IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **Volume 10, Iss 11 , 2021**

WORKLOAD PREDICTION FRAMEWORK FOR TASK SCHEDULING IN CLOUD COMPUTING

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ABSTRACT: Cloud computing has been developed and become the foundation of a wide range of applications. It is a distributed computing model which enables developers to automatically deploy their applications onto the cloud. Task scheduling plays a vital role in the function and performance of the cloud computing system. While there exist many approaches for improving task scheduling in the cloud, it is still an open issue. This paper presents, Workload Prediction Framework for Task scheduling in Cloud Computing. Task scheduling algorithms can be designed for static or dynamic scenarios. The aim of the proposed system is to improve resource utilization & response time in the cloud using scheduling algorithms. Rather than implementing single scheduling algorithms, multiple scheduling algorithms are implemented. Selection of the efficient scheduling algorithm is done using machine learning classification. Based on classification rules efficient scheduling algorithm is selected and tasks are executed. Task scheduling can consider different parameters for scheduling purposes like Makespan, QoS, energy consumption, execution time, and load balancing. The outcome of the proposed work leads to the selection of the best task scheduling algorithm for the input task (request).

KEYWORDS: Task scheduling, Cloud computing, Resource utilization, Makespan.

I. INTRODUCTION

Cloud computing is an extension of parallel, grid and distributed computing. Cloud computing provides secure, fast, user-friendly data storage and processing power with the help of internet. Cloud contains a number of data centers and each data center contains a number of resources. For the data centers an important issue is resource utilization and from user point of view is response time [1]. Scheduling is assigning an appropriate number of resources to the jobs so as to handle heavy load. Cloud contains a number of data centers [2]. Each data center contains one or more scalable virtual Machines (VM's). Initially user sends input request to the broker then broker is responsible for allocating virtual machine(s) to the user task depending on respective scheduling policy. Finally a task is executed and the result is returned back to the user [3].

The devices connected keep posting requests to be processed at the cloud, which may vary in their characteristics. Some may be CPU (Central Processing Unit) intended tasks that require immense CPU utilization like floating-point operations or parallel processing tasks. Some may be memory seeking requests that need to allocate memory or access memory-related operations like read/write operations. And some may be too circumscribed with extensive data-intensive operations like significant data operations all these tasks scheduled among the resources available to process these requests.

The virtual machine single on the cloud to process these requests would vary in processing behaviour and computing capabilities. The incoming tasks shall be classified and shall be allotted to the excellent processing machine of that

ISSN PRINT 2319 1775 Online 2320 7876
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category of job. This task scheduling operation is the most critical and sensitive operation on the cloud. There are wellframed task scheduling algorithms available, but the algorithm that can process the given task and schedule it to the contextoriented machine for processing is always in demand [4].
Task scheduling is one of the crucial technologies in cloud computing, and proper task scheduling is required so as to improve the efficiency and to minimize the execution time. Task scheduling in a cloud environment can be done statically or dynamically. Task scheduling depends on the existence of dependencies among the tasks. The parameters to be considered for task scheduling in a cloud environment can be listed as execution time, resource utilization, energy consumption, response time, cost, makespan, QoS, fault tolerance and throughput. In cloud computing, the purpose behind task scheduling is to specify a particular resource from all the available resources so that the efficiency of the computing environment increases. Load balancing scheduling plays a key role in efficient resource utilization in a cloud computing environment.

In this paper, we focus on improving resource utilization & response time on the cloud, as well as system load is also taken into consideration [5]. The performance of each scheduling algorithm depends on the type of environment and the type of task. Gang scheduling is proposed to schedule related processes or threads to run simultaneously on different processors. But, Processors remain idle when the system performs I/O operation. So instead of one algorithm, we have implemented four scheduling algorithms. Selection of efficient scheduling algorithm for the particular cloud environment and input task is done using machine learning classification. Proposed system tries to predict which scheduling algorithm is efficient for the task and cloud environment and task is scheduled & executed based on that scheduling policy.

The remainder of this paper is organized as follows: Section II discusses Literature survey. Section III presents described Workload Prediction Framework for Task scheduling in Cloud Computing. Section IV presents results and discussions and finally paper concludes with Section V.

II. LITERATURE SURVEY

Shakeel Ahmad , Imtiyaj Ahmad, and Sourav Mirdha, et. al. [6] optimizes the starvation problem in cloud computing scheduling, a new dynamic priority-based job scheduling algorithm. This algorithm considers different criteria like job criticality, resource requirement for CPU and resource requirement of I/O. The recommended algorithm targets to optimize the waiting time & turnaround time of the tasks and to increase the throughput and CPU utilization of the overall system. A comparison with the SJF algorithm in terms of waiting time, turnaround time and total finish time are performed. Virtual machines are assigned to jobs with the highest priority. A threshold value is maintained by each job to avoid starvation. If any job's waiting time is more than the threshold value, then the priority of the job is increased so that it can get the chance of execution.

G. Shyam and S. Manvi, et al. [7] proposed Bayesian model for resource prediction of each VM and compared with linear regression method and support vector regression. They observed that by using Bayesian based model, the workloads of approximately 75% of the servers in datacenter could be predicted with accuracies over 80%. G. Patel, R. Mehta, and U.Bhoi et. al. [8], have a different take on optimizing the Min-Min algorithm. They present an enhanced Load Balanced Min-Min (LBMM) algorithm which optimizes resource utilization and makespan. LBMM essentially runs the traditional Min-Min algorithm in the first round of scheduling and therefore, the overloaded VMs are identified. After this,

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
Research paper **Volume 10, Iss 11 , 2021**

the tasks in these overloaded VMs are reassigned to lighter or less occupied resources.

Atul Vikas Lakra, and Dharmendra Kumar Yadav, et. al. [9] proposes multi-objective tasks scheduling algorithm for cloud computing optimization of throughput. In cloud computing most often cloud resources are underutilized due to poor scheduling of tasks (or application) in the data center. The main idea behind this work is that rather than having only one criterion for scheduling, it is required to consider various criteria like execution time, cost, the bandwidth of user, etc. The proposed multi-objective task scheduling algorithm was compared for a different set of workloads against First Come First Serve (FCFS) and priority scheduling algorithms and results were better than FCFS and priority scheduling algorithms.

H. Yang et. al. [10] described the improved ant colony algorithm depends on partial swarm optimization which is known as ACA-PSO. Initially, the ants are in the lineup with ant colony algorithm for the completion of the traverse, and re-arrangement of the solutions, while keeping in view the confined and universal solutions. While ACA-PSO controls the short comings of the algorithm, it easily gets into confined solutions in cloud computing resource scheduling.

III. WORKLOAD PREDICTION FRAMEWORK FOR TASK SCHEDULING

The framework of Workload Prediction Framework for Task scheduling in Cloud Computing is represented in below Fig. 1.

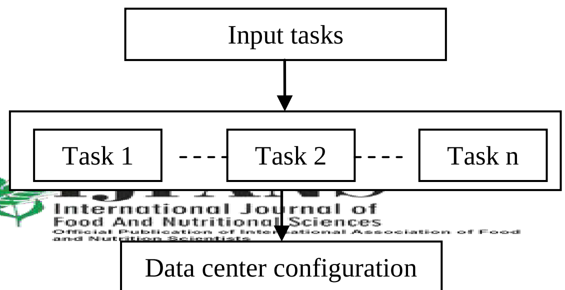

Fig. 1: FRAMEWORK OF WORKLOAD PREDICTION FRAMEWORK FOR TASK SCHEDULING

In the dynamic task scheduling scenario, the task scheduler must map the instant task request to the available pool of resources. For task scheduling, the scheduler has plenty of choices out of the existing basic and advanced task scheduling algorithms. Task manager provides computing as a utility service on a pay per use basis. The performance and efficiency of cloud computing services consistently rely upon the performance of the user tasks submitted to the cloud system.

Task scheduling can consider different parameters either in case of static or dynamic scheduling like makespan, energy consumption, waiting time, and response time. Task scheduling can be a single objective by considering any one parameter or multi-objective considering two or more parameters.

Data Center configuration includes creation of processing elements & hosts as well as setting up Data Center characteristics. Virtual Machine configuration includes setting up values for virtual memory size, image size, processing power (MIPS) and number of processing elements to create. After creating the cloud environment, cloudlets (tasks), broker as well as scheduling algorithms are designed. Cloudlets are nothing but the tasks which user wants to execute. Cloudlets and VM attributes are given as input to Selection of the efficient task scheduling algorithm using machine learning algorithm.

In the design of scheduling algorithm, we have implemented four scheduling algorithms which includes FCFS, NTS (Novel task scheduling in cloud), CMBF and AMBF. Using trained classifier the best algorithm suited for particular cloudlet and VM attributes is chosen and task is scheduled depending on the selected task scheduling algorithm. Scheduling algorithms are as follows:
1. FCFS (First Come First Serve): The simple & popular batch scheduling algorithm for parallel jobs is first come, first serve (FCFS). In FCFS, each job has to specify the number of nodes required. Processing of jobs by the scheduler is done on the basis of arrival time.

2. AMBF-Aggressive Migration Supported Back Filling: AMBF is advancement to EASY or aggressive backfilling and alternative to CMBF algorithm. AMBF allows only head of queue job to preempt other jobs. Meaning that rest of jobs is not allowed to preempt jobs, but they are allowed to dispatch to idle nodes. Also AMBF only keeps track of job which is at the head of the queue which saves additional overhead and cost.

3. Novel Task Scheduling (NTS) in the cloud: This is very simple but effective approach where user tasks are sorted according to priority. The task with highest priority is assigned to a VM with highest MIPS (Million Instruction per Second). The important parameter for the task is the priority and for virtual machine is processing power. Let's consider 4 tasks where the priorities of tasks are given as 1, 2, 3 and 4.

4. CMBF -Conservative migration supported backfilling: CMBF is advancement to a traditional backfilling algorithm where migration of the tasks is supported. The CMBF algorithm considers that the state of a job can be saved and can be later resumed on another node. So, the scheduler is able to suspend a job & resume it on another node. If there is enough number of nodes available, then CMBF schedules jobs according to arrival time.

Then, Selection of the efficient task scheduling algorithm is done using predicted classification which we will get from trained classifier. Machine learning algorithm produces classification rules or decision tree or mathematical formula depending on the type of classification algorithm used. The types of classification algorithm are tree based, rule based, bayes and lazy classification. Machine learning classifiers are used to train cloudlet and VM attributes. Finally, an efficient task scheduling algorithm will be selected & tasks are executed.

IV. RESULTS AND DISCUSSIONS

There are many simulators developed for the performance analysis of cloud computing environment, including SPECI, DCSim, CloudSim and GroudSim. But the CloudSim simulator is probably the most sophisticate out

IJFANS International Journal of Food And Nutritional Sciences
Official Publication of International Association of Food and Nutrition Scientists

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

 Volume 10, Iss 11 , 2021

of the above mentioned simulators because it is open source toolkit. Also CloudSim supports modeling of cloud computing system components like data centers, host, virtual machines, Cloudlets. Data Center contains a set of hosts and a host contains set of processing elements. Host is responsible for managing virtual machine during their life cycle. A virtual machine is a software implementation of a machine that runs programs like a physical machine. Cloudlet is a representation of tasks/jobs in CloudSim. The simulations are carried out for the performance characteristics listed below and the appropriate graphs and comparisons have also been shown. Considered parameters are Makespan and Load Balancing.

Makespan: The total time to complete a cloud computing workflow task Makespan, that is, the longest time to complete a cloud computing workflow from the beginning of the task to the end of the task.

We performed experiments by setting VM count to 40, 60, 80 and 100. We vary the task count in the range [200-800] in the interval of 200. We exhibit the experimental results with VM=60 in Fig. 2 which states the Makespan of algorithms increases with the rise in task count. This is because, as there is an addition to tasks the completion time of tasks will also grow with fixed VM count. Moreover, we can see that Workload Prediction Framework for Task scheduling (WLP-TS) has minimum Makespan as compared to others as Dynamic Task Scheduling (DTS), Learning Automata based Scheduling (LAS) and the trend is similar for all the task count.

Table 1: MAKESPAN VARIATION IN TASK COUNT

Task count	Makespan (sec) for VM=60		
	WLP-TS	DTS	LAS
200	48	56	65
400	55	62	74
600	79	83	96
800	85	110	135

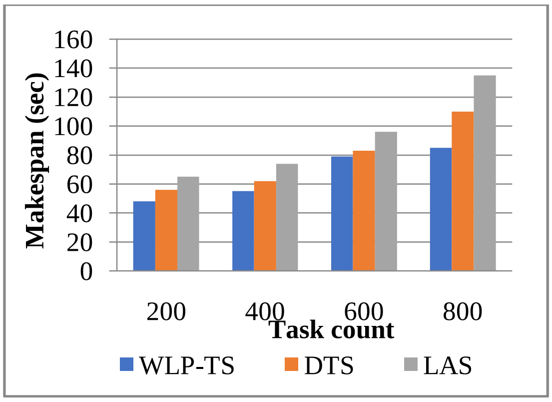

Fig. 2: MAKESPAN WITH VARIATION IN TASK COUNT

Load Balancing: Sometimes certain VMs become over encumbered by the number of incoming cloudlets. Hence it is important that all the cloudlets are distributed uniformly to all VMs. The percentage of the total load taken up by a VM is computed and compared.

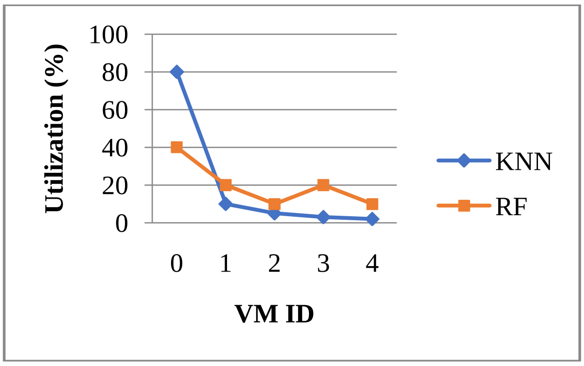

Fig. 3: PERCENTAGE OF TOTAL CLOUDLETS ASSIGNED TO DIFFERENT VM'S

Fig. 3 shows the percentage utilization of different VMs using classifiers. In all these cases VM0 is the VM with the highest load, followed by VM1. Both K-Nearest Neighbor **(**KNN) and Random Forest (RF) propose allocations wherein VM0 is the highest loaded VM. Load balanced allocation is achieved using the classifiers for allocation of tasks.

ISSN PRINT 2319 1775 Online 2320 7876
 Volume 10, Iss 11 , 2021

V. CONCLUSION

In this paper, Workload Prediction Framework for Task scheduling in Cloud Computing is described. The selection of appropriate scheduling classifiers for cloud computing is a critical issue. With the correct selection of algorithms, it helps to improve the efficiency of cloud resources. We have implemented four scheduling algorithms which includes FCFS, NTS (Novel task scheduling in cloud), CMBF and AMBF. We can see that Workload Prediction Framework for Task scheduling (WLP-TS) has minimum makespan as compared to others as Dynamic Task Scheduling (DTS), Learning Automata based Scheduling (LAS). Both KNN and Random Forest propose allocations wherein VM0 is the highest loaded VM. Therefore, Workload Prediction Framework for Task scheduling (WLP-TS) efficiently schedules the tasks in cloud computing environments.

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