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A Comparison of FCFS, SPN, and HRRN Algorithms

Introduction

This project was intended to dissect three different scheduling algorithms: First-Come-First-Served (FCFS), Shortest-Process-Next (SPN), and Highest-Response-Ratio-Next (HRRN) to try and discern the strengths and weaknesses for each of the algorithms. The challenge for us was to try and simulate the three algorithms in a C program that would keep track of the turnaround time (which can be defined as the entire time spent by the process waiting to execute and actually executing) and the ratio of the turnaround time to the actual service time of the process, also known as the normalized turnaround time.

Scheduling Algorithms

The FCFS algorithm acts like the traditional queue where the processor executes each process in the order of the processes' arrival. It is also a non-preemptive scheduling policy where each process executes until it is completed by the processor. An advantage of this policy is that there is no chance for starvation, as all processes eventually are executed, but by this same coin the algorithm will inherently have better response times for longer processes, but short processes could potentially wait an inordinate amount of time if they were to arrive shortly after a long process.

The SPN algorithm is preemptive where the processor will queue up processes that have arrived, and after one has finished executing, the processor looks for the shortest process in the queue and executes that next. The advantage of this policy is that for short processes the turnaround time is blazing fast, but this also entails that for longer processes the turnaround time can be extremely long, and in cases where there is a constant steady stream of short processes the longer processes will suffer from starvation.

Finally the HRRN algorithm executes each process until it is finished, and then tries to normalize the turnaround time for every process that has arrived, which is why the processor's selection of the next process is the same as the formula for normalized response time (time spent waiting + service time / service time). This algorithm does in fact yield a good balance between shorter and longer processes, as longer ones will eventually have a large enough numerator to have the highest response ratio and be selected next. However, as the denominator in the selection formula is the process' service time, the algorithm will slightly favor short processes. Another positive aspect of this algorithm is that because it tries to normalize the turnaround time for each process, starvation is not possible.

Performance Metrics

The tests ran each selection algorithm and measured the turnaround time for each process, which is calculated as the time spent waiting before execution and the total service time. This value was then averaged, yielding the values shown on the chart shown later. In addition the normalized turnaround time was calculated for each process in the queue by the formula:

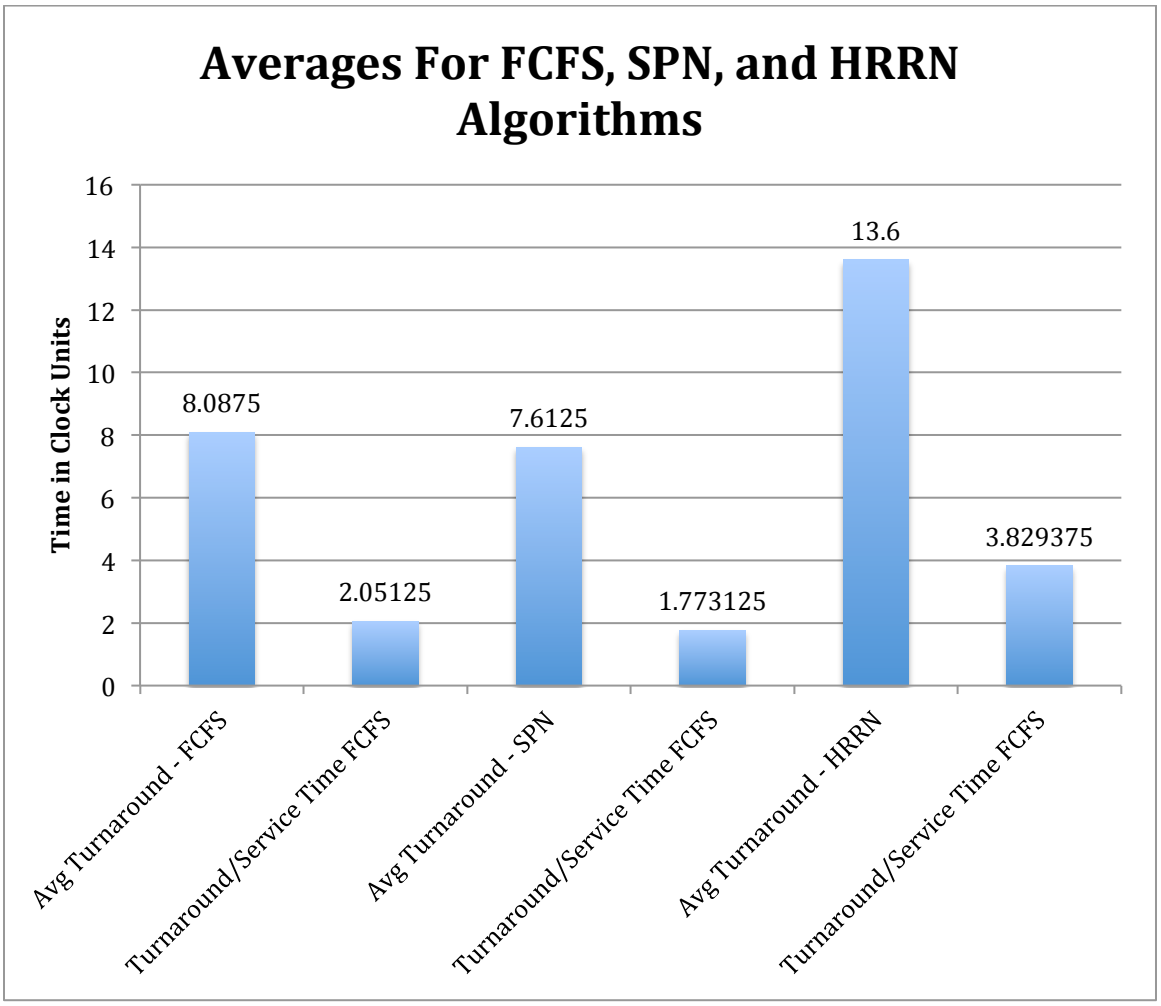
$$\frac{(wait\ time + service\ time)}{service\ time} = \frac{turnaround\ time}{service\ time} = normalized\ turnaround\ time$$

This was of course tabulated for each process and then averaged for the simulation.

Simulation Algorithm

The algorithm would create an array of processes that had random arrival and service times and each function would loop through the array in a clock-like fashion, incrementing and subsequently adding to the processes wait time (except the first process). When the process begins to execute, the service time is decremented until zero, at which point the process was marked completed in another array, which would allow for the next process to be selected determined by the policy the main function is testing (FCFS, SPN, HRRN).

Results


Averages For FCFS, SPN, and HRRN Algorithms
Time in Clock Units
16
14
12
10
8
6
4
2
0
8.0875
2.05125
7.6125
1.773125
13.6
3.829375
Avg Turnaround - FCFS
Turnaround/Service Time FCFS
Avg Turnaround - SPN
Turnaround/Service Time FCFS
Avg Turnaround - HRRN
Turnaround/Service Time FCFS