SYSC 4001 A3 Part 1 Report

Student 1:Ezomnachi Otuonye (101306172)
Student 2: Jason Huang (101265573)
Github link :https://github.com/Dashx2/SYSC4001_A3_P1

The purpose is to compare the results of three different scheduling algorithms, External Priority, Round Robin, and External Priority with Round robin using test cases that cover different aspects of process utilization and total time taken and other metrics.

CPU Bound
Example 1: Test7
8, 1, 0, 15, 0, 0
9, 1, 3, 10, 0, 0
EP_RR

SYSC4001_A3_P1 > output_files > test7 > execution_test7_EP_RR.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 |  8 |       NEW |     READY |
|                 0 |  8 |     READY |   RUNNING |
|                 3 |  9 |       NEW |     READY |
|                14 |  8 |   RUNNING |TERMINATED |
|                15 |  9 |     READY |   RUNNING |
|                24 |  9 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.08ms
Average Waiting Time: 6ms
Average Turnaround:   18.5ms
Average Response:     6ms
=========================================

```

EP

SYSC4001_A3_P1 > output_files > test7 > execution_test7_EP.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 |  8 |       NEW |     READY |
|                 0 |  8 |     READY |   RUNNING |
|                 3 |  9 |       NEW |     READY |
|                15 |  8 |   RUNNING |TERMINATED |
|                15 |  9 |     READY |   RUNNING |
|                25 |  9 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.08ms
Average Waiting Time: 6ms
Average Turnaround:   18.5ms
Average Response:     6ms
=========================================

```

RR

SYSC4001_A3_P1 > output_files > test7 > execution_test7_RR.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 |  8 |       NEW |     READY |
|                 0 |  8 |     READY |   RUNNING |
|                 3 |  9 |       NEW |     READY |
|                15 |  8 |   RUNNING |TERMINATED |
|                15 |  9 |     READY |   RUNNING |
|                25 |  9 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.08ms
Average Waiting Time: 6ms
Average Turnaround:   18.5ms
Average Response:     6ms
=========================================

```

I/O Bound

Example 2: Test10

14, 1, 0, 12, 3, 1

EP_RR

SYSC4001_A3_P1 > output_files > test10 > execution_test10_EP_RR.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 | 14 |       NEW |     READY |
|                 0 | 14 |     READY |   RUNNING |
|                 2 | 14 |   RUNNING |   WAITING |
|                 4 | 14 |   WAITING |     READY |
|                 4 | 14 |     READY |   RUNNING |
|                 6 | 14 |   RUNNING |   WAITING |
|                 8 | 14 |   WAITING |     READY |
|                 8 | 14 |     READY |   RUNNING |
|                10 | 14 |   RUNNING |   WAITING |
|                12 | 14 |   WAITING |     READY |
|                12 | 14 |     READY |   RUNNING |
|                14 | 14 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.0666667ms
Average Waiting Time: 3ms
Average Turnaround:   15ms
Average Response:     12ms
=========================================

```

EP

SYSC4001_A3_P1 > output_files > test10 > execution_test10_EP.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 | 14 |       NEW |     READY |
|                 0 | 14 |     READY |   RUNNING |
|                 3 | 14 |   RUNNING |   WAITING |
|                 4 | 14 |   WAITING |     READY |
|                 4 | 14 |     READY |   RUNNING |
|                 7 | 14 |   RUNNING |   WAITING |
|                 8 | 14 |   WAITING |     READY |
|                 8 | 14 |     READY |   RUNNING |
|                11 | 14 |   RUNNING |   WAITING |
|                12 | 14 |   WAITING |     READY |
|                12 | 14 |     READY |   RUNNING |
|                15 | 14 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.0666667ms
Average Waiting Time: 3ms
Average Turnaround:   15ms
Average Response:     12ms
=========================================

```

RR

SYSC4001_A3_P1 > output_files > test10 > execution_test10_RR.txt

```
+-----------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-----------------------------------------------+
|                 0 | 14 |       NEW |     READY |
|                 0 | 14 |     READY |   RUNNING |
|                 3 | 14 |   RUNNING |   WAITING |
|                 4 | 14 |   WAITING |     READY |
|                 4 | 14 |     READY |   RUNNING |
|                 7 | 14 |   RUNNING |   WAITING |
|                 8 | 14 |   WAITING |     READY |
|                 8 | 14 |     READY |   RUNNING |
|                11 | 14 |   RUNNING |   WAITING |
|                12 | 14 |   WAITING |     READY |
|                12 | 14 |     READY |   RUNNING |
|                15 | 14 |   RUNNING |TERMINATED |
+-----------------------------------------------+

================ METRICS ================
Throughput:           0.0666667ms
Average Waiting Time: 3ms
Average Turnaround:   15ms
Average Response:     12ms
=========================================

```

Mix of CPU and I/O
Example 3: Test18

30, 1, 0, 12, 4, 2
31, 1, 1, 12, 4, 2
EP_RR

SYSC4001_A3_P1 > output_files > test18 > execution_test18_EP_RR.txt

```
+-------------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-------------------------------------------------+
|                 0 | 30 |       NEW |     READY |
|                 0 | 30 |     READY |   RUNNING |
|                 1 | 31 |       NEW |     READY |
|                 3 | 30 |   RUNNING |   WAITING |
|                 4 | 31 |     READY |   RUNNING |
|                 6 | 30 |   WAITING |     READY |
|                 7 | 31 |   RUNNING |     READY |
|                 7 | 30 |     READY |   RUNNING |
|                10 | 30 |   RUNNING |   WAITING |
|                11 | 31 |     READY |   RUNNING |
|                13 | 30 |   WAITING |     READY |
|                13 | 31 |   RUNNING |   WAITING |
|                14 | 30 |     READY |   RUNNING |
|                16 | 31 |   WAITING |     READY |
|                18 | 30 |   RUNNING |TERMINATED |
|                19 | 31 |     READY |   RUNNING |
|                22 | 31 |   RUNNING |   WAITING |
|                25 | 31 |   WAITING |     READY |
|                25 | 31 |     READY |   RUNNING |
|                28 | 31 |   RUNNING |TERMINATED |
+-------------------------------------------------+

================ METRICS ================
Throughput:           0.0689655ms
Average Waiting Time: 11.5ms
Average Turnaround:   23.5ms
Average Response:     19ms
=========================================

```

EP

SYSC4001_A3_P1 > output_files > test18 > execution_test18_EP.txt

```
+-------------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-------------------------------------------------+
|                 0 | 30 |       NEW |     READY |
|                 0 | 30 |     READY |   RUNNING |
|                 1 | 31 |       NEW |     READY |
|                 4 | 30 |   RUNNING |   WAITING |
|                 4 | 31 |     READY |   RUNNING |
|                 6 | 30 |   WAITING |     READY |
|                 8 | 31 |   RUNNING |   WAITING |
|                 8 | 30 |     READY |   RUNNING |
|                10 | 31 |   WAITING |     READY |
|                12 | 30 |   RUNNING |   WAITING |
|                12 | 31 |     READY |   RUNNING |
|                14 | 30 |   WAITING |     READY |
|                16 | 31 |   RUNNING |   WAITING |
|                16 | 30 |     READY |   RUNNING |
|                18 | 31 |   WAITING |     READY |
|                20 | 30 |   RUNNING |TERMINATED |
|                20 | 31 |     READY |   RUNNING |
|                24 | 31 |   RUNNING |TERMINATED |
+-------------------------------------------------+

================ METRICS ================
Throughput:           0.0833333ms
Average Waiting Time: 9.5ms
Average Turnaround:   21.5ms
Average Response:     17.5ms
=========================================

```

RR

SYSC4001_A3_P1 > output_files > test18 > execution_test18_RR.txt

```
+-------------------------------------------------+
|Time of Transition |PID | Old State | New State |
+-------------------------------------------------+
|                 0 | 30 |       NEW |     READY |
|                 0 | 30 |     READY |   RUNNING |
|                 1 | 31 |       NEW |     READY |
|                 4 | 30 |   RUNNING |   WAITING |
|                 4 | 31 |     READY |   RUNNING |
|                 6 | 30 |   WAITING |     READY |
|                 9 | 31 |   RUNNING |   WAITING |
|                 9 | 30 |     READY |   RUNNING |
|                11 | 31 |   WAITING |     READY |
|                14 | 30 |   RUNNING |   WAITING |
|                14 | 31 |     READY |   RUNNING |
|                16 | 30 |   WAITING |     READY |
|                19 | 31 |   RUNNING |   WAITING |
|                19 | 30 |     READY |   RUNNING |
|                21 | 31 |   WAITING |     READY |
|                24 | 30 |   RUNNING |TERMINATED |
|                24 | 31 |     READY |   RUNNING |
|                28 | 31 |   RUNNING |TERMINATED |
+-------------------------------------------------+

================ METRICS ================
Throughput:           0.0714286ms
Average Waiting Time: 13.5ms
Average Turnaround:   25.5ms
Average Response:     21ms
=========================================

```

CPU Bound (Test 5-9)

Scheduler	Avg Throughput	Avg Waiting (ms)	Avg Turnaround (ms)	Avg Response (ms)
EP	0.0586	5.87	26.17	5.87
RR	0.0586	5.13	25.43	5.13
EP_RR	0.0586	5.87	26.17	5.87

All schedulers show nearly identical throughput for CPU-bound workloads. RR slightly reduces average waiting and turnaround due to time-slice sharing, while EP and EP_RR behave similarly when no I/O is present.

I/O Bound (Test 10-14)

Scheduler	Avg Throughput	Avg Waiting (ms)	Avg Turnaround (ms)	Avg Response (ms)
EP	0.0625	11.73	25.03	22.93
RR	0.0553	14.73	28.03	25.77
EP_RR	0.0560	14.37	27.67	25.57

EP clearly outperforms RR and EP_RR for I/O-heavy workloads by minimizing waiting, turnaround, and response times. RR exhibits the worst performance due to repeated quantum preemption during I/O contention. EP_RR provides moderate improvement over RR.

Mixed (Test 15-20)

Scheduler	Avg Throughput	Avg Waiting (ms)	Avg Turnaround (ms)	Avg Response (ms)
EP	0.0799	13.60	25.57	20.72
RR	0.0720	19.60	31.57	26.44
EP_RR	0.0713	16.94	28.92	24.99

In realistic mixed workloads, EP consistently delivers the lowest latency and highest throughput. RR incurs substantially higher waiting and response times. EP_RR offers a compromise, staying closer to EP than RR in most metrics.

Total Average(Test 1-20)

Scheduler	Avg Throughput	Avg Waiting (ms)	Avg Turnaround (ms)	Avg Response (ms)
EP	0.0776	8.93	22.55	14.22
RR	0.0730	11.35	24.96	16.48
EP_RR	0.0729	10.62	24.23	16.25

Across all 20 tests, External Priority (EP) consistently achieves the highest throughput and the lowest average waiting, turnaround, and response times. Round Robin (RR), while guaranteeing fairness, incurs significantly higher latency, particularly under I/O and mixed workloads. EP_RR demonstrates balanced behavior, improving fairness relative to EP while maintaining lower latency than RR. These trends are consistent across CPU-bound, I/O-bound, and mixed workloads, confirming the theoretical performance expectations of all three schedulers.