Highest Response Ratio next with quant time

Submitted by **Group H**

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Problem Statement

To propose and implement a novel CPU scheduling mechanism.

- It should be able to schedule more than two processes.
- It should have several process states such as: ready, running, waiting, blocked, terminated, etc.
- It should have requisite queues corresponding to the process states.
- Processes can be preempted.

Input parameters:

Number of processes, Process ID, Arrival time, CPU burst, I/O_burst

Output parameters:

Average waiting time, Average turnaround time, Throughput, Difference of AWT, ATAT with FCFS, RR, SJF, priority

The proposed scheduling algorithm should be better than the available scheduling algorithm in at least one parameter.

Proposed Algorithm

Highest Response Ratio Next with Quant time=1 unit

Highest Response Ratio Next

Highest Response Ratio Next is a non-preemptive algorithm which calculates a “priority” for each process by taking the value of a response ratio. The response ratio is defined as:

$$Response\ Ratio\ = \frac{Waiting\ time +\ Burst\ time}{Burst\ time} = \frac{Waiting\ time}{Burst\ time} + 1$$

This response ratio helps decide which process should be given priority by taking into consideration the waiting time of the process and the burst time. A process with a higher response ratio has a higher priority and hence, is executed first.

- Response ratio is inversely proportional to Burst time: Similar to SJF, a process which has lesser burst time has a higher priority and is executed first.

- Response ratio is directly proportional to waiting time: A process which has been waiting for a long time will be given priority over others. This helps in preventing starvation. A process will always execute when the waiting time becomes large enough.

Preemption

In order to make HRRN preemptive, the response ratio is calculated after a quant time of 1unit. This would mean that after every 1 unit of time, a decision is taken on which process to be executed. There is a possibility that the algorithm can be further improved upon by finding optimal quant time for the processes.

With this, the new Response Ratio is defined as

$$Response\ Ratio\ = \frac{Waiting\ time +\ Remaining\ Burst\ time}{Remaining\ Burst\ time} = \frac{Waiting\ time}{Remaining\ Burst\ time} + 1$$

Note: In case two processes have the same highest priority, FCFS is followed and the process which arrived first is executed.

Parameters chosen

Parameter chosen: AWT or ATT
As seen from the examples calculated below, the algorithm offers equal to if not better performance than the existing algorithms in terms of AWT and ATT.

Code

The code is attached in the zip file under the name oscode.cpp
(language used- c++)

Example 1

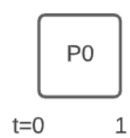
Given 3 processes with their arrival times and burst times, to find average waiting time and average turnaround time using HRRN with quant time algorithm.

Process ID	Arrival Time	Burst Time
P0	0	5
P1	1	2
P2	2	7

Solution:

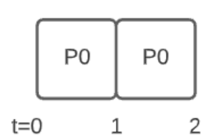
At time t=0, there is only one process in the ready queue (P0) and it executes for 1 second till the next process arrives.

Process	Remaining burst time	Waiting time	Response Ratio
P0	5	0	(5+0)/5=1



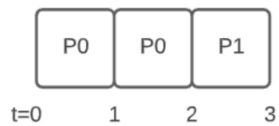
At time t=1, process P1 arrives . Since both the processes have the same response ratio, we consider P0 following FCFS.

Process	Remaining burst time	Waiting time	Response Ratio
P0	4	0	(4+0)/4=1
P1	2	0	(2+0)/2=1



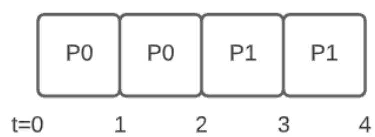
At time t=2, process P2 arrives. P0 finishes executing and only 1 process is left in the ready queue (P1). So, P1 executes for 1 second.

Process	Remaining burst time	Waiting time	Response Ratio
P0	3	0	(3+0)/3
P1	2	1	(2+1)/2
P2	7	0	1



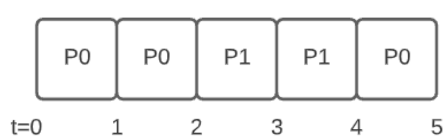
At time t=3, comparing the response ratios, we see that P1 has a higher ratio. So, P1 executes for 1 second and completes.

Process	Remaining burst time	Waiting time	Response Ratio
P0	3	1	(3+1)/3=4/3
P1	1	1	(1+1)/1=2
P2	7	1	(7+1)/7=8/7



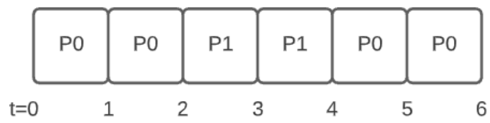
At time t=4,comparing response ratios, the process P0 is executed according to FCFS.

Process	Remaining burst time	Waiting time	Response Ratio
P0	3	2	(3+2)/3=5/3
P2	7	2	(7+2)/7=9/7



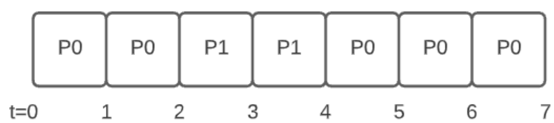
At time t=5, after calculating response ratio, we see that P0 has the highest. So, P0 is executed.

Process	Remaining burst time	Waiting time	Response Ratio
P0	2	2	(2+2)/2=2
P2	7	3	(7+3)/7=10/7



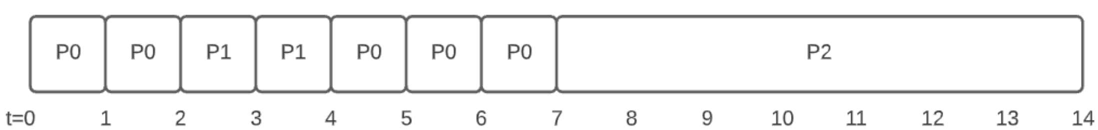
At time t=6,after calculating response ratio, P0 is executed.

Process	Remaining burst time	Waiting time	Response Ratio
P0	1	2	(1+2)/1=3
P2	7	4	(7+4)/7=11/7

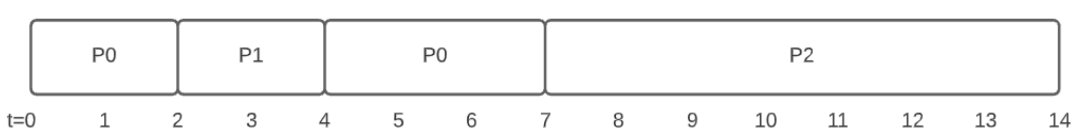


At time t=7, only process P2 is left in the queue and it executes for 7 units of time

Process	Remaining burst time	Waiting time	Response Ratio
P2	7	5	-



Gantt chart



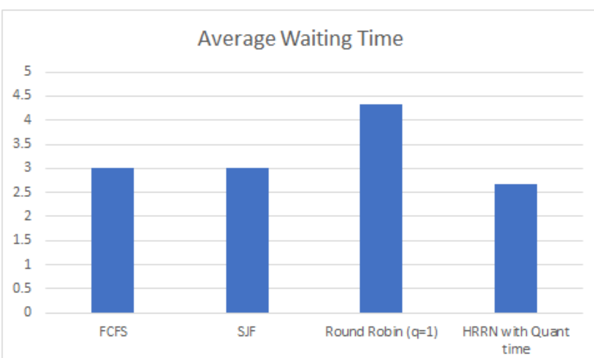
From this, we can calculate the Average Waiting time and Average turn-around time:

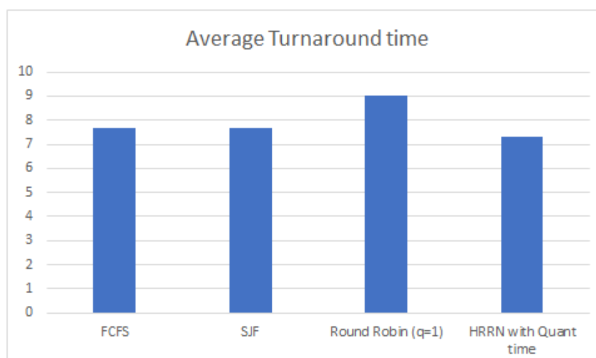
Process	Waiting time	Turnaround time
P0	2	7
P1	1	3
P2	5	12

Average waiting time=8/3
Average turnaround time=22/3

Comparison with other algorithms

Algorithm	Average Waiting time	Average Turnaround time
FCFS	3	7.6667
SJF	3	7.6667
Round Robin (q=1)	4.3333	9
HRRN with Quant time	2.6667	7.3333



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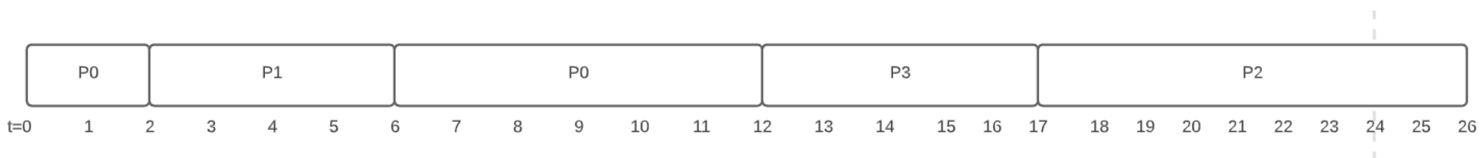
        Process ID         Arrival Time            Burst Time       i/o Burst Time          Burst Time         Waiting Time       Turn-around Time
                 0                    0                     5                    0                   0                    2                      7
                 1                    1                     2                    0                   0                    1                      3
                 2                    2                     7                    0                   0                    5                     12
Average Turn-around Time: 7.33333
Average Waiting Time: 2.66667
Throughput: 0.214286
Comparision Table
                                   FCFS                   SJF          Round Robin              NewAlgo
    Average Waiting Time              3                     3              4.33333              2.66667
 Average Turnaround Time        7.66667               7.66667                    9              7.33333
```

Example 2

Given 3 processes with their arrival times and burst times, to find average waiting time and average turnaround time using HRRN with quant time algorithm.

Process ID	Arrival Time	Burst Time
P0	0	8
P1	1	4
P2	2	9
P3	3	5

Gantt chart

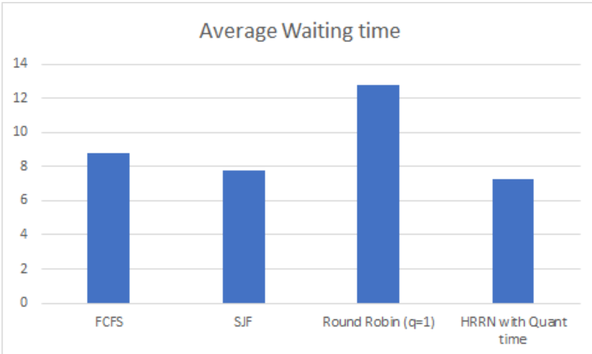


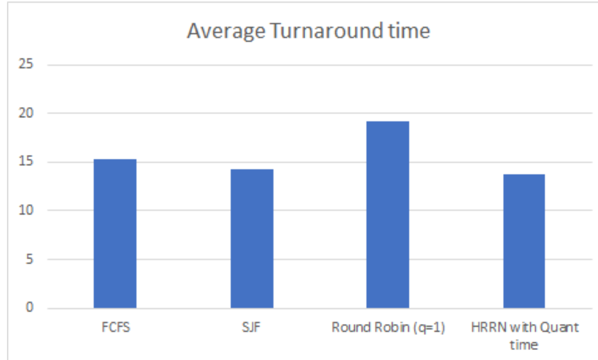
Process	Waiting time	Turnaround time
P0	4	12
P1	1	5
P2	15	24
P3	9	14

Average waiting time=29/4=7.25
Average turnaround time=55/4=13.75

Comparison with other algorithms

Algorithm	Average Waiting time	Average Turnaround time
FCFS	8.75	15.25
SJF	7.75	14.25
Round Robin (q=1)	12.75	19.25
HRRN with Quant time	7.25	13.75





Process ID	Arrival Time	Burst Time	i/o Burst Time	Burst Time	Waiting Time	Turn-around Time
0	0	8	0	0	4	12
1	1	4	0	0	1	5
2	2	9	0	0	15	24
3	3	5	0	0	9	14

Average Turn-around Time: 13.75
Average Waiting Time: 7.25
Throughput: 0.153846
Comparision Table

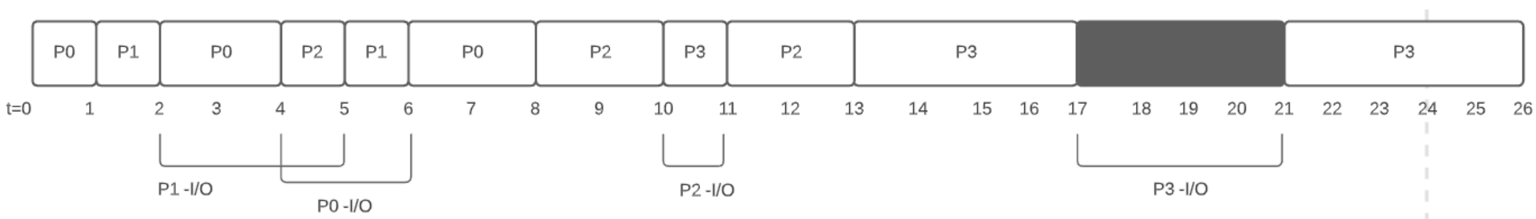
	FCFS	SJF	Round Robin	NewAlgo
Average Waiting Time	8.75	7.75	12.75	7.25
Average Turnaround Time	15.25	14.25	19.25	13.75

Example 3

Given 3 processes with their arrival times and burst times, to find average waiting time and average turnaround time using HRRN with quant time algorithm.

Process ID	Arrival time	Burst time	i/o burst time	Burst time
P0	0	3	2	2
P1	0	1	3	1
P2	3	3	1	2
P3	6	5	4	5

Gantt chart

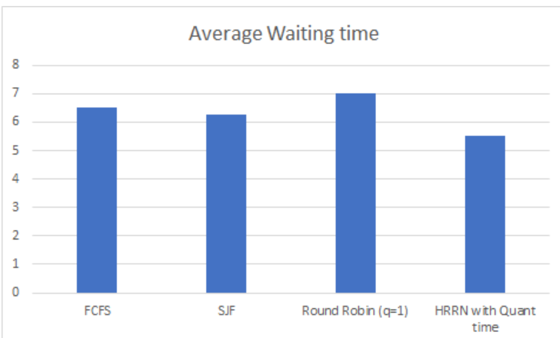


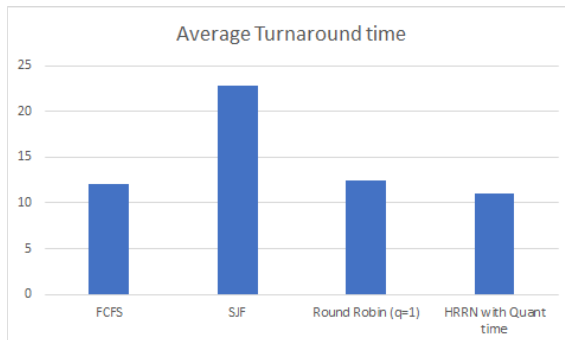
Process	Waiting time	Turnaround time
P0	3	8
P1	4	6
P2	5	10
P3	10	20

Average waiting time=22/4=5.5
Average turnaround time=44/4=11

Comparison with other algorithms

Algorithm	Average Waiting time	Average Turnaround time
FCFS	6.5	12
SJF	6.25	11.75
Round Robin (q=1)	7	12.5
HRRN with Quant time	5.5	11



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     Process ID    Arrival Time      Burst Time    i/o Burst Time      Burst Time    Waiting Time   Turn-around Time
              0               0               3                 2               2               3                  8
              1               0               1                 3               1               4                  6
              2               3               3                 1               2               5                 10
              3               6               5                 4               5              10                 20
Average Turn-around Time: 11
Average Waiting Time: 5.5
Throughput: 0.153846
Comparision Table
                           FCFS             SJF       Round Robin          NewAlgo
    Average Waiting Time    6.5            6.25                 7              5.5
  Average Turnaround Time    12           11.75              12.5               11
```