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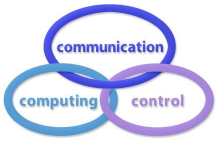

CCC Publications

Development of a Hybrid Algorithm for efficient Task Scheduling in Cloud Computing environment using Artificial Intelligence

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Abstract

Cloud computing is developing as a platform for next generation systems where users can pay as they use facilities of cloud computing like any other utilities. Cloud environment involves a set of virtual machines, which share the same computation facility and storage. Due to rapid rise in demand for cloud computing services several algorithms are being developed and experimented by the researchers in order to enhance the task scheduling process of the machines thereby offering optimal solution to the users by which the users can process the maximum number of tasks through minimal utilization of the resources. Task scheduling denotes a set of policies to regulate the task processed by a system. Virtual machine scheduling is essential for effective operations in distributed environment. The aim of this paper is to achieve efficient task scheduling of virtual machines, this study proposes a hybrid algorithm through integrating two prominent heuristic algorithms namely the BAT Algorithm and the Ant Colony Optimization (ACO) algorithm in order to optimize the virtual machine scheduling process. The performance evaluation of the three algorithms (BAT, ACO and Hybrid) reveal that the hybrid algorithm performs better when compared with that of the other two algorithms.

Keywords: Cloud Computing, virtual machines, Task Scheduling, Ant Colony Optimization algorithm, Bat Algorithm, Hybrid algorithm.

1 Introduction

Cloud computing is a novel technique that enhances the virtualized resources usage over the Internet to the end user. Cloud computing host services, resources and offers to the end-users over Internet based on pay-as-you-use[24]. Cloud computing is the distributed system with inter-connected virtualized computing resources that are dynamically provisioned to the customer[8]. The main purpose behind cloud computing is offering on demand different services and resources from service providers with greater scalability and availability in a distributed system [24]. Cloud computing comprises of a set of several number of resources of computing such as bandwidth of network, virtual machines, storage and processing [1]. Supply of these resources on demand is one of the main purposes of task scheduling[25]. The TSP (task scheduling problem) is the most critical barrier in cloud surroundings[4]. Task Scheduling Problem is a non-deterministic polynomial time hard issue and is liable for allocating application tasks to resources of computation effectively[33]. Task scheduling is the method of organizing incoming tasks in some way so that the feasible resources are used properly[7]. Because cloud computing is the technique that provides services through internet medium, service users must submit their online requests. The scheduler considers several constraints at the scheduling time involving the task nature, task size, execution time of task, the resource availability, load on resource and the task queue[17]. Task scheduling is one of the major problems in cloud computing. Proper scheduling of tasks may outcome in effective use of resources[2]. The major benefit of cloud is that it enhances appropriate use of resources [10][13]has stated that the task scheduling issue comprises of M machines and N tasks. Every task must be processed by one of the virtual machines M such that at the end the whole process scheduling duration is minimized. The scheduling algorithm is concentrated on QoS parameters namely task execution cost, make span and flow time. Keshk et al. proposed the modified ACO use in load balancing. Ant colony optimization is a random search algorithm that uses a positive feedback process and imitates the actual ant colonies behavior in nature to browse for food and to link to each other by phenomena placed on paths traveled[32]. This method develops the job's makespan. This system does not regard the resource availability or tasks weight[26]. According to Maruthanayagam et al. the ant colony optimization targets to allocate tasks into feasible cloud computing environment resources. The aim of cloud scheduler is to allocate jobs to feasible nodes. The best match must be predicted from the list of feasible jobs to the list of feasible resources. The selection is based on findings of computing resource power. The cloud scheduler must allocate jobs to resources effectively. The efficiency relies upon two criteria one is flow time and other is make span. The tasks feasible are contrast with feasible resources and the best one will be choose. The times of execution from simulation are employed for estimated ant based algorithm in cloud surroundings. The major benefit of ant colony optimization over Meta heuristic algorithms[31] is the example may alter dynamically. The decisions made by entire ants are purposeful and result of all ants' decision used in all the iteration to build the new optimal solution[22]. Ding et al. proposed algorithm of scheduling using ant colony optimization aimed at developing availability of system and managing an ideal time of response of submitted tasks. They established the availability of heterogeneity and computational heterogeneity concept. The class I of computational weight on j node is referred as the proportion between its rate of service on j node and the rapid rate of service in the system[11]. According to Kumar et al. Bat Algorithm is a new meta-heuristic algorithm for optimization in different tasks of optimization. The new method is based on altered RNG (random number generator) with chaotic consequences for initialization of parameter. On certain mathematical benchmark functions. Simulation describes the new methods validity in which CBA (chaotic bat algorithm) outperformed classical Bat Algorithm[21]. Yang et al. used the Bat algorithm to resolve the issues of topology optimization. The distribution of various topological features namely materials was accomplished effectively. The bat algorithm verified by resolving benchmarks of nonlinear design. The Bat algorithm was effective in resolving nonlinear issues of global optimization and optimization of topology[34]. Raghavan et al. used Bat algorithm to resolve the scheduling issue of workflow in cloud targeting to reduce the complete workflow processing cost. The algorithm runs better in processing cost terms when compared with best resource selection algorithm[28]. A hybrid of multi objective Bat algorithm and particle swarm optimization is used for maximization of profit in cloud. Particle swarm optimization algorithm is employed for global update and local search is performed by Bat algorithm as Bat algorithm

has greater worldwide convergence [6]. Thus, it can be inferred that task scheduling and resource allocation must be analyzed and optimized carefully in cloud environment to accomplish reduced cost and time, which leads to quality of better reliability[30]. The reminder of this paper is divided in to six sections: Section 1 is the problem statement, section 2 gives the literature review, section 3 is proposed model, section 4 show the simulation results, and section 5 is conclusion and section 6 acknowledgement.

2 Problem statement

Efficient scheduling is one of the major concerns while executing workflows in cloud surroundings. The scheduling of workflow in cloud defines to representation of tasks of workflow to resources of cloud to optimize certain objective function. Cloud computing is a heterogeneous system and it processes and holds huge number of complicate data. The task scheduling effectively can lead to much throughput s and better performance in the system. The study of Moon et al. proposes a novel algorithm of cloud task scheduling based on optimization of ant colony that allots cloud users tasks to virtual machines in cloud computing surroundings in an efficient way. This research has adapted reinforcement and diversification strategies with slave ants to enhance the task scheduler performance in cloud computing surroundings with ACO [23]. Similarly, Kaur et al. proposed Bat algorithm to resolve the multi-objective workflow scheduling issue in clouds that reduces the time of execution and extends the reliability by maintaining the budget within specified limit of user[20]. This study proposes a hybrid algorithm combining Ant colony optimization and Bat algorithm for scheduling tasks in an appropriate way. This study evaluates the development of a hybrid Algorithm for efficient task scheduling in Cloud environment.

3 Literature Review

Jacob (2014) proposed a study on Bat Algorithm for Resource Scheduling in cloud computing. The resource scheduling is a complicate method in cloud computing because of cloud's heterogeneous nature and several copies of relevant task is provided to several PCs. Therefore in this research a Bat algorithm is suggested to schedule resources in the cloud surroundings. This study presents the growth of Bat algorithm based scheduling tool for resource scheduling in cloud computing.

Ali and Fatma(2015) proposed a hybrid algorithm with Particle Swarm Optimization and Cukoo Search algorithm called PSOCS. Algorithm tested in cloudsim simulator. Proposed system is compared with existing Random Allocation algorithm and original particle swarm algorithm. Results show makespan and utilization with PSOCS show significant improvement.[4]

According to the study of Kalra et al. (2015) Cloud computing as become an essential concept in high performance distributed computing area as it offers on request access to shared resources pool over internet in a self-service, metered way and dynamically scalable way. Still cloud computing is in its development stage so as to reap its complete advantages much studies is needed across several concepts. One of the essential problems which are required to be concentrated for its effective performance is scheduling. The main aim of scheduling is to represent tasks to proper resources that optimize more than one objective. In cloud computing scheduling belong to a set of issues referred ads NP hard issue due to huge space solution and thus it takes a big time to predict an optimal solution. It is preferable to predict suboptimal solution in cloud environment but in short span of time. The techniques of met heuristics have been proved to accomplish optimal solutions within cheap time for such issues. In this study a comprehensive survey and comparative examination of different algorithms of scheduling for grid and cloud surroundings based on 3 familiar meta-heuristic techniques namely genetic algorithm, particle swarm optimization and ant colony optimization and two novel technologies namely BAT algorithm and League Championship Algorithm[19].

In the research of Tawfeek et al (2015) cloud computing is the growth of parallel computing, grid computing or distributed computing or referred as commercial computer science concepts implementation. One of the major problems in this surrounding is associated to task scheduling. The task scheduling of cloud is an NP hard optimization issue and several meta-heuristic algorithms have been

suggested to resolve it. In this study a cloud task scheduling policy based on ACO algorithm is compared with various algorithms of scheduling. Round Robin and First Come First Serve has been used in this study. The main aim of these algorithms in reducing the given tasks set makesspan. Ant colony optimization is a random optimization search method that will be employed for incoming jobs allocation to virtual machines[33],[32].

Baxodirjonovich et al. (2016) proposed a research on dynamic task scheduling algorithm based on Ant Colony Scheme. Several scientific applications performing in cloud computing are applications of workflow that comprises huge number of tasks and in which the tasks are linked by relations of precedence. Scheduling the workflow efficiently becomes a barrier in cloud computing surroundings because the scheduling determines the application performance. Predicting the optimal scheduling is referred a NP-hard. ACO can be used to frame effective algorithms of scheduling. This study proposes an algorithm of tasks scheduling that employs a modified ACO and this changed version employs probability in order for ants to determine target machine. The proposed algorithm of task scheduling is implemented in WorkflowSim to estimate the performance[5].

According to the study of Kumar et al. (2016) the trend on cloud computing usage is developing essentially and the greater cloud demand leads to process different and huge number of information at a time and several tasks are in scientific workflow form. Workflows are DAG (direct acyclic graphs) in which every edges indicates dependencies and every node indicates tasks. In order to make the cloud satisfy the request of user efficiently then how workflow scheduling can be acquired in essential. In this study a proposed technique which is a combination of Ant colony optimization and Particle swarm optimization has been implemented. Two parameters that is last dag finish time and cost is employed to analyze and compare for performance[26].

According to Guo (2017) in order to optimize the strategy of task scheduling in cloud surroundings a cloud computing task scheduling algorithm is proposed based on the algorithm of ant colony. The main aim of this algorithm is to reduce the total costs and makespan of tasks while making the load of the system much balanced. In this study the objective function of the costs and makespan of tasks is established, referring the function of load balance. Meanwhile this study also develops the pheromone initialization, the pheromone update approach and heuristic function in the algorithm of ant colony[15].

Sunitha Rani et al. (2017) have stated that cloud computing is explained by dynamic provisioning, shared infrastructures, managed metering and access of network. It has surfaced as an essential archetype using virtualized infrastructure to manage many complicate servers on different environments of execution. Virtual machines are regarded as the processing units and facilitators in cloud surroundings. Effective use of virtual machine instances is accomplished through efficient mechanism of task scheduling which enables similar workload distribution among nodes resulting in developed time of response. This study concentrates on optimal use of virtual machines modeled around directed acyclic graph with topology order to schedule task using inspired BAT algorithm. This algorithm reduces the task waiting time and virtual machines idle time as its rate of convergence is greater[29].

Al-Arasi et al. (2018) mentioned that nowadays cloud computing makes it feasible for users to utilize the resources of computing namely application, hardware and software etc., on the model of pay as use through internet. One of the challenging and core problem in cloud computing is the scheduling of tasks. Task scheduling issue is an NP hard issue and is liable for representing tasks to resources in a way to distribute the load commonly. The proper representation between tasks and resources decreases the makespan and extends the utilization of resource. In this study an independent task scheduling algorithm is presented and implemented that allots the tasks to users to numerous resources of computing. The proposed algorithm is a hybrid algorithm for scheduling tasks in cloud computing based on PSO (particle swarm optimization) and GA(genetic algorithm). The algorithm is simulated and implemented using simulator of CloudSim[3].

In the research of Bezdan et al. scheduling task in cloud computing is a larger problem to accomplish greater effectiveness. Scheduling can be referred as the actions list that can be carried out using usual algorithms of scheduling but these are NP hard issues they can even determinable if this study utilizes meta-heuristic algorithm like Bat algorithm. It offers a highly optimized solution in allocating tasks. In this study Bat algorithm is going to be implemented in the toolkit of cloud Sim and it

mentions the benefits of using this method when compared with general algorithms of scheduling[6].

Kumar et al.(2018) proposed a research on task scheduling using Meta heuristic optimization techniques in cloud environment. Cloud computing enables the access of network everywhere to a shared number of configurable resources of computing and offers different services for allocation namely computation and virtualization storage. The resource utilization and task scheduling are the major barriers in cloud surroundings. Scheduling allocates various kinds of job in resources and scheduling is determined based on quality of service response. QOS is the assured service which manages various tasks in allocation of job. For that reason in order to plan the demanding information several heuristic algorithms has been suggested such as PSO (particle swarm optimization), ACO (ant colony optimization), GA (Genetic Algorithm) and ABC (Artificial Bee Colony) algorithms to resolve the task scheduling and resource utilization. It is suggested to utilize Bat algorithm which offers an effective mechanism of scheduling that will develop the performance and efficiency of system by reducing the deadline and time of execution[27].

Timea et al. proposed hybrid meta heuristic algorithm. It combines bat algorithm and artificial bee colony algorithm. Task scheduling with multiple criteria is the complex optimization problem. Better the task allocation method better the quality of service. Thus, the Meta heuristic approach is required to get approximate solution in short time when compared to NP-hard optimization approach. Proposed BA-ABC technique outperformed other meta heuristic approaches, EMS-C , ECMSMOO, BOGA and CMSOS. Significant improvement in makespan and reduced cost[6].

Yi Gu and Chandu Budati proposed a multi heuristic algorithm for effective workflow scheduling called Energy Aware Time and Throughput Optimization heuristic algorithm (EATTO). They address the issue of energy consumption, throughput and execution time. N number of tasks are searched in n- dimensional search space with multi-objective function that results in overall improvement in performance of all three objectives [14].

4 Proposed System

In this study the Ant colony optimization algorithm and Bat algorithm is combined for efficient task scheduling in cloud environment. In the proposed system, first the population for both ant colony optimization and Bat algorithm is initialized. Then the fitness function for the solutions produced from every algorithm is evaluated. After that the best solutions from both the algorithms are predicted and the best solutions are combined. After the combination, the solutions are updated. Then the solutions are evaluated and again the combined solutions are optimized using Bat algorithm. Given below Flowchart illustrates the steps of proposed algorithm. From the above chart the cloud environment is deployed with finite number of VM. Then the population is initialized which denotes the solution of Bat and Ant Colony optimization algorithm which must be generated. After that the function of fitness is evaluated to predict the weaker users from Bat and Ant colony optimization algorithm and changed with strong users from other algorithms. Then the Bat and Ant colony optimization algorithm completes their search and output-scheduling result is obtained when it meets maximum. Iteration number. If it ends, it integrates the best solution of Bat and Ant colony optimization algorithm to enhance the process of optimization and task scheduling exists. If it does not end, it again estimates the adjustment of fitness affinity using Bat and Ant colony optimization algorithm. Thus the solution generates gets swapped best with the bad and vice versa and then the population is updated. Then again, it goes to the evaluation step of fitness. If it is yes then the process ends otherwise it again repeats the complete process. Thus by integrating the ant colony optimization algorithm with bat algorithm is regarded as strong. BA develops the solutions diversity using a technique of frequency tuning in the population. The evaluation function of fitness is employed to predict weaker user from both Bat and Ant colony optimization algorithm and it is changed with strong users from other type of algorithms. Stronger users of both Bat and ant colony optimization algorithm are integrated to enhance the process of optimization.

Table 1: Reviews of hybrid Algorithm for efficient task scheduling in Cloud environment

S.No	Author	Year	Algorithm	Finding of the Research
1	Jacob [18]	2014	Bat Algorithm	Greater efficiency and greater value of accuracy
2	Baxodirjonovich et al. [5]	2014	Probabilistic Load balancing Ant colony optimization, Min-Min and Ant colony Optimization algorithm	Reduce the average makespan
3	Sajjad et al.[9]	2014	Firefly Algorithm	minimization of makespan time
4	Kalra et al. [19]	2015	Ant colony optimization, Particle swarm optimization, Genetic Algorithm, League Championship Algorithm and Bat Algorithm	Makespan reduction, cost of execution, time of response, time of flow, throughput and average utilization of resource
5	Tawfeek et al. [33]	2015	Ant Colony Optimization, Round Robin and First Come First Serve	The task scheduling in cloud based on ant colony optimization outperformed round robin and first come first serve algorithms
6	Kumar et al. [26]	2016	Ant Colony Optimization and Particle Swarm Optimization	Reduces the cost and decrease the finish time of last day of the workflow
7	Guo,Q [15]	2017	Multi Objective Ant Colony optimization and Min-Min	Improves the pheromone update rule and heuristic function of ant colony algorithm
8	Rani et al. [29]	2017	BAT algorithm	Reduce the virtual machines idle time and tasks waiting time
9	Al-Arasi et al. [3]	2018	Particle swarm optimization, Genetic algorithm	Reduces the makespan and develops the utilization
10	Bezdan et al. [6]	2018	Bat Algorithm	Highly optimized solution for task allocation
11	Kumar et al. [27]	2018	Ant colony optimization, Particle Swarm optimization, Genetic algorithm, Bat algorithm and Artificial Bee Colony algorithms	Increase the performance and efficiency of system by reducing the deadline and execution time
12	Hariharan et al. [16]	2019	Hybrid Bat Algorithm	Improved Job scheduling task with hybrid optimization algorithm
13	Timea Bezdan et al. [6]	2020	Hybridized Bat Algorithm	Increase the multi-object task scheduling.
14	Yi Gu et al.[14]	2020	Bat Algorithm	Reduce the execution time for computation-intensive workflows

4.1 Ant Colony Optimization algorithm

Ant colony is a set of development evaluations set up on insect settlement activities. . In this Algorithm when the group of ant attempts to view for food, they employ a special type of chemical to interact with each other. That chemical is known as pheromone. Initially ants initiate their food search randomly. Once the ants find a way to their source of food, they leave pheromone on the way. An ant can face other ant's trails to the source of food by sensing pheromone on the ground. As this method continues several ants attract to select the shortest path as there have been several accumulated pheromones on this way. Small departure from this method is the calculation of honey bee that is much relevant to scavenging bumble bee instances [33]. The pseudo code of ACO is explained below:

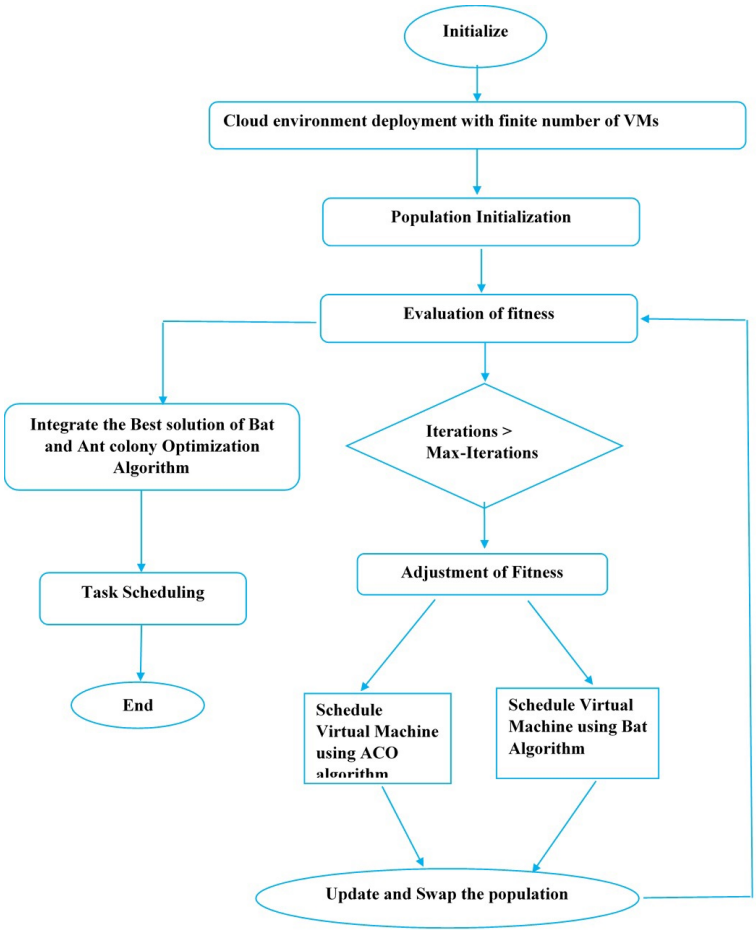

Figure 1: Flowchart of Proposed System

4.2 Bat Algorithm

Bat algorithm is based on echo location characteristics of micro bats which are proven to be effective. Bat algorithm develops the solutions diversity using a technique of frequency tuning in the population. In nature, the bat algorithm is iterative hence for iteration the parameters must be updated. The evaluation function of fitness is employed to predict weaker users from both bat and ant colony optimization algorithm and changed with powerful users from other algorithm. Powerful users of both Bat and ant colony optimization algorithm are integrated to enhance the process of optimization. Bat algorithm uses randomization for estimating the optimal value. To assure the algorithm's superiority an algorithm is verified with many standard functions. If an algorithm is capable to reduce the functions of standard with utmost accuracy then these algorithm are regarded to be the best algorithm. Bat algorithm is one of the few algorithms which provide accurate outputs and it is one of the major reasons for selecting this algorithm for scheduling of workflow [10]. The

Pseudo code of ACO

```
1 Start
2   For every ant ? ListofAnt
3         for every Sx
4              for every Ty
5                    Assign Sx an Tywith parameter of probability,
6               End for
7         End for
8         Call UpdateMakespanInformation();
9      End for
10    For every z ? tabu
11          for every Sx
12               for every Ty
13                    Call UpdateLocalPheromones ();
14               End for
15           End for
16          Call RunBat();
17     End for
18     Elect Bestant as a queen an based on makespan;
19     Call GlobalPheromoneUpdate();
20     if a Antbest solution is better than existing map (Sx, Ty)best then
21     end if
22     return map (Sx, Ty)best
23  End
```

Figure 2: Pseudo Code Ant Colony Optimization

pseudo code of Bat Algorithm is explained below:

Pseudo Code of Run Bat() Algorithm:

```
1     Start the population of bat ai and bi where (i=1, 2,….., n)
2     Start frequencies Fi, rates of pulse pi and loudness li
3     While (s < Maximum number of iterations)
4           Generate new solution by adjusting the frequency
5           Update locations and velocities/solutions;
6     F_i = F_min + (F_maximum − F_minimum)rand
7     u^(a+1) = u_i^a + (d_i^s − d_*)F_i
8     d_i^(a+1) = d_i^a + V_i^(T=1)
9           if (rand > r_i) then
10                Choose a solution among best solutions
11                Generate local solution among the chosen best solutions
12          end if
13          Generate a new solution by flying randomly
14          if (rand < M_i & f(d_*)) then
15                Accept the new solution
16                Increase r_i and reduce M_i using constants β and γ according to:
17    M_i^(a+1) = β M_i^a
18    R_j^(a+1) = R_i^0[1 − exp(−γS)]
19          end if
20          Rank the bats and find the current best d_*
21    end while
```

Figure 3: Pseudo Code RunBat Algorithm

4.3 Simulation Results

For this analysis totally 700 tasks have been chosen with 300 preprocessing + makespan in seconds for combining the Ant Colony optimization and Bat algorithm. The simulation output is presented below: From the above figure (Figure 4) it can be inferred that the proposed hybrid algorithm is superior to that of the ant colony optimization algorithm and the BAT algorithm in terms of makespan and preprocessing of multiple tasks at the same time.

5 Conclusion and future scope

Task scheduling has been regarded as one of the most vital issues in cloud computing. Optimized scheduler would help in the enhancement of the performance and throughput in cloud system. The

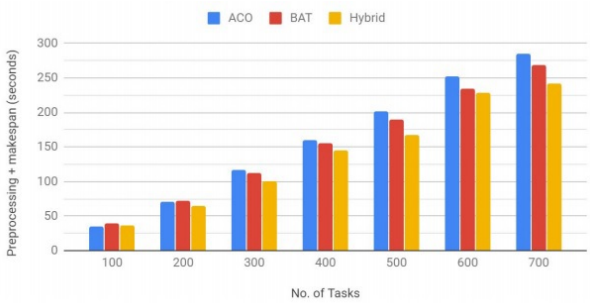

Figure 4: Proposed Hybrid Algorithm results

proposed algorithm has combined BAT and ACO to gain the best benefit of both the algorithms. The Bat algorithm is employed for scheduling workflow in clouds and it not only optimize the time of execution but also assures that the tasks are allotted to greater reliability VM while meeting the defined budget of user. The Ant colony optimization algorithm optimizes the resources in an effective way and it is used to select one among various alternative ways to decide the order of processing of every resource. Ant colony optimization algorithm reduces the energy amount used by every resource and hence the system performance is developed. Efficient utilization of time is performed using the ant colony optimization algorithm. In the proposed research, Ant colony optimization algorithm is integrated with BAT algorithm in the way to remove the bad solution and to integrate the best solutions to much optimizing the solution. The proposed hybrid algorithm is superior and quicker in system balancing compared to other algorithms. In future research multi optimization can be performed and the parameters can be increased for enhancing aspects like the quality of service, resource allocation etc of the virtual machines.

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