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An Adaptive Fuzzy-Based Two-Layered HRRN CPU Scheduler: FHRRN

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ABSTRACT

Fuzzy-based CPU scheduler has become an emerging component of an operating system. It can handle the imprecise nature of parameters used in scheduler. This paper introduces an adaptive fuzzy-based highest response ratio next CPU scheduler which is an extension of conventional CPU scheduler. The proposed scheduler works in two layers. At the first layer, a fuzzy inference system is defined that handles the uncertainties of parameters, and at the second layer, an adaptive scheduling algorithm is used to schedule each task. The proposed scheduler intelligently generates the response ratio for each ready-to-run task which makes the system adaptive at run time. The work is compared with the conventional highest response ratio next scheduling and the existing fuzzy highest ratio next scheduling algorithms. Results validate the better performance of proposed scheduler. The proposed scheduler also provides comparable results with respect to shortest job-first scheduling and shortest remaining task-first scheduling algorithms.

KEYWORDS

CPU Scheduler, Fuzzy Inference System (FIS), Fuzzy-Based HRRN CPU Scheduler, Highest Response Ratio Next (HRRN) Scheduling, Operating System, Scheduling Algorithms

INTRODUCTION

In multiprogramming framework, the emphasis of any operating system is on utilization of CPU. Every OS tries to make the CPU busy for achieving its effective utilization. The CPU with uniprocessor capability can dispatch only one task at a time with CPU. Therefore, these systems must have an OS which manages the productivity of CPU time. OS is having a component called CPU Scheduler to facilitate the multiprogramming. It takes the decision of selection of one task among multiple ready to run tasks and then, it passes the selected tasl to the dispatcher (Silberschatz et. Al,2018; Tanenbaum & Woodfull, 2006). Then dispatcher allocates the selected task to CPU. The flow from submission to the execution of task is illustrated through fig. 1. Different scheduling algorithms are having different criteria of selection which can affect the performance of any OS. As selection of task directly affects the performance, hence, CPU schedulers are still an emerging area for researchers.

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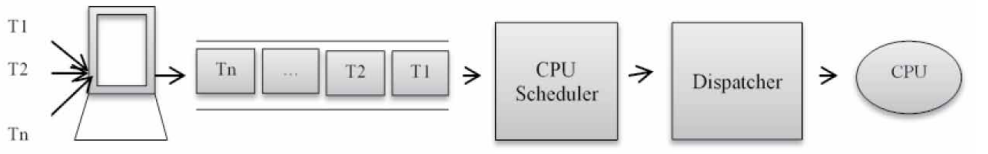
Figure 1. Flow of task from system to CPU



Following are the acronyms used in the present work:

- **CPU:** Central Processing Unit
- **OS:** Operating System
- **HRRN:** Highest Response Ratio Next
- **SJF:** Shortest Job First
- **FCFS:** First Come First Serve
- **RR:** Response Ratio
- **FHRRN:** Fuzzy Based Highest Response Ratio Next
- **SRTF:** Shortest Remaining Time First
- **VHRRN:** Vague Logic Based Highest Response Ratio Next
- **FIS:** Fuzzy Inference System
- **S.A.:** Scheduling Algorithm

A Scheduler must meet certain performance measures. It should focus to reduce the average waiting time, average turn-around time, and average normalized turn-around time. Meanwhile, it must also improve the throughput of the system (Zaim,2013; Rao & Shet, 2010). Several scheduling algorithms like FCFS, priority, SJF, SRTF and HRRN scheduling, and their improved versions are introduced by researchers. Each scheduling algorithm has their own importance based on the system setup environment (Silberschatz et al, 2018; Stallings, 2018). So, each algorithm has different performance criteria based on the environment. The present work gives emphasis on one of the preferred scheduling algorithms named HRRN scheduling algorithm. HRRN scheduling algorithm has been proved as the best algorithm among different algorithms (Raheja, 2019).

Computing devices are not enough capable to compute the definite value of parameters (Liu et al, 1991; Mohammed & Mostafa, 2019). It enables the possibility of taking imprecise value of parameter 'burst time' by the scheduler which may affect the value of response ratio. It further affects to the performance of HRRN scheduler. Numerous studies in the open literature concluded that the fuzzy set theory is enough capable to manage this impreciseness (Chahar & Raheja, 2013; Hooda & Raheja, 2014; Zanjirani & ES maclian, 2018).

Keeping this in mind, the present work proposes a novel 2-layered Fuzzy based HRRN CPU scheduler. The key features of the proposed scheduler are:

- It deals with the impreciseness of two parameters 'burst time' and 'waiting time'.
- It works in two layers. The first layer is having a fuzzy inference system which generates the response ratio using fuzzy set theory and passes to the second layer. Then, second layer executes the modified HRRN (F-HRRN) scheduling algorithm.
- It is adaptive. The second layer constantly receives the response ratio from the first layer which makes the scheduler adaptive. In the real world, the system must be adaptive to make the changes according to the current situation.