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Task Scheduling for Multi-Objective Optimization in a Cloud Computing Environment

Arpit Agrawal

Dept. of Computer Engineering, IET, Devi Ahilya Vishwavidyalaya, Indore- India

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***Abstract*—** Scheduling is the process of allocating cloud resources to several users in accordance with a predetermined schedule. Proper parallel operations planning is necessary to achieve good performance in scattered conditions. Work scheduling must take a number of limits and objectives into account in order to create meaningful schedules in the cloud environment. The difficulty of task mapping given the resources at hand is categorised as an NP-hard problem. Cloud computing's Quality of Service (QoS) problem has to be overcome before it can be deemed successful. Resource allocation is crucial when it comes to tasks with performance Optimization restrictions. The only way to effectively accomplish crucial objectives in cloud computing including high performance, high profit, high utilization, scalability, provision efficiency, and economy is by using an effective task scheduling system. This article suggests a framework based on the Grey Wolf Optimization, Particle Swarm Optimization, and Flower Pollination Algorithms for efficient job scheduling in a cloud computing environment. Job scheduling is done by Grey Wolf Optimization to shorten execution times and lower costs.

***Keywords*—** Cloud Computing, Task Scheduling, Grey Wolf Optimization, Multi Objective Optimization, Execution Time, Reduced Cost

I. INTRODUCTION

The emergence of cloud computing has made it possible to offer internet-based, massively dynamic services at a lower cost and with greater scalability. Because to the development of cloud computing, this is now possible. A wide range of resources, including memory, data storage, and network bandwidth, are made accessible on demand thanks to cloud computing. These are but a few of the resources that may be set up. A huge number of users can use cloud resources concurrently, and they can be redistributed in response to changing demand. [1].

When working in the cloud, users only need to pay for the resources that they really use. Users can access cloud-based services and apps from any computer or mobile device, provided that the device has an active internet connection. The user of cloud resources is not in charge of keeping them up to date or taking into account their size when using them. Users of cloud computing are beginning to give the availability of resources more weight. Because of this, it's essential to utilise resources as effectively as possible in order to meet end-user demands. To do this, well designed time management techniques may be applied. It is harder for cloud service providers to guarantee optimal use of cloud resources as the number of cloud customers rises. Problems with job scheduling thus follow directly from this challenge. Building a more effective positioning and structure is essential if you want to maximise the advantages of employing cloud computing. It is important to include the virtual machine in the schedule since it has such a significant impact on how cloud resources are scheduled. Because of this, it is essential to keep each virtual machine in a specific virtual environment separate from its neighbouring virtual machines. Each virtual machine's processing power, central processing unit (CPU), memory size, and bandwidth are all constrained by the host computer it is using [2] [3].

Scheduling is the practise of assigning cloud resources to a variety of users in line with a schedule that has been defined beforehand. To achieve high performance in distributed settings, effective planning for simultaneous activities is crucial. Task scheduling in the cloud environment must take into account a variety of restrictions and objectives in order to provide meaningful schedules. Task mapping is an NP-hard issue due to the difficulty of using the resources at hand. Before cloud computing can be deemed effective, the Quality of Service (QoS) problem [4] must be resolved.

The cloud service provider's and the user's established limitations must be complied with by the scheduling criterion. It is important to follow the time constraints set by the users, which may include financial, security, or deadline restrictions. constraints set by cloud service providers, such as raising the number of activities that are completed correctly while also maximising resource consumption and their benefits. When scheduling an application or a job, any scheduling algorithm must keep these needs in mind. Jobs, which are characterised as computation-intensive tasks, are processed similarly to user applications. The labour is broken down into several easier tasks that must be finished one after the other. As their names suggest, tasks are the smallest computing units that may be performed utilising a certain resource. A job is regarded as a single computing entity that cannot be broken down into smaller computing units. If we employ non-preemptible instructions in the design process, we will be able to create a job that can run on a certain resource or node. The method of execution of the work can be done in a variety of different ways. The optimization criteria, which are crucial in and of themselves, make up the next crucial component of a scheduling strategy. Using optimization criteria will help you finish the project as quickly as you can while keeping the maximum degree of safety when the user doesn't set any type of deadline or budget. It is crucial to take into account any limits or optimization criteria offered by both customers and cloud service providers when creating a scheduling algorithm that matches workloads with resources [5] [6].

The task of dynamically adding and removing physical resources from the cloud environment falls on the cloud service provider. For instance, tasks can be submitted whenever it is convenient and planned in accordance with the preferences of the user within the constraints of the resources available. Cloud virtualization is important to give users of the cloud the flexibility to connect to and utilise cloud resources whenever needed over the internet.

Task scheduling is a requirement for every cloud computing framework in order to efficiently manage resources and serve cloud users, according to the findings displayed in Figure 1. It is crucial for the distribution of resources for jobs when performance optimization is constrained. Implementing a productive work scheduling system is the only method to achieve crucial objectives in cloud computing, such as high performance, high profit, high utilization, scalability, provision efficiency, and economy.

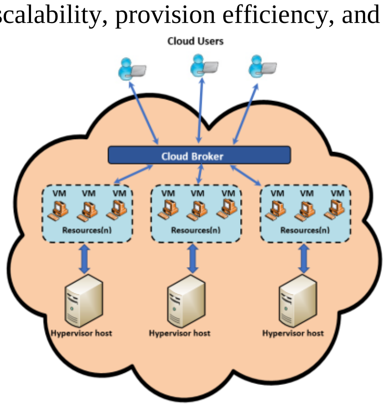

Figure 1: Task Scheduling in Cloud Computing

You require management and capacity in place when job scheduling isn't always reliable so that you may choose the best virtual machine resources. Numerous QoS issues are included in the tasks related to cloud frameworks. The virtual machine (VM) is a resource that gives cloud users a virtualized environment in which to do their tasks. According to the defined resource provisioning needs, an operating system and configuration on a single server may be divided up into a number of virtual machines (VMs) [7] [8].

The task scheduler module starts looking for the virtual machine (VM) that is most suited to complete the task as soon as a user submits a job to the cloud framework. Determining whether to assign straightforward tasks to a virtual machine (VM) with a high capacity or substantial tasks to a VM with limited capabilities is the true problem. The increased wait times and prolonged makespan may have an adverse effect on the system's overall performance. From the standpoint of a cloud provider, there is a decline in overall throughput as well as revenue. You won't be able to fulfil high quality of service (QoS) standards as a cloud customer, which will cause longer wait times and more expensive costs. Additionally, this will result in less satisfied clients.

The algorithm used for task scheduling has to be improved if both the cloud service provider and cloud clients are satisfied with the cloud. The optimum scheduling technique should allow workloads to be assigned to the VM resources that are most appropriate for them while taking the least amount of time and money. The task scheduling algorithm must be able to fulfil QoS requirements such as make-span, resource utilization, and cost from a business perspective.

In order to schedule tasks effectively in a cloud computing environment, this article introduces a system based on the Grey Wolf Optimization, Particle Swarm Optimization, and Flower Pollination Algorithm. Task scheduling is done by Grey Wolf Optimization with less effort and expense.

II. LITERATURE SURVEY

The scheduling is an NP-hard issue because it is difficult to predict how long a job will take to finish [9]. As a result, conventional scheduling techniques cannot be used. The conventional approach yields better results when the population size cannot be altered and the whole length of time available is known. The issues with Optimization are typically caused by inadequate or inaccurate data, as well as a limited amount of resources. It is feasible to use both a random selection and the search for the optimum solution when tackling Optimization issues with techniques that are based on meta-heuristics.

In order to reduce makespan, [10] modified PSO technique for task scheduling made use of the one-to-one mapping and the fastest processor. This was done to make sure that the most effective processors were given the most time-consuming tasks. The suggested method has a few disadvantages as compared to PSO and the genetic algorithm, such as longer wait times if the project size increases.

The [11] used an ACO-based task scheduling technique to address the makespan issue in a dynamic cloud system. This method addressed the issue by utilising the brainpower and constructive feedback processes of natural ant colonies. It was discovered that Round Robin and FCFS delivered very little to no benefit in terms of shortening the required amount of time. Despite this, the suggested treatment does not lessen the imbalance and can instead inhibit the system's capacity to expand.

Studying task scheduling based on LBMPSO was done by researchers [12]. As a consequence of their research, they created a work scheduling method that uses a mutation process in order to balance load. Regarding reducing the time needed to complete a task and ensuring that the burden is divided equitably among virtual machines, the results were equivocal. Additionally, it has been shown that the distribution strategy has helped the product's reliability increase.

ACOPS is a dynamic load balancing technique that authors [13] suggested for providing tailored virtual machine (VM) demand facilities while taking into account three resource demands. This approach includes a pre-rejection module that uses previous workload requests to anticipate those that will be made in the future in order to offer a speedier response. The amount of time needed to decide and act, as well as the system's overall performance, are both greatly reduced. Declining the request is not an option, though, if the author does not take SLA into account.

III. METHODOLOGY

Customers can use cloud computing in a variety of ways, such as to access services, store enormous amounts of data, and create apps. It is difficult to manage all of the available resources while giving several users on-demand access. To make the most of the resources that are now available, all tasks that depend on one another must be carefully planned and handled. For the aim of scheduling jobs and achieving a number of goals, including but not limited to cost reduction, execution time Optimization, and enhanced server utilization, several methods have been developed.

A framework based on the PSO, GWO, and FPA is offered for efficient task scheduling in the cloud environment in order to increase scheduling efficacy and achieve several goals, including reduced execution time, cost, and server utilization. In order to enable efficient job scheduling in the cloud environment, this is done.

The FPA Flower Pollination Algorithm was created to imitate the behaviour of blossoming plants during pollination, using natural design cues as inspiration. The plant, the wind, the water, the feathers of birds, and the bodies of animals are all ways that pollen can move. Depending on the kind of pollinators involved, the pollination process can be divided into two separate categories: self-pollination and cross-pollination. Cross-pollination and biotic pollination are both used throughout the Optimization phase to enlarge the search space. The Levy flight function is a mathematical model that is used to simulate the movement of pollen [14]. The GWO algorithm is meant to mimic the social behaviour of a pack of grey wolves when hunting and pursuing prey.

As an additional stochastic technique, the PSO algorithm will take use of the swarming behaviour of several animals, including fish and birds. Each particle in the search zone has its own unique position and velocity, and is free to travel in any direction.

IV. RESULT ANALYSIS

Both a simulation environment and a Java implementation of CloudSim 3.0.1 are included in the configuration. For the purpose of conducting this research, a datacenter and 20 cloudlets, each containing four virtual computers, are being used. Thus, it is possible to use the GWO, PSO, and FPA algorithms to enhance the outcomes that the scheduling strategies offer. The aims of minimising costs, completing activities in less time, and boosting server utilization may be achieved by scheduling the operations in such a fashion. Table 1 and Figure 2 both display the execution time. Table 2 and Figure 3 display his price.

Table 1: Execution time of GWO, FPA and PSO in milliseconds

No of Tasks	**GWO**	**FPA**	**PSO**
200	122.2	144.1	146.4
400	127.3	155.6	159.6
600	132.1	159.8	164.7
800	142.5	170.9	176.2
1000	162.6	179.7	188.3

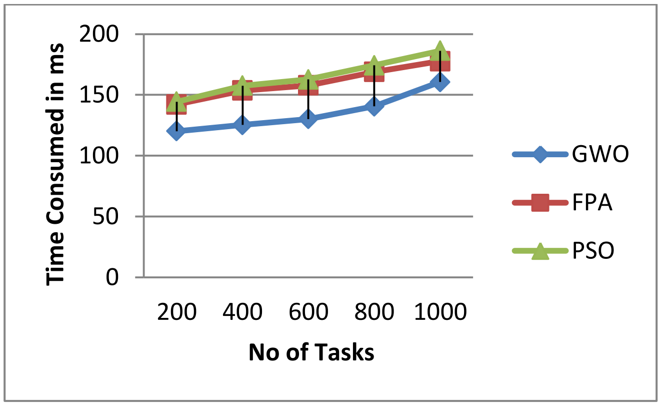

Figure 2: Execution time of GWO, FPA and PSO in milliseconds

Table 2: Cost of GWO, FPA and PSO in Rs.

No of Tasks	GWO	FPA	PSO
200	123.2	136.5	156.2
400	128.3	140.3	160.3
600	133.6	144.6	166.3
800	142.2	149.6	222.4
1000	152.6	164.5	237.4

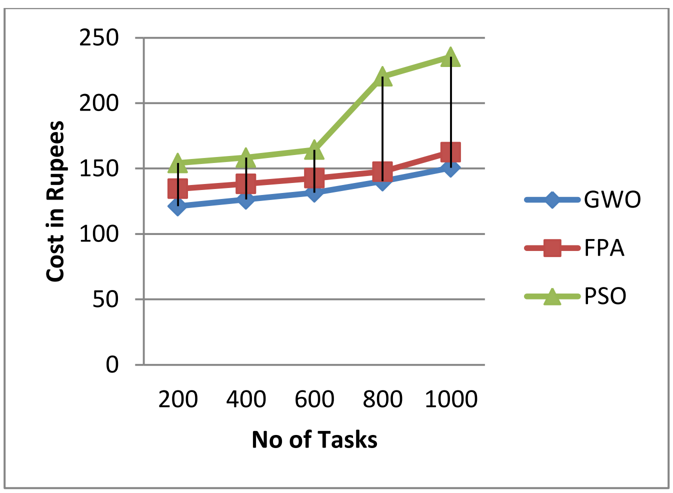

Figure 3: Cost of GWO, FPA and PSO

V. CONCLUSION

Scheduling is the practise of distributing cloud resources to a variety of users in line with a schedule that has been defined beforehand. In spite of the dispersed character of the circumstances, successful performance depends on careful simultaneous activity planning. Work scheduling must take a wide range of various restrictions and objectives into account in order to produce effective schedules in a cloud environment. A complex solution, like laying out tasks with the resources at hand, is what is referred to as an NP-hard issue. Before cloud computing can be deemed successful, the Quality of Service, or QoS, issue needs to be resolved. When it comes to tasks with performance Optimization constraints, it is crucial to distribute resources effectively. Implementing a productive work scheduling system is the only method to successfully achieve important objectives in cloud computing, such as high performance, high profit, high utilization, scalability, provision efficiency, and economy. The only approach that will work is this one. In the context of cloud computing, this article proposes a methodology for effective job scheduling that is based on the Grey Wolf Optimization, Particle Swarm Optimization, and Flower Pollination Algorithms, respectively. Grey Wolf Optimization performs job scheduling to shorten execution times and lower expenses.

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