

**“Comparative Review of Various Scheduling Algorithms”**

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**Abstract**

The number of processes performed together has grown exponentially from the improvement in development of multitasking processors in computer systems. The Multi-programmed operating system executes the process simultaneously to increases the uses of CPU. A number of programs can be in memory at the same time, allows overlap of CPU and I/O. Scheduling deals with the problem of choosing a process from the ready queue to be executed by the system. This paper attempts to summarize and present the comparative analysis of various scheduling algorithms such as First Come First Serve, Shortest Job First, Round Robin and Priority Scheduling. These algorithms are compared on the basis of their average waiting time and average turnaround time providing the best optimal schedular for different set of jobs.

**Introduction**

Scheduling is a process of determining which process will own CPU for execution while another process is on hold. The main task of scheduling is to make sure that whenever the CPU remains idle, the OS at least select one of the processes available in the ready queue for execution. The selection process will be carried out by the scheduler. For this project we will implement a simulation of a job scheduler, as might be employed in a simple multi-tasking environment. The scheduler will receive jobs to be carried out and manage the simulated execution of those jobs. For the purpose of this assignment, a job will possess three attributes: Arrival Time, Burst Time, Priority. The increasing demand to handle large amounts of digital data in many scientific and commercial areas has led to growing importance of data centres as these centres are supposed to provide better service at lower costs. Job scheduling is a necessary and revolutionary step forward in IT automation, allowing IT operations to eliminate much of the manual processes filling their schedules and opening a world of possibilities for digital enterprises.

**Literature Review**

The operating system plays a major role in managing processes arriving in the form of multiple queues. The arrival of a process is random along with their different categories and types. All these require scheduling algorithms to work over real time environment with special reference to task, control and efficiency. Many Researchers have introduced various CPU scheduling algorithms from time to time. Some researches that appropriate with our work are:

Siahaan, A.P.U., 2016. Comparison analysis of CPU scheduling: FCFS, SJF and Round Robin. *International Journal of Engineering Development and Research*, *4*(3), pp.124-132.

Hamayun, M. and Khurshid, H., 2015. An optimized shortest job first scheduling algorithm for CPU scheduling. *J. Appl. Environ. Biol. Sci*, *5*(12), pp.42-46.

Khatri, J., 2016. An enhanced Round Robin CPU scheduling algorithm. *IOSR Journal of Computer Engineering (IOSR-JCE)*, *18*(4), pp.20-24.

Zouaoui, S., Boussaid, L. and Mtibaa, A., 2019. Priority based round robin (PBRR) CPU scheduling algorithm. *International Journal of Electrical & Computer Engineering (2088-8708)*, *9*(1).

Monika Verma, Er. Krishan Kumar, Dr. Himanshu Monga. "Comparative analysis of Job Scheduling algorithms :A Review", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Vol.5, Issue 3, pp.1231-1236, September 2017Siahaan, A.P.U., 2017. Comparison Analysis of CPU Scheduling FCFS. *SJF and Round Robin*.

Jorgensen, A.N., Kowalski, M. and Lazier, C.L., Amazon Technologies Inc, 2017. *Providing service quality levels through CPU scheduling*. U.S. Patent 9,535,736.

Dave, B., Yadav, S., Mathuria, M. and Tech, M., 2017. Customary Methods for CPU Scheduling: A Review. *vol*, *3*, pp.344-348.

Somula, R., Nalluri, S., NallaKaruppan, M.K., Ashok, S. and Kannayaram, G., 2019. Analysis of CPU scheduling algorithms for cloud computing. In *Smart Intelligent Computing and Applications* (pp. 375-382). Springer, Singapore.

Saini, M. and Kumar, N., 2015. A Survey on CPU Scheduling. *International Journal Of Research In Computer Applications and Robotics*, *3*, pp.7-12.

**Methodology**

**A. FIRST COME FIRST SERVED (FCFS) Scheduling.**

It is the simplest CPU Scheduling algorithm. The criteria of this algorithm is, the process that requests first, holds the CPU first or which process enter the ready queue first is served first. Whichever process comes first is scheduled first. The process to be scheduled first is decided by the arrival time of the processor. Such a technique is fair in the case of smaller processes but is quite unfair for long an unimportant job. It has low throughput since long processes can keep processor occupied for a long time making small processes suffer. As a result, waiting time, turnaround time and response time can be low. The lesser the arrival time of the job, the sooner will the job get the CPU. FCFS scheduling may cause the problem of starvation if the burst time of the first process is the longest among all the jobs.

**B. Shortest Job First (SJF) Scheduling.**

The criteria of this algorithm are which process having the smallest CPU burst, CPU is assigned to that process next. If two process having the same CPU burst time FCFS is used to break up the tie. SJF favours shorter processes over longer ones which is an overhead as compared to FCFS. Whichever process has the shortest burst time is scheduled first. The processor selects the waiting process with the smallest execution time to execute next. It selects the job with the smallest burst time ensuring CPU availability for other processes as soon as the current process reaches its completion.

**C. Priority Based Scheduling.**

In this algorithm, priority is associated with each process and on the basis of that priority CPU is allocated to the processes. Each process has a priority associated with it and as each process hits the queue, it is stored in based on its priority so that process with higher priority are dealt with first. The process that has the highest is executed first then the lower. If multiple processes having the same priorities are ready to execute, control of CPU is assigned to these processes on the basis of FCFS. Priority scheduling also helps OS to involve priority assignments. The processes with higher priority should be carried out first, whereas jobs with equal priorities are carried out on a round-robin or FCFS basis. Priority can be decided based on memory requirements, time requirements, etc.

**D. Round Robin (RR) Scheduling.**

The Round Robin algorithm designed on the basis of time distribution where a time quantum or slice has given to individual job. Thus, based upon this concept each job has assigned with the slice and executes according to that time interval and works as a circular queue model. In Round Robin scheduling if the Time Slice/Quantum is too short, then too much process switching takes place and the whole process will become slow. If the set time is too long, then the system may become unresponsive, time wasting and would emulate First Come First Served.

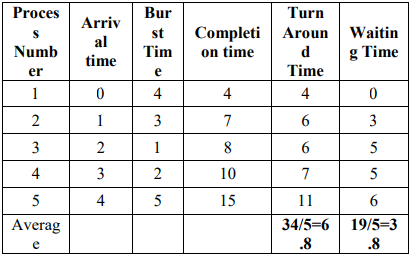
It is designed especially for time sharing systems. When the time quantum expired, the CPU is

switched to another process. Performance of Round Robin totally depends on the size of the time quantum. New processes are added to the tail of the ready queue.The CPU scheduler picks the first process from the ready queue, sets a timer to interrupt after 1 time quantum, and dispatches the process.The average waiting time under the RR policy is often long.

**Existing Algorithms/ techniques**

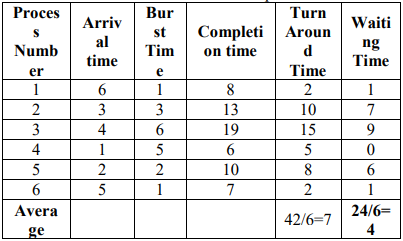
**First Come First Serve:**

In this the process that requests the CPU first, is allocated the CPU first. The implementation of the FCFS policy managed by FIFO queue.



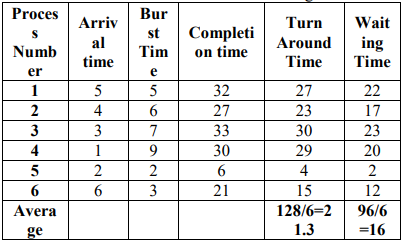
**Shortest Job First**

The second calculation is using SJF algorithm. It is FCFS concept, but the process which comes at the same time or the same ready queue must be sorted in ascending order. The smallest burst time will be the first order while the bigger will be the last one.



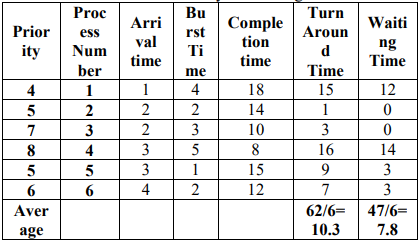
**Round Robin Scheduling**

The calculation in Round Robin is more difficult than the earlier calculations. In this algorithm, it needs to split the best time into several subprocesses in a period. Quantum Time is a time slicing technique to split burst time into several subprocesses.



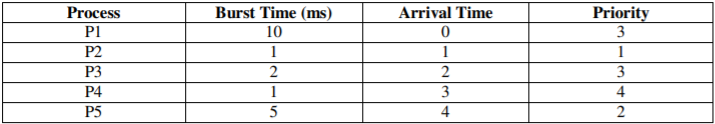
**Priority Scheduling**

In Priority Scheduling a priority number (integer) is associated with each process and CPU is allotted to the highest priority process as shown in figure 3. If priority of two or more processes is equal then they are scheduled in FCFS order.



**Comparison between algorithms for one dataset**

We assume that we have five processes P1 to P5 as shown in the below table. We compare the results of the discussed algorithms over a set of data provided.

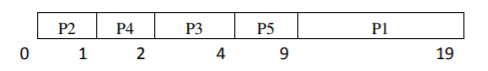


The processing of jobs is shown by a Gantt chart, from which the average waiting time and the average turnaround time are calculated.

1. First Come First Serve (FCFS)



1. Shortest Job First (SJF)



1. Round Robin Scheduling (RR Time Quantum = 2ms)



1. Priority Scheduling



Summary of comparisons:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Process | Waiting time | | | |
| **FCFS** | **SJF** | **Round Robin** | **Priority** |
| Process 1 (P1) | 0 | 9 | 9 | 6 |
| Process 2 (P2) | 10 | 0 | 2 | 0 |
| Process 3 (P3) | 11 | 2 | 3 | 16 |
| Process 4 (P4) | 13 | 1 | 5 | 18 |
| Process 5 (P5) | 14 | 4 | 10 | 1 |
| Average Wating Time | 9.6 | 3.2 | 5.8 | 8.2 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Process | Turn Around Time | | | |
| **FCFS** | **SJF** | **Round Robin** | **Priority** |
| Process 1 (P1) | 10 | 19 | 19 | 16 |
| Process 2 (P2) | 11 | 1 | 3 | 1 |
| Process 3 (P3) | 13 | 4 | 5 | 18 |
| Process 4 (P4) | 14 | 2 | 6 | 19 |
| Process 5 (P5) | 19 | 9 | 15 | 6 |
| Avg. Turnaround Time | 13.4 | 7 | 9.6 | 12 |

**RESULT AND DISCUSSION**

The waiting time for the processes is calculated as time taken by the process to wait in the ready queue is observed from Gantt chart. For FCFS scheduling, the order of the process is taken as P1, P2, P3, P4 and P5. The Waiting time for processes P1, P2, P3, P4, & P5 is obtained as 0, 10, 11, 13, and 14 respectively and average waiting time is (0+10+11+13+14)/5=9.6ms. For SJF scheduling (without arrival time) the waiting time for processes P1, P2, P3, P4, & P5 is obtained as 9, 0, 2, 1, and 4 respectively and average waiting time is (9+0+2+1+4)/5=3.2ms. Similarly, the waiting time is calculated for all other algorithms and summarized in table.

The turnaround time for the processes is calculated as time taken by the process to wait in the ready queue and its execution time together i.e., Turnaround time = Waiting time + Burst time; For FCFS scheduling, the turnaround time for processes P1, P2, P3, P4, & P5 is obtained as 10, 11, 13, 14 and 19 respectively and average waiting time is (10+11+13+14+19)/5=13.4ms. For SJF scheduling (without arrival time) the turnaround time for processes P1, P2, P3, P4, & P5 is obtained as 19, 1, 2, 2 and 6 respectively and average turnaround time is (19+1+2+2+6)/5=7ms. Similarly, turnaround time is calculated for all other algorithms and summarized in table.

The comparison of results of the data set clearly depicts that for the given data set Shortest Job First (SJF) takes minimal time to completely execute processes and have approximately minimal average waiting time. Drawback with Priority scheduling is when the operating system gives a particular task very low priority so it sits in queue for a larger amount of time, not being dealt with by the CPU.

**Conclusion**

The present paper shows analysis on comparison of four scheduling algorithms FCFS, SJF, Round Robin, Priority Scheduling. The comparative analysis was made by implementing a C program. By this experimental setup, statistical analysis of the performance of all the four basic scheduling algorithms have been done, as stated above. From the comparison of the results that are recorded in the above tables. We can say here, that the SJF algorithm has the lowest waiting time, so it is classified as the best algorithm. Here the focus was on two parts in the comparison process, namely average waiting time and turnaround time.

It can be concluded that:

* FCFS is simple to understand and suitable only for batch system where waiting time is large.
* Turnaround time, Waiting time and Response time of the processes are optimum for SJF scheduling algorithm compared to all other fundamental algorithms.
* The priority scheduling algorithm is based on the priority in which the highest priority job can run first and the lowest priority job need to wait.
* The treatment of shortest process in SJF scheduling tends to result in increased waiting time for long processes. And the long process will never get served, though it produces minimum average waiting time and average turnaround time.
* The shortest job first scheduling algorithm deals with different approach, in this algorithm the major benefit is it gives the minimum average waiting time.

From the comparative study, it’s been deliberated that scheduling is one of the utmost significant responsibilities of the system. Depending upon the type and requirements to make the most appropriate system a good scheduling algorithm must be chosen. All the necessary factors i.e. waiting time, response time, turnaround time must be considered to make that decision.

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THANK YOU