CS314: Lab Assignment 4

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1 Introduction

In this report, we will discuss the two schedulers that we coded in this lab assignment. For each of the schedulers, we will first analyze the following:

- Explanation of the scheduling scheme
- Expected job characteristics
- Test process data to bring out suitability of the scheme
- Test process data to bring out shortcomings of the scheme
- Analysis of the performance of the scheduler when run on the test cases provided (along with graphs to capture variations)

2 Shortest Job First (SJF) Scheduling

2.1 About this scheduling scheme

In this scheduling scheme, when the cpu is idle, the job in the ready queue with the shortest cpu burst is picked for execution. Here, this is a non pre-emptive scheduler, since, once a process is scheduled, it is not descheduled until the end of its burst. Note that in this assignment, we dealt with multi-burst processes, which leads to us having to make a number of assumptions, such as:

- I/O Devices go with a FIFO approach for execution.
- I/O Burst processes may have to wait if another process is already taking up the I/O Device. So this introduces a kind of "waiting" scenario between an I/O process and its blocked state.

2.2 Expected Job Characteristics

- If a short job arrives just after a long job starts its CPU burst, the short job must wait until the long job finishes. This would affect the turnaround time of short jobs adversely.
- If short jobs keep entering the scheduler, it is possible that long jobs are never scheduled, hence leading to their starvation.
- This algorithm optimizes average waiting time.

2.3 Best-case test process data

The following would be ideal for SJF, since all jobs arrive simultaneously. This would minimize waiting time.

```
0 100 2 90 2 80 3 70 2 60 2 10 -1
0 80 2 80 2 50 3 70 2 40 2 10 -1
0 70 2 70 2 40 3 70 2 20 2 10 -1
0 10 2 60 2 30 3 70 2 10 2 10 -1
```

2.4 Worst-case test process data

The following would be worst-case (bounded-time) process arrival for SJF, since short jobs need to all wait for the long job to finish its burst.

```
0 100 2 90 2 80 3 70 2 60 2 10 -1
1 2 2 5 -1
1 3 2 3 -1
2 4 3 4 -1
3 3 2 3 2 4 -1
```

2.5 Performance Analysis

For each program, the per-process statistics can be obtained by running the code, then checking the contents of `stats.txt` . Screenshots of the same are included at the end of this report.

The system averages are as follows:

Process File	Average Turnaround Time	Average Waiting Time	Average Response Time	Penalty Ratio
`process1.dat`	754.2857	538.1429	323.7143	0.248351
`process2.dat`	214.5000	139.9444	118.1667	0.233036
`process3.dat`	995.8333	727.7500	550.9167	0.391380

3 Round Robin (RR) Scheduling

3.1 About this scheduling scheme

In this scheduling scheme, time quantum of some length is assigned to jobs. These jobs are selected from a ready (circular) queue, and all jobs get a 'fair' share of the CPU's time. This involves a lot of context switching. Here, we make the same FIFO I/O assumptions from earlier. This scheduler optimizes response time, but may not bode well for the turnaround time. One may note that optimizing the size of the time slice/quantum is a difficult task, and there's no direct way to find out what its optimal value would be for a given use case.

3.2 Expected Job Characteristics

- No matter the size of a job, it obtains a proportionally 'fair' burst time to complete its execution. This is good for fairness of the scheduler.
- Since there are many context switches, this may have quite a bit of overhead. Also, turnaround time would be quite high for the jobs.
- Almost all jobs' execution begins shortly after they arrive, since their first allotted time slice would arrive less than one full cycle of the circular queue away. This optimizes response time.
- By design, starvation is averted, for any kind of job.
- The waiting time would get quite high, since processes spend a lot of time cycling around in the ready queue while they wait for their chance to get a time slice for execution.

3.3 Best-case test process data

If a long job and many short jobs are present, the initial time slices are equitably assigned to all the jobs. Once the short jobs finish executing, the long job can get an uninterrupted time slice. Even if short jobs appear later on, it doesn't starve the long job. In the below test case, the long job keeps occurring "parallely" (Note that this is NOT parallelism, but if we looked at it as 5-quanta chunks, then it has the general idea of paralleism) alongside the short jobs.

```
0 100 2 90 2 80 3 70 2 60 2 10 -1
1 2 2 5 -1
1 3 2 3 -1
2 4 3 4 -1
3 3 2 3 2 4 -1
```

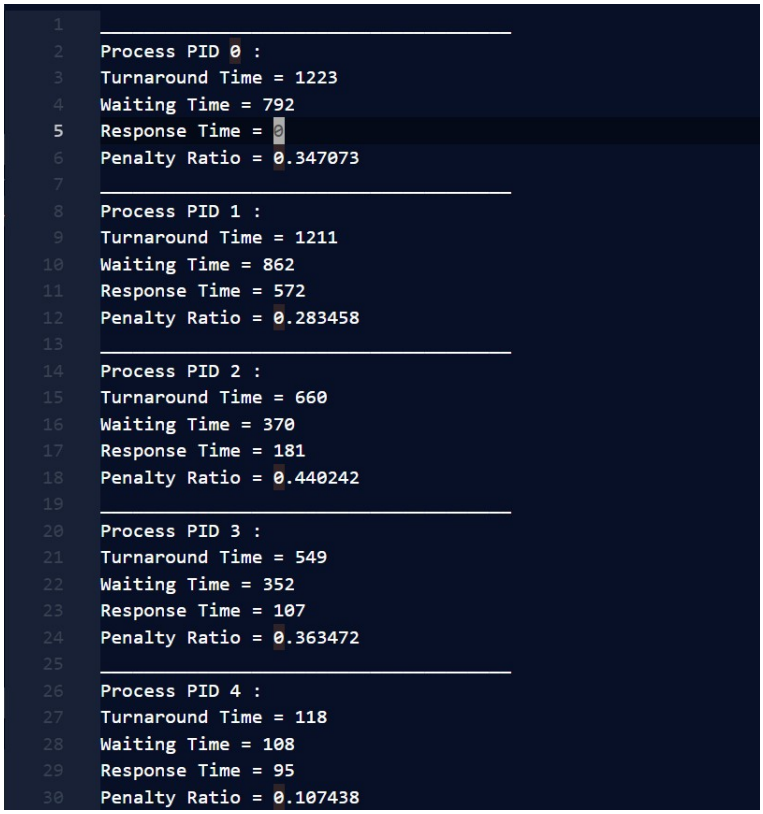
3.4 Worst-case test process data

If, say, 50 long jobs arrive, they will share the CPU equitably, but it would take a very long time for all of them to complete. Small jobs wouldn't, however, be fazed by this.

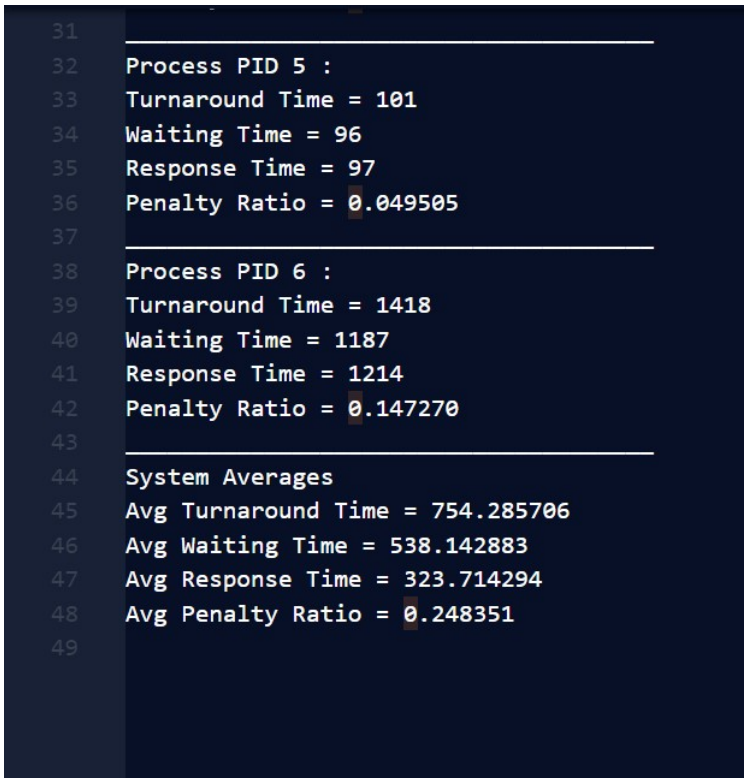
```
0 100 2 90 2 80 3 70 2 60 2 10 -1
1 200 2 45 -1
1 100 2 20 -1
2 200 3 210 -1
3 100 2 230 2 10 -1
```

(Note: A much simpler example to think about is 10 single-burst CPU tasks of size 100 each. With RR Scheduling, their average turnaround time is about 995, while with SJF Scheduling, the same would be around 550. That's a roughly 80% increase!)

4 Screenshots



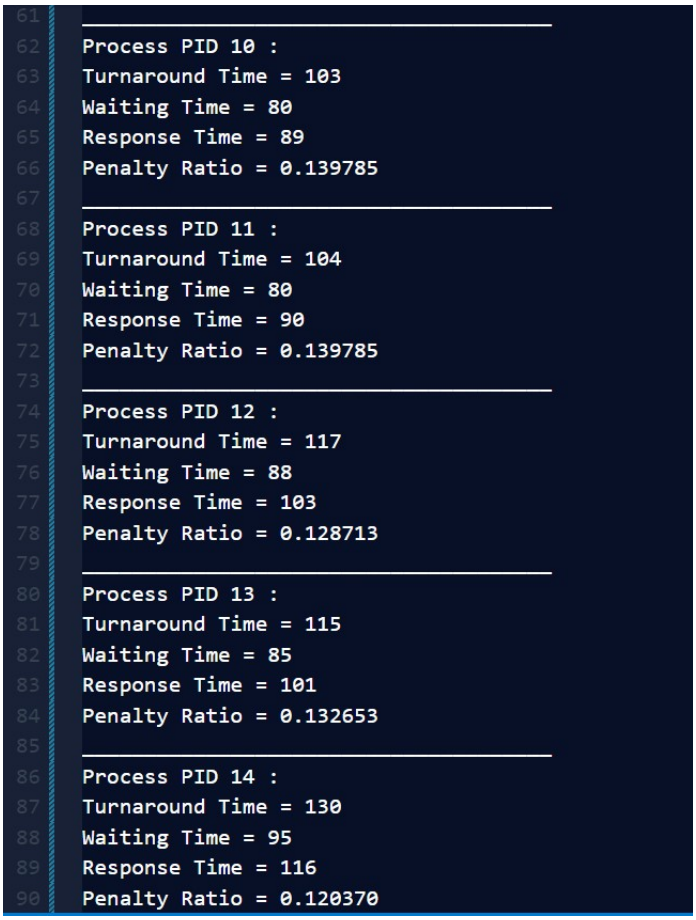
```
_____________________________________
Process PID 0 :
Turnaround Time = 1223
Waiting Time = 792
Response Time = 0
Penalty Ratio = 0.347073
_____________________________________
Process PID 1 :
Turnaround Time = 1211
Waiting Time = 862
Response Time = 572
Penalty Ratio = 0.283458
_____________________________________
Process PID 2 :
Turnaround Time = 660
Waiting Time = 370
Response Time = 181
Penalty Ratio = 0.440242
_____________________________________
Process PID 3 :
Turnaround Time = 549
Waiting Time = 352
Response Time = 107
Penalty Ratio = 0.363472
_____________________________________
Process PID 4 :
Turnaround Time = 118
Waiting Time = 108
Response Time = 95
Penalty Ratio = 0.107438
```

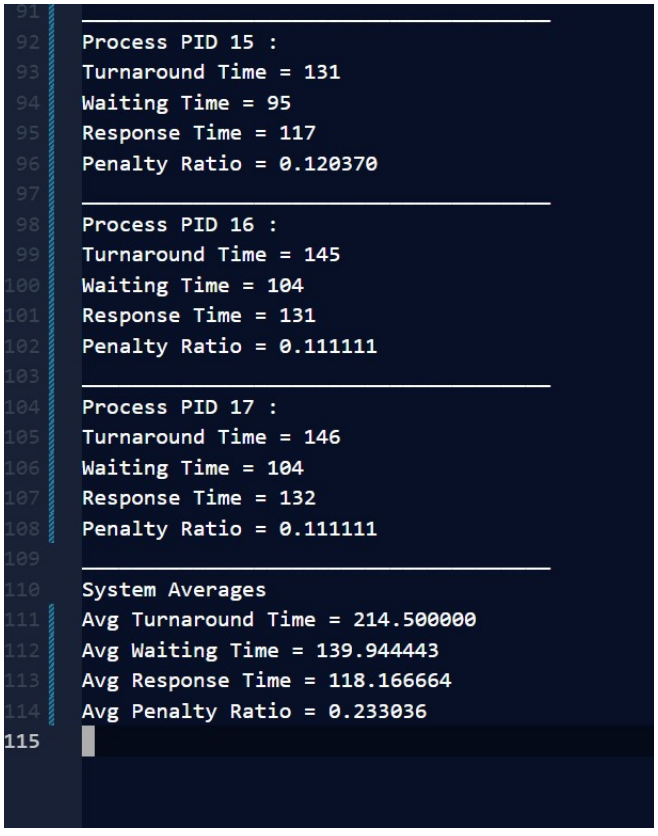


```
_____________________________________
Process PID 5 :
Turnaround Time = 101
Waiting Time = 96
Response Time = 97
Penalty Ratio = 0.049505
_____________________________________
Process PID 6 :
Turnaround Time = 1418
Waiting Time = 1187
Response Time = 1214
Penalty Ratio = 0.147270
_____________________________________
System Averages
Avg Turnaround Time = 754.285706
Avg Waiting Time = 538.142883
Avg Response Time = 323.714294
Avg Penalty Ratio = 0.248351
```

```
_____________________________________________
Process PID 0 :
Turnaround Time = 4
Waiting Time = 0
Response Time = 0
Penalty Ratio = 1.000000
_____________________________________________
Process PID 1 :
Turnaround Time = 82
Waiting Time = 72
Response Time = 4
Penalty Ratio = 0.152941
_____________________________________________
Process PID 2 :
Turnaround Time = 480
Waiting Time = 249
Response Time = 2
Penalty Ratio = 0.446667
_____________________________________________
Process PID 3 :
Turnaround Time = 75
Waiting Time = 64
Response Time = 61
Penalty Ratio = 0.168831
_____________________________________________
Process PID 4 :
Turnaround Time = 812
Waiting Time = 487
Response Time = 303
Penalty Ratio = 0.374036
```

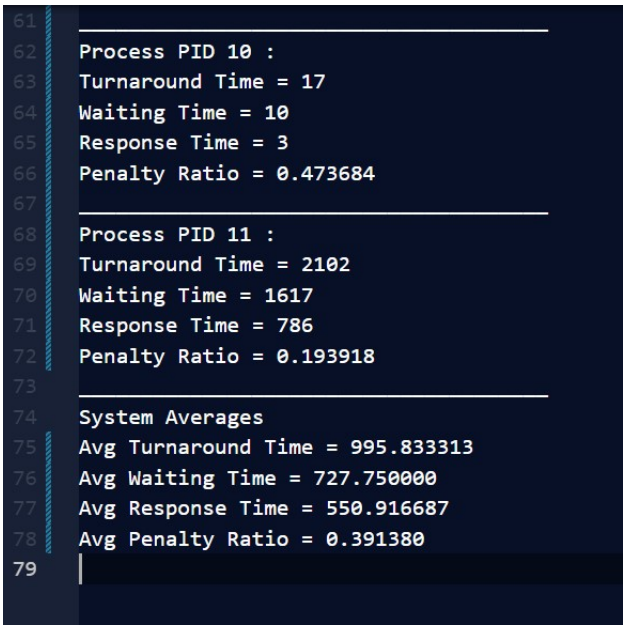
```
_____________________________________________
Process PID 5 :
Turnaround Time = 76
Waiting Time = 64
Response Time = 62
Penalty Ratio = 0.168831
_____________________________________________
Process PID 6 :
Turnaround Time = 934
Waiting Time = 552
Response Time = 501
Penalty Ratio = 0.381859
_____________________________________________
Process PID 7 :
Turnaround Time = 89
Waiting Time = 72
Response Time = 75
Penalty Ratio = 0.152941
_____________________________________________
Process PID 8 :
Turnaround Time = 228
Waiting Time = 156
Response Time = 164
Penalty Ratio = 0.191710
_____________________________________________
Process PID 9 :
Turnaround Time = 90
Waiting Time = 72
Response Time = 76
Penalty Ratio = 0.152941
```


Process PID 10 :
Turnaround Time = 103
Waiting Time = 80
Response Time = 89
Penalty Ratio = 0.139785
Process PID 11 :
Turnaround Time = 104
Waiting Time = 80
Response Time = 90
Penalty Ratio = 0.139785
Process PID 12 :
Turnaround Time = 117
Waiting Time = 88
Response Time = 103
Penalty Ratio = 0.128713
Process PID 13 :
Turnaround Time = 115
Waiting Time = 85
Response Time = 101
Penalty Ratio = 0.132653
Process PID 14 :
Turnaround Time = 130
Waiting Time = 95
Response Time = 116
Penalty Ratio = 0.120370


Process PID 15 :
Turnaround Time = 131
Waiting Time = 95
Response Time = 117
Penalty Ratio = 0.120370
Process PID 16 :
Turnaround Time = 145
Waiting Time = 104
Response Time = 131
Penalty Ratio = 0.111111
Process PID 17 :
Turnaround Time = 146
Waiting Time = 104
Response Time = 132
Penalty Ratio = 0.111111
System Averages
Avg Turnaround Time = 214.500000
Avg Waiting Time = 139.944443
Avg Response Time = 118.166664
Avg Penalty Ratio = 0.233036

```
_____
Process PID 0 :
Turnaround Time = 530
Waiting Time = 270
Response Time = 0
Penalty Ratio = 0.457831
_____
Process PID 1 :
Turnaround Time = 1828
Waiting Time = 1389
Response Time = 1254
Penalty Ratio = 0.174688
_____
Process PID 2 :
Turnaround Time = 520
Waiting Time = 180
Response Time = 10
Penalty Ratio = 0.628099
_____
Process PID 3 :
Turnaround Time = 1487
Waiting Time = 1184
Response Time = 993
Penalty Ratio = 0.124260
_____
Process PID 4 :
Turnaround Time = 973
Waiting Time = 737
Response Time = 519
Penalty Ratio = 0.186534
```

```
_____
Process PID 5 :
Turnaround Time = 2056
Waiting Time = 1529
Response Time = 1046
Penalty Ratio = 0.199895
_____
Process PID 6 :
Turnaround Time = 790
Waiting Time = 478
Response Time = 516
Penalty Ratio = 0.330532
_____
Process PID 7 :
Turnaround Time = 5
Waiting Time = 0
Response Time = 0
Penalty Ratio = 1.000000
_____
Process PID 8 :
Turnaround Time = 69
Waiting Time = 10
Response Time = 10
Penalty Ratio = 0.857143
_____
Process PID 9 :
Turnaround Time = 1573
Waiting Time = 1329
Response Time = 1474
Penalty Ratio = 0.069979
```


Process PID 10 :
Turnaround Time = 17
Waiting Time = 10
Response Time = 3
Penalty Ratio = 0.473684
Process PID 11 :
Turnaround Time = 2102
Waiting Time = 1617
Response Time = 786
Penalty Ratio = 0.193918
System Averages
Avg Turnaround Time = 995.833313
Avg Waiting Time = 727.750000
Avg Response Time = 550.916687
Avg Penalty Ratio = 0.391380