12, B= 8, C=4, D=4 (d) A= 8, B= 12, C=8, D=10

Round Robin CPU scheduling

Round robin fashion with a time quantum of 5-time units. Arrival= T=0.

There are exactly two context switching from A to B, one context switching from B to C, and no context switching from B to D and B to A.

5 < CPU burst (A), CPU burst (B) <10 & 0 < CPU burst (C), CPU burst (D)<=5

A	B	C	D	A	B	
0	5	10	x	y	z	q

(a) A= 9, B= 10, C=12, D=5 **(b) A= 8, B= 9, C=3, D=4**

(c) A= 12, B= 8, C=4, D=4 (d) A= 8, B= 12, C=8, D=10

Round Robin CPU scheduling

Q2: Consider 4 processes P, Q, R, S scheduled in round robin fashion with a time quantum of 4-time units on a CPU. The processes are assumed to have arrived in the order P, Q, R and S all at time T=0. There are exactly one context switching each from S to Q, and from R to Q. There is exactly two context switching from Q to R and no context switching from S to P. Which one of the following is **not** possible as CPU bursts (in time units) of these processes? ?

(a) P= 4, Q= 10, R=6, S=2 (b) P= 3, Q= 9, R=5, S=4

(c) P= 4, Q= 12, R=8, S=4 (d) P= 2, Q= 6, R=6, S=4

Round Robin CPU scheduling

4 processes P, Q, R, S in round robin fashion with a time quantum of 4-time units Arrival – T=0. There are exactly one context switching each from S to Q, and from R to Q. There is exactly two context switching from Q to R and no context switching from S to P.

Summary: P<=4; Q>8; 4<R<=8; S<=4

(a) P= 4, Q= 10, R=6, S=2

(b) P= 3, Q= 9, R=5, S=4

(c) P= 4, Q= 12, R=8, S=4

(d) P= 2, Q= 6, R=6, S=4

FCFS CPU scheduling

Q3: Consider a ready queue which gets a new process of CPU burst 5 cycles in clock cycle X (X is a multiple of 10) and a new process of CPU burst 6 cycles in clock cycle Y (Y is a multiple of 11), FCFS scheduling is used. Neglect overhead of context switching. First process enters ready Q at clock cycle 10 and moves to running state at the same cycle itself. What is the average waiting time for first 20 process that enters the ready queue?

Let us assume processes A1, A2, A3 .., A9, A10 arrives at clock cycles 10, 20, 30,..,100, respectively. Similarly processes B1, B2, B3,…B9, B10 arrives at clock cycles 11, 22, 33,…,99, 110, respectively.

Gantt chart

A1	B1	A2	B2	A3	B3	A4	B4	A5	B5

10 15 21 26 32 37 43 48 54 59 65

A6	B6	A7	B7	A8	B8	A9	B9	A10	B10

65 70 76 81 87 92 98 103 109 114 120

FCFS CPU scheduling

Let us assume processes A1, A2, A3 .., A9, A10 arrives at clock cycles 10, 20, 30,..,100, respectively. Similarly processes B1, B2, B3,…B9, B10 arrives at clock cycles 11, 22, 33,…,99, 110, respectively.

Gantt chart

A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	
10	15	21	26	32	37	43	48	54	59	65

A6	B6	A7	B7	A8	B8	A9	B9	A10	B10	
65	70	76	81	87	92	98	103	109	114	120

Waiting time of A’s = (10-10) + (21-20) + (32-30) + .. + (109-100)

= 0 +1 +2 +……+9 = 45

Waiting time of B’s = (15-11) + (26-22) + (37-33) + … + (114-110)

= 4 + 4 +…. + 4 = 40

Average waiting time = (45+40)/20 = 4.25

Round Robin CPU scheduling

Q4. Consider 4 processes P, Q, R, S scheduled in round robin fashion with a time quantum of 3-time units on a CPU. The processes are assumed to have arrived in the order P, Q, R and S, all at time T=0. There are exactly one context switching each from Q to P, R to P and S to P. There is exactly three context switching from P to Q. After three processes complete their execution, the last process will not take more than one time quantum to complete. Answer the following:-

(a) Average Waiting time

(b) Average turnaround time

Round Robin CPU scheduling

P, Q, R, S in round robin fashion with a time quantum of 3-time units. T=0 arrival There are exactly one context switching each from Q to P, R to P and S to P. There is exactly three context switching from P to Q. After three processes complete their execution, the last process will not take more than one time quantum to complete.

Gantt chart

P	Q	R	S	P	Q	R	P	Q	P
3	3	3	1/2/3	3	3	1/2/3	3	1/2/3	1/2/3

Dynamic Round Robin scheduling

Q5: Consider 4 processes P, Q, R, S that were to be scheduled on a CPU using a dynamic round robin scheduling with a time quantum of $\mathbf{2^{\mathit{x}}}$ clock cycles, where ***x*** indicates the round number starting with 1, and then 2, and then 3, and so on for subsequent rounds. ie, time quantum increases in each round. Each process will get at most one slot of running state in each round. The arrival time of P, Q, R and S are at clock cycles 0, 1, 2 and 3, respectively. It was found that P and R completed execution at clock cycles 12 and 17, respectively. Turnaround time of S is one clock cycle more than the turnaround time of Q. If average turnaround time of the 4 processes is 31 cycles, with the help of a neat Gantt chart answer the following.

a) How long is the CPU burst of each of the processes?

b) How many preemptive context switching happened overall?

c) What is the waiting time for process R?

Dynamic Round Robin scheduling

Dynamic round robin scheduling, T= $\mathbf{2^x}$ clock cycles, where ***x=1,2,3…***

Each process will get at most one slot of running state in each round.

Arrival P→0, Q→1, R→2 and S→3

P and R completed execution at clock cycles 12 and 17, respectively.

Turnaround time of S is one clock cycle more than the turnaround time of Q.

Average turnaround time of the 4 processes is 31 cycles.

TAT = 12 + y + (17-2) + (y+1) = 31 x 4 → y = 48

So Q should complete at 48 +1 = 49, and S should complete on 49 + 3= 52

Dynamic Round Robin scheduling

|< Round-1 >|< Round-2 >|< Round-3>|< Round-4>|

P	Q	R	S	P	Q	R	S	Q	S	Q	S

0 2 4 6 8 12 16 17 21 29 37 49 52

(a) How long is the CPU burst of each of the processes?

Turnaround time {T_completion-T_arrival}for each process as follows,

P→ 12-0 = 12 : Q→ 49-1= 48 : R→ 17-2 = 15 : S→ 52-3= 49

Avg. Turnaround time= (12+48+15+49)/4 = 31

CPU burst P→6, Q→ 26, R→3, S→17 {Overall 52 cycles of execution}

Dynamic Round Robin scheduling

|< Round-1 >|< Round-2 >|< Round-3>|< Round-4>|

P	Q	R	S	P	Q	R	S	Q	S	Q	S

0 2 4 6 8 12 16 17 21 29 37 49 52

(b) How many preemptive context switching happened overall?

– 8 times. @ clock cycles 2, 4, 6, 8, 16, 21, 29, 37

(c) What is the waiting time for process R?

T_waiting (R) = T_completion(R)_Tarrival(R)_CPU burst(R) = 17-2-3 = 12 cycles

Thank You