OPERATING SYSTEMS

CPU Scheduling _ 1

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Non-Preemptive First Come First Serve and Shortest Job First / Next (SJF/SJN) Scheduling

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Scheduling Criteria

- **CPU utilization** – keep the CPU as busy as possible
- **Throughput** – # of processes that complete their execution per time unit
- **Turnaround time** – amount of time to execute a particular process (performance metric)
- **Waiting time** – amount of time a process has been waiting in the ready queue
- **Response time** – amount of time it takes from when a request was submitted until the first response is produced, not output (for time-sharing environment)

Scheduling Algorithm Optimization Criteria

- Maximize CPU utilization
- Maximize throughput
- Minimize turnaround time
- Minimize waiting time
- Minimize response time

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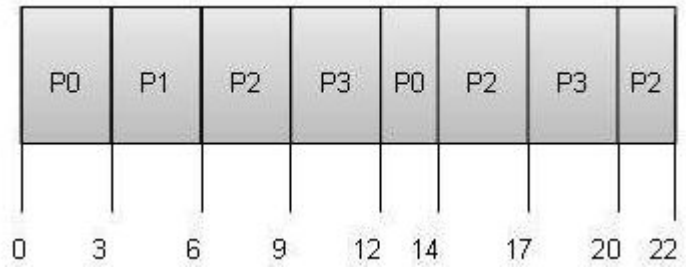
Sample Schemas and Tools for solving Scheduling Problems

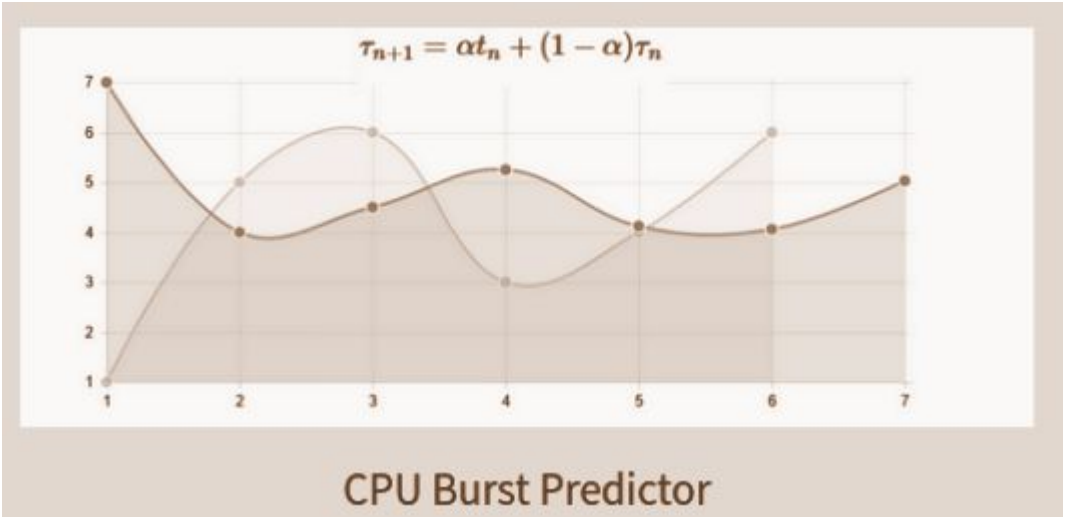
Process	Arrival Time	Execute Time	Service Time

Process	Execution time	Arrival time

Process	Arrival Time	Execution Time	Priority	Service Time

GANTT Chart





Sample Schemas and Tools for solving Scheduling Problems

Arrival Time: Time at which the process arrives in the ready queue.

Completion Time: Time at which process completes its execution.

Burst Time: Time required by a process for CPU execution.

Turn Around Time: Time Difference between completion time and arrival time.

Turn Around Time = Completion Time – Arrival Time

Waiting Time(W.T): Time Difference between turn around time and burst time.

Waiting Time = Turnaround Time – Burst Time

First Come First Serve (FCFS) Scheduling

- First Come First Serve, is just like **FIFO**(First in First out) Queue data structure, where the data element which is added to the queue first, is the one who leaves the queue first.
- FCFS is used in Batch Systems.
- First come first serve (FCFS) scheduling algorithm simply schedules the jobs according to their arrival time. The job which comes first in the ready queue will get the CPU first.
- 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.
- Advantages of FCFS
  - Simple
  - Easy
  - First come, First serve
- Disadvantages of FCFS
  - The scheduling method is non preemptive, the process will run to the completion.
  - Due to the non-preemptive nature of the algorithm, the problem of starvation may occur.
  - Although it is easy to implement, but it is poor in performance since the average waiting time is higher as compare to other scheduling algorithms.

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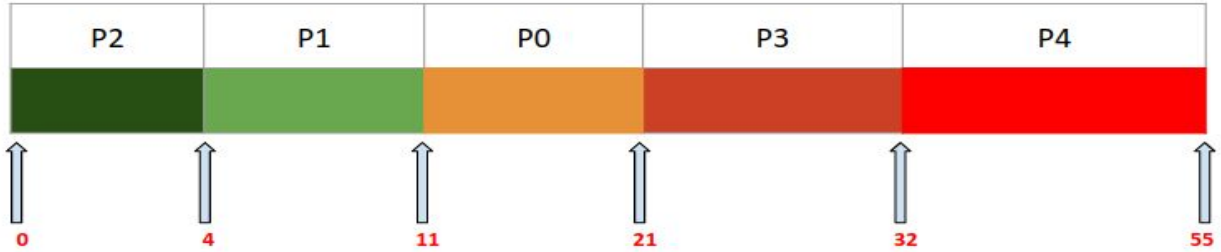
First Come First Serve (FCFS) Scheduling

Using the below given Process Table, applying First Come First First Serve (FCFS) Scheduling Algorithm. Find the following by drawing appropriate GANTT Chart

1. Waiting Time (WT) for each process
2. Turn Around Time (TAT) for each process
3. Response Time (RT) for each process
4. Average Response Time (ART)
5. Average Waiting Time (AWT)
6. Average Turnaround Time (ATAT)

Note: FCFS algorithm is inherently non-preemptive, the Response time depends on the arrival time,and the size of the job. In this case the larger process arriving earlier makes the smaller process to wait till the larger process completes its turn. It also results in Convoy effect where in the shortest is behind the longer process



GANTT Chart

Process Table			
Process ID	Arrival Time	CPU Burst	Remarks
P0	0	10	
P1	0	7	
P2	0	4	
P3	0	11	
P4	0	23	
Considering Shortest Job First since the arrival time is same			

Process ID	Response Time	Waiting Time	Turn Around Time
P0	11	11	21
P1	4	4	11
P2	0	0	4
P3	21	21	32
P4	32	32	55
Average	13.6	13.6	24.6
Remarks	ART	AWT	ATAT

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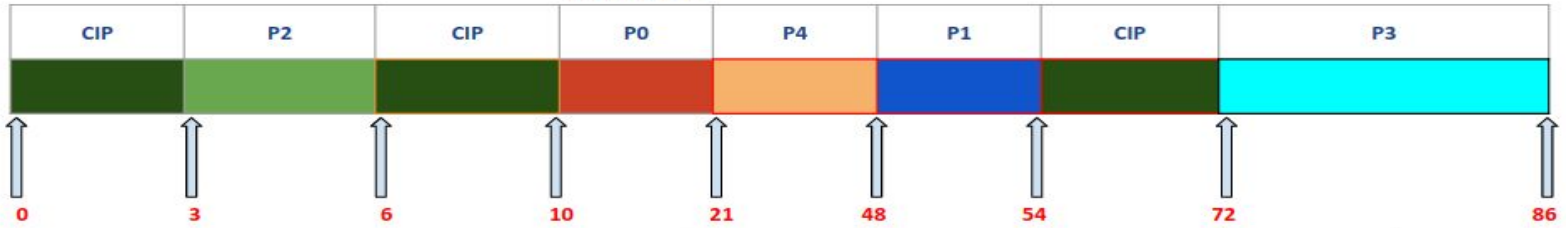

Process Table			
Process ID	Arrival Time	CPU Burst	Remarks
P0	10	11	
P1	43	6	
P2	3	3	
P3	72	14	
P4	11	27	
Considering based on arrival time			

Process ID	Arrival Time	Response Time	Waiting Time	Turn Around Time
CIP	Omnipresent	Omnipresent	Omnipresent	Omnipresent
P0	10	10-10=>0	10-10=>0	21-10=>11
P1	43	48-43=>5	48-43=>5	54-43=>11
P2	3	3-3=>0	3-3=>0	6-3=>3
P3	72	72-72=>0	72-72=>0	86-72=>14
P4	11	21-11=>10	21-11=>10	48-11=37
Average	27.8	15/5=>3	15/5=>3	15.2
Remarks	AAT	ART	AWT	ATAT

Shortest Job First / Next Non-Preemptive Scheduling

- It is associated with each job as a unit of time to complete.
- This algorithm method is helpful for batch-type processing, where waiting for jobs to complete is not critical.
- It can improve process throughput by making sure that shorter jobs are executed first, hence possibly have a short turnaround time.
- It improves job output by offering shorter jobs, which should be executed first, which mostly have a shorter turnaround time.
- In any non-preemptive scheduling, once the CPU cycle is allocated to process, the process holds it till it reaches a waiting state or terminated

Shortest Job First / Next Non-Preemptive Scheduling

Advantages of SJF / SJN

- SJF is frequently used for long term scheduling.
- It reduces the average waiting time over FIFO (First in First Out) algorithm.
- SJF method gives the lowest average waiting time for a specific set of processes.
- It is appropriate for the jobs running in batch, where run times are known in advance.
- For the batch system of long-term scheduling, a burst time estimate can be obtained from the job description.
- For Short-Term Scheduling, we need to predict the value of the next burst time.
- Probably optimal with regard to average turnaround time.

Disadvantages of SJF / SJN

- Job completion time must be known earlier, but it is hard to predict.
- It is often used in a batch system for long term scheduling.
- SJF can't be implemented for CPU scheduling for the short term. It is because there is no specific method to predict the length of the upcoming CPU burst.
- This algorithm may cause very long turnaround times or starvation.
- Requires knowledge of how long a process or job will run.
- It leads to the starvation that does not reduce average turnaround time.
- It is hard to know the length of the upcoming CPU request.
- Elapsed time should be recorded, that results in more overhead on the processor.

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Shortest Job First / Next Non-Preemptive Scheduling

Using the below given Process Table, applying Shortest Job First / Next (SJF / SJN) non-preemptive Scheduling Algorithm. Find the following by drawing appropriate GANTT Chart

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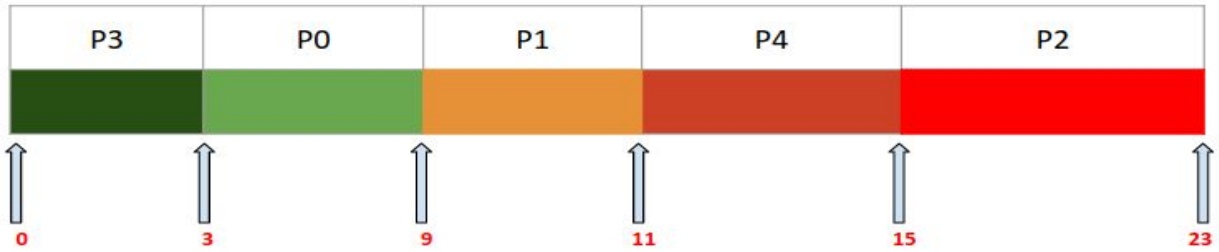

GANTT Chart

Process Table			
Process ID	Arrival Time	CPU Burst	Remarks
P0	2	6	
P1	5	2	
P2	1	8	
P3	0	3	
P4	4	4	
Note: In both FCFS and Non-Preemptive SJF/SJN waiting time equals response time			

Process ID	Arrival Time	Response Time	Waiting Time	Turn Around Time
CIP	Omnipresent	Omnipresent	Omnipresent	Omnipresent
P0	2	3-2=>1	3-2=>1	9-2=>7
P1	5	9-5=>4	9-5=>4	11-5=>6
P2	1	15-1=>14	15-1=>14	23-1=>22
P3	0	0	0	3-0=>3
P4	4	11-4=>7	11-4=>7	15-4=>11
Average	2.4	5.2	5.2	9.8
Remarks	AAT	ART	AWT	ATAT

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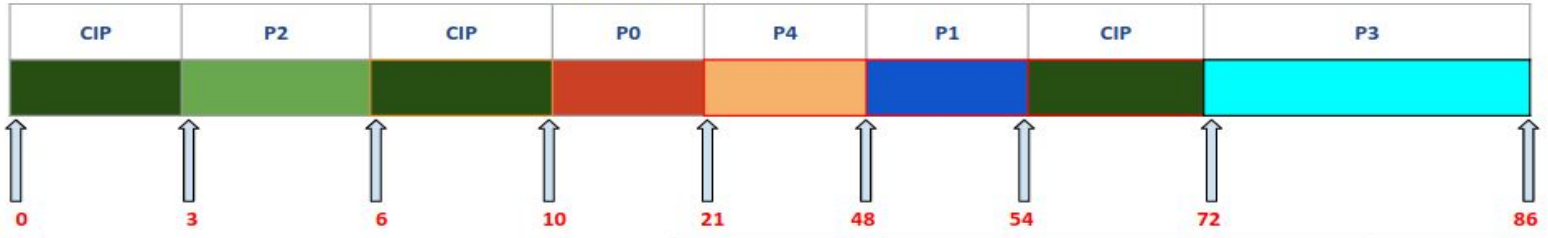

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THANK YOU

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