Processes and CPU Scheduling, Part II

Overview

The practise questions are designed to complement and enhance your knowledge of topics covered in the lectures. Not all answers will be readily found on the lecture notes and slides, and you may be required to engage in some self-learning to complete the questions.

Suggested answers to the practise questions shall be provided at a later date. It is strongly advised that you attempt these questions on your own, and discuss them with your peers before consulting the suggested answers.

Practise Questions

1. Why is it important for a process scheduler to distinguish between I/O-bound programs and CPU-bound programs?

2. CPU scheduling decisions may take place when a process
   a. Switches from running to ready state
   b. Switches from running to waiting state

   In general, which of the above scheduling is *pre-emptive*, and which is *non-pre-emptive*? Why?

3. Consider the following set of processes in Table I, with the length of the CPU burst times given in milliseconds

Table I

Process	Burst Time (ms)	Priority
P1	2	2
P2	1	1
P3	8	4
P4	4	2
P5	5	3

Assume the processes arrive in the following order `P1` (first), `P2`, `P3`, `P4`, `P5` (last), all at time 0.

a. Draw four Gantt charts to illustrate the execution of these processes using the following scheduling algorithms
   i. First-come, first-served
   ii. Shortest job first
   iii. Non-pre-emptive priority (a smaller priority number implies a higher priority)
   iv. Round-robin (with time quantum 1)

b. What is the turnaround time of each process, for each of the scheduling algorithms in Question 3.a?

c. What is the waiting time of each process, for each of the scheduling algorithms in Question 3.a?

d. Which of the algorithms in Question 3.a results in the minimum average waiting time over all processes?

4. Consider a system running ten I/O-bound tasks and one CPU-bound task. Assume that the I/O-bound tasks issue an I/O operation once for every millisecond of CPU computing, and that each I/O operation takes 10 milliseconds to complete. Also assume that the context-switching overhead is 0.1 millisecond and that all processes are long-running tasks. Describe the CPU utilization for a round-robin scheduler when
   a. The time quantum is 1 millisecond
   b. The time quantum is 10 milliseconds

5. Consider a pre-emptive priority scheduling algorithm based on dynamically changing priorities. In this algorithm, a larger priority number imply higher priority.

6. When a process is waiting for the CPU (in the ready queue, but not running), its priority changes at a rate α; when it is running, its priority changes at a rate β. All processes are given a priority of 0 when they enter the ready queue.

   The parameters α and β can be set to give many different scheduling algorithms.
   a. What is the algorithm that results from $\beta > \alpha > 0$?
   b. What is the algorithm that results from $\alpha < \beta < 0$?

7. Consider the following set of processes in Table II, with the length of the CPU burst times given in milliseconds

Table II

Arrival Time (ms)	Process	Burst Time (ms)
0	P1	8
0	P2	10
2	P3	5
5	P4	7
7	P5	3

a. Draw Gantt charts to illustrate the execution of these processes using the following scheduling algorithms
   i. First-come, first-served
   ii. Shortest job first
   iii. Shortest remaining time first
   iv. Round-robin (with time quantum 4)

b. Compute the average waiting time and turnaround time for each of the scheduling algorithms in Question 7.a.

c. How many context switches are needed for each of the scheduling algorithms in Question 7.a?

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