CS 4323 Operating Systems Project

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Group Project Progress Report

Project Due: May 5th, 2022

Introduction

In this group project, team members developed and organized code to program and analyze process scheduling algorithms used in practical operating systems. The purpose of this project is for team members to better understand the behaviors of the algorithms, their benefits in efficiency, and their drawbacks in implementation.

The final programs were developed using Excel VBA as its language, so the programs and their operations reside within macro-enabled Microsoft Excel workbooks. The programs feature the specifications of five or six processes for their arrival times in the system, their required burst times, and their relative priorities to one another. The length of a time quantum is also specified. The user opens the workbook corresponding to the desired scheduling type, inputs the process specifications, and outputs the resulting schedule as a Gantt chart.

Scheduling Techniques

In this project we analyze the two scheduling CPU algorithms:

Round Robin Scheduling with Preemptive Priority (RRS-PP) - Considered to be impartial, RRS uses time quanta that are delegated to each CPU process in the queue. Each process is then allowed to use the CPU for a given amount of time. If the process doesn't finish within the allotted time, it is preempted and moved to the back of the queue so the next process in the queue is able to use the CPU for the given time quantum.

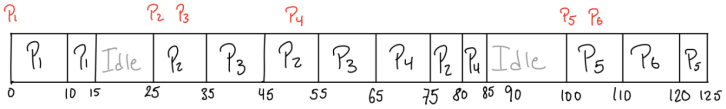
Thread	Priority	Burst	Arrival
P_1	40 (H)	15	0
P_2	30	25	25
P_3	30	20	30
P_4	35	15	50
P_5	5 (L)	15	100
P_6	10	10	105

TQ = 10

Round Robin

~~P_1~~	~~P_4~~
~~P_1~~	~~P_2~~
~~P_2~~	~~P_4~~
~~P_3~~	~~P_5~~
~~P_2~~	~~P_6~~
~~P_3~~	~~P_5~~

✓ P_1 15 - 10 = 5 - 5 = 0
✓ P_2 25 - 10 = 15 - 10 = 5 - 5 = 0
✓ P_3 20 - 10 = 10 - 10 = 0
✓ P_4 15 - 10 = 5 - 5 = 0
✓ P_5 15 - 10 = 5 - 5 = 0
✓ P_6 10 - 10 = 0



Completion - Arrival Time = TAT

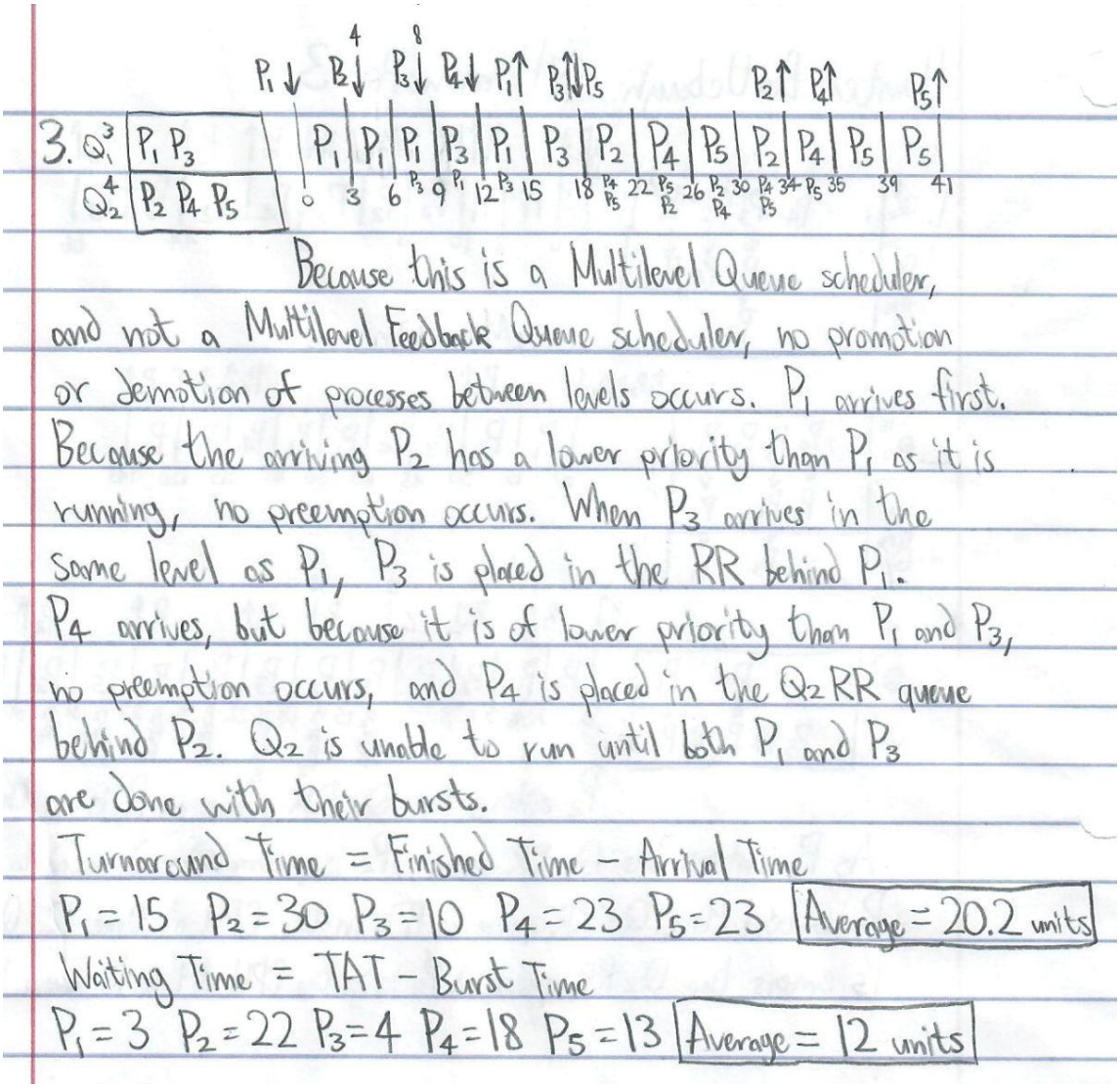
Turnaround Time - Burst Time = WT

	Turn Around Time	Waiting Time
P_1	15 - 0 = 15	15 - 15 = 0
P_2	80 - 25 = 55	55 - 25 = 30
P_3	65 - 30 = 35	35 - 20 = 15
P_4	85 - 50 = 35	35 - 15 = 20
P_5	125 - 100 = 25	25 - 15 = 10
P_6	120 - 105 = 15	15 - 10 = 5

CPU Utilization Rate:

Idle time = 20
125 - 20 = 105
(105/125) * 100 = 84%

Multilevel queue scheduling (MLQ) - Is used when processes in the ready queue can be divided into different classes where each class has its own scheduling needs. Every queue will have an absolute priority over low priority queues. No process can run until the high priority queues are empty. The advantages of MLQ include being able to apply different scheduling algorithms for different processes and having a low scheduling overhead.



Because this is a Multilevel Queue scheduler, and not a Multilevel Feedback Queue scheduler, no promotion or demotion of processes between levels occurs. P_1 arrives first. Because the arriving P_2 has a lower priority than P_1 as it is running, no preemption occurs. When P_3 arrives in the same level as P_1, P_3 is placed in the RR behind P_1. P_4 arrives, but because it is of lower priority than P_1 and P_3, no preemption occurs, and P_4 is placed in the Q_2 RR queue behind P_2. Q_2 is unable to run until both P_1 and P_3 are done with their bursts.

Turnaround Time = Finished Time − Arrival Time

$P_1 = 15$ $P_2 = 30$ $P_3 = 10$ $P_4 = 23$ $P_5 = 23$ **Average = 20.2 units**

Waiting Time = TAT − Burst Time

$P_1 = 3$ $P_2 = 22$ $P_3 = 4$ $P_4 = 18$ $P_5 = 13$ **Average = 12 units**

Program Operation

Round Robin with Priority Scheduling

Setup

1. Open the '**RR Priority.xls**' file on a Windows PC. * not compatible with Mac.
2. Depending on the version of Microsoft Office Excel you have, the program may prompt you to allow "Enable Editing", "Enable Content" or "Enable Macros" near the top of the screen. If it does, then please do so at this time.
3. On the top-left corner of the open worksheet there are 3 properties for each process: Arrival Time, Burst Time, and Priority. There are cells to input information for the six processes (B2-D7). Some default information is already present in these cells. You may edit this information as you wish, so long as the information generates valid schedules. (All values must be positive numbers).
4. If you wish, you may also edit the "Time Quantum" (B8) value to specify the time quantum length.
5. There are 3 non-preemptive and 3 preemptive algorithms to choose from:
    a. Non-preemptive Algorithms
        i. First Come First Serve (FCFS)
        ii. Shortest Job First (SJF)
        iii. Non Preemptive Priority (NPP)
    b. Preemptive Algorithms
        i. Preemptive Priority (PP)
        ii. Shortest Job First (SRTF)
        iii. **Round Robin (RR)** **required*
6. * If you run into a *Run time error '1004': Application-defined or object-defined error* at any time, simply click the 'End' button in the dialogue box that appears and reset the Gantt Chart to try again.

Startup

1. To start the simulation, use the drop-down menu (D13) to select the desired scheduling algorithm.
2. To begin instantly processing the Gantt chart with the input information, press the "Start" button(B15). If you wish to see each CPU cycle of the algorithm individually instead, click the "Step" button (B17) repeatedly. The Gantt chart will begin to generate (K4) and stretch to the right.
3. A "Status Report" window will immediately appear upon completion of the Gantt chart. It should display wait time statistics about the processes. Click "OK" to close this window.

4. Press the “Reset” button (B19) to clear the Gantt chart from the worksheet.
5. You may repeat this operation with new values after resetting the chart.

Output

Process	Arrival Time	Burst Time	Priority
P1	0	15	40
P2	25	25	30
P3	30	20	30
P4	50	15	35
P5	100	15	5
P6	105	10	10
Time Quantum	10		

CPU Scheduling Algorithm Menu

Round Robin (RR)

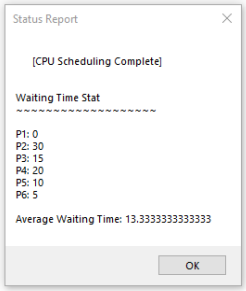
START

STEP

RESET

GANTT CHART

Process	P1	IDLE	P2	P3	P2	P3	P4	P2	P4	IDLE	P5	P6	P5	
Delta Time	0	15	25	35	45	55	65	75	80	85	100	110	120	125



Multi Level Queue with Round Robin

Setup

1. Open the '**MLQ.xlsm**' file on a Windows PC. * not compatible with Mac.
2. Depending on the version of Microsoft Office Excel you have, the program may prompt you to allow "Enable Editing", "Enable Content" or "Enable Macros" near the top of the screen. If it does, then please do so at this time.
3. On the top-left corner of the open worksheet there are 4 properties for each process: Burst Time, Arrival Time, Priority Queue, and TAT. **Leave the TAT cells blank, as these will display output.** You may input the specifications for the five processes in the other cells (B2-D6). Some default information is already present in these cells. You may edit this information as you wish, so long as the information generates valid schedules. (All values must be positive numbers).
4. If you wish, you may also edit the "Time Queue 1" and "Time Queue 2"(I2)(I3) values to specify the time quantum lengths of the separate queues.

Startup

1. To start the simulation, click the Calculate button (C8).
2. The Gantt chart will begin to generate (B15) and stretch to the right. Under the process name, there will be the ending times for each quantum or the current computation time.
3. Upon completion, the TAT for each process will display in Cells (E2) through (E6), and the average TAT and Wait Time will be output to cells (I6) and (I7).
4. Press the "Reset" button (C10) to clear the Gantt chart, TAT, and average data output values from the worksheet.
5. You may repeat this operation with new values after resetting these processes.

Output

Process	Burst Time	Arrival	Priority Queue	TAT
1	12	0	1	18
2	8	4	2	30
3	6	5	1	10
4	5	12	2	23
5	10	18	2	23

MLQ WITH 2 QUEUES	
Time Queue 1	3
Time Queue 2	4

Average TAT	20.8
Average WT	12.6

Calculate

Reset

Gantt													
Process	P1	P1	P3	P1	P3	P1	P2	P4	P5	P2	P4	P5	P5
Delta Time	3	6	9	12	15	18	22	26	30	34	35	39	41

References

Jerabek, Alex, et al. “Getting Started with VBA in Office.” *Microsoft Docs*, Microsoft, 21 Jan. 2022, https://docs.microsoft.com/en-us/office/vba/library-reference/concepts/getting-started-with-vba-in-office.

“Preemptive Priority Scheduling Program in C++ with Explanation.” *Cricket,Coding and Life*, 10 Apr. 2020, https://shivammitra.com/operating%20system/preemptive-priority-program/#.

“Round Robin Scheduling with Different Arrival Times.” *GeeksforGeeks*, 4 Mar. 2022, https://www.geeksforgeeks.org/round-robin-scheduling-with-different-arrival-times/.

Valdez, Sony. “CPU Scheduling.” *GitHub*, GitHub Inc., 20 May 2010, https://github.com/MrValdez.

Williams, Lawrence. “CPU Scheduling Algorithms in Operating Systems.” *Guru99*, 5 Mar. 2022, https://www.guru99.com/cpu-scheduling-algorithms.html.

Meeting Reports

Jan 24

- Created group:
    - Hunter Bartlebaugh (hubartl@connorsstate.edu),
    - Michelle Echeverri (michelle.a.echeverri@okstate.edu),
    - Lijo Philip (lijo.philip@okstate.edu)

Jan 31

- Discussed logistics of group availability
- Considered programming languages to use for the project.

Feb 7

- Received more information regarding the project objective:
    - User Inputs information, “clicks a button”, and the program generates a Gantt chart and outputs the order of service for each process.
    - Needs to account for 5 processes, no more than that.
    - 2 CPU scheduling types: Round Robin w/ Preemptive priority and Multilevel queue scheduling.
    - 2 separate programs or 1 program
    - Drop-down menu or radio buttons to select which schedule to use
- Deciding on whether to implement JAVA or VBA (needs further research)

Feb 21

- Decided on VBA as our primary language.

April 4

- Reporting group progress.
- Lijo Philip, submitted a prototype program of Round Robin Preemptive Scheduling - waiting for review.
- Lijo Philip, created a Written Report for final submission.

April 19

- Completed and Submitted Round Robin Scheduling Algorithm - Lijo Philip

Member Responsibilities

Hunter Bartlebaugh - Hunter was responsible for organizing the group and took up most of the non-programming duties. The most important of these duties was ensuring communication between team members and the professor whenever necessary. He regularly spoke with Lijo and Michelle in person wherever possible to keep all members up to date on each other's progress. If in-person communication was not possible, he messaged them over a private Discord group chat. He hosted a Dropbox folder to which all members could upload files and contribute to the project. Aside from team organization and communication, Hunter also wrote and formatted large parts of this progress report document, helped verify program output by hand whenever such help was required, and constructed one of the earliest designs for the worksheet appearance before development on the code began.

Michelle Echeverri - Duties involved both programming and non-programming duties. In the programming aspect, a MLQ (Multilevel Queue) was developed and programmed in VBA. This was designed with the purpose of solving the programming question assigned in the PDF for the assignment. This program generates a gantt chart and the values for the processes. The time quanta can be changed to the desires of the user. In the non-programming aspect, communication between programming partner Lijo was established to help solve several issues that were encountered during the creation of the programs. Communication was also made through Discord in meetings to talk about the progress of the project. Record of references was utilized during creation. In the report, Michelle wrote the Multilevel Queue with Round Robin explanation, and formatting the report was also carried out.

Lijo Philip - Created a detailed scheduling technique and Gantt chart for the Round Robin Scheduling algorithm with Preemptive Priority (RR-PP) question given in the project description by hand. Used the previously mentioned scheduling technique to implement a program that does both Preemptive and NonPreemptive CPU Scheduling techniques in Visual Basic for Applications which also generates a Gantt Chart. Other responsibilities included actively participating in meetings to voice concerns and suggestions for program implementation. Keeping track of weekly / monthly "Meeting Reports" for any outside communication or collaboration for the project. Kept a record of all "References" used in creating his portion of the project. Created the write-up for the "Program Operation" section of the written report for the Robin Scheduling algorithm with Preemptive Priority.