Operating Systems Programming Assignment 1 Report

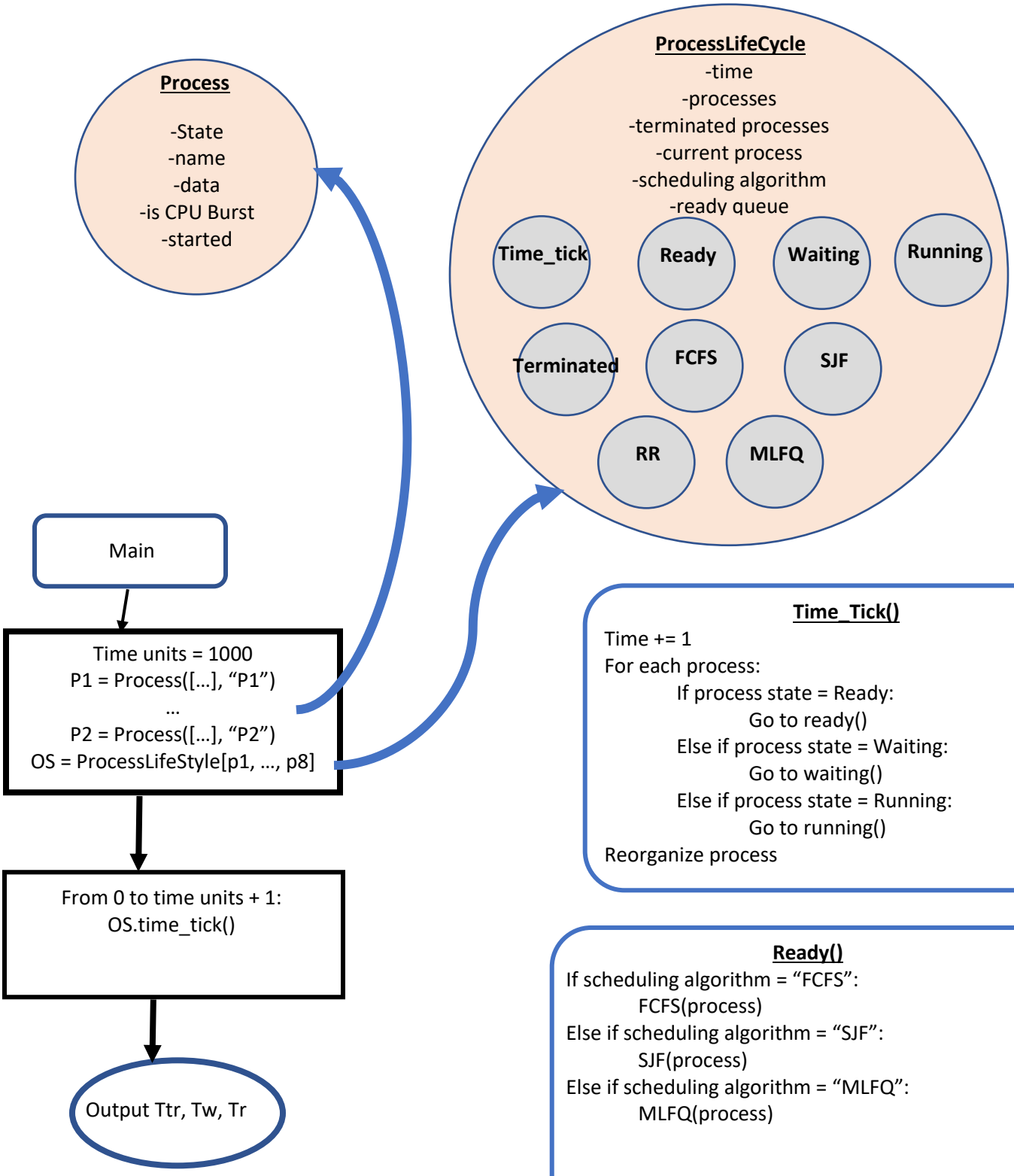
Using Python

Table Of Contents

Introduction

I was tasked to simulate 3 scheduling algorithms: First-Come-First-Served, Shortest-Job-First, and Multi-Level-Feedback-Queue which uses Round Robin Scheduling as well. I decided to write the simulation in python 3 because at the time of writing this I am taking a python course at FAU. Python has lots of useful applications as well as readability, so I hope the code is easy on the eyes. I started by creating a class called Process simply a constructor that creates a multitude of variables used to move the simulation forward. I then created another class called Process Life Cycle which is the class representation of the different states in the process life cycle. It contains the functions new, ready, waiting, running, and terminated to match the flow of the process life cycle. Enums were added to assign each process to a state, so p1 state is equal to new when it starts then is moved to ready, running, waiting, running, and terminated throughout the simulation. Inside the process life cycle class, a function called time tick was created to handle the processes each time tick, the main function will have a for loop that will act as a clock. Then once that started working, I created functions that would be their respective scheduling algorithms called by the ready function depending on which algorithms was to be simulated. In the main function you can enter the string abbreviation in all caps as a parameter of the process life cycle class to choose which algorithm you want to test. Finally, some functions that don't pertain to a class were made to calculate the average waiting time, average response time, average turnaround time, and CPU utilization. You can see the flow of logic on the following page.

General Flow Chart(logic) of the simulation program



Waiting()

```
If last burst is finished:
        Go to terminated()
        Remove from ready queue
Else if burst finished:
        Go to ready()
        Put in ready queue
        Upgrade burst index
        Invert CPU to IO
Else if burst > 0:
        Burst -= 1
```

Running()

```
If last burst is finished:
        Go to terminated()
        Remove from ready queue
Else if burst finished:
        Go to waiting()
        Upgrade burst index
        Invert CPU to IO
Else if needs to be preempted:
        preempt
Else if burst > 0:
        Burst -= 1
```

Terminated()

```
Add to list of terminated processes
```

FCFS()

```
Remove from ready queue
Process state = Running
Go to Running()
```

SJF()

```
Shortest process = process with shortest burst
If process == shortest process:
        Remove from ready queue
        Process state = Running
        Go to Running()
```

RR()

```
Process counter = Time Quantum
Remove from ready queue
Process state = Running
Go to Running()
```

MLFQ()

```
Queue counts = calculated value
If Queue 1 count > 0 and current_qeueue == 1:
        Remove process from Queue 1
        RR(process, 5)
If Queue 2 count > 0 and current_qeueue == 2:
        Remove process from Queue 2
        RR(process, 10)
If Queue 3 count > 0 and current_qeueue == 3:
        Remove process from Queue 2
        FCFS(process)
```

Results and discussion

	SJF	FCFS	MLFQ
CPU Utilization	82.81%	84.58%	89.64%
Avg Waiting time (Tw)	134.38	186.25	152.0
Avg Turnaround time (Ttr)	470.63	522.5	488.25
Avg Response time (Tr)	27.13	24.38	16.13

	SJF CPU utilization: 82.81%			**FCFS CPU utilization:** 84.58%			**MLFQ CPU utilization:** 89.64%		
	Tw	***Ttr***	***Tr***	***Tw***	***Ttr***	***Tr***	***Tw***	***Ttr***	***Tr***
P1	43	269	11	170	396	0	48	274	0
P2	74	501	3	168	595	5	109	536	5
P3	277	669	16	170	562	9	226	618	9
P4	51	535	0	171	655	17	17	501	14
P5	238	547	109	211	520	20	278	587	17
P6	122	337	24	227	442	36	186	401	22
P7	150	478	47	188	516	47	183	511	27
P8	120	429	7	185	494	61	169	478	35
Avg	***134.38***	***470.63***	***27.13***	***186.25***	***522.5***	***24.375***	***152.0***	***488.25***	***16.13***

As I expected SJF has the lowest waiting time, turnaround time, and CPU utilization of the three while also having the longest turnaround time because it must keep pushing the largest burst away. FCFS is the worst scheduling algorithm of the three because it has the highest waiting time and turnaround time, while also having the 2nd highest response time and an average CPU utilization. MLFQ sits right in the middle between SJF and FCFS but utilizes the CPU much more than the other two.

Program Output Sample

FCFS

```
Time: 0
p1 Started at 0
READY QUEUE
p2 <---------- Queue 1, Burst = 4
p3 <---------- Queue 1, Burst = 8
p4 <---------- Queue 1, Burst = 3
p5 <---------- Queue 1, Burst = 16
p6 <---------- Queue 1, Burst = 11
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4


Time: 5
p1 FINISHED CPU BURST
I/O BURST LEFT: 27 p1
p2 Started at 5
READY QUEUE
p3 <---------- Queue 1, Burst = 8
p4 <---------- Queue 1, Burst = 3
p5 <---------- Queue 1, Burst = 16
p6 <---------- Queue 1, Burst = 11
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4


Time: 9
p2 FINISHED CPU BURST
I/O BURST LEFT: 48 p2
I/O BURST LEFT: 23 p1
p3 Started at 9
READY QUEUE
p4 <---------- Queue 1, Burst = 3
p5 <---------- Queue 1, Burst = 16
p6 <---------- Queue 1, Burst = 11
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4
```

```
Time: 17
p3 FINISHED CPU BURST
I/O BURST LEFT: 33 p3
I/O BURST LEFT: 40 p2
I/O BURST LEFT: 15 p1
p4 Started at 17
READY QUEUE
p5 <---------- Queue 1, Burst = 16
p6 <---------- Queue 1, Burst = 11
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4


Time: 20
p4 FINISHED CPU BURST
I/O BURST LEFT: 35 p4
I/O BURST LEFT: 30 p3
I/O BURST LEFT: 37 p2
I/O BURST LEFT: 12 p1
p5 Started at 20
READY QUEUE
p6 <---------- Queue 1, Burst = 11
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4


Time: 36
p5 FINISHED CPU BURST
I/O BURST LEFT: 24 p5
I/O BURST LEFT: 19 p4
I/O BURST LEFT: 14 p3
I/O BURST LEFT: 21 p2
p6 Started at 36
READY QUEUE
p7 <---------- Queue 1, Burst = 14
p8 <---------- Queue 1, Burst = 4
p1 <---------- Queue 1, Burst = 3
```

```
Time: 47
p6 FINISHED CPU BURST
I/O BURST LEFT: 22 p6
I/O BURST LEFT: 13 p5
I/O BURST LEFT: 8 p4
I/O BURST LEFT: 3 p3
I/O BURST LEFT: 10 p2
p7 Started at 47
READY QUEUE
p8 <---------- Queue 1, Burst = 4
p1 <---------- Queue 1, Burst = 3


Time: 61
p7 FINISHED CPU BURST
I/O BURST LEFT: 46 p7
I/O BURST LEFT: 8 p6
p8 Started at 61
READY QUEUE
p1 <---------- Queue 1, Burst = 3
p3 <---------- Queue 1, Burst = 12
p4 <---------- Queue 1, Burst = 4
p2 <---------- Queue 1, Burst = 5
p5 <---------- Queue 1, Burst = 17


Time: 65
p8 FINISHED CPU BURST
I/O BURST LEFT: 14 p8
I/O BURST LEFT: 42 p7
I/O BURST LEFT: 4 p6
READY QUEUE
p3 <---------- Queue 1, Burst = 12
p4 <---------- Queue 1, Burst = 4
p2 <---------- Queue 1, Burst = 5
p5 <---------- Queue 1, Burst = 17
```

Program Output Sample

SJF

```
Time: 0
p4 Started at 0
READY QUEUE
p1 <----------- Queue 1, Burst = 5
p2 <----------- Queue 1, Burst = 4
p3 <----------- Queue 1, Burst = 8
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4


Time: 3
p4 FINISHED CPU BURST
I/O BURST LEFT: 35 p4
p2 Started at 3
READY QUEUE
p1 <----------- Queue 1, Burst = 5
p3 <----------- Queue 1, Burst = 8
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4


Time: 7
p2 FINISHED CPU BURST
I/O BURST LEFT: 48 p2
I/O BURST LEFT: 31 p4
p8 Started at 7
READY QUEUE
p1 <----------- Queue 1, Burst = 5
p3 <----------- Queue 1, Burst = 8
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
```

```
Time: 11
p8 FINISHED CPU BURST
I/O BURST LEFT: 14 p8
I/O BURST LEFT: 44 p2
I/O BURST LEFT: 27 p4
p1 Started at 11
READY QUEUE
p3 <----------- Queue 1, Burst = 8
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14


Time: 16
p1 FINISHED CPU BURST
I/O BURST LEFT: 27 p1
I/O BURST LEFT: 9 p8
I/O BURST LEFT: 39 p2
I/O BURST LEFT: 22 p4
p3 Started at 16
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14


Time: 24
p3 FINISHED CPU BURST
I/O BURST LEFT: 33 p3
I/O BURST LEFT: 19 p1
I/O BURST LEFT: 1 p8
I/O BURST LEFT: 31 p2
I/O BURST LEFT: 14 p4
p6 Started at 24
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p7 <----------- Queue 1, Burst = 14
```

```
Time: 35
p6 FINISHED CPU BURST
I/O BURST LEFT: 22 p6
I/O BURST LEFT: 22 p3
I/O BURST LEFT: 8 p1
I/O BURST LEFT: 20 p2
I/O BURST LEFT: 3 p4
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p7 <----------- Queue 1, Burst = 14


Time: 40
p8 FINISHED CPU BURST
I/O BURST LEFT: 33 p8
I/O BURST LEFT: 17 p6
I/O BURST LEFT: 17 p3
I/O BURST LEFT: 3 p1
I/O BURST LEFT: 15 p2
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p7 <----------- Queue 1, Burst = 14


Time: 44
p4 FINISHED CPU BURST
I/O BURST LEFT: 41 p4
I/O BURST LEFT: 29 p8
I/O BURST LEFT: 13 p6
I/O BURST LEFT: 13 p3
I/O BURST LEFT: 11 p2
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p7 <----------- Queue 1, Burst = 14
```

Program Output Sample

MLFQ

```
Time: 0
QUEUES:
Q1: 8
Q2: 0
Q3: 0
Queue 1 p1 in Queue 1
p1 Started at 0
READY QUEUE
p2 <----------- Queue 1, Burst = 4
p3 <----------- Queue 1, Burst = 8
p4 <----------- Queue 1, Burst = 3
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4


Time: 5
p1 FINISHED CPU BURST
I/O BURST LEFT: 27 p1
QUEUES:
Q1: 7
Q2: 0
Q3: 0
Queue 1 p2 in Queue 1
p2 Started at 5
READY QUEUE
p3 <----------- Queue 1, Burst = 8
p4 <----------- Queue 1, Burst = 3
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4
```

```
Time: 9
p2 FINISHED CPU BURST
I/O BURST LEFT: 48 p2
I/O BURST LEFT: 23 p1
QUEUES:
Q1: 6
Q2: 0
Q3: 0
Queue 1 p3 in Queue 1
p3 Started at 9
READY QUEUE
p4 <----------- Queue 1, Burst = 3
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4


Time: 14
p3 PREEMPTED
p3 Moved to Queue 2
I/O BURST LEFT: 18 p1
I/O BURST LEFT: 43 p2
QUEUES:
Q1: 5
Q2: 1
Q3: 0
Queue 1 p4 in Queue 1
p4 Started at 14
READY QUEUE
p5 <----------- Queue 1, Burst = 16
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4
p3 <----------- Queue 2, Burst = 3
```

```
Time: 17
p4 FINISHED CPU BURST
I/O BURST LEFT: 35 p4
I/O BURST LEFT: 15 p1
I/O BURST LEFT: 40 p2
QUEUES:
Q1: 4
Q2: 1
Q3: 0
Queue 1 p5 in Queue 1
p5 Started at 17
READY QUEUE
p6 <----------- Queue 1, Burst = 11
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4
p3 <----------- Queue 2, Burst = 3


Time: 22
p5 PREEMPTED
p5 Moved to Queue 2
I/O BURST LEFT: 10 p1
I/O BURST LEFT: 35 p2
I/O BURST LEFT: 30 p4
QUEUES:
Q1: 3
Q2: 2
Q3: 0
Queue 1 p6 in Queue 1
p6 Started at 22
READY QUEUE
p7 <----------- Queue 1, Burst = 14
p8 <----------- Queue 1, Burst = 4
p3 <----------- Queue 2, Burst = 3
p5 <----------- Queue 2, Burst = 11
```

Program Output of the results

FCFS

```
Total Time is  655

Turn Around Time
p1: 396
p2: 595
p3: 562
p4: 655
p5: 520
p6: 442
p7: 516
p8: 494
Average Turn Around Time:  522.5 ms

Waiting Time
p1: 170
p2: 168
p3: 170
p4: 171
p5: 211
p6: 227
p7: 188
p8: 185
Average Waiting Time:  186.25 ms

Response Time
p1: 0
p2: 5
p3: 9
p4: 17
p5: 20
p6: 36
p7: 47
p8: 61
Average Response Time:  24.375 ms

CPU Utilization
84.58015267175573 %
```

Program Output of the results

SJF

```
Total Time is  669

Turn Around Time
p1: 269
p2: 501
p3: 669
p4: 535
p5: 547
p6: 337
p7: 478
p8: 429
Average Turn Around Time:  470.625 ms

Waiting Time
p1: 43
p2: 74
p3: 277
p4: 51
p5: 238
p6: 122
p7: 150
p8: 120
Average Waiting Time:  134.375 ms

Response Time
p1: 11
p2: 3
p3: 16
p4: 0
p5: 109
p6: 24
p7: 47
p8: 7
Average Response Time:  27.125 ms

CPU Utilization
82.8101644245142 %
```

Program Output of the results

MLFQ

```
Total Time is  618

Turn Around Time
p1: 274
p2: 536
p3: 618
p4: 501
p5: 587
p6: 401
p7: 511
p8: 478
Average Turn Around Time:  488.25 ms

Waiting Time
p1: 48
p2: 109
p3: 226
p4: 17
p5: 278
p6: 186
p7: 183
p8: 169
Average Waiting Time:  152.0 ms

Response Time
p1: 0
p2: 5
p3: 9
p4: 14
p5: 17
p6: 22
p7: 27
p8: 35
Average Response Time:  16.125 ms

CPU Utilization
89.64401294498381 %
```