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Course- CSE2005 Operating Systems Component (EPJ) L7+L8

Title

An improved context switching algorithm for a Round Robin (RR) with Dynamic Time Quantum Assignment.

Abstract

Process Management is considered a very important function of any OS as it is the backbone of the system. There are several kinds of scheduling algorithms to perform the given task each of which have their own pros and cons. Round Robin is among the most prominent scheduling algorithms. Round Robin schedulers preempt the task based on a specific time quantum and switches to next task and run it for the same time quantum and repeat this process until no tasks are left in the ready queue. The performance and efficiency of a Round Robin scheduler is heavily dependent upon one's choice of the time quantum. If time quantum is too high, the scheduler tends to morph into a First in First Out scheduler while if it is too small, it causes a lot of context switches wasting a lot of time performing unnecessary task. This project revolves around how to dynamically pick an appropriate time quantum for one cycle and at the same time prevent context switching for tasks that use a very small portion of time quantum otherwise.

Details of Algorithm

The ready queue is First Come First Served based. Before starting to perform a task in ready queue, the calculation for the time quantum is done and the process is run for that specific amount of time after which we take a peek on the remaining burst time of the process and if the burst time remaining is very small when compared to the time quantum assigned during that cycle then the task is allowed to run completely hence saving an addition context switching later.

The problem with normal RR scheduling Is that its performance is heavily dependent on the selection of Time Quantum whose extremes can morph the scheduler into FCFS if its too high and can lead to too much context switching at extremely low values leading to too much time wastage in just switching between processes. Dynamic Time Quantum assignment help with this problem. There are several ways to determine the value of time-quantum for one cycle like mean, median, deviation etc. and I decided to use mean as one of my parameter, but the problem with using mean directly as our time quantum is that it can sometimes convert our RR scheduler to FCFS if the burst times are same for all the remaining processes and in case of very little standard deviation across the mean, and if standard deviation is very low, it can actually lead to more unnecessary context switches than needed so we need to normalize it a little bit. For my scheduler I decided to use a variation of mean of remaining burst time of processes along with a preset burst time as a guide to limit the minimum time quantum of any process. Also, if the remaining burst time of the process is very small in comparison to the time quantum for that cycle, the process can be allowed to run to its completion to avoid the

time it might take to context switch between processes later and potentially improving turnaround time and waiting time of the processes with a minor potential compromise to the response time of the processes.

T→Time Quantum for normal Round Robin

*→Means Process Completion

No. of Process=3 →P1,P2,P3

Process	Arrival Time (AT)	Burst Time (BT)
P1	0	2T
P2	T/2	T+dx
P3	T	T

Normal Round Robin (TQ=T)

P1	P2	P3*	P1*	P2*
Remaining BT=T	Remaining BT=dx	Remaining BT=0	Remaining BT=0	Remaining BT=0

0   T   2T   3T   4T   4T+dx

Number of context switches=4

Time wasted for switching tasks for a process with very small remaining Burst Time.

Round Robin extended Time quantum for small remaining BT (TQ=T)

P1	P2	P2*	P3*	P1*
Remaining BT=T	Remaining BT=dx	Remaining BT=0	Remaining BT=0	Remaining BT=0

0   T   2T   2T+dx   3T+dx   4T+dx

No Context switch at time 2T.

Number of context switches=3

Time Saved by reducing context switches but approaching FCFS approach

RR with Dynamic Time Quantum (min TQ= T/2, max TQ=3T/2)

P1	P2	P3	P1	P2*	P3*	P1*
Remaining BT=2T/3	Remaining BT=T/9	Remaining BT=11T/27	Remaining BT=T/6	Remaining BT=0	Remaining BT=0	Remaining BT=0

0   4T/3   20T/9   76T/27   179T/54   (185T/54)+dx   (207T/54)+dx   4T+dx

Number of context switches=6

Potential for saving time used for context switching without having the algorithm approach FCFS.

System Specifications

The main software we need is gcc compiler for LINUX based systems and mingw compiler for Windows environment with standard c libraries such as stdio, unistd, stdlib, string, cmath pre-loaded. There are no particularly specific hardware requirements for the program to work as long as it supports the software mentioned.

Literature Review

1) Sonia Zouaoui , Lotfi Boussaid , Abdellatif Mtibaa (February 2019). PRIORITY BASED ROUND ROBIN CPU SCHEDULING ALGORITHM (PBRR) CPU SCHEDULING ALGORITHM
   In this paper the authors propose a Priority based Round Robin scheduling algorithm which maintains the advantages of having a Round Robin scheduling algorithm by reducing starvation and adds to that the advantage of priority scheduling. It propose a scheduling model which is more scalable for real time operating systems by improving the operating system's waiting time, response time, turnaround time, and throughput.
   It throws light upon different kinds of existing scheduling algorithms such as First In First Out, Shorter First, Round Robin, Priority Based Scheduler, Rate Monotonic, Dead Monotonic etc.

2) Tithi Paul Rahat Hossain Faisal Md. Samsuddoha (September 2019). IMPROVED ROUND ROBIN SCHEDULING ALGORITHM WITH PROGRESSIVE TIME QUANTUM
   The authors of this research paper emphasize on the how time quantum of a Round Robin Scheduler affects its performance and context switching time. They propose an algorithm where the time quantum is selected dynamically and numerous experiments have been conducted to prove its efficiency. The performance of an Round Robin Scheduler is heavily dependant upon the choice of Time Quantum selected. A very large TQ might mean the RR scheduler morphed into FCFS and when it becomes too small, the context switch skyrockets. However this algorithm does not work where priority based scheduling is required and also the selection of time quantum by the system becomes obnoxious towards the end of the processes if the remaining burst times of the processes are very distinct after every cycle resulting in heavily compromised waiting times for some set of processes depending on type of processes.

3) Sohrawordi , Ehasn Ali , Palash Uddin and Mahabub Hossain (Feb 2019). A MODIFIED ROUND ROBIN CPU SCHEDULING ALGORITHM WITH DYNAMIC TIME QUANTUM.
   In This Research paper, the authors propose a Round Robin with Dynamic Time Quantum (RRDTQ) system for enhancing the CPU performance using dynamic time quantum assignment. In their proposed algorithm the burst time of all the processes in the ready queue are noted and the TQ's value is assigned based on that average value. It reduces the number of context switches required however might not be the best if the burst times of all processes are very close to each other but not equal to mean.

4) Debashree Nayak, Sanjeev Kumar Malla, Debashree Debadarshini (January 2012). IMPROVED ROUND ROBIN SCHEDULING USING DYNAMIC TIME QUANTUM
   This Research paper also uses RRDTQ to reduce the number of context switches but instead of using mean to calculate TQ of a certain process, Median is used to calculate effective time quantum. This algorithm fails when the burst times of the processes does not follow any sort of consistent trend.

5) O. Oyetunji and E. Oluleye (August, 2009). PERFORMANCE ASSESSMENT OF SOME CPU SCHEDULING ALGORITHMS. In this report the authors compare various aspects of a CPU scheduling algorithms with each other, namely waiting time, turnaround time, CPU utilization, Throughput etc amongst FCFS, PS and SJF schedulers to find optimum scheduling algorithms for different kind of needs.

6) Abdulaziz A. Alsulami , Qasem Abu Al-Haija , Mohammed Thanoon , Qian Mao (April 2019). PERFORMANCE EVALUATION OF DYNAMIC ROUND ROBIN ALGORITHMS FOR CPU SCHEDULING
In this paper, the authors throw light upon different RR algorithms and their performance statistics such as RR with static time quantum, RR with Dynamic time quantum, RRDTQ using Manhattan distance(RRDTQ), Improved time quantum RR(static TQ RR), Adaptive RR and Best Time Quantum RR to give insight upon the pros and cons of each type of Round Robin Scheduler.