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REVIEW ARTICLE

The Optimization-based Approaches for Task Scheduling to Enhance the Resource Utilization in Cloud Computing: A Review

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ABSTRACT

At prior era, the task scheduling explorations utilized as a chief concern. The swarm-based optimization methods are introduced to advance the task scheduling in huge network. The optimization strategy for task scheduling examination is developed to obtain optimized solutions for achieving optimal task scheduling. Consequently, the optimal strategy has an auxiliary mechanism in examination by means of general task scheduling technique. In a while, obtaining the optimized schedulers by exploiting swarm-based techniques, the best task schedulers are unbiased during their substance loads by exchanging the supplementary loads among machines. In the course of the numerous databases, modeling, clustering, and task scheduling concerns may occur, and task scheduling has become one of the significant scrutinize concerns. This paper illustrated numerous existing task scheduling strategies such as fuzzy theory; optimization-related schemes, and machine learning and relationship amid strategies. Extensive assessment of vast variety of task scheduling and optimization schemes related on some effective features such as execution time, cost, energy, and overhead is notified in tabular arrangement. Task scheduling and numerous optimization methods have been described. This paper dissertates the assessment of numerous task scheduling mechanisms. Later than the examination of optimal task scheduling mechanisms, the assessment of methods motivates us to be familiar with the issues and concerns in task scheduling, and optimization methods.

Key words: Fuzzy theory, machine learning, overhead, optimization, task scheduling

INTRODUCTION

Task scheduling is a scheme of ruling the arrangement, where tasks must be accomplished. It is allocating assets to suitable task; where tasks are introduced for their end to cloud it's appearing in the NP hard crisis[1] feature due to the huge numeral of solution exploration and accepts maximum period for establishing the optimal results. It is a resource maintenance process to produce results optimally in cloud environment. Task scheduling is extricated the crisis whereas sets are to be assigned to several tasks for enhancing the resource usage and diminish the running period.[2,4,5] In favor of superior utilization, scheduling techniques require being competent and it believes load complementary of the entire network, disturbance management, and error lenience, and declines the complete execution time [Figure 1].

Users raised the tasks for processing to cloud environment, the task require allocating to central processing unit (CPU) for run. At present, the issue is with the intention of how tasks be allocated to CPU, therefore, least running period and highest benefit are achieved by cloud holder. At this time, the task scheduling determines the way of allocating the tasks to optimize CPU to manage other circumstances. Task scheduling[5,6,7,8] is the superior strategy for improved resource usage and earning the cost competence. A lot of tasks scheduling techniques are developed and examined in several aspects.

The task scheduling of cloud computing is divided into two parts, distributed and centralized scheduling [Figure 2]. The tasks are allocated on various resources, positioning in several locations in nature in distributed scheduling. The tasks are allocated on various resources, positioning in one location in centralized scheduling with minimum

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complexity.[9] A further division in distributed scheduling is performed and three types, hybrid, heuristic, and meta-heuristic, are generated. The static and dynamic are two kinds of heuristic scheduling and cost, efficiency, energy, and quality of service-based scheduling are four types of hybrid scheduling.[10,11,73] The swarm and bioinspired are two classes of meta-heuristic scheduling.

LITERATURE REVIEW

The critical issues of task scheduling such as interconnection inside a machine, transparency of scheduling, and fine arranging of tasks are to be recognized in prior research works. While, stay in wits the constraint of task scheduling, scheduling methods cannot be exploited to obtain best scheduling and the usage of optimization, like a deputy pledge, is uncovered.[11,12] Fine produced scheduling can be circulated into types and numerous types of task scheduling have multiple impactions and exertion. Optimal task scheduling protects the brilliant assets to allocate the tasks into best virtual machines without any job failure.

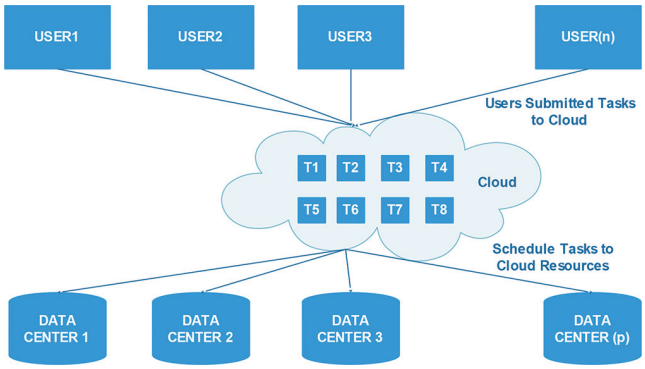

Figure 1: Tasks scheduling in cloud computing

Create the thresholds permitting the optimal scheduling without any excess.[13,14]

To examine prior methods exploited to obtain task scheduling, the author examines the purpose of optimal task scheduling that obtains whether the tasks of a job allocated to virtual machines was updated for the duration of scheduling examination.[4] To guarantee the authenticity or accessibility, the job components for auxiliary exploitation in real time eras have examined.[16] At a moment, an analysis of numerous task scheduling methods has been measured and well-known factors like throughput, overall cost, power, resource utilization, space, overhead and response time have illustrated and also numerous optimization based task scheduling methods exploited in cloud computing have been explained.[17, 18].The inevitability of litheness in task scheduling and optimization method has illustrated in the tabular formation.

The task scheduling is utilized to allocate the tasks in glowing produced virtual machines exploiting various applications. A virtual machine is extra appropriate for applications as measure up to the distributed tasks.[19] The numerous researchers have introduced and implemented the task scheduling strategies and achieved few fruitful outputs while initiating various task scheduling strategies over cloud computing [Table 1].

The better task scheduling is used to reduce the processing time and single system overloading and also to enhance the throughput and efficiency of cloud computing. The main purpose of task scheduling is to preserve the steadiness of device, increase the energy efficiency,[23] build the robust device, and obtain future digression in device like security and resource utilization.

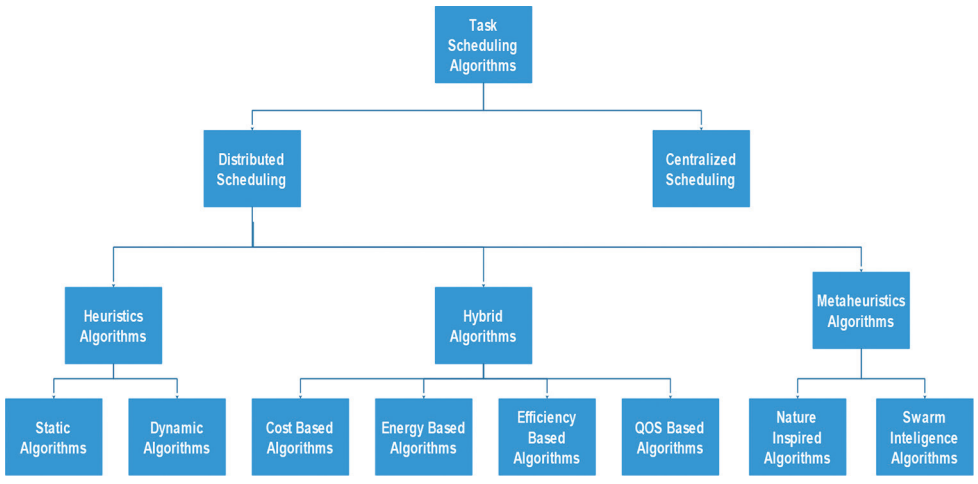

Figure 2: Task scheduling algorithms

Table 1: Different approaches for modeling of task scheduling in cloud computing

Authors	Algorithm used	Performance factor				
		Throughput	Power consumption	Resource utilization	Space overhead	Response time
Chen *et al*.[20]	WOA and IWC	High	Average	High	High	Average
Attiya *et al*.[21]	HHO and SA	High	Average	Average	Average	High
Rahayfeh *et al*.[15]	WLC and MHEFT	Average	Average	High	Moderate	High
Krishnadoss *et al*.[22]	OLOA	Average	High	High	Moderate	Average
Dubey *et al*.[1]	Modified HEFT Algorithm	High	High	High	High	Low
Dordaie *et al*.[12]	Hybrid PSO and hill climbing algorithm	Average	High	High	High	High
Jena[23]	TSCSA	High	Average	Low	Average	High
Zhao *et al*.[20]	Improved PSO	Average	High	Average	High	Average
Alworafi *et al*.[25]	SCA	High	Average	High	Low	Average
Gawali *et al*.[5]	SDMCOA	Average	Low	Average	High	Average
Mahmood *et al*.[26]	Adaptive genetic algorithm	High	High	High	Average	Average
Hu *et al*.[27]	PIS	High	-	-	Average	High
Balagoni *et al*.[28]	LLPAMTS	Average	-	Average	High	High

The efficient and reliable task scheduling does not only utilize the processing strength of resources but also well used the memory space of cloud storage with minimum expenditure. The superior task scheduling strategies have increased the efficiency of cloud computing due to generate minimum computing time with load balancing and maximum throughput. Specifically, the task scheduling is used to conserve the resource strength, improve power efficiency, develop reliable resource, and generate future resource excursion such as protection and resources usage.[29]

The distribution of tasks is performed over distributed devices to compute various factors such as instance, price, flexibility, make span, consistency, accessibility, throughput, and store exploitation. A particle swarm optimization (PSO) is introduced for load balancing to improve the reliability of resources for task scheduling. The cloud environment is probably utilized for evaluating the fastest processing of jobs among distributed systems precisely and cost-effectively. The load balancing is also a major concern in cloud due to heavy loads of jobs and minimum resources with maximum covered area.[30]

Cloud computing builds it probable in favor of clients to utilize dissimilar applications in the course of the network devoid of having to establish them. It is measured near be original equipment which is intended at managing and as long as online schemes. In favor of increasing competence in cloud environment, proper task arrangement schemes are desired. Because of the restrictions and heterogeneity of devices, the concern of scheduling is extremely intricate. For this reason, it is supposed that a proper scheduling strategy can cover a momentous collision on falling makespan and attractive device effectiveness. By means of the limitations of the conventional heuristic techniques utilized in task management, lately, the common of researchers comprise alert on cross meta-heuristic schemes for job arrangement. A heterogeneous earliest finish time approach is introduced with genetic algorithm and PSO to evaluate the makespan for several tasks.[31]

The WSN is tremendously responsible to frequent extensive attacks because of controlled resource management in the vast communiqué field. The intruder controls a few devices to assist by means of full system and pinch away the confidential data and cryptographic keys, denoted as node imprison attack. A gray wolf optimization algorithm (GWOA) is introduced to identify the systems with chance of attack. The GWOA is initiated for computing the outcomes depending on cost and time.[32]

The dragonfly optimization algorithm (DOA) is an another optimization scheme for providing the data with optimal probability for attack. The

Table 2: Comparative description of several task scheduling approaches

Authors	Approach	Parameters	Platforms	Advantages	Limitations
Awad *et al*.[30]	LBMPSO	Makespan, execution time, round trip time, transmission cost	CloudSim	Minimum complexity, load balancing	Response time is larger
AL-Rahayfeh *et al*.[15]	DSC and WLC	Response time, makespan, resource utilization, service reliability	CloudSim 3.0	Maximum resource utilization	Execution time not taken
Kamalinia *et al*.[28]	GA and PSO	Makespan	Visual Studio, C#.net	Minimum communication cost	Response time not taken
Mahmood *et al*.[26]	AGA	Solution quality	C++	Adaptive solution generate	Not cover larger tasks graph
Khare *et al*.[32]	GWOA	Energy utilization	MATLAB 2019a	Maximum stable and optimal results	Execution time is not considered
Khare *et al*.[33]	DOA	Energy consumption	MATLAB 2019a	Maximum utilization of resources	Time complexity not covered
Khare *et al*.[34]	BWOA	Time complexity, energy utilization	MATLAB 2019a	Maximum Security, Link utilization	Space complexity not defined
Lakra *et al*.[39]	SLA	Execution time, cost, bandwidth	CloudSim	Minimum execution time	QoS parameters not taken
Hu *et al*.[27]	PIS	Execution time	CloudSim	Dynamic computing	Space complexity not covered
Tseng *et al*.[35]	Gateway based edge computing	Average waiting and response time	MATLAB	Used for on demand service of 5G	Not include multi queue task scheduling
Yao *et al*.[36]	EETS	Energy consumption	Android smartphone	Mobile network is used	Power consumption not taken for idle cases
Ibrahim *et al*.[40]	Task scheduling	Makespan, task running cost	Java	Time and cost both are taken	Dependent tasks not taken
Ibrahim *et al*.[40]	Task Scheduling	Makespan	Java	Better resource utilization	Cost not considered
Alkayal *et al*.[37]	MOPSO	Execution time, waiting time, throughput	CloudSim	Used for multiple objectives	Cost not considered
Tani *et al*.[10]	Smarter Round robin	Turnaround time, waiting time	CloudSim	Dynamic time quanta considered	Not used big data platforms
Sun *et al*.[42]	Benefit fairness and Berger model	Length, expected time, cost	CloudSim	QoS parameters taken	Not for larger tasks
Yao *et al*.[43]	Improved genetic algorithm	Completion time	CloudSim	Used for maximum tasks	QoS parameters not taken
Attiya *et al*.[21]	Modified HHO	Makespan	CloudSim	Better balancing between exploration and exploitation	Not used for IoT, fog computing
de Matos *et al*.[44]	Genetic and Static algorithm	Timespan	CloudSim	Used for real time application	Waiting time not taken
Dubey *et al*.[1]	Modified HEFT	Makespan	CloudSim	Heterogeneous processor used	Time complexity not taken
Zuo *et al*.[18]	ACO	Makespan, cost, resource utilization	CloudSim	Time and Space complexity	Big data taken
Gawali *et al*.[5]	SDMCOA	Finish time, response time	CloudSim	Optimal time taken	QoS service not taken
Gawali *et al*.[45]	BATS + BAR	Response time, turnaround time	CloudSim	Better utilization of resources	Not provide optimal time
Farheen *et al*.[46]	Enhanced PSO	Execution time, throughput, resource utilization	CloudSim	Effective utilization	Response time not taken

(*Contd...*)

Table 2: (***Continued***)

Authors	Approach	Parameters	Platforms	Advantages	Limitations
Mosleh *et al*.[47]	ACTS	Execution time, computation cost, bandwidth	CloudSim	Cost-effective task scheduling	Load balancing not considered
Alworafi *et al*.[25]	Scheduling cost approach	Cost, storage, bandwidth	CloudSim	Load balancing is described	Time complexity not taken
Brintha *et al*.[48]	PSO and GA	Execution time, computation cost	CloudSim	Production cost is considered	Space complexity not taken
Kumar[49]	PSO	Response time, cost	CloudSim	Economical and resource utilization	Virtualized cloud not taken
Zhang *et al*.[50]	RC-GA	Power consumption, stability, execution time	CloudSim	Optimal stable scheduling	Idle resources not taken
Saluja *et al*.[51]	Improved task migration consolidation scheduling	Resource utilization rate	NetBeans 8.1	Resource failures minimum	Optimization not performed
Dordaie *et al*.[12]	Hybrid PSO and hill climbing	Makespan	CloudSim	Optimal DAGs utilized	Load balancing not considered
Navimipour *et al*.[52]	CSA	Speed, coverage	MATLAB	Computation time is taken	Optimization not compared
Hamdy *et al*.[53]	Firefly, artificial neural network	Turnaround time	CloudSim	Fast convergence	Optimal circumstance not taken
Almezeini *et al*.[54]	Lion optimization algorithm	Resource utilization, cost	CloudSim	High resource utilization	Execution cost not minimized
Mohammad[55]	Greedy and ant lion optimizer	Load balancing, cost, execution time	CloudSim	QoS services taken	Real time application not considered
Singh *et al*.[56]	Improved firefly algorithm	Execution time	CloudSim	Real time applications taken	Larger tasks not taken
Rani *et al*.[57]	Enhanced Max-Min and Max-Min	Makespan	CloudSim	Better Resource utilization	Cost and time is not evaluated
Krishnadoss *et al*.[22]	OLOA	Makespan, cost, resource utilization	Java	QoS parameters utilization	Real time application not taken
Krishnados *et al*.[58]	OCSA	Makespan, cost	Java	QoS parameters utilization	Resource utilization not found
Jena[23]	TSCSA	Makespan	CloudSim	Dynamic environment is used	Load balancing, cost not considered
Khurma *et al*.[14]	Modified round robin	Waiting time	CloudSim	Better response time considered	Bandwidth, memory not taken
Alla *et al*.[59]	EATSD	Makespan, Energy consumption, resource utilization	CloudSim	Fast convergence time	Load balancing not taken
Khurana *et al*.[60]	Modified BAT algorithm	Cost, Makespan	CloudSim	Maximum Resource utilization rate	Time complexity not considered
Zhao *et al*.[24]	Improved PSO	Fitness	CloudSim	Time and Cost for real time application	Resource utilization not taken
Mittal *et al*.[61]	Enhanced Round robin	Waiting time	CloudSim	Dynamic nature is taken	Real distributed application not considered
Srichandan *et al*.[62]	Hybrid bacteria foraging algorithm	Energy consumption	MATLAB 2013a	Cost-effective method	Time consuming method

(*Contd...*)

Table 2: (***Continued***)

Authors	Approach	Parameters	Platforms	Advantages	Limitations
Choe *et al*.[63]	SA, SOS, CLS	Makespan, degree of imbalance	MATLAB R2017a	Better convergence speed	QoS factors not considered
Kaur *et al*.[64]	Modified genetic algorithm	Makespan, processing cost	JAVA	Better processing cost	Dynamic nature not taken
Chena *et al*.[65]	MSLBL	Cost, Acceptance ratio	JAVA	Cost-effective parallel design	Response time not taken
Liu *et al*.[66]	FRS	Overhead, overall utilization	Xen 4.1.2 hypervisor	Dynamic virtual machines utilized	CPU utilization is not good
Chen *et al*.[20]	IWC and WOA	Cost	MATLAB R2018a	Cost-effective design	Convergence speed not good
Balagoni *et al*.[28]	LLPAMTS	Cost	CloudSim	QoS load balancing perform	Robustness not taken
Zhong *et al*.[67]	GPSO	Completion time	CloudSim	Processing capacity is evaluated	Bandwidth not considered
Zhong *et al*.[68]	SLO	Cost, Energy consumption	CloudSim	Cost-effective design	Load balancing not taken
Fatemeh *et al*.[69]	Artificial Bee Colony	Makespan	CloudSim	Provide optimal load balancing	QoS factor not considered
Abdullahi *et al*.[70]	Symbiotic Organism Search	Makespan, Response Time	CloudSim	High convergence rate	Hybridization not used
Kaur *et al*.[71]	Min-Min and Ant Colony	Makespan	Java and WampServer	Minimum cost utilization	Heterogeneous resources not considered
Kaur *et al*.[72]	Enhanced Genetic Algorithm	Makespan	NetBeans Toolkit	Time saving procedure	Space complexity not considered
Zuo *et al*.[18]	Ant Colony Optimization	Makespan, Cost, Resource Utilization	CloudSim	Cost-effective design	Time complexity not taken

energy cost, keys, and speed are major factors for the selection of nodes optimally to minimize the expenses of maintenance of the network. The nodes are moving in multidimensional environment with dynamic velocity and structure of network is continuously changed moment by moment. The DOA is used against this dynamic environment for selecting the nodes and results demonstrate the superior strength of DOA against PSO and prior schemes.[33]

For choosing of nodes, a Black Widow Optimization Algorithm (BWOA) is developed for multidimensional atmosphere to improve the protection of distributed data management system. This method thinks in attacker point of view, where the selection of nodes can be optimally done using BWOA to apply over objective function for combining stability, mobility, energy, and cost. The BWOA evaluates the outcomes for network traffic, attacking efficiency, and complexity against ACO and other schemes.[34]

A dynamic model for job scheduling is very popularly defined to distributed tasks among machines virtually. The policy iteration scheduling is one of the task management approaches to realize independent tasks. The time expenses for priority bases are evaluated to find out the poison distribution of distributed data in cloud environment.[27]

The requirement for rewarding examines needs, successfully distributing evaluating assets, and as long as examination on-demand purpose incessantly enhances beside amid the speedy enlargement of the network. The circumference evaluation is utilized to convince the minimum time instance, internet association, and limited information dispensation necessities. A gateway depending boundary evaluation proposes to provide service model for decreasing the time of information communication and the internet bandwidth. The circumference gateway preserve to progression the examination desires in the restricted 5G communication area.[35]

The cloud computing be able to improve the evaluation strength of mobile devices through load distribution. Nevertheless, the communiqué among the portable systems and communicating maximum information to cloud users are having

little extra power as compared to dispensation information in portable system, particularly in a minimum bandwidth situation. Supplementary, few dispensation jobs can keep away from communicating maximum information among portable systems. A task scheduling is introduced to distribute the tasks effectively based on energy and cost in cloud computing environment with maximum accuracy.[36]

The job management in information center is an intricate work because of their length developments and performance evaluation. A PSO-based multiobjective optimization is progressed to model structuring for distributed task scheduling. A PSO is well defined and initiated to reduce the waiting instances with improving the effectiveness of distributed network. The throughput of PSO is increased rapidly with increasing the tasks in distributed manner for resource utilization in cloud environment.[37]

The several task scheduling approaches are represented in Table 2 for comparative analysis.

CONCLUSION AND FUTURE WORK

This paper illustrated numerous existing task scheduling mechanisms such as adaptive genetic, PSO, hill climbing, and HEFT and alliance amid them. Prevalent assessment of several task scheduling and optimization methods dependent on some performance factors such as throughput, power consumption, resource utilization, space overhead, and response time is represented in table. Consequently, arrangement of tasks becomes effortless. The task scheduling mechanisms are exploited solitary for job processing and optimization methods are exploited for the assortment of optimal schedulers in these researches. Later than the examination of optimal task scheduling mechanisms, numerous open research issues illustrate the enthusiasm of the research competence in task scheduling mechanisms.

Consequently, variety of information and task scheduling strategies becomes uncomplicated. A lot of researchers furthermore describe their work in the field of task scheduling strategy by means of optimization and machine learning depending on factors such as cost, energy, power, load balancing, and execution time. The task scheduling schemes are introduced only for information processing, job management, and optimization methods for the allocation of tasks in optimal virtual machines. Hence, it summaries that task scheduling and optimization schemes are introduced for optimal job scheduling but they contain yet several boundaries, then, the task scheduling through optimization schemes has been anticipated in paper to enlarge the effectiveness and to diminish the boundaries of prior schemes.

The task scheduling can be performed on audio and video files in future. The strength of chaos BSA and EHOTS can be enhanced using few entropy and multidimensional chaotic maps concepts in future. The task scheduling strength can be improved. In the future, time and space complexity of this research can be calculated.

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