

Assignment 3 - Part I - Report

SYSC 4001

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GitHub Repository:

https://github.com/SamyKadd/SYSC4001_A3_P1.git

Introduction

The objective of this assignment was to create and analyze three different CPU scheduling algorithms, the three being; Enhanced Priority (**EP**), Round Robin (**RR**), Enhanced Priority Round Robin (**EP RR**). After the creation of these CPU algorithms, we ran several tests and analyzed the schedulers' performances under a variety of different use cases (*the use cases can be found under input_files, the results to analyze are under output_files*).

Setting up the CPU Schedulers

Each scheduler has a similar build structure, as they each followed the following flow:

Every millisecond, the simulation would

Update the CPU burst time → Decrement the I/O timers for processes in WAITING State → Return the completed I/O requests to READY states → Apply each of the scheduling algorithm rules (*this is the part that differed between each scheduler*) → Log every state transition → and tracks/calculate metrics

For I/O handling, the process enters WAITING state on an I/O request, and will return to READY state after *io_duration*. This was used to calculate response time using the average time between consecutive I/O requests per every process.

The metrics tracked and calculated were the following, and was done through code our code;

Turnaround Time, which was found through *completion time - arrival time*

Waiting Time, which was found through *the use of READY state tracking loops*

Throughput, which was found through *total processes / total simulation time*

Response Time (*explained above*)

RESULTS

A cumulative of 60 tests were run, 20 tests per CPU Scheduler. For this report, we will focus on just 5 of these tests:

Test 1 being a CPU-Bound scenario

Test 10 being a mix workload with moderate amounts of CPU burst scenario

Test 15 being heavy CPU-Bound scenario, with different arrivals

Test 20 being a multiprocess workload scenario

Below are the tables comparing the outputs from the different schedulers for each test listed above.

Test 1 Results

Scheduler	Avg Turnaround	Avg Waiting	Throughput	Avg Resp Time
EP	85.25	53.75	0.031008	0
RR	85.25	53.75	0.031008	0
EP_RR	85.25	53.75	0.031008	0

Test 10 Results

Scheduler	Avg Turnaround	Avg Waiting	Throughput	Avg Resp Time
EP	271.80	192.20	0.012376	0
RR	288.50	187.50	0.009780	0
EP_RR	313.00	214.40	0.010020	0

Test 15 Results

Scheduler	Avg Turnaround	Avg Waiting	Throughput	Avg Resp Time
EP	313.00	214.00	0.010020	0
RR	288.50	187.50	0.009780	0
EP_RR	313.00	214.40	0.010020	0

Test 20 Results

Scheduler	Avg Turnaround	Avg Waiting	Throughput	Avg Resp Time
EP	271.80	191.80	0.012376	0
RR	271.80	191.80	0.012376	0
EP_RR	302.80	223.20	0.012376	0

Analysis

First let's take a look at the test 1 results. Every single metric across all the scheduling types holds the same value. This is because for this test, we used CPU bursts that are lower than 100 ms (which was the quantum we chose). There were also no I/Os in this test. This just shows that when we have no I/Os, and bursts shorter than the quantum, all schedulers will act as a FCFS. Thus no scheduling type here is more efficient than the other.

The test 10 results tell a different story. Every single metric had a different value. Here the CPU bursts were longer, and job overlapping while still maintaining the no I/O concept. This helps us observe how the schedulers actually work (priority wise).

EP had the lowest turnover time → the higher priority processes finished earlier

Average response time was 0 → as we did not have an I/Os

RR had lowest wait time → CPUs time was spread

EP_RR had performed the worst, due to the fact that there was a lot of context switching being done.

For test 15, we aimed to test heavy CPU-Bound workload, meaning longer CPU Bursts, and a continuation and different arrivals of processes. What was noticed was that EP and EP_RR had very similar metrics, showing that EP AND EP_RR allowed the higher priority arrivals to run uninterrupted. RR did not enforce this, and instead showed a more fair priority spread, thus the lowest wait time. What these results show is how the Enhanced Priority scheduling create this starvation effect.

Lastly, there is test 20. This Test included a larger multi process workload. The results here indicate that EP and RR performed identically, as they had the same metrics throughout the board. The reason for this was because the quantum were larger than the bursts. This created a FCFS effect, similar to test 1. The reasons EP_RR did not behave like this was because the preemptions caused READY queue reshuffling which would interrupt and cause a longer waiting time.

In conclusion, EP optimizes turnaround for high priority jobs, but will cause starvation to other jobs. The RR minimizes waiting time, but will sacrifice the turnaround time for this to happen. Lastly EP_RR is very responsive, but will consume the most resources. I also performs the worst for mixed workloads.

BONUS

We used memory in your simulation using `free_memory()`. What we noticed with this addition was the following:

CPU-Bound workloads will reflect a more steady memory usage

I/O-Bound workloads lead to a constant amount of deallocations and reallocations. This causes an increase in fragmentation.

Memory turnover is increased when the amounts of active processes are increased. This is because there are more state transitions, thus we are allocating and deallocating more and more.