Design of Optimal Scheduler for Process Scheduling

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Abstract: CPU Scheduling takes plays an important role in multiprogramming systems. There are several programs present in memory. It is the responsibility of operating systems to select the process and assign it to CPU. There are various algorithms available for CPU Scheduling. The algorithm's performance depends on various factors like arrival time, priority etc. This paper helps to select the best algorithm by comparing various algorithms under the same condition and analyzed them based on various factors like waiting time, turnaround time, CPU utilization, Throughput.

Keywords: scheduler, throughput, turnaround time

I. INTRODUCTION

In earlier days the processors are capable of executing a single program at a time. The CPU utilization is very less and also it took lot of time to complete the process. When there are multiple programs it has to execute one by one. In recent days multi programming system are capable of executing multiple programs at a time. It improves the CPU utilization as well as consumes less time to complete the process.

CPU SCHEDULER

The CPU scheduler or short term scheduler selects the process from the ready queue and assign it to the CPU for execution. The process will be moving from ready to running state (Figure 1). When the process waiting for any event and I/O to happen, then the process is moved to waiting state. Upon completion of I/O or event, the process is again coming back to ready state and moved to running state by the scheduler when the CPU is available. If the process gets completed then it is moved to the terminated state.[1]

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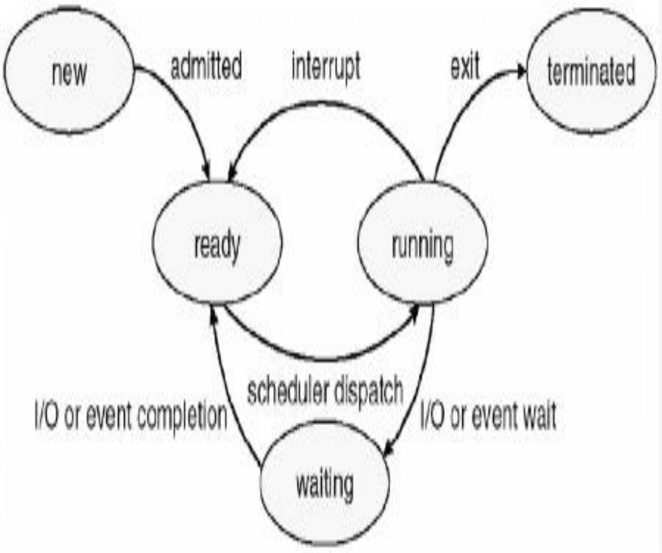

Figure 1 Process scheduling

The best CPU scheduler select the best algorithm in such a way that it leads to minimum turnaround time, minimum waiting time, minimum response time, maximum CPU utilization rate and maximum throughput. The Scheduling algorithms available are:[2]

1. First come first served(FCFS) scheduling
2. Shortest job first scheduling(SJF).
3. Priority scheduling.
4. Round Robin scheduling(RR).

The performance of the scheduling algorithm is estimated based on various criteria like CPU utilization, Throughput, Turnaround time, waiting time and response time.[3]

1. CPU utilization indicates how effectively CPU is utilized.
2. Throughput denotes the number of processes completed per unit time.[4]
3. Turnaround Time is the time needed for the process to complete its execution.[5]
4. Waiting Time is the amount of time a process waiting in the queue.
5. Response Time is the time between submission of request for execution and till the first response is produced not the output.

II. FCFS SCHEDULING

The processes are loaded from memory into ready queue. From the ready queue the processes are taken based on their arrival time and assigned to the processor for execution. [6]

The table 1 lists the processes and their execution time (burst time). The FCFS scheduling (Figure 2) is applied and the average waiting time and turnaround time are calculated and it is listed in table 1.

Table 1 Process and their burst times

Process	BurstTime	WaitingTime	Turnaround time
P1	7	0	7
P2	5	7	12
P3	3	12	15
P4	8	15	23

P1	P2	P3	P4

0 7 12 15 23

Figure 2 FCFS Scheduling

waiting time for P1=0,P2=7,P3=12,P4=15

Average waiting time=(0+7+12+15)/4=8.5.

Average TurnaroundTime=(7+12+15+23)/4=14.25.

III. SJF SCHEDULING

The processes are selected in the order of the burst time and assigned to CPU for execution. [8]

The table 2 lists the processes and their execution time (burst time). The SJF scheduling (Figure 3) is applied and the average waiting time and turnaround time are calculated and it is listed in table 2.

Table 2 Process and their burst times

Process	BurstTime	WaitingTime	Turnaround time
P1	7	8	15
P2	5	3	8
P3	3	0	3
P4	8	15	23

P3	P2	P1	P4

0 3 8 15 23

Figure 3 SJF Scheduling

waiting time for P1=8,P2=3,P3=0,P4=15.

Average waiting time=(8+3+0+15)/4=6.5.

Average TurnaroundTime=(15+8+3+23)/4=12.25.

IV. PRIORITY SCHEDULING

In this type of scheduling additional input called priority is given for each process. The process which is having the highest priority will be selected and assigned to the CPU for execution. The starvation problem is the main issue in ths kind of scheduling. i.e., low priority processes will never execute. This problem can be solved the method of aging. Aging technique increases the priority of the processes as the time progresses in the queue.[7]

The table 3 lists the processes and their execution time (burst time). The priority scheduling (Figure 4) is applied and the average waiting time and turnaround time are calculated and it is listed in table 3.

Table 3 Process, burst times and priority

Process	Burst Time	Priority	Waiting Time	Turnaround time
P1	7	2	5	12
P2	5	1	0	5
P3	3	4	20	23
P4	8	3	12	20

P2	P1	P4	P3

0 5 12 20 23

Figure 4 Priority Scheduling

waiting time for process P1=5,P2=0,P3=20,P4=12.

Average waiting time=(5+0+20+12)/4=9.25

Average TurnaroundTime=(12+5+23+20)/4=15

V. ROUND ROBIN SCHEDULING

The processes are scheduled using FCFS algorithm but each process is given with time quantum or time slice. Each process will execute for that amount of time slice and switches to next process in the FCFS order till their completion.[8] The table 4 lists the processes and their execution time (burst time) and time slice is given as 3 time units. The round robin scheduling (Figure 5) is applied and the average waiting time and turnaround time are calculated and it is listed in table 4.

Table 4 Process and their burst times

Process	Burst Time	Waiting Time	Turnaround time
P1	7	14	21
P2	5	12	17
P3	3	6	9
P4	8	15	23

P1	P2	P3	P4	P1	P2	P4	P1	P4

0 3 6 9 12 15 17 20 21 23

Figure 5 RoundRobin Scheduling

waiting time for process P1=14,P2=12,P3=6,P4=15.

Average WaitingTime=(14+12+6+15)/4=11.75

Average Turnaround Time=(21+17+9+23)/4=17.5

VI. DESIGN OF OPTIMAL SCHEDULER

The job of optimal scheduler is to schedule the jobs in such a way that it gives minimum average waiting time and turnaround time. The proposed scheduler (Figure 6) selects the Round Robin algorithm if the time slice input is available. Otherwise it checks for the priority input. If available it goes for priority algorithm. If both are not available the SJF algorithm is selected by the scheduler because SJF gives minimum waiting time and turnaround time when compare to FCFS.

VII. RESULT AND DISCUSSION

The various scheduling algorithms are applied to the same problem and the results are compared. From table 5 and Figure 7 it is clear that SJF algorithm gives better performance compared to other algorithms.

Table 5 Average waiting time and turnaround time using various algorithms

Algorithm	Average Waiting Time (time units)	Average Turnaround time (time units)
FCFS	8.5	14. 25
SJF	6.5	12.25
Priority	9. 25	15
Round Robin	11.75	17.5

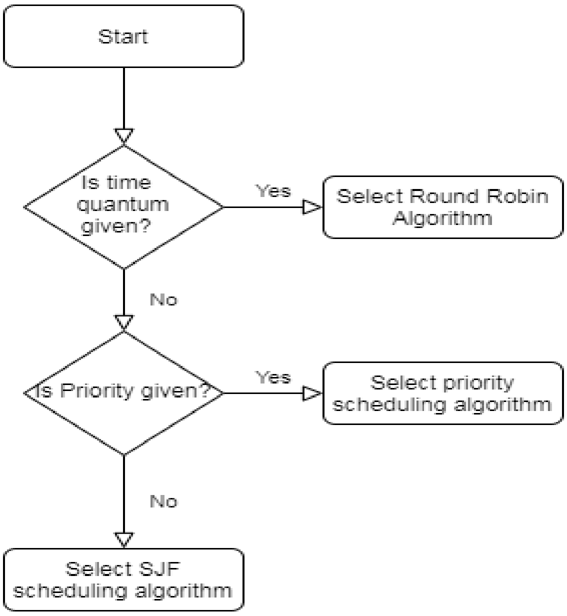
Start
Is time quantum given?
Yes
Select Round Robin Algorithm
No
Is Priority given?
Yes
Select priority scheduling algorithm
No
Select SJF scheduling algorithm

Figure 6 Optimal Scheduler

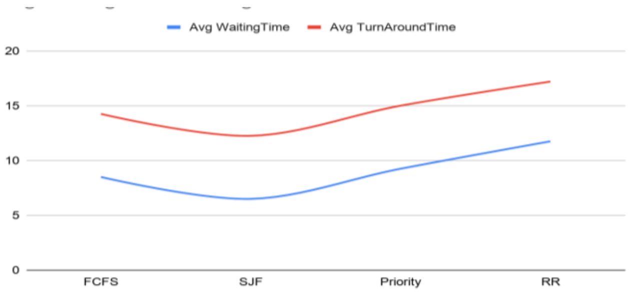

Figure 7 Average waiting time and turnaround time for different algorithms

VIII. CONCLUSION

The Optimal CPU scheduler is designed based on the results of applying the different scheduling algorithms to the same problem. By default SJF algorithm is selected as the best algorithm by the scheduler. If the time quantum is given then the scheduler selects RoundRobin algorithm for scheduling. If the priority is given then the priority algorithm will be selected for scheduling.

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