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Optimizing Task Scheduling in Cloud Computing: A Review of Hybrid Meta-heuristic Strategies

Megha Goel
Research Scholar, Department of Computer Science and Engineering,
Jayoti Vidyapeeth Women's University, Jaipur , Rajasthan

Abstract - Cloud computing has revolutionized the way computing resources are utilized and managed. Task scheduling, a crucial aspect in cloud computing, significantly impacts resource utilization, performance, and cost-effectiveness. This paper presents a comprehensive review of hybrid meta-heuristic scheduling approaches for independent task scheduling in cloud computing environments. The study examines various hybrid meta-heuristic algorithms and their effectiveness in addressing the challenges of task scheduling in the cloud. Furthermore, it discusses the strengths, weaknesses, and opportunities for future research in this domain. The insights provided in this review can aid researchers and practitioners in selecting appropriate scheduling techniques to optimize resource allocation and enhance overall system performance in cloud environments.

1 INTRODUCTION

Cloud computing has emerged as a dominant paradigm in the realm of computing, offering scalable and on-demand access to a pool of shared computing resources over the internet. This transformative technology has revolutionized the way businesses and individuals consume computational resources, enabling flexible and cost-effective solutions for various computing tasks. Central to the efficiency and effectiveness of cloud computing is task scheduling, a critical process that allocates computational tasks to available resources in the cloud environment.

Task scheduling in cloud computing involves the allocation of computational tasks to suitable virtual machines (VMs) or physical servers in a manner that optimizes resource utilization, minimizes execution time, and reduces operational costs. The complexity of this task scheduling process increases significantly due to the dynamic and heterogeneous nature of cloud environments, where numerous factors such as varying workload demands, resource availability, and network conditions must be considered.

Traditional task scheduling algorithms, including First Come First Serve (FCFS), Round Robin (RR), and Least Loaded (LL), exhibit limitations in effectively handling the intricate challenges posed by cloud computing environments. To address these challenges, researchers have turned to

meta-heuristic algorithms, which offer robust and adaptive solutions for optimizing complex optimization problems.

Meta-heuristic algorithms, inspired by natural phenomena or human behavior, provide efficient search strategies for finding near-optimal solutions in large solution spaces. Genetic algorithms, particle swarm optimization, ant colony optimization, simulated annealing, and tabu search are among the most widely studied meta-heuristic techniques in the context of task scheduling in cloud computing.

While these individual meta-heuristic algorithms demonstrate promising performance in certain scenarios, they may struggle to address the diverse and evolving challenges inherent in cloud task scheduling. Consequently, researchers have explored hybridization strategies that combine multiple meta-heuristic algorithms or integrate meta-heuristic techniques with other optimization approaches to enhance the effectiveness and robustness of task scheduling solutions in cloud environments.

This comprehensive review aims to provide an in-depth analysis of hybrid meta-heuristic scheduling approaches for independent task scheduling in cloud computing. By examining the strengths, weaknesses, and potential applications of hybrid meta-heuristic algorithms, this paper seeks to contribute to the advancement of research in cloud task scheduling and facilitate informed decision-making for researchers and practitioners in selecting suitable scheduling techniques to optimize resource allocation and improve system performance in cloud computing environments.

2 BACKGROUND AND RELATED WORK

Cloud computing has become a cornerstone of modern computing infrastructure, offering unprecedented scalability, flexibility, and cost-effectiveness for a wide range of applications and services. In cloud computing environments, tasks or jobs submitted by users need to be efficiently allocated to available computational resources to meet performance objectives and optimize resource utilization. Task scheduling plays a pivotal role in achieving these goals by orchestrating the execution of tasks across the cloud infrastructure.

Traditional task scheduling algorithms, such as First Come First Serve (FCFS), Round Robin (RR), and Shortest Job Next (SJN), have been widely used in various computing environments, including cloud computing. However, these algorithms often lack adaptability and optimization capabilities required to handle the dynamic and heterogeneous nature of cloud environments effectively. As a result, researchers have turned to meta-heuristic algorithms, which offer powerful optimization techniques for addressing complex scheduling problems in cloud computing.

Meta-heuristic algorithms are iterative search methods inspired by natural phenomena or human behavior, which efficiently explore large

solution spaces to find near-optimal solutions. These algorithms do not guarantee an optimal solution but aim to find satisfactory solutions within a reasonable amount of time. Some of the popular meta-heuristic algorithms used in cloud task scheduling include Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Simulated Annealing (SA), and Tabu Search (TS).

Genetic Algorithms (GA) are inspired by the process of natural selection and evolution. They involve the generation of a population of candidate solutions, which undergo selection, crossover, and mutation operations to produce new offspring solutions. GA has been applied to cloud task scheduling to evolve task scheduling policies that maximize resource utilization and minimize task execution time.

Particle Swarm Optimization (PSO) is based on the collective behavior of particles moving through a solution space. Each particle represents a potential solution, and the particles adjust their positions based on their own experience and the experiences of neighboring particles. PSO has been utilized for task scheduling in cloud environments to efficiently explore the search space and find optimal task-to-resource assignments.

Ant Colony Optimization (ACO) is inspired by the foraging behavior of ants. In ACO algorithms, artificial ants deposit pheromone trails on solution components, and the probability of selecting a particular component is influenced by the amount of pheromone present. ACO has been applied to cloud task scheduling to find near-optimal task-resource mappings while considering factors such as resource availability and communication latency.

Simulated Annealing (SA) is based on the annealing process in metallurgy, where a material is gradually cooled to reach a low-energy state. In SA, candidate solutions are iteratively modified, and the acceptance of new solutions is probabilistically determined based on a temperature parameter. SA has been used for task scheduling in cloud computing to explore the solution space and escape local optima.

Tabu Search (TS) is a meta-heuristic algorithm that iteratively explores the neighborhood of the current solution by applying move operations and maintaining a short-term memory of recently visited solutions to avoid revisiting them. TS has been employed for cloud task scheduling to efficiently navigate the search space and find high-quality task-resource assignments.

While individual meta-heuristic algorithms offer effective solutions for specific scheduling problems, they may struggle to handle the diverse and dynamic nature of cloud environments comprehensively. To address this limitation, researchers have proposed hybrid meta-heuristic approaches that combine multiple meta-heuristic algorithms or integrate meta-heuristic

techniques with other optimization methods to enhance the robustness and efficiency of task scheduling in cloud computing.

3 REVIEW OF LITERATURE

Hicham et. al. [1] Presented task scheduling is one of the most challenging aspects of optimizing cloud utilization and Quality of Service (QoS) and improving cloud computing's overall performance. The optimization of Task Scheduling employs a novel strategy based on hybrid meta-heuristic algorithms and Dynamic dispatch Queues (TSDQ). The first of these hybrid metaheuristic algorithms, TSDQ-FLPSO, combines the Fuzzy Logic algorithm with the Particle Swarm Optimization algorithm; the second, SAPSO, combines Simulated Annealing with Particle Swarm Optimization. Several experiments based on real and fake data sets from real systems have been carried out using an open source simulator called CloudSim. TSDQ-FLPSO provides the best results when compared to TSDQ-SAPSO and other existing scheduling algorithms, particularly in a high-dimensional problem, as demonstrated by the experimental results. In terms of waiting time, queue length, span, cost, resource utilization, degree of imbalance, and load balancing, the TSDQ-FLPSO algorithm has a significant advantage.

Jai et. al. [2] One of the most important new technology paradigms is cloud computing. End users can choose from a variety of hardware, software, and development platforms. In the cloud computing environment, task scheduling can be an exciting job. There are two types of tasks: dependent and independent. There is no parent-child concept connected to independent tasks. To schedule the independent tasks, a number of meta-heuristic algorithms have been implemented. In this paper, independent tasks were used to simulate a hybrid HCCSO algorithm. The standard Cat Swarm Optimization algorithm, the HEFT algorithm, and the Self-Motivated Inertia Weight factor were utilized in the creation of this hybrid algorithm. The H-CSO algorithm was able to avoid getting stuck in the local fragment and overcome the issue of premature convergence by employing the Crow Search algorithm. Using independent tasks of 500 to 1300 random lengths, the simulation revealed that the H-CSO algorithm outperformed the PSO, ACO, and CSO algorithms, while the hybrid HC-CSO algorithm performed flawlessly in spite of Cat Swarm Optimization, Particle Swarm Optimization, and the HCSO algorithm for the sake of processing cost and time. When it comes to minimizing computation costs, the HC-CSO algorithm outperforms the H-CSO and standard CSO by 9.60% and 14.59%, respectively, in all scenarios. In terms of makespan, the HC-CSO algorithm outperforms the H-CSO by 4.15 percent and the standard CSO by 7.18 percent.

Mohammed et. al. [3] Due to its high potential, adaptability, and profitability in providing multiple sources of hardware and software to serve connected users, cloud computing has attracted the attention of large

businesses. Effective scheduling methods are required to manage these resources while simultaneously achieving the objectives of cloud providers and cloud users due to the size and dynamic nature of modern data centers' resource provisioning. In cloud computing, task scheduling is regarded as an NP-hard problem that classical optimization techniques cannot easily solve. As a result, methods like meta-heuristics and heuristics have been used to solve problems like these with optimal or close to optimal solutions in a reasonable amount of time. In this article, an outline of heuristic and meta-heuristic strategies for settling the errand planning streamlining in cloud-haze frameworks is introduced. In order to give readers a clear picture of the options available to them, comprehensive reviews, discussions, and analyses of cost- and time-conscious scheduling strategies for both workflow tasks and bag of tasks are conducted.

Puneet et. al. [4] uncovered distributed computing, a popular expression of the present that consolidates the force of both equal and circulated registering. It provides its output in the form of services, which can be Infrastructure, Software, and Platform-as-a-Service (IaaS), SaaS, or PaaS. In cloud computing, we will not compute locally but rather on premises managed by another party. Actually, different kinds of virtualized resources are handled in the cloud environment. As a result, it takes significant effort to efficiently allocate and schedule resources. Task scheduling is an essential component of one of the core phases. It can be thought of as finding the best way to divide a set of tasks among the available resources in order to achieve desired goals like cost, service quality, and time, among others. Even so, the majority of businesses have already begun implementing the CTQ model, which stands for "less cost, minimum time, and assured quality," in order to maximize return while maintaining quality. This paper's goal is to look at a variety of independent task scheduling methods that fall under the heuristic mapping category so that we can use them according to our current needs.

Sandeep et. al. [5] With the availability of high-bandwidth internet access in recent years, cloud computing applications have expanded. The demand for highly effective methods of job scheduling has also grown in tandem with an increase in the number of cloud-based applications and cloud platform users. The task of a standard job scheduling algorithm is to select a job execution sequence that consumes the fewest resources, such as time and memory, as possible. Most of the time, the user wants more services and high efficiency. Utilizing resources effectively requires an effective scheduling strategy. In this field of study, hybrid meta-heuristic algorithms have proven to be much more cost-effective than single-agent algorithms at optimizing task scheduling. The various hybrid variants of meta-heuristic methods, such as Genetic Algorithm, Tabu Search, Harmony Search, Artificial Bee Colony, and Particle Swarm Optimization, are used in

this comprehensive and systematic analysis of cloud computing task scheduling techniques. The use of various performance evaluation metrics in the literature is the subject of a separate section of this review.

Rasha et. al. [6] introduced cloud computing uses a network to provide users with computing resources like software and hardware as a service. We need effective scheduling strategies to manage these resources because of the size of modern datacenters and the dynamic nature of their resource provisioning. The fundamental target of booking is to relegate assignments to satisfactory assets to accomplish at least one advancement measures. Since scheduling is a difficult problem in the cloud, numerous researchers have attempted to find the best cloud task scheduling solution. They have shown that conventional booking isn't proficient in taking care of this issue and produce an ideal arrangement with polynomial time in the cloud climate. However, in a short amount of time, they introduced subpar solutions. For such issues, meta-heuristic methods have provided solutions that are either close to or equal to the ideal in a reasonable amount of time. We have provided a comparative analysis of numerous task scheduling techniques based on various optimization criteria and introduced the main ideas of resource scheduling in this work.

Roshni et. al. [7] the generation that provides services that can cut down on maintenance costs and computational complexity will benefit greatly from the proposed cloud. For better performance, scheduling the user's work in the cloud resources is crucial. Due to the possibility of multiple viable solutions, task scheduling is an NP-hard problem. The artificial bee colony algorithm and the particle swarm optimization algorithm are combined to create the hybrid algorithm known as the ABPS algorithm, which is the subject of this paper. The proposed ABPS algorithm balances the load and optimizes task scheduling in a cloud environment by minimizing duration, cost, and resource utilization. The CloudSim simulation tool was used to simulate the proposed ABPS algorithm in comparison to the ABC and PSO algorithms.

Neeraj et. al. [8] due to its numerous advancements, such as on-demand processing, resource sharing, and pay-per-use, revealed cloud computing is one of the emerging fields of computer science. Security, quality of service (QoS) management, data center energy consumption, and scaling are just a few of the cloud computing issues. One of the difficult problems in cloud computing is scheduling, in which resources must be given a number of tasks in order to maximize the quality of service parameters. In cloud computing, scheduling is a well-known NP-hard problem. A suitable scheduling algorithm will be required for this. For optimally allocating the user's task to the cloud computing resources, a number of heuristic and meta-heuristic algorithms were proposed. In cloud computing, hybrid scheduling algorithms are becoming increasingly

popular. We looked at hybrid algorithms, which are combinations of two or more algorithms that are used for scheduling in cloud computing, in this paper. The basic idea behind the algorithm's hybridization is to take good parts of the algorithms that are used. In addition, the hybrid algorithms are categorized, their goals, QoS parameters, and potential future directions for hybrid scheduling algorithms are examined in this article.

Mahendra et. al. [9] presented technology necessitates cloud computing. Cloud computing has a lot to do with task scheduling and resource allocation. The modified analytic hierarchy process (MAHP), bandwidth aware divisible scheduling (BATS) + BAR optimization, longest expected processing time preemption (LEPT), and divide-and-conquer methods are all combined in this paper to create a heuristic strategy for scheduling tasks and allocating resources. Using a MAHP process, this method processes each task before allocating it to cloud resources. The combined BATS + BAR optimization method, which takes into account the cloud resources' load and bandwidth as constraints, is used to allocate the resources. Additionally, the proposed system employs LEPT preemption to avert resource-intensive tasks. When turnaround time and response time are used as performance metrics, the experimental comparison with the existing BATS and improved differential evolution algorithm (IDEA) frameworks demonstrates that the divide-and-conquer strategy enhances the proposed system.

Deafallah et. al. [10] It is difficult to implement the optimal allocation of virtual machines for user-submitted tasks in a cloud computing environment. For large tasks in the cloud, the search for the ideal task scheduling solution is regarded as an NP-hard problem. Scheduling tasks to a virtual machine's data center while minimizing essential, crucial, and cost-effective parameters like energy consumption, manufacturing time, and cost is the best approach. A metaheuristic framework known as MDVMA is presented in this work to help optimize task scheduling and dynamic virtual machine allocation in a cloud computing environment. The MDVMA focuses on developing a multi-objective scheduling method that makes use of a metaheuristic algorithm based on the non-dominated sorting genetic algorithm (NSGA)-II. The goal of this method is to optimize task scheduling with the goal of simultaneously reducing energy consumption, duration, and cost in order to offer cloud service providers a trade-off that meets their needs. We compared the results of two distinct scenarios of benchmark real-world workload data sets using the existing approaches, namely the Artificial Bee Colony (ABC), Whale Optimization Algorithm (WOA), and Particle Swarm Optimization (PSO) algorithms, to determine how well the MDVMA approach performed. The results of the simulation show that optimizing task scheduling improves overall outcomes in terms of reducing the cloud data center's cost, energy consumption, and lifespan. The paper

concludes that task scheduling in a cloud computing environment using metaheuristic algorithms is promising.

Poria et. al. [11] It is difficult to implement the optimal allocation of virtual machines for user-submitted tasks in a cloud computing environment. For large tasks in the cloud, the search for the ideal task scheduling solution is regarded as an NP-hard problem. Scheduling tasks to a virtual machine's data center while minimizing essential, crucial, and cost-effective parameters like energy consumption, manufacturing time, and cost is the best approach. A metaheuristic framework known as MDVMA is presented in this work to help optimize task scheduling and dynamic virtual machine allocation in a cloud computing environment. The MDVMA focuses on developing a multi-objective scheduling method that makes use of a metaheuristic algorithm based on the non-dominated sorting genetic algorithm (NSGA)-II. The goal of this method is to optimize task scheduling with the goal of simultaneously reducing energy consumption, duration, and cost in order to offer cloud service providers a trade-off that meets their needs. We compared the results of two distinct scenarios of benchmark real-world workload data sets using the existing approaches, namely the Artificial Bee Colony (ABC), Whale Optimization Algorithm (WOA), and Particle Swarm Optimization (PSO) algorithms, to determine how well the MDVMA approach performed. The results of the simulation show that optimizing task scheduling improves overall outcomes in terms of reducing the cloud data center's cost, energy consumption, and lifespan. The paper concludes that task scheduling in a cloud computing environment using metaheuristic algorithms is promising.

Amit et. al. [12] Because it provides global IT solutions at a price that is affordable, the presented cloud computing technology is becoming a profitable technology. The dynamic reduction of execution time and optimal utilization of cloud resources are guaranteed by a well-designed task scheduling algorithm. The scheduling of interdependent subtasks on unrelated parallel computing machines in a cloud computing environment is the subject of this research paper. In this paper, two distinct problem-based objective function values are taken into consideration. The total completion time objective function is minimized in the first variant, while the makespan objective function is minimized in the second. To address the scheduling issues, heuristic and meta-heuristic (HEART)-based algorithms are proposed. The property of the list scheduling algorithm is used in these algorithms to solve a separate parallel machine scheduling problem. For each of the two versions of the problem, a Mixed Integer Linear Programming (MILP) formulation has been provided. Using A Mathematical Programming Language (AMPL) software, the MILP formulation can be solved to find the best possible solution. The proposed algorithms' performance has been evaluated through extensive numerical experiments.

It is discovered that the proposed algorithms outperform the existing ones in terms of solving the problem. Cloud computing service providers (CCSPs) can use the proposed algorithms to improve resource utilization and lower operating costs.

Laith et. al. [13] One of the most pressing issues in cloud computing is the introduction of efficient task scheduling. Since task scheduling is an NP-complete problem, it is hard to find the best solution, especially for large tasks. In a cloud computing environment, it may be necessary to efficiently schedule multiple tasks across multiple virtual machines while simultaneously maximizing resource utilization and minimizing time spent. For solving multi-objective task scheduling issues in cloud computing environments, we present a novel hybrid antlion optimization algorithm with elite-based differential evolution. The need to simultaneously reduce time and maximize resource utilization is the root cause of the multi-objective nature of the problem in the proposed method, which we refer to as MALO. Using elite-based differential evolution as a local search method, the antlion optimization algorithm was improved to improve its ability to exploit and avoid getting stuck in local optima. Using the CloudSim toolkit, two experimental series were carried out on real and fake trace datasets. MALO outperformed other well-known optimization algorithms, according to the findings. MALO was suitable for large scheduling issues because it converged more quickly than the other approaches in larger search spaces. In the end, statistical t-tests were used to analyze the results, and the results showed that MALO achieved a significant improvement.

Mohamed et. al. [14] In order to achieve cost-effective execution and increase resource utilization, proposed task scheduling has attracted the attention of numerous researchers over the past few decades. It is one of the most significant obstacles in the cloud computing environment. Task scheduling is a nondeterministic polynomial time (NP)-hard problem that classical methods can't solve because they can't find a close-to-optimal solution in a reasonable amount of time. As a result, metaheuristic algorithms have recently been used to solve this issue. However, these algorithms still fall into a local minima and have a slow convergence rate. As a result, the problem of task scheduling in a cloud computing environment is addressed with the help of a brand-new task scheduler called hybrid differential evolution (HDE) in this study. Two proposed enhancements to the conventional differential evolution serve as the foundation for this scheduler. The first change is based on increasing the scaling factor to include numerical values that are generated dynamically and based on the current iteration in order to enhance both the exploration and exploitation operators. The second change is designed to enhance the exploitation operator of the classical DE in order to achieve superior outcomes in fewer iterations. To demonstrate the effectiveness of HDE, a number of tests were

carried out with the help of the CloudSim simulator and randomly generated datasets. The slime mold algorithm (SMA), equilibrium optimizer (EO), sine cosine algorithm (SCA), whale optimization algorithm (WOA), grey wolf optimizer (GWO), classical DE, first come first served (FCFS), round robin algorithm (RR), and shortest job first scheduler (SJF) were also compared to HDE. For a variety of task sizes, from 100 to 3000, makespan and total execution time values were gathered during trials. The studies revealed that HDE produced superior outcomes when compared to the other metaheuristic and heuristic algorithms that were taken into consideration. As a result, of the various approaches investigated, HDE was found to be the most effective metaheuristic scheduling algorithm.

Shilpa et. al. [15] revealed that the heterogeneous collection of autonomous systems and wide-ranging, adaptable computational architecture are the primary reasons why cloud computing is developing into a platform for high-performance computing. Since virtualization is used to manage resources in cloud technology, resource scheduling has emerged as a crucial issue. The scheduling of cloud tasks is an NP-complete problem that cannot be solved in any specific way. Also, managing resources and tasks becomes difficult when a database system has a lot of data, especially when it comes to deadlines and costs. A number of metaheuristic algorithms have been developed to solve this issue. Under- and over-provisioning are two issues that can result in either performance degradation or resource waste in the cloud due to redundant resource and time wasting. We introduce a task scheduling strategy that incorporates reinforcement learning and nature-inspired meta-heuristic optimization in order to maximize cloud throughput, reduce completion time, and reduce production costs in IaaS cloud. As a result of reinforcement learning, the agent will select the appropriate action from a list of options, and the scheduler succeeds in assigning tasks, resulting in shorter wait times and higher system utilization rates.

Rajni et. al. [16] presented, the creation of effective resource management systems has been required by the expansion of scientific applications. Cloud resource management systems center on resource scheduling and provisioning. Due to the heterogeneity of cloud resources, their interdependencies, and unpredictability of load, cloud resource scheduling is the most difficult problem to effectively solve. We go over the history of scheduling as well as the most recent methods for scheduling in cloud computing in this paper. The phases of scheduling and general background are first discussed. High-level taxonomy is used to provide a comprehensive overview of the proposed solutions to the aforementioned resource scheduling issues. The placement of Virtual Machines (VMs), Quality of Service (QoS) parameters, heuristic methods, and various resource scheduling strategies are all taken into account in this high-level

taxonomy. In addition, scheduling in Infrastructure as a Service (IaaS) clouds is the subject of this investigation, as is comparison based on significant parameters. In-depth discussion is given to the significance of artificial intelligence and meta-heuristic techniques for cloud computing resource scheduling strategies. By addressing scheduling issues and studying the methods that are already in use, this work aims to help researchers comprehend the fundamental concepts of scheduling and make the process of designing new scheduling methods simpler.

Jafar et. al. [17] task scheduling is a problem that is frequently encountered in the context of cloud computing. This issue has two primary repercussions: the attenuation of performance and the planning of tasks on virtual machines. The present paper proposes a hybrid multiple-objective approach known as hybrid grey wolf and whale optimization (HGWWO) algorithms, which integrates two algorithms, namely the grey wolf optimizer (GWO) and the whale optimization algorithm (WOA), with the intention of conjoining the advantages of each algorithm for minimizing costs, energy consumption, and total execution time needed for task implementation, in addition to improving the use of resources. This is done in order to address the issue of task scheduling in cloud computing, which nec CloudSim is a tool that is used in the evaluation of the goals of the proposed approach. According to the findings of the experimentation that was carried out, the proposed method has the capability of performing at a level that is superior to that of the original algorithms GWO and WOA on their own in terms of costs, energy consumption, time span, resource use, and degree of imbalance. This is in comparison to how well it performs.

Ibrahim et. al. [18] based on pay-per-use, remotely accessible, Internet-based, and on-demand concepts that provide customers with a shared of configurable resources, cloud computing is becoming the highly scalable and widely used computing technology in the world as a result of the rapid development of information and computing technologies. However, due to the high volume of requests from users, task scheduling and resource allocation are becoming essential for the effective and efficient load balancing of a workload among cloud resources in order to improve cloud system performance as a whole. Task scheduling algorithms like traditional, heuristic, and meta-heuristic are introduced for these reasons. The task scheduling issue is being dealt with through the use of heuristic algorithms like MET, MCT, Min-Min, and Max-Min. In the context of cloud computing, a brand-new hybrid algorithm based on the Min-Min and Max-Min heuristic algorithms is proposed in this paper. The Cloudsim simulator was used with various optimization parameters to evaluate this algorithm, including makespan, average resource utilization, load balancing, average waiting time, and concurrent execution between tasks of different lengths and sizes.

For those parameters, the findings demonstrate that the proposed algorithm outperforms the Min-Min and Max-Min algorithms.

Mohit et. al. [19] revealed, the heterogeneity and dispersion of cloud resources make resource provisioning and scheduling a major issue, as we investigate. Due to the high demand for computational power, which poses a serious threat to the environment in terms of energy consumption, cloud service providers are expanding their datacenter footprint. To get around these problems, we need a good meta-heuristic method that evenly divides applications among virtual machines and improves the quality of services (QoS) parameters to meet the needs of the end user. Real-world discrete optimization problems can be solved with binary particle swarm optimization (BPSO), but simple BPSO does not provide the best solution because the transfer function behaves incorrectly. We modified the binary PSO transfer function to improve exploration and exploitation capabilities and optimize a number of QoS parameters, including execution cost, energy consumption, and span time, to address this issue. Over a variety of synthetic datasets, the computational results demonstrate that the modified transfer function-based BPSO algorithm is superior to other baseline algorithms in terms of efficiency and performance.

4.CONCLUSION

In conclusion, this paper provides a comprehensive review of hybrid meta-heuristic scheduling approaches for independent task scheduling in cloud computing environments. Task scheduling is a critical aspect of cloud computing that significantly impacts resource utilization, performance, and cost-effectiveness. Traditional scheduling algorithms often struggle to address the dynamic and heterogeneous nature of cloud environments effectively.

To overcome these challenges, researchers have turned to meta-heuristic algorithms, which offer efficient search strategies for finding near-optimal solutions in large solution spaces. However, individual meta-heuristic algorithms may have limitations in addressing the diverse and evolving challenges of cloud task scheduling. Therefore, hybridization strategies that combine multiple meta-heuristic algorithms or integrate them with other optimization approaches have been explored to enhance the effectiveness and robustness of task scheduling solutions in cloud environments.

The review examines various hybrid meta-heuristic algorithms and their effectiveness in addressing the challenges of task scheduling in the cloud. By analyzing the strengths, weaknesses, and potential applications of these approaches, the paper contributes to the advancement of research in cloud

task scheduling. Moreover, it aims to facilitate informed decision-making for researchers and practitioners in selecting suitable scheduling techniques to optimize resource allocation and improve system performance in cloud computing environments. Overall, the insights provided in this review can guide future research efforts towards developing more efficient and adaptive task scheduling solutions for cloud environments.

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