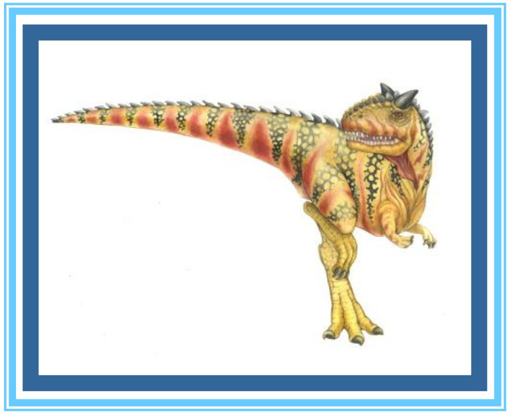
Chapter 6: Part-2
CPU Scheduling



Chapter 6: CPU Scheduling

- Basic Concepts
- Scheduling Criteria
- Scheduling Algorithms
- Thread Scheduling
- Multiple-Processor Scheduling
- Real-Time CPU Scheduling
- Operating Systems Examples
- Algorithm Evaluation

Objectives

- To introduce CPU scheduling, which is the basis for multiprogrammed operating systems
- To describe various CPU-scheduling algorithms
- To discuss evaluation criteria for selecting a CPU-scheduling algorithm for a particular system
- To examine the scheduling algorithms of several operating systems

Determining Length of Next CPU Burst

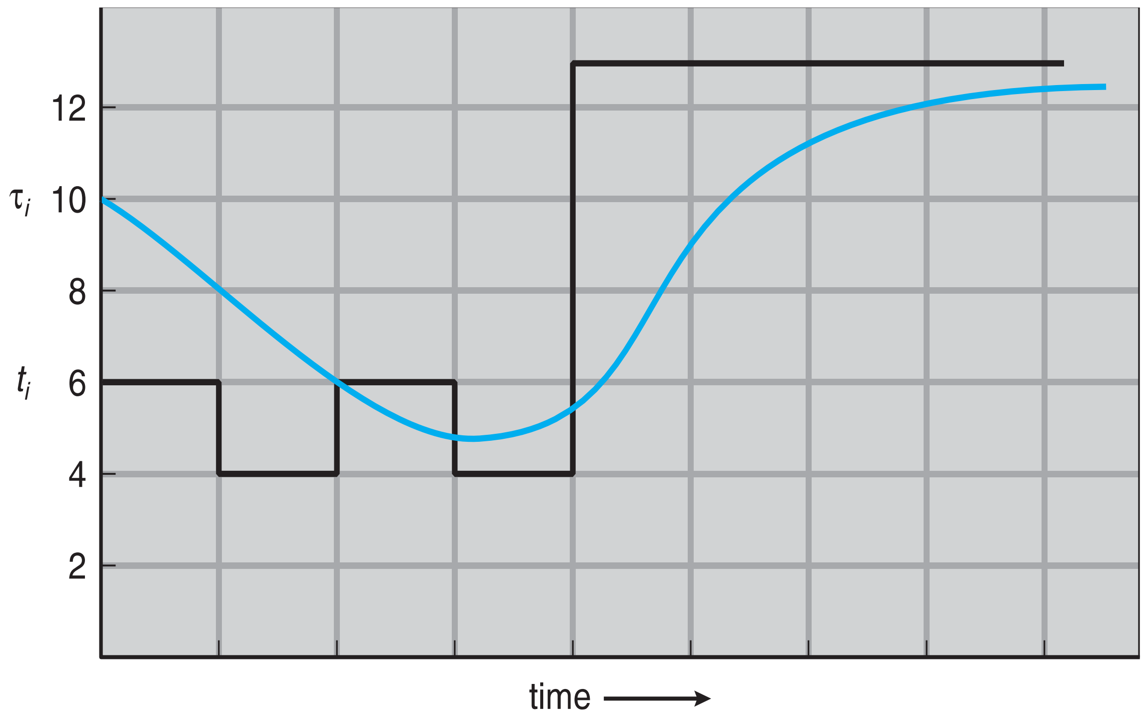
- Can only estimate the length – should be similar to the previous one
  - Then pick process with shortest predicted next CPU burst

- Can be done by using the length of previous CPU bursts, using exponential averaging

  1. $t_n =$ actual length of n^{th} CPU burst
  2. $\tau_{n+1} =$ predicted value for the next CPU burst
  3. $\alpha, 0 \leq \alpha \leq 1$
  4. Define: $\tau_{n=1} = \alpha\, t_n + (1 - \alpha)\tau_n.$

- Commonly, α set to ½
- Preemptive version called **shortest-remaining-time-first**

Prediction of the Length of the Next CPU Burst



CPU burst (t_i)		6	4	6	4	13	13	13	…
"guess" (τ_i)	10	8	6	6	5	9	11	12	…

Examples of Exponential Averaging

- $\alpha = 0$
  - $\tau_{n+1} = \tau_n$
  - Recent history does not count
- $\alpha = 1$
  - $\tau_{n+1} = \alpha \, t_n$
  - Only the actual last CPU burst counts
- If we expand the formula, we get:

$$\tau_{n+1} = \alpha\, t_n + (1 - \alpha)\alpha\, t_{n-1} + \ldots + (1 - \alpha)^j \alpha\, t_{n-j} + \ldots + (1 - \alpha)^{n+1} \tau_0$$

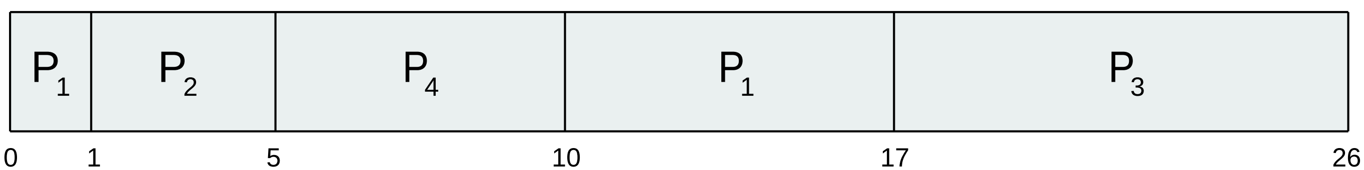
- Since both α and $(1 - \alpha)$ are less than or equal to 1, each successive term has less weight than its predecessor

Example of Shortest-Remaining-Time-First

- Now we add the concepts of varying arrival times and preemption to the analysis

Process	*Arrival* Time	Burst Time
P_1	0	8
P_2	1	4
P_3	2	9
P_4	3	5

- *Preemptive* SJF Gantt Chart

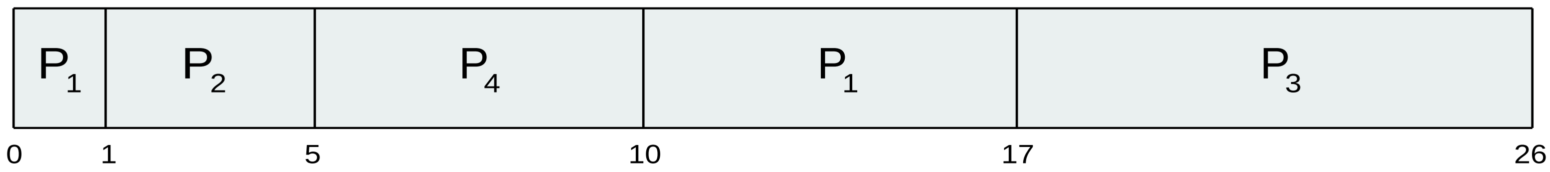


- Average waiting time = [(10-1)+(1-1)+(17-2)+5-3)]/4 = 26/4 = 6.5 msec

Example of Shortest-Remaining-Time-First

Another Solution :

Process	Arrival Time	Burst Time
P1	0	8 7 6 5 4 3 2 1 0
P2	1	4 3 2 1 0
P3	2	9 8 7 6 5 4 3 2 1 0
P4	3	5 4 3 2 1 0



Example of Shortest-Remaining-Time-First

Find below

- Turn-Around Time (TAT) = Complete Time (CT) – Arrival Time (AT)
- WT = Turn-Around Time (TAT) - Burst Time (BT)
- Response Time (RT) = Start Time (ST) – Arrival Time (AT)

Process	Complete Time	Turn Around Time	Waiting Time	Response Time
P1	17	17-0 = 17	17-8 = 9	0 – 0 = 0
P2	5	5-1 = 4	4 -4 = 0	1-1 =0
P3	26	26-2 = 24	24-9 =15	18 – 2 =16
P4	10	10-3 =7	7-5 = 2	6 -3 = 3

- Average Waiting Time = (9+0+15+2)/4 → 26 / 4 = 6.5
- Average Turn-Around Time (TAT) = (17+4+24+7) / 4 = 13

Example of Shortest-Remaining-Time-First

Another Example:

Process	Arrival Time	Burst Time
P1	0	8 7 6 5 4 3 2 1 0
P2	1	4 3 2 1 0
P3	2	2 1 0
P4	3	1 0
P5	4	3 2 1 0
P6	5	2 1 0

P1	P2	P3	P3	P4	P6	P6	P2	P2	P2	P5	P1	P5	P1	P1	P1	P1	P1	P1	P1	P1
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Example of Shortest-Remaining-Time-First

Find below

- Turn-Around Time (TAT) = Complete Time (CT) – Arrival Time (AT)
- WT = Turn-Around Time (TAT) - Burst Time (BT)
- Response Time (RT) = Start Time (ST) – Arrival Time (AT)

Process	Complete Time	Turn Around Time	Waiting Time	Response Time
P1	20	20	12	0
P2	10	9	5	0
P3	4	2	0	0
P4	5	2	1	1
P5	13	9	6	6
P6	7	2	0	0

- Average Waiting Time = (12+5+0+1+6+0)/6 → 24 / 6 = 4
- Average Turn-Around Time (TAT) = (20+9+2+2+9+2) / 4 → 44/4 = 11

HW of Shortest-Remaining-Time-First

- Find the average waiting time according to the SRTF (preemptive SJF) scheduling algorithm?

Process	Arrival Time	Burst Time
P1	0	11
P2	1	9
P3	2	7
P4	3	5
P5	4	8

- Consider the following set of process with the length of CPU burst cycle given in milliseconds:

HW of Shortest-Remaining-Time-First

- Find the average waiting time according to the SRTF (preemptive SJF) scheduling algorithm?

Process	Arrival Time	Burst Time
P1	0	12
P2	3	8
P3	5	4
P4	10	10
P5	12	6

- Consider the following set of process with the length of CPU burst cycle given in milliseconds:


Q
&
A


NEXT

CPU Scheduling

Priority Scheduling


Thank you
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