SYSC4001A - Assignment 3 Part 1

Scheduler Simulator Report

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Introduction:

This report analyzes three different CPU scheduling algorithms, External Priority(EP), Round Robin(RR), and a combination of the two (EP+RR), across 20 different test cases. The Goal is to understand how the algorithms act under different conditions such as I/O-bound, CPU-bound, and mixed processes. Our analysis is going to be based on the calculated Throughput, Average Wait Time, Average Turnaround Time, and Average Response Time.

Definitions:

Throughput:

- The number of processes that complete their execution per time unit

Turnaround Time:

- The amount of time it takes for a program to execute

Waiting Time:

- The amount of time a process has been waiting in the ready queue

Response Time:

- The amount of time it takes from when a request was submitted until the first response is produced.

This is how we calculated each needed statistic:

- Throughput = Total number of processes / Total simulation time
- Average Wait Time = Sum of Waiting Time for all processes / Number of processes
- Average Turnaround Time = Sum of Turnaround Times for all processes / Number of processes
- Average Response Time = Sum of all Time it Took to Run From Arrival / Number of processes

Test Cases:

Simple Sequential Processes:

These Test Cases have no I/O, and runs sequentially

- Test 1, Test 17, Test 18, Test 19, Test 20

I/O Intensive Processes:

These Test Cases have high I/O frequency and processing time

- Test 2, Test 6, Test 7, Test 8, Test 11

CPU Intensive Processes:

These Test Cases have no I/O but have lots of CPU usage

- Test 3, Test 4, Test 12

Mixed Processes:

These Test Cases have a mixture of I/O and CPU usage

- Test 5, Test 9, Test 10, Test 13, Test 14

Short Processes with I/O

These Test Cases have short processing time with I/O bursts

- Test 15, Test 16

Calculations and Tables:

External Priorities (EP)

Test Cases	Throughput	Avg. Turnaround Time	Avg. Waiting Time	Avg. Response Time
#1	0.143	9.5	1.5	0.0
#2	0.0054	445.33	202	40.33
#3	0.0054	408.67	225.33	225.33
#4	0.0054	365.0	188.33	188.33
#5	0.2	9.33	1.67	1.0
#6	0.0057	396.33	169.667	108.0
#7	0.0061	292.5	105.0	22.5
#8	0.0087	281.67	128.33	75
#9	0.0061	420.67	202.33	32.33
#10	0.0046	411.67	178.33	121.67
#11	0.0054	324.0	101.5	24.0
#12	0.0046	190.0	0.0	0.0
#13	0.0050	368.33	168.33	168.33
#14	0.0058	429.33	226.0	46.0
#15	0.0182	106.67	41.67	31.67
#16	0.0143	145.0	51.67	25.0
#17	0.02	100.0	50.0	50.0
#18	0.03	70.0	36.67	36.67
#19	0.0176	110.0	53.33	53.33
#20	0.0273	80.0	43.33	43.33

Round Robin(RR)

Test Cases	Throughput	Avg. Turnaround Time	Avg. Waiting Time	Avg. Response Time
#1	0.143	9.5	1.5	0
#2	0.0052	455.33	212.0	48.67
#3	0.0054	488.67	305.33	98.67
#4	0.0057	455.0	278.33	95.0
#5	0.2	9.33	1.67	1.0
#6	0.0059	401.33	147.67	38.0
#7	0.0061	295.5	105.0	22.5
#8	0.0084	306.67	153.33	16.67
#9	0.0061	410.67	192.33	37.33
#10	0.0047	451.67	218.33	95.00
#11	0.0054	324.0	101.5	24.0
#12	0.00465	190.0	0.0	0.0
#13	0.0053	438.33	238.33	81.67
#14	0.0058	419.33	216.0	46.0
#15	0.02	110.0	45.0	10.0
#16	0.0133	153.33	60.0	1.67
#17	0.02	90.0	40.0	40.0
#18	0.03	70.0	36.67	36.67
#19	0.0176	113.33	56.67	56.67
#20	0.0273	76.67	40.0	40.0

Combination (EP+RR)

Test Cases	Throughput	Avg. Turnaround Time	Avg. Waiting Time	Avg. Response Time
#1	0.143	9.5	1.5	0.0
#2	0.0048	399.0	155.67	0.0
#3	0.0054	343.33	160.0	0.0
#4	0.0057	365.0	188.33	188.33
#5	0.167	10.0	3.33	0.67
#6	0.0058	393.0	181.33	94.67
#7	0.0059	282.5	97.5	22.5
#8	0.0083	273.33	130.0	75.0
#9	0.0055	343.33	125.0	42.67
#10	0.0059	373.33	140.0	0.0
#11	0.0054	341.5	124.0	24.0
#12	0.0046	190.0	0.0	0.0
#13	0.0049	368.33	168.33	168.33
#14	0.0054	375.0	171.67	0.0
#15	0.0182	100.0	38.33	21.67
#16	0.0133	150.0	61.67	38.33
#17	0.02	100.0	50.0	50.0
#18	0.03	70.0	36.67	36.67
#19	0.0176	110.0	53.33	53.33
#20	0.0273	80.0	43.33	43.33

Final data across all 20 test cases, So the averages is the (sum of the answer from test cases 1-20)/20

In milliseconds	External Priorities (EP)	Round Robin(RR)	Combination (EP+RR)
Throughput	0.02693	0.02699	0.0252
Avg. Wait Time	248.2	263.43	233.86
Avg. Turnaround Time	108.75	122.48	96.50
Avg. Response Time	64.64	39.48	42.96

Results:

Simple Processes:

All three schedulers, EP, RR, and EP+RR, show almost identical performances for these test cases. This is to be expected due to the fact that there is no preemption and no I/O waiting. The processes finish in almost the identical order regardless of what scheduler you used.

I/O Intensive:

This Group has the largest difference between the schedulers. Due to the fact that EP is no preemption High priority tasks will only be picked if an interrupt happens, which is good for I/O intensive processes but can still be stuck behind processes that are CPU heavy. RR performs a little bit better because tasks are only given a set amount of time they can operate for, but the overall best scheduler for I/O intensive processes would be the EP+RR, this is because the scheduler kicks out lower priority tasks for higher priority ones meaning it has the best balance of tasks starting early and the fairness from RR.

Example:

Test 2

Scheduler	Turnaround	Wait	Response
EP	445.33	202	40.33
RR	455.33	212	48.67
EP+RR	399.0	155.67	0.0

CPU Intensive

EP can be good depending on whether the high priority tasks are the first to be loaded, if not then they can be stuck behind many lower priority tasks which is not good. The non-preemptive behavior of EP works in its favor in this case making it the best option out of the three. The RR scheduler has a problem where the constant switching slows down the completion of the process, EP+RR fixes this problem and includes the benefits of EP making the best out of the three for this case.

Example:

Test 3

Scheduler	Turnaround	Wait	Response
EP	408.67	225.33	225.33
RR	488.67	305.33	98.67
EP+RR	343.33	160.0	0.0

Mixed Processes:

Both EP and RR are ok when it comes to processes that have a mix of CPU and I/O, EP is better due to the fact that now higher priorities are going to be done faster than just a straight CPU, and RR brings a good fairness into the processes but it slows down on long CPU parts. EP+RR on the other hand has the advantages of both EP and RR but not their downsides.

Example:

Task 10

Scheduler	Turnaround	Wait	Response
EP	411.67	178.33	121.67
RR	451.67	218.33	95.00
EP+RR	373.33	140.0	0.0

Short Processes with I/O:

RR excels in these processes due to the fact that with frequent preemption short tasks can get to the CPU faster than without any preemption. EP+RR is also good for the exact same reason, but EP on the other hand isn't the best due to the fact that when a process get back from I/O it has to wait until a different program is done which could be longer than quantum time from RR or EP+RR.

Example:

Test 15

Scheduler	Turnaround	Wait	Response
EP	106.67	41.67	31.67
RR	110.0	45.0	10.0
EP+RR	100.0	38.33	21.67

Summary Table:

	Best Scheduler	Reason
Simple Sequential	All Equal	No preemption is needed
I/O Intensive	RR or EP+RR	Frequent preemption helps keep I/O tasks responsive
CPU Intensive	EP+RR	Has the benefit of EP and the fairness of RR
Mixed	EP+RR	It balances priority and fairness
Short with I/O	RR or EP+RR	Changing frequently is good for short tasks