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A Survey on Heuristic Approach for Task Scheduling in Cloud Computing

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Abstract: In cloud computing, data or resources are provided to the user by paying for the share of resources used by them. For efficient allocation of resources to the appropriate user, an efficient task scheduling algorithm is required, which can achieve minimum response time, high throughput and proper resource utilization, etc. Heuristic based algorithm is one such way to achieve the optimal or near optimal solution of task scheduling in the cloud environment. Heuristic methods are the subset of meta-heuristic approach. In this paper, various type of task scheduling algorithms in cloud computing have been surveyed.

***Keywords*:** Cloud computing, heuristic algorithm, optimization, task scheduling.

I. INTRODUCTION

Cloud can be defined as a large pool of easily available resources, software and information. To get access to all these resources, a cloud user just needs an internet connection. After that, a user can access and take benefit of powerful computing [1]. Cloud computing is also known as utility computing, because it can be defined as a business model where a user can pay as per usage of a particular resource. Here, a user does not need to buy every software or hardware. That is why cloud computing is also known as on-demand computing.

An important concept used in a cloud is virtualization. It is a technique by which the user can easily access the resources without considering the complexity and internal details of the system. The whole process is assumed to be in a cloud. So cloud computing has been coined as an umbrella term [2].

Cloud computing consists of three main assets:

1. Cloud user,
2. Cloud Service Provider(CSP),
3. Cloud services.

In cloud computing, cloud users use the cloud services provided by the Cloud Service Provider (CSP) [3].

There are countless definitions of cloud computing, but they all have some common concepts or characteristics. Fig. 1 describes some characteristics of cloud computing.

In cloud environment, there are several interconnected virtual machines, abbreviated as VMs. These VMs can share CPU, memory and bandwidth etc. on a single host [4]. When many users request for the resources at the same time, a proper task scheduling algorithm is necessary for proper resource utilization and maintaining the system performance.

In cloud computing, scheduling of tasks can be concluded as a vital requirement for increasing the efficiency of the cloud computing environment. Task scheduling can be defined as the selection of the appropriate resource from the available pool of resources for executing a task efficiently [5].

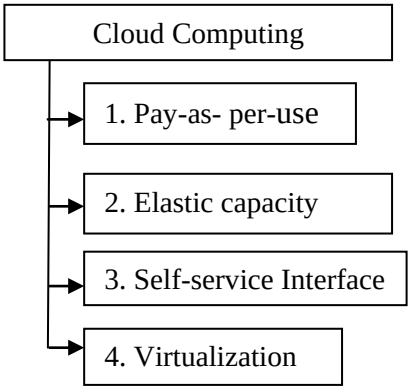

Fig. 1: Characteristics of cloud computing

There are so many task scheduling techniques available to schedule the tasks in the cloud environment, which are described under following three categories:

a) Traditional Techniques: Traditional techniques are the fundamental techniques for scheduling various tasks such as: First Come First Serve (FCFS), Round Robin (RR) and Shortest Job First (SJF) etc. These techniques are simple and deterministic, but they get stuck in local optima [1].

b) Heuristic Techniques: These techniques are used to find the optimal or near optimal solution by using a sample space of random solutions. Some of heuristic techniques are min-min, max-min, enhanced max-min [6] and priority based min-min etc. These techniques give better results as compared to the traditional approaches [7].

c) Meta-heuristic Techniques: These techniques also make use of random solution space for scheduling the tasks but the main difference between heuristic and meta-heuristic is that heuristic methods are problem specific while meta-heuristic methods are problem independent [8]. They generally use population based concepts inspired by social behavior of insects such as Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Tabu Search algorithm and Honey bee foraging algorithm etc.

The rest of the paper has been described as follows: Sections II describes the literature work done in the field of task scheduling algorithms. Section III presents the comparison among different types of task scheduling algorithms and section IV concludes the paper.

II. LITERATURE SURVEY

a) **Efficient Task Scheduling Algorithm**: In order to minimize the completion time of cloudlets, an enhanced task scheduling algorithm has been proposed by S. Sindhu et al. [9]. It consists of two algorithms named as, Longest Cloudlet Fastest Processing Element (LCFP) and Shortest Cloudlet Fastest Processing Element (SCFP). In this paper, the objective is to minimize the completion time of the cloudlets.

b) **Improved Min-Min Algorithm:** In order to achieve the maximum resource utilization in distributed environment, an improved min-min algorithm has been proposed by Rajwinder Kaur et al. [10]. This algorithm has two phases; the first phase is similar to the traditional min-min algorithm, in which minimum completion time of each task is calculated. In the second phase, tasks are rescheduled and selection of those resources which has been unutilized for a long period is made.

c) **Enhanced Max-Min Algorithm:** For optimizing the task scheduling in cloud computing environment, an Enhanced Max-Min Algorithm has been proposed by Santosh B. et al. [11]. It consists of two algorithms based on improved Max-Min algorithm. The authors take the average time of job execution instead of maximum completion time. In the first algorithm, arithmetic mean is used for calculating an average. In the second algorithm, geometric mean is used for the same purpose. Then the job which has execution completion time just greater than the calculated average time is selected. These two averages are calculated by considering the nature of jobs. If they are independent of each other, then arithmetic mean gives the best average and if they are dependent on each other than geometric mean calculates the best average time.

d) **Selective Algorithm:** For ensuring the quality of service (QOS) in cloud computing environment, a selective algorithm has been proposed by Kobra Etminani et al.[12]. This algorithm is based on the two basic scheduling algorithms- min-min and max-min. It uses the advantages of both and tries to overcome the disadvantages of them. The selective parameter in this paper is the standard deviation of the completion time of unassigned tasks in Meta task.

e) **Optimized Task Scheduling Algorithm:** In order to improve the scalability in cloud environment, an optimized task scheduling algorithm has been proposed by Shubham Mittal et al. [5]. In this paper, scalability is taken as the optimizing parameter. For improving scalability in the cloud environment, authors have taken five algorithms (min-min, max-min, RASA, improved max-min and enhanced max-min).

f) **Improved Task Scheduling Algorithm:** In order to achieve the proper utilization of the network bandwidth in the cloud computing environment, an improved task scheduling algorithm has been proposed by Abdul Razaque et al., which uses a non-linear programming model for assigning a proper number of tasks to each virtual machine [4]. The optimizing parameter for this algorithm is network bandwidth. Before assigning a task to a VM, this algorithm checks the available bandwidth of the VM and bandwidth of task. If the VM has sufficient bandwidth for executing the task, then this task is assigned to that VM otherwise to another VM. So the makespan of the task is reduced.

g) **Cloud-based Workflow Scheduling Algorithm:** In order to enhance the workflow in a multi-tenant cloud environment, a Cloud-based Workflow Scheduling Algorithm has been proposed by Bhaskar Prasad Rimal et al.[13]. In this paper, the authors have defineed four layers of services instead of three. Workflow as a Service is a new layer on the top of the Infrastructure as a Service layer. In the algorithm, Directed Acyclic Graph (DAG) is used to represent the workflow in the systems. The label on the nodes represents the cost of computation and the label on the edges represents the cost of communication. The main key of this algorithm is that it uses the ideal time of resources, reduces the makespan, properly utilizes resources and minimizes the cost.

h) **Task Scheduling Algorithm based on Quality of Service (QoS) in Cloud Computing:** For optimizing the service quality in cloud computing, a Task Scheduling – Quality of Service (TS-QOS) algorithm has been proposed by Xiaonian Wu et al. [14], in which quality of service parameters is taken as an optimization tool. In this, firstly the algorithm computes the priority of each task on the basis of certain parameters and then it sorts the entire list of tasks according to their priority. The task having minimum completion time is considered as highest priority task and gets the resource first for job completion. This algorithm takes the three indexes for measuring the performance. First is execution time span (makespan); second is Average waiting time of the long task (Average Latency) and third is Load balancing index.

i) **Task Scheduling Algorithms with Multiple Factors:** A comparison among various task scheduling algorithms has been proposed by Nidhi Bansal et al. [15]. In this paper comparison between traditional scheduling methods, i.e. FCFS, optimization method, QoS-driven, ABC (Activity Based Costing) and priority based algorithms etc. has been performed by using CloudSim as a simulator. Main aim of this paper is to show that the resource utilization and cost factor are the main criteria in any scheduling algorithm to perform best and it concluded that optimization based methods performed better as compared to the traditional methods.

III. Comparative Analysis

Scheduling Algorithms	Scheduling Parameters	Simulation Tool	Future Scope/ Limitations
A Min-Min Max-Min Selective Algorihtm for Grid Task Scheduling [12]	Execution time of the tasks for calculating standard deviation	GridSim	Availability of resources, communication cost, execution cost etc. can be considered in future.
Efficient Task Scheduling Algorithms for Cloud Computing Environment [9]	Execution time and utilization of resources	CloudSim	It can be enhanced for the tasks having priorities.
Resource Allocation with improved Min-Min Algorithm [10]	Makespan and load balancing	JAVA	It can be evaluated in public cloud environment.
Task Scheduling Algorithm based on Quality of Service (QoS) in Cloud Computing [14]	Makespan, Average waiting time, Load balancing index	CloudSim	Improvement required when two or more tasks have the same priority.
An Improved Task Scheduling Algorithm based on Max-Min for Cloud Computing [11]	Job execution time	WorkflowSim (extended version of CloudSim)	Type of a job i.e. either heterogeneous or homogeneous, is a major concern.
Cloud based Workflow Scheduling Algorithm [13]	Workflow in multi-tenant cloud environment	CloudSim	It can be improved when tasks have defined priorities. Here scalability is a concern.
An Optimized Task Scheduling Algorithm in Cloud Computing [5]	Distribution of jobs and Scalability	JAVA 7	Simulation can be done in actual cloud environment (CloudSim).
Task Scheduling in Cloud Computing [4]	Network bandwidth to reduce execution time and resource consumption	JAVA	Improvement required when tasks are dependent and one task needs more than one resource.

IV. CONCLUSION

In this paper, a survey on various types of heuristic based task scheduling algorithms has been presented, and then a comparative analysis has been performed on the basis of scheduling parameters, simulation tools, future scope observed and limitations etc. From the above study, it can be concluded that there is no such heuristic approach which can fulfill all the required parameters, but they can perform better when some particular parameter among makespan, resource utilization, execution time for each task, and workflow etc. has been considered at a time. In future, there is a vast scope of improvement for performing task scheduling in cloud computing through the proper resource utilization and cost effective schemes.

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