Module 9 – CPU scheduler Code and Report

Name: Alina Tutuianu

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Language used: C++

1. Introduction

The current CPU scheduler assignment implements a Multilevel Feedback Queue algorithm to schedule a given set of processes with CPU and i/o time. The results calculated by the simulator (waiting time, response time, turnaround time, CPU utilization) have to be compared with a set of given results of a Shortest Job First scheduler, and with previous simulated FCFS scheduler. The scheduler was implemented using the C++ language. I expected to see that MLFQ will have the lowest average response time, since all processes start in queue 1, but are given only a 5 units time quantum, thus decreasing the response time of each process. Most of my prediction matched the results of the scheduler, although I was surprised to see that MLFQ has the best CPU utilization. The most difficult part in developing the program was to take into account all the conditions that had to be applied and working with the containers of choice (std::list) and iterators was also difficult.

2. Table with simulation results

Process(SFJ results)	**RT**	**WT**	**TT**
P1	11	43	268
P2	3	73	500
P3	16	276	668
P4	0	50	534
P5	109	237	546
P6	24	121	336
P7	47	149	477

P8	7	119	428
AVG	27.125	133.5	469.625
CPU utilization	82.78%		
Process(FCFS results)			
P1	0	170	395
P2	5	164	591
P3	9	165	557
P4	17	164	648
P5	20	221	530
P6	36	230	445
P7	47	184	512
P8	61	184	493
AVG	24.375	185.25	521.375
CPU utilization	85.34%		
Process(MLFQ results)			
P1	0	50	275
P2	5	134	561
P3	9	198	590
P4	14	17	501
P5	17	266	575
P6	22	179	394
P7	27	243	571
P8	32	151	460
AVG	15.75	154.75	490.875
CPU utilization	93.7288%		

3. Discussion of the results:

a. Which algorithm (MLFQ, FCFS or SJF) has the best CPU utilization?

MLFQ

b. Which algorithm (MLFQ, FCFS or SJF) has the worst CPU utilization?

   SJF

c. How many context switches are in the simulation of MLFQ?

   96

d. Which algorithm (MLFQ, FCFS or SJF) has the lowest average waiting time.

   SJF

e. Which algorithm (MLFQ, FCFS or SJF) has the lowest average response time.

   MLFQ

f. Which algorithm (MLFQ, FCFS or SJF) has the lowest average turnaround time.

   SJF

g. How well did the results match your prediction?

My prediction were close to the results given by the FCFS and MLFQ simulator. Results that match my prediction are: MLFQ will have the most context switches, SJF will have the lowest average waiting time, SJF will have the lowest average turnaround time, MLFQ will have the lowest average response time. One wrong prediction was that FCFS will have the worst CPU utilization, but the results were not confirming that prediction.

4. Sample Program Output (First and last 50 units)

FIRST 50 units

Current Time: 0

Next Process on the CPU: P1 CPU burst: 5

.....

List of processes in Queue1:

Process	Burst
P2	4
P3	8
P4	3
P5	16
P6	11
P7	14
P8	4

.....

List of processes in Queue2:

Process	Burst
[empty]	

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
[empty]	

.....

No completed processes

::

Current Time: 5

Next Process on the CPU: P2 CPU burst: 4

.....

List of processes in Queue1:

Process	Burst
P3	8
P4	3
P5	16
P6	11
P7	14
P8	4

.....

List of processes in Queue2:

Process	Burst
[empty]	

.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process Remaining I/O time
P1 27
.....

No completed processes

::

Current Time: 9

Next Process on the CPU: P3 CPU burst: 8
.....

List of processes in Queue1:

Process Burst
P4 3
P5 16
P6 11
P7 14
P8 4
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process Remaining I/O time
P1 23

P2 48

.....

No completed processes

::

Current Time: 14

Next Process on the CPU: P4 CPU burst: 3

.....

List of processes in Queue1:

Process	Burst
P5	16
P6	11
P7	14
P8	4

.....

List of processes in Queue2:

Process	Burst
P3	3

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P1	18
P2	43

.....

No completed processes

::

Current Time: 17

Next Process on the CPU: P5 CPU burst: 16
.....

List of processes in Queue1:

Process	Burst
P6	11
P7	14
P8	4

.....

List of processes in Queue2:

Process	Burst
P3	3

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P1	15
P2	40
P4	35

.....

No completed processes

::

Current Time: 22

Next Process on the CPU: P6 CPU burst: 11
.....

List of processes in Queue1:

Process	Burst
P7	14
P8	4

.....

List of processes in Queue2:

Process	Burst
P3	3
P5	11

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P1	10
P2	35
P4	30

.....

No completed processes

::

Current Time: 27

Next Process on the CPU: P7 CPU burst: 14

.....

List of processes in Queue1:

Process	Burst
P8	4

.....

List of processes in Queue2:

Process	Burst
P3	3
P5	11
P6	6

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P1	5
P2	30
P4	25

.....

No completed processes

::

Current Time: 32

Next Process on the CPU: P8 CPU burst: 4

.....

List of processes in Queue1:

Process	Burst
P1	3

.....

List of processes in Queue2:

Process	Burst
P3	3
P5	11
P6	6
P7	9

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time

P2	25
P4	20

.....

No completed processes

::

Current Time: 36

Next Process on the CPU: P1 CPU burst: 3

.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
P3	3
P5	11
P6	6
P7	9

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P2	21
P4	16
P8	14

.....

No completed processes

::

Current Time: 39

Next Process on the CPU: P3 CPU burst: 3

.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
P5	11
P6	6
P7	9

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P2	18
P4	13
P8	11
P1	31

.....

No completed processes

::

Current Time: 42

Next Process on the CPU: P5 CPU burst: 11

.....

List of processes in Queue1:

Process	Burst

[empty]

.....

List of processes in Queue2:

Process	Burst
P6	6
P7	9

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P2	15
P4	10
P8	8
P1	28
P3	33

.....

No completed processes

::

Current Time: 50

Next Process on the CPU: P8 CPU burst: 5

.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
P6	6
P7	9

P5 3

.....

List of processes in Queue3:

Process Burst
[empty]

.....

List of processes in I/O:

Process Remaining I/O time
P2 7
P4 2
P1 20
P3 25

.....

No completed processes

::

Current Time: 55

Next Process on the CPU: P4 CPU burst: 4

.....

List of processes in Queue1:

Process Burst
[empty]

.....

List of processes in Queue2:

Process Burst
P6 6
P7 9
P5 3

.....

List of processes in Queue3:

Process Burst
[empty]

.....

List of processes in I/O:

Process	Remaining I/O time
P2	2
P1	15
P3	20
P8	33

.....

No completed processes

::

LAST 50 units
Current Time: 532

Next Process on the CPU: [IDLE]
.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
[empty]	

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P2	19
P3	16
P7	27
P5	13

.....

Completed: P1, P4, P6, P8,

::

Current Time: 545

Next Process on the CPU: P5 CPU burst: 3
.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
[empty]	

.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P2	6
P3	3
P7	14

.....

Completed: P1, P4, P6, P8,

::

Current Time: 548

Next Process on the CPU: P3 CPU burst: 5
.....

List of processes in Queue1:

Process Burst
[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process	Remaining I/O time
P2	3
P7	11
P5	11

.....

Completed: P1, P4, P6, P8,

::

Current Time: 553

Next Process on the CPU: P2 CPU burst: 8
.....

List of processes in Queue1:

Process Burst
[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process	Burst
[empty]	

.....

List of processes in I/O:

Process	Remaining I/O time
P7	6
P5	6
P3	31

.....

Completed: P1, P4, P6, P8,

::

Current Time: 561

Next Process on the CPU: P7 CPU burst: 10

.....

List of processes in Queue1:

Process	Burst
[empty]	

.....

List of processes in Queue2:

Process	Burst
[empty]	

.....

List of processes in Queue3:

Process	Burst
P5	4

.....

List of processes in I/O:

Process	Remaining I/O time
P3	23

.....

Completed: P1, P2, P4, P6, P8,

::

Current Time: 571

Next Process on the CPU: P5 CPU burst: 4
.....

List of processes in Queue1:

Process Burst
[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process Remaining I/O time
P3 13
.....

Completed: P1, P2, P4, P6, P7, P8,

::

Current Time: 575

Next Process on the CPU: [IDLE]
.....

List of processes in Queue1:

Process Burst

[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process Remaining I/O time
P3 9
.....

Completed: P1, P2, P4, P5, P6, P7, P8,

::

Current Time: 584

Next Process on the CPU: P3 CPU burst: 6
.....

List of processes in Queue1:

Process Burst
[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]

.....

List of processes in I/O:

Process Remaining I/O time
[empty]
.....

Completed: P1, P2, P4, P5, P6, P7, P8,

::

Current Time: 590

Next Process on the CPU: [IDLE]
.....

List of processes in Queue1:

Process Burst
[empty]
.....

List of processes in Queue2:

Process Burst
[empty]
.....

List of processes in Queue3:

Process Burst
[empty]
.....

List of processes in I/O:

Process Remaining I/O time
[empty]
.....

Completed: P1, P2, P3, P4, P5, P6, P7, P8,

::

Finished

Total time: 590

CPU utilization: 93.7288 %

Response time:

P1	P2	P3	P4	P5	P6	P7	P8
0	5	9	14	17	22	27	32

Average response time: 15.75

Waiting time:

P1	P2	P3	P4	P5	P6	P7	P8
50	134	198	17	266	179	243	151

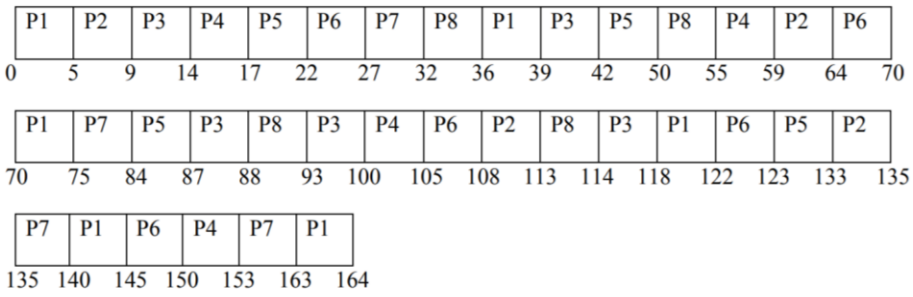
Average waiting time: 154.75

Turnaround time:

P1	P2	P3	P4	P5	P6	P7	P8	
275		561	590	501	575	394	571	460

Average turnaround time: 490.875

5. Partial Gantt chart



6. Instructions

Download the MLFQ.cpp source file. Open Visual Studio 2015 and start a new empty project. Click on Project, then Add Existing Item, and select FCFS.cpp. To run the simulator go to Debug, Start without Debugging. The output will appear in a console window. To view the output in a text file go to Project – Properties – Configuration Properties – Debugging. Write > output. txt in Command Arguments. The file ouput.txt will be in the project folder after running.