# C211 – Operating Systems

# Tutorial: Scheduling

## *– Answers –*

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1. State which of the following are true and which false. Justify your answers.

   (a) Interactive systems generally use nonpreemptive processor scheduling.

   *False. They use preemptive scheduling to guarantee a fast response to new requests. The goal is to service trivial, I/O-bound, interactive requests immediately and quickly in favor of more lengthy requests that can receive lower levels of service.*

   (b) Turnaround times are more predictable in preemptive than in nonpreemptive systems.

   *False. In a nonpreemptive system, once a process gets a processor, it will run to completion; there is no uncertainty caused by the possibility of repeatedly being preempted by other processes.*

   (c) One weakness of priority scheduling is that the system will faithfully honor the priorities, but the priorities themselves may not be meaningful.

   *True. The point here is that the assignment of priorities in such a system is an important task. If, indeed, we create a priority-honoring system, then we should put substantial effort into ensuring that priorities are assigned meaningfully. If not, then we have a mechanism that works properly yet delivers questionable results.*

2. (a) Give an example showing why FCFS is not an appropriate scheduling scheme for interactive users.

   *The assumption is that with FCFS, once a process is initiated it runs to completion. Such a scheme would prevent the system from guaranteeing good interactive response times. For example, suppose a large batch process enters a uniprocessor system. While that process executes, no other processes can execute. A user that attempts to load a web page or send an instant message must wait until the batch process completes before the system will respond to those requests.*

   (b) Using the example from (a), show why round-robin is a better scheme for interactive users.

   *Round-robin is a preemptive scheme that makes use of the interrupt clock. Long processes can not delay shorter ones, because the shorter ones are assured of getting the processor periodically. Interactive users will thus receive the processor frequently enough to maintain good response times. In our example, the large batch job will be interrupted to service the processes that try to load a web page or send an instant message.*

3. Five jobs are waiting to be run. Their expected run times are 9, 6, 3, 5, and X. In what order should they be run to minimize average turnaround time? (Your answer will depend on X.)

   *Shortest job first is the way to minimize average turnaround time:*

   - $0 < X \leq 3$*: X, 3, 5, 6, 9*
   - $3 < X \leq 5$*: 3, X, 5, 6, 9.*

- $5 < X \leq 6$*: 3, 5, X, 6, 9.*
- $6 < X \leq 9$*: 3, 5, 6, X, 9.*
- $X > 9$*: 3, 5, 6, 9, X.*

4. Five batch jobs, A through E, arrive at a computer centre at essentially the same time. Their estimated running time are as follows: A = 15min, B = 9min, C = 3 min, D = 6 min and E = 12 min. Their (externally defined) priorities are: A = 6, B = 3, C = 7, D = 9 and E = 4, with a lower value corresponding to a higher priority. For each of the following scheduling algorithms, determine the turnaround time for each job, and the average turnaround time for all jobs. Ignore process switching overhead and assume all jobs are completely CPU bound.

   (a) Non-preemptive priority scheduling. *Jobs are run to completion in the order B, E, A, C, D. The turnaround time for each job is B = 9 min, E = 21 min, A = 36 min, C = 39 min, D = 45 min. The average turnaround time is: (9+21+36+39+45) / 5 = 30 min.*

   (b) FCFS (run in order A, B, C, D, E). *Jobs are run to completion in the order A, B, C, D, E. The turnaround time for each job is A = 15 min, B = 24 min, C = 27 min, D = 33 min, E = 45 min. The average turnaround time is: (15+24+27+33+45) / 5 = 28.8 min.*

   (c) Shortest job first (SJF). *Jobs are run to completion in the order C, D, B, E, A. The turnaround time for each job is C = 3 min, D = 9 min, B = 18 min, E = 30 min, A = 45 min. The average turnaround time is: (3+9+18+30+45) / 5 = 21 min.*

   (d) Round robin with a time quantum of 1 minute. *Jobs are run in round robin order:*
   *A,B,C,D,E.*
   *A,B,C,D,E,*
   *A,B,C,D,E,*
   *A,B,D,E,*
   *A,B,D,E,*
   *A,B,D,E,*
   *A,B,E,*
   *A,B,E,*
   *A,B,E,*
   *A,E,*
   *A,E,*
   *A,E,*
   *A,*
   *A,*
   *A.*
   *The turnaround time for each job is A = 45 min, B = 35 min, C = 13 min, D = 26 min, E = 42 min. The average turnaround time is = (45+35+13+26+42) / 5 = 32.2 min.*