Chapter 3 .Process Scheduling

CPU–I/O Burst Cycleprocess execution consists of a cycle of CPU execution and I/O wait. Processes alternate between these two states. Process execution begins with a CPU burst That is followed by an I/O burst, which is followed by another CPU burst, then another I/O burst, and so on.

CPU Scheduling Criteria

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CPU scheduling is essential for the system's performance and ensures that processes are executed correctly and on time. Different CPU scheduling algorithms have other properties and the choice of a particular algorithm depends on various factors. Many criteria have been suggested for comparing CPU scheduling algorithms.

What is CPU scheduling?

CPU Scheduling is a process that allows one process to use the CPU while another process is delayed due to unavailability of any resources such as I / O etc, thus making full use of the CPU. In short, CPU scheduling decides the order and priority of the processes to run and allocates the CPU time based on various parameters such as CPU usage, throughput, turnaround, waiting time, and response time. The purpose of CPU Scheduling is to make the system more efficient, faster, and fairer.

Criteria of CPU Scheduling

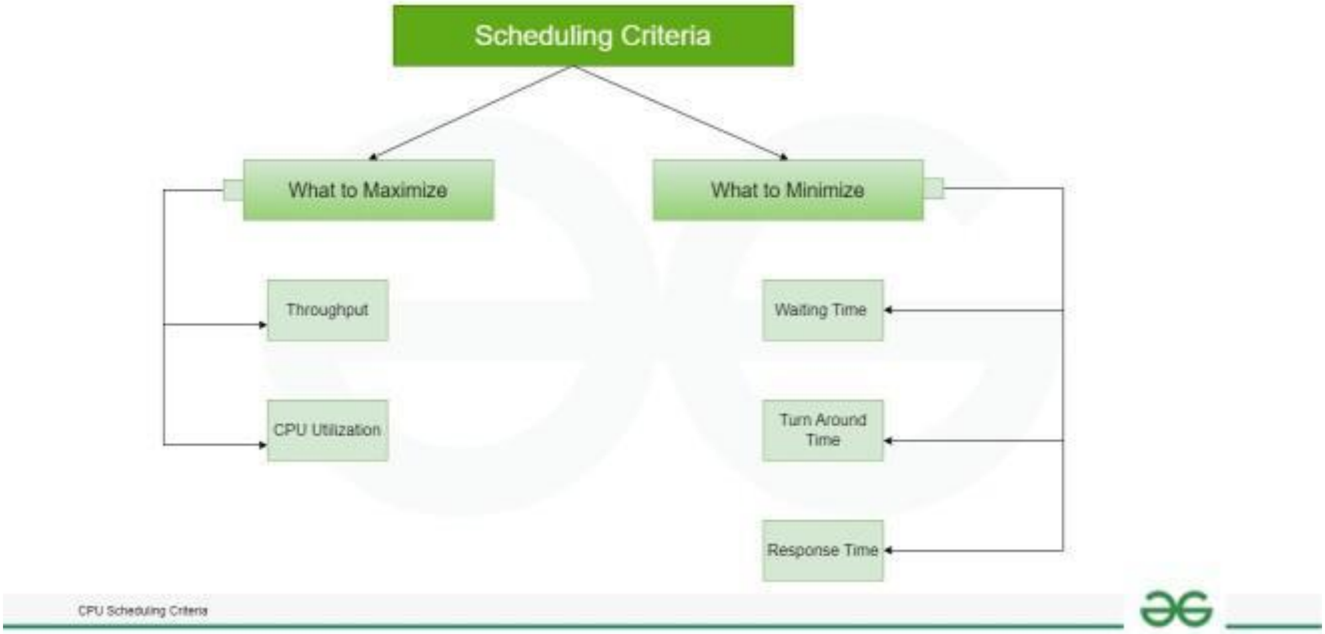
CPU Scheduling has several criteria. Some of them are mentioned below.

1. CPU utilization

The main objective of any CPU scheduling algorithm is to keep the CPU as busy as possible. Theoretically, CPU utilization can range from 0 to 100 but in a real-time system, it varies from 40 to 90 percent depending on the load upon the system.

2. Throughput

A measure of the work done by the CPU is the number of processes being executed and completed per unit of time. This is called throughput. The throughput may vary depending on the length or duration of the processes.



CPU Scheduling Criteria

3. Turnaround Time

For a particular process, an important criterion is how long it takes to execute that process. The time elapsed from the time of submission of a process to the time of completion is known as the turnaround time. Turn-around time is the sum of times spent waiting to get into memory, waiting in the ready queue, executing in CPU, and waiting for I/O.

Turn Around Time = Completion Time – Arrival Time.

4. Waiting Time

A scheduling algorithm does not affect the time required to complete the process once it starts execution. It only affects the waiting time of a process i.e. time spent by a process waiting in the ready queue.

Waiting Time = Turnaround Time – Burst Time.

5. Response Time

In an interactive system, turn-around time is not the best criterion. A process may produce some output fairly early and continue computing new results while previous results are being output to the user. Thus another criterion is the time taken from submission of the process of the request until the first response is produced. This measure is called response time.
Response Time = CPU Allocation Time(when the CPU was allocated for the first) – Arrival Time

6. Completion Time

The completion time is the time when the process stops executing, which means that the process has completed its burst time and is completely executed.

7. Priority

If the operating system assigns priorities to processes, the scheduling mechanism should favor the higher-priority processes.

8. Predictability

A given process always should run in about the same amount of time under a similar system load.

Preemptive Scheduling:-

Preemptive scheduling is used when a process switches from the running state to the ready state or from the waiting state to the ready state. The resources (mainly CPU cycles) are allocated to the process for a limited amount of time and then taken away, and the process is again placed back in the ready queue if that process still has CPU burst time remaining. That process stays in the ready queue till it gets its next chance to execute

dispatcher

The dispatcher is the module that gives a process control over the CPU after it has been selected by the short-term scheduler. This function involves the following: Switching context. Switching to user mode.

- **Scheduling Algorithms –**

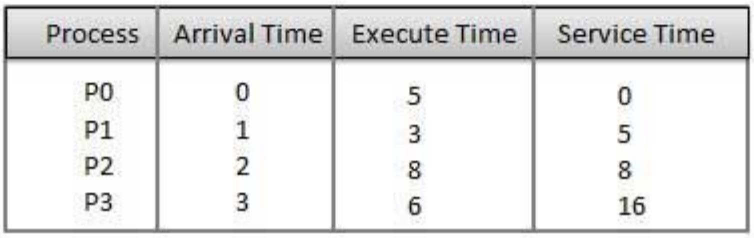
A Process Scheduler schedules different processes to be assigned to the CPU based on particular scheduling algorithms. There are six popular process scheduling algorithms which we are going to discuss in this chapter −

- First-Come, First-Served (FCFS) Scheduling
- Shortest-Job-Next (SJN) Scheduling
- Priority Scheduling
- Shortest Remaining Time
- Round Robin(RR) Scheduling
- Multiple-Level Queues Scheduling

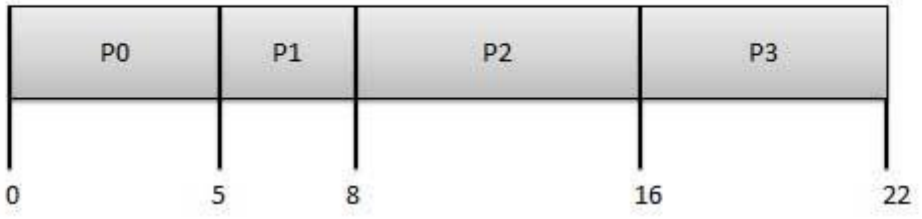
These algorithms are either **non-preemptive or preemptive**. Non-preemptive algorithms are designed so that once a process enters the running state, it cannot be preempted until it completes its allotted time, whereas the preemptive scheduling is based on priority where a scheduler may preempt a low priority running process anytime when a high priority process enters into a ready state.

1.First Come First Serve (FCFS)

- Jobs are executed on first come, first serve basis.
- It is a non-preemptive, pre-emptive scheduling algorithm.
- Easy to understand and implement.
- Its implementation is based on FIFO queue.
- Poor in performance as average wait time is high.



Process	Arrival Time	Execute Time	Service Time
P0	0	5	0
P1	1	3	5
P2	2	8	8
P3	3	6	16



Wait time of each process is as follows −

Process	Wait Time : Service Time - Arrival Time
P0	0 - 0 = 0
P1	5 - 1 = 4
P2	8 - 2 = 6
P3	16 - 3 = 13

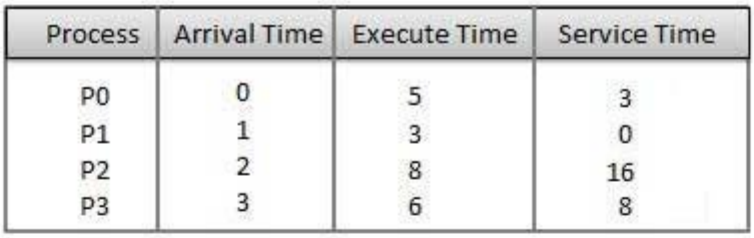
Average Wait Time: (0+4+6+13) / 4 = 5.75

2.Shortest Job Next (SJN)

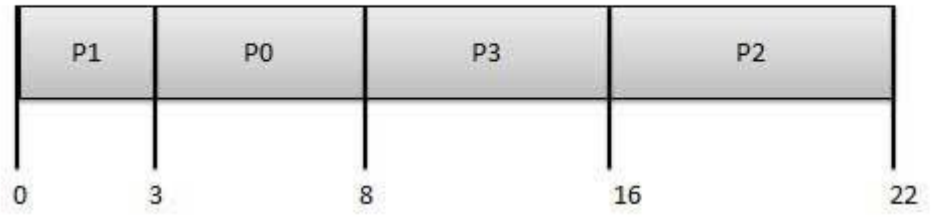
- This is also known as **shortest job first**, or SJF
- This is a non-preemptive, pre-emptive scheduling algorithm.
- Best approach to minimize waiting time.
- Easy to implement in Batch systems where required CPU time is known in advance.
- Impossible to implement in interactive systems where required CPU time is not known.
- The processer should know in advance how much time process will take.

Given: Table of processes, and their Arrival time, Execution time

Process	Arrival Time	Execution Time	Service Time
P0	0	5	0
P1	1	3	5
P2	2	8	14
P3	3	6	8



Process	Arrival Time	Execute Time	Service Time
P0	0	5	3
P1	1	3	0
P2	2	8	16
P3	3	6	8



Waiting time of each process is as follows −

Process	**Waiting Time**
P0	0 - 0 = 0
P1	5 - 1 = 4
P2	14 - 2 = 12
P3	8 - 3 = 5

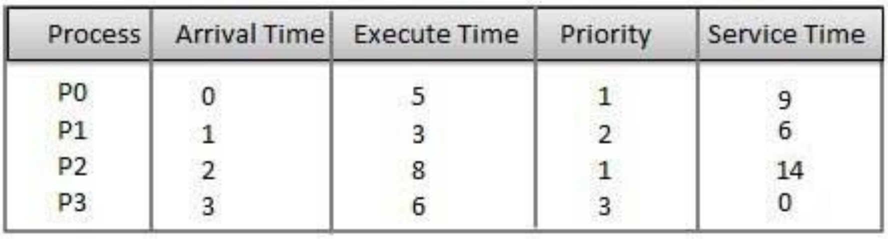
Average Wait Time: (0 + 4 + 12 + 5)/4 = 21 / 4 = 5.25

3.Priority Based Scheduling

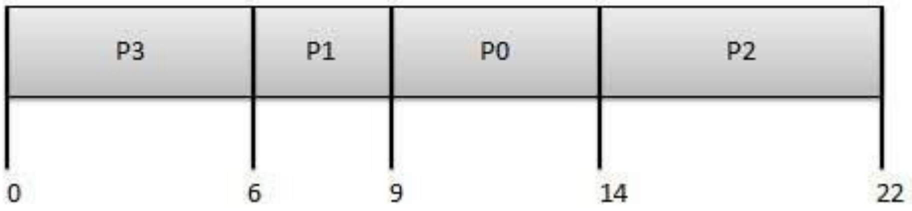
- Priority scheduling is a non-preemptive algorithm and one of the most common scheduling algorithms in batch systems.
- Each process is assigned a priority. Process with highest priority is to be executed first and so on.
- Processes with same priority are executed on first come first served basis.
- Priority can be decided based on memory requirements, time requirements or any other resource requirement.

Given: Table of processes, and their Arrival time, Execution time, and priority. Here we are considering 1 is the lowest priority.

Process	Arrival Time	Execution Time	Priority	Service Time
P0	0	5	1	0
P1	1	3	2	11
P2	2	8	1	14
P3	3	6	3	5



Process	Arrival Time	Execute Time	Priority	Service Time
P0	0	5	1	9
P1	1	3	2	6
P2	2	8	1	14
P3	3	6	3	0



Waiting time of each process is as follows −

Process	Waiting Time
P0	0 - 0 = 0
P1	11 - 1 = 10

P2	14 - 2 = 12
P3	5 - 3 = 2

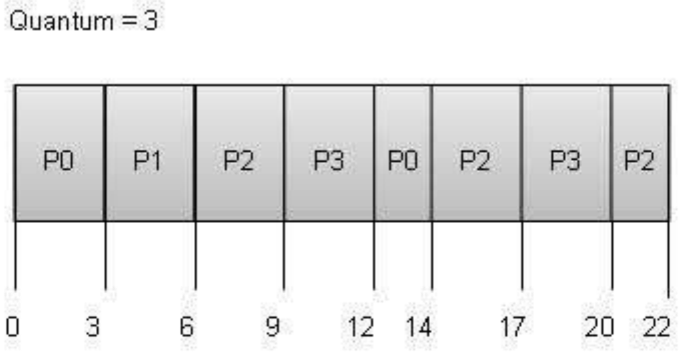
Average Wait Time: (0 + 10 + 12 + 2)/4 = 24 / 4 = 65.

4.Shortest Remaining Time

- Shortest remaining time (SRT) is the preemptive version of the SJN algorithm.
- The processor is allocated to the job closest to completion but it can be preempted by a newer ready job with shorter time to completion.
- Impossible to implement in interactive systems where required CPU time is not known.
- It is often used in batch environments where short jobs need to give preference.

5.Round Robin Scheduling

- Round Robin is the preemptive process scheduling algorithm.
- Each process is provided a fix time to execute, it is called a **quantum**.
- Once a process is executed for a given time period, it is preempted and other process executes for a given time period.
- Context switching is used to save states of preempted processes.



Wait time of each process is as follows −

Process	**Wait Time : Service Time - Arrival Time**

P0	(0 - 0) + (12 - 3) = 9
P1	(3 - 1) = 2
P2	(6 - 2) + (14 - 9) + (20 - 17) = 12
P3	(9 - 3) + (17 - 12) = 11

Average Wait Time: (9+2+12+11) / 4 = 8.5

6.Multiple-Level Queues Scheduling

Multiple-level queues are not an independent scheduling algorithm. They make use of other existing algorithms to group and schedule jobs with common characteristics.

- Multiple queues are maintained for processes with common characteristics.
- Each queue can have its own scheduling algorithms.
- Priorities are assigned to each queue.

For example, CPU-bound jobs can be scheduled in one queue and all I/O-bound jobs in another queue. The Process Scheduler then alternately selects jobs from each queue and assigns them to the CPU based on the algorithm assigned to the queue.

******************Thank you****************

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