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(Review Article)

Exploration of dynamic task scheduling using machine learning approaches

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Abstract

Allocating shared resources gradually allows tasks to be completed efficiently within the allocated time. This is the process of scheduling. The terms "task" and "resource" are used separately in task scheduling and resource allocation, respectively. In computer science and operational management, scheduling is a hot topic. Efficient schedules guarantee system effectiveness, facilitate sound decision-making, reduce resource waste and expenses, and augment total productivity. Selecting the most appropriate resources to complete work items and schedules for computing and business process execution is typically a laborious task. Particularly in dynamic real-world systems, where scheduling different dynamic tasks involves multiple tasks, is a difficult problem. Emerging technology known as "Machine Learning Algorithms" has the ability to dynamically resolve the issue of scheduling tasks and resources optimally. This review paper discusses a study that looked at Machine Learning algorithms used them to schedule tasks dynamically. The Machine Learning Algorithms utilized in dynamic task scheduling and a comparative analysis of those methods are used in this paper to address the study's findings.

Keywords: Task Scheduling; Machine Learning Algorithms; KNN; Random Forest; Decision Tree Algorithm; Support Vector Machine.

1. Introduction

The process of task allocation guarantees that the appropriate resources have been distributed efficiently to complete work tasks with a specific outcome at the appropriate time. It ensures that the availability of resources and the demand for process execution facilities are balanced. Scheduling, which is the process of allocating tasks or resources, has several applications, including Network Routing, Public Transport, Grid Computing, and Industrial Workforce Management. Since dynamic task scheduling is essential to efficient resource sharing, it has attracted a lot of attention in these domains [1].

The Scheduler component in a computer system handles scheduling, which primarily addresses response time, latency, and throughput. Throughput is the rate at which a given number of tasks can be completed from start to finish in a given amount of time. On the other hand, latency refers to the turnaround time, or the amount of time needed to finish a task from the moment it is requested or submitted to the end, including any waiting periods required to fulfill the request. Response time, or waiting time, is the amount of time it has taken to complete a task or fulfill a request [2-7].

Static and dynamic scheduling are the two main categories into which scheduling solutions can be separated [8-11]. Decisions are made during compilation in static scheduling, while computational state information is used in decision-making during execution in dynamic scheduling/adaptive work sharing. Complete prior knowledge of the task set characteristics is required for static scheduling, which is difficult to come by in an unpredictable setting. Because dynamic scheduling can handle situations where dependencies are unknown at compile time, it is more promising than static scheduling. It requires dynamic load balancing and is more computationally demanding, allowing for different parallelization strategies. Because dynamic schedulers are adaptable and can adjust to changing task scenarios, they are

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a great choice for deployment in unpredictable environments. Mainly, this article focuses on dynamic scheduling [12-15].

This article explains the initial attempts to use machine learning algorithms for dynamic task scheduling. Section 3 concludes by summarizing the difficulties in research for dynamic task scheduling and emphasizing the feasibility of machine learning algorithms in an effort to offer a better solution.

2. Evolution and State-of-the-Art of Machine Learning Algorithms in Dynamic Task Scheduling

The insights from earlier studies on dynamic task scheduling with machine learning algorithms are presented at this part. The section begins by explaining the underlying theory of machine learning algorithms [16-21]. The majority of machine learning Algorithms used for dynamic task scheduling is then explored. Deep learning and Nature-inspired algorithms researches are also conducted by the dynamic task scheduling. The readers can get the idea of machine learning [10-15] and deep learning in details from the papers [22-26].

2.1. Machine Learning Algorithms

Machine learning is an artificial intelligence approach and a subfield of computer science. This method has the benefit of allowing a model to address issues that are not amenable to explicit algorithms, and it can be applied in multiple domains. A thorough analysis of various deterministic and machine learning techniques for predicting food, crop yield, weather, and hepatitis is provided in [27-29]. Even in situations where representation is not feasible, machine learning models identify relationships between inputs and outputs; this characteristic allow the use of machine learning models in many cases, for example in data mining and forecasting problems, spam filtering, classification problems, and pattern recognition. Because one must work with large datasets and machine learning models can handle pre-processing and data preparation, the classification and data mining aspects of this field are especially intriguing. Following this stage, forecasting issues can be solved using the machine learning models. This article provides the details of dynamic task scheduling using machine learning algorithms.

2.1.1. Decision tree

This is a very basic idea. Predicting a response or class Y from inputs X1, X2,..., Xp is necessary. To accomplish this, a binary tree is grown. A test is applied to one of the inputs, let's say Xi, at every node in the tree. Either the left or the right sub-branch of the tree is chosen, depending on the test's result. When a leaf node is eventually reached, a prediction is made there. The training data points that arrive at that leaf are all averaged or combined in this prediction. Using each of the independent variables, a model is produced. The optimal split is found using mean squared error for each of the individual variables. The total number of features is the maximum number that must be taken into account at each split [30-33].

2.1.2. Random Forest

In order to increase prediction accuracy and prevent over-fitting, a random forest is a meta estimator that fits several classification decision trees on different subsamples of the dataset by averaging them [34].

2.1.3. Support Vector Machine

In recent years, SVM has become one of the most popular machine learning models for remote sensing applications because it determines the best hyperplane for data classification. To find the optimal hyperplane, SVM effectively uses a kernel function to convert the data dimension into a higher one. In our test, the radial basis function outperformed the linear and polynomial basis functions as the best kernel function. To get the optimum performance in identifying the development of tropical cyclones, the kernel and penalty parameters employed in the SVM model were automatically changed during the data training process [35-37]. Every predictor variable was scaled linearly to fall between 0 and 1 before to data training to account for the magnitude difference.

SVM does not instantly reveal the information on the relative value of predictors, in contrast to other machine learning techniques. As an alternative, the F-score test is used to pinpoint the key SVM-based traits that distinguish the genesis of tropical cyclones. A test's accuracy is measured by the F score, also known as the F1 score or the F measure, which is the weighted harmonic mean of the test's recall and precision [27].

3. Conclusion

It was possible to compile a substantial amount of information about the approaches, theories, strategies, benefits, and drawbacks of scheduling systems and frameworks created for dynamic task scheduling in the fields of computer science and operational management through the literature review. Machine Learning Algorithms, the primary method of dynamic task scheduling, have yielded a great deal of success. An approach that can be applied to real-world scheduling problems in complex and uncertain environments is much needed, though, as this has been a major issue in many fields of work. In dynamic real-world scenarios, an adaptable and scalable model-independent dynamic task scheduling framework with optimized Machine Learning Algorithms would result in efficient resource utilization. It will take time for Machine Learning Algorithms to advance and develop through problem-solving, but in the end, this will provide significant research benefits for the field. being a field of emerging research; In the near future, a viable technology that would empower numerous research directions and offer great prospects in dynamic scheduling would be Nature Inspired Algorithms.

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