CSC446 Operating Systems, Fall 2021, Instructor: Vijayalakshmi Saravanan

Project: Analysis of different types of Scheduling Algorithms on basis of performance on an Operating System

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Abstract:

Modern operating systems transition from a single task to a multitasking environment. The demand of today's computing is to maximize resource consumption. To schedule CPU resources, a variety of scheduling algorithms are available. Due to rapid context switching, high reaction time, big average waiting time, low throughput, and long turnaround time, these algorithms are not implemented in a real-time setting. This research project is comparative analysis of different scheduling algorithms that are used widely in various multiprogramming operating systems. The comparison criteria in my case is performance. The comparison is going to be in between First Come First Serve (FCFS), Shortest Job First (SJF) Preemptive, Shortest Job First (SJF) Non-Preemptive, Priority Scheduling Preemptive, Priority Scheduling Non-Preemptive, and Round Robin. After comparing the Average waiting times and Average turnaround times of these algorithms, I found that Priority scheduling(Non Preemptive) is the fastest overall but if we compare based on average waiting turnaround time FCFS is the fastest among them all however I also found out that Round Robin can faster depending on different Time Quantum (TQ).

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Implementation:

For this project I have used:

Operating System (OS): Ubuntu 21.10

RAM: 2 GB

CPU Cores: 2

CPU Clock Speed: 1 GHz

Architecture: 64 bits

I have created this computing environment using Oracle VM Virtual Box v6.2

I have used a code with all the algorithms implemented in it which prints out the Average waiting time, Average turn around time, and the Gantt Chart after running a set of processes. I have used C code and compiled it using Ubuntu's terminal. After running a process for example, the 'tree' command, I have documented the process IDs and some other attributes of the process using 'Stat' System call and then entered this information along with number of processes as parameters on my code.

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Theory:

First Come First Serve (FCFS): is an operating system scheduling algorithm that automatically executes queued requests and processes in order of their arrival. It is the easiest and simplest CPU scheduling algorithm. In this type of algorithm, processes which requests the CPU first get the CPU allocation first. This is managed with a FIFO queue.

Shortest Job First (SJF) Preemptive: is an algorithm in which the process having the smallest execution time is chosen for the next execution. This scheduling method can be preemptive or non-preemptive. It significantly reduces the average waiting time for other processes awaiting execution.

Shortest Job First (SJF) Non-Preemptive: In non-preemptive scheduling, once the CPU cycle is allocated to process, the process holds it till it reaches a waiting state or terminated.

Priority Scheduling Preemptive: Fixed-priority preemptive scheduling is a scheduling system commonly used in real-time systems. With fixed priority preemptive scheduling, the scheduler ensures that at any given time, the processor executes the highest priority task of all those tasks that are currently ready to execute.

Priority Scheduling Non-Preemptive: In the Non-Preemptive Priority scheduling, The Processes are scheduled according to the priority number assigned to them. Once the process gets scheduled, it will run till the completion. Generally, the lower the priority number, the higher is the priority of the process.

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Round Robin: is one of the algorithms employed by process and network schedulers in computing. As the term is generally used, time slices (also known as time quanta) are assigned to each process in equal portions and in circular order, handling all processes without priority (also known as cyclic executive). Round-robin scheduling is simple, easy to implement, and starvation-free.

Turnaround time: It is the number of processes executed per unit time. More the processes have been executed the more is the throughput. The turnaround time is the summation of wait time and execution time; where execution time is the time when the process is performs the task as the CPU is allocated to the process. Turnaround time is calculated as: Turnaround time = Finish time – Arrival time. The average turnaround time is calculated as [6]: Average Turnaround Time (ATAT) = TATj/n

Wait time: It is the time period of a process waiting in the ready queue because of the lack of resources. The waiting time can be calculated as: Wait Time = (1st start Time – arrival Time) + (2nd Start Time – First end Time) +...+ (nth Start Time – (n-1)th end Time) i.e Wait time = Turnaround time- Burst time In [6], average waiting time is defined as: Average Waiting Time (AWT) =WTj/n;where WTj is the waiting time of jth process and n is over-all number of processes.

Gannt Chart: A Gantt chart is a horizontal bar chart developed 1917 by Henry L. Gantt, an American engineer and social scientist. Gantt chart is used to represent operating systems CPU scheduling in graphical view that help to plan, coordinate and track specific CPU utilization factor like throughput, waiting time, turnaround time etc.

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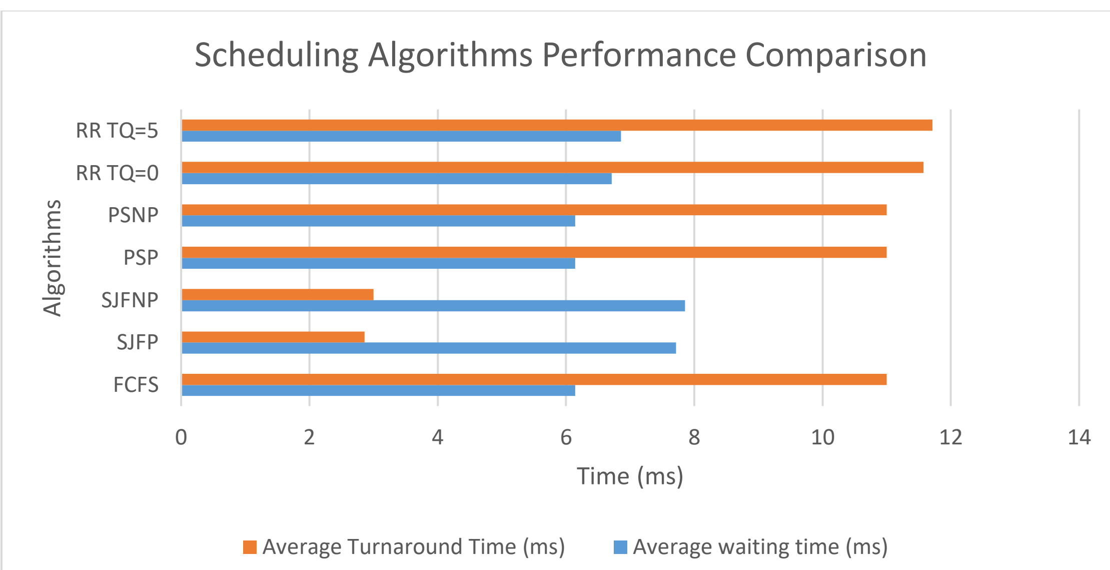
Results:

Comparison Table:

Algorithm	Average waiting time (ms)	Average Turnaround Time (ms)
FCFS	6.14286	11
SJFP	7.71429	2.85714
SJFNP	7.85714	3
PSP	6.14286	11
PSNP	6.14286	11
RR TQ=0	6.71429	11.57143
RR TQ=5	6.85714	11.71429

Comparison Graph:



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Gantt Charts:

First Come First Serve (FCFS):

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A 1/3	A 2/3	A 3/3	B 1/6	B 2/6	B 3/6	B 4/6	B 5/6	B 6/6	C 1/10	C 2/10	C 3/10	C 4/10	C 5/10	C 6/10	C 7/10	C 8/10	C 9/10	C 10/10	D 1/1

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
E 1/5	E 2/5	E 3/5	E 4/5	E 5/5	F 1/2	F 2/2	G 1/7	G 2/7	G 3/7	G 4/7	G 5/7	G 6/7	G 7/7	- 0/0

Shortest Job First (SJF) Preemptive:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A 1/3	A 2/3	A 3/3	B 1/6	B 2/6	B 3/6	B 4/6	D 1/1	B 5/6	B 6/6	E 1/5	E 2/5	E 3/5	E 4/5	E 5/5	F 1/2	F 2/2	C 1/10	C 2/10	C 3/10

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
C 4/10	C 5/10	C 6/10	C 7/10	C 8/10	C 9/10	C 10/10	G 1/7	G 2/7	G 3/7	G 4/7	G 5/7	G 6/7	G 7/7	- 0/0

Shortest Job First (SJF) Non-Preemptive:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A 1/3	A 2/3	A 3/3	B 1/6	B 2/6	B 3/6	B 4/6	B 5/6	B 6/6	D 1/1	E 1/5	E 2/5	E 3/5	E 4/5	E 5/5	F 1/2	F 2/2	C 1/10	C 2/10	C 3/10

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
C 4/10	C 5/10	C 6/10	C 7/10	C 8/10	C 9/10	C 10/10	G 1/7	G 2/7	G 3/7	G 4/7	G 5/7	G 6/7	G 7/7	- 0/0

Priority Scheduling Preemptive:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A 1/3	A 2/3	A 3/3	B 1/6	B 2/6	B 3/6	B 4/6	B 5/6	B 6/6	C 1/10	C 2/10	C 3/10	C 4/10	C 5/10	C 6/10	C 7/10	C 8/10	C 9/10	C 10/10	D 1/1

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
E 1/5	E 2/5	E 3/5	E 4/5	E 5/5	F 1/2	F 2/2	G 1/7	G 2/7	G 3/7	G 4/7	G 5/7	G 6/7	G 7/7	- 0/0

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Priority Scheduling Non-Preemptive:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	A	A	B	B	B	B	B	B	C	C	C	C	C	C	C	C	C	C	D
1/3	2/3	3/3	1/6	2/6	3/6	4/6	5/6	6/6	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10	1/1

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
E	E	E	E	E	F	F	G	G	G	G	G	G	G	-
1/5	2/5	3/5	4/5	5/5	1/2	2/2	1/7	2/7	3/7	4/7	5/7	6/7	7/7	0/0

Round Robin:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	A	A	B	B	B	B	B	C	C	C	C	C	D	E	E	E	E	E	B
1/3	2/3	3/3	1/6	2/6	3/6	4/6	5/6	1/10	2/10	3/10	4/10	5/10	1/1	1/5	2/5	3/5	4/5	5/5	6/6

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
C	C	C	C	C	F	F	G	G	G	G	G	G	G	-
6/10	7/10	8/10	9/10	10/10	1/2	2/2	1/7	2/7	3/7	4/7	5/7	6/7	7/7	0/0

Conclusion:

As we see the previous results these shows that when we use First Come First Serve its computational overhead is small, but we notice that it produces low through put hence its performance was poor. The other drawback of FCFS is that it has high waiting time. The Shortest Job First served is an ideal scheduling algorithm to reduce the average waiting time of the given set of available process. Though SJF gives less average waiting time for all available process but it has more waiting time for process which requires more time to complete their execution when we compare it with FCFS algorithm. In case short process arrive continuously then the starvation for long process will be possible. The round robin is the algorithm which provides the fair CPU sharing to all the available processes. In round robin a fix quantum is assigned to all the process in the ready line. The processes with short burst time can complete their execution in single given time quantum, it shows relatively better response time. In case of processes with long burst time it gives comparatively long turnaround time and their waiting time also increase. There is also a possibility for processes with small time quantum can wait for long time for their turn. When we talk about the priority-based scheduling, we can see that starvation is also appears here. The process with high priority will execute first so the process with low priority may never get the chance for their execution, this creates the starvation for lower priority processes.

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