

Santa Clara University
Department of Computer Engineering
Advanced Operating Systems (COEN 383)

Project-2 (6 pts)
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Process Scheduling Algorithms

This assignment will give you experience with process scheduling algorithms. Write a Java or C program that performs runs for fixed (same) workload using each of the following process scheduling algorithms:

- First-come first-served (FCFS) // non-preemptive
- Shortest job first (SJF) // non-preemptive
- Shortest remaining time (SRT) // preemptive
- Round robin (RR) // preemptive
- Highest priority first (HPF) // both non-preemptive and preemptive

Run each algorithm for 100 quanta (time slices), labeled 0 through 99. Before each run, generate a set of simulated processes. For each simulated process, randomly generate:

- **An arrival time:** an integer value from 0 through 99 (measured in quanta).
- **An expected total run time:** an integer value from 1 through 10 quanta.
- **A priority:** integer 1, 2, 3, or 4 (1 is highest)

Tip-1: Process can arrive at any time but it is scheduled only on quantum boundaries

Tip-2: For debugging, you may want to use the same (pseudo) random numbers each time. For this to happen, you should set the **seed** of the random number generator to a value, such as 0. For Java, see <http://docs.oracle.com/javase/6/docs/api/java/util/Random.html>

Assume only one process queue. Sort the simulated processes so that they enter the queue in arrival time order. Your process scheduler can do process switching only at the start of each time quantum. For this assignment, only consider CPU time for each process (no I/O wait times).

For RR, use a time slice of 1 quantum.

For HPF (Highest Priority First), use 4 priority queues. Do separate runs for **non-preemptive scheduling** and for **preemptive scheduling** (i.e., consider HPF to be two algorithms, giving 6 algorithms altogether). For preemptive scheduling, use RR with a time slice of 1 quantum for each priority queue. For non-preemptive scheduling, use FCFS.

Each simulation run should last until the completion of the last process, even if it goes beyond 100 quanta. No process should get the CPU for the first time after time quantum 99.

How many simulated processes should you create before each algorithm run? Create enough so that the CPU is never idle for more than 2 consecutive quanta waiting for work to do, except possibly at the very beginning of each run. It's OK to create more processes for a run than you can actually use.

Run each algorithm **5 times** to get averages for the statistics below. Before each run, clear the process queue and create a new set of simulated processes.

Outputs for each algorithm run (total 25-30 runs)

- Each created process's name (such as A, B, C, ...), arrival time, expected run time, and priority.
- A time chart of the 100+ quanta, such as ABCDABCD ...
Show a process's name in a quantum even if it completed execution before the end of that quantum (so then the CPU is idle at least until the start of the next quantum).
- **Calculated statistics for the processes during the run:**
 - Average turnaround time
 - Average waiting time
 - Average response time
- **Calculated statistic for the algorithm for the run:**
 - Throughput

For each run of HPF, you should compute the averages and throughput separately for each priority queue along with the overall averages and throughput for the run.

Because we're limiting each run not to give the CPU to a process for the first time (start new process) after quantum 99, your statistics should only include the processes that actually ran. In other words, if you created too many simulated processes for the run, don't count the ones that entered the process queue but never

started. This means that with HPF, if a priority queue has a throughput of 0, starvation probably occurred but you won't know how many processes starved.

Final outputs and report

Final output should be the average statistics over 5 runs for each scheduling algorithm.

In a short report (1 or 2 pages), discuss which algorithm appears to be best for each of the calculated statistics.

Extra credit (Extra 1 points)

Add aging to both HPF non-preemptive and HPF preemptive. After a process has waited for 5 quanta at a priority level, bump it up to the next higher level.

What to turn in

Create a zip file containing:

- Your Java or C source files.
- A text file containing output from your simulation runs.
- Your report as a text file, Word document, or PDF.

Important: Name the zip file after your class number-Group#-HW#, for example **COEN383-G3-HW2.zip**. Some mailers may not

allow you to mail zip files, so you may have to rename the file to have the suffix other than **.zip**, such as **.zzz**. Do not include **.class** files and do not email executable files.

Email a message to the grader that you posted your project to Camino. Your subject line should be: **COEN383 Assignment #2, Group-n**. Cc all your group members so that the grader can do a "Reply all" when needed. This is a group assignment; all group members will receive the same score.