INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 4 - V7I4-1414)
Available online at: https://www.ijariit.com

A study on various optimization algorithms for task scheduling in cloud computing

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ABSTRACT

The prompt development of storage technologies, processing and the internet's success has made the computing resources more available, more influential and cheaper than before. This drift in the technological field has paved way for the realization of a new computational model which is the Cloud Computing. One of the most challenging problems faced in cloud computing is task scheduling, where the clients want their task to be finished as per the deadline within a shortest time possible. Task scheduling in cloud is done based on various parameters such as the priority, cost, time, bandwidth, resource utilization, performance, etc. The current work focuses on providing a detailed review on various optimization algorithms for scheduling in cloud. This study is useful in understanding various optimization algorithms that are used for task scheduling, the way they behave and function. The algorithms presented here are mainly focused to minimize the computational cost and execution time there by increasing the overall efficiency.

Keywords— *ACO Algorithm, BCO Algorithm, Cloud Computing, Genetic Algorithm, PSO Algorithm, Task Scheduling.*

1. INTRODUCTION

Cloud computing is said as a "Developing computing technology where the central remote servers and internet are used to maintain the applications and the data" Manipulating, configuring and accessing the applications online is considered as cloud computing. A network service is delivered as a combination of both hardware and software resources. The applications as utilities can be accessed over the internet by means of cloud computing. It allows the applications to be created, configured and customized online. The database resources can be accessed from anywhere as per the user requirement through the internet without having any fear of maintenance and management of the actual resources. Cloud computing has been made reasonable and handy to the end-to-ends users by certain models and services that are working behind. The working models in cloud are of following the types:

- Service Models
- Deployment model

1.1 Deployment Models

The access to the cloud is defined by the deployment models. They are of the following types:
(Figure 1[1] shows the types of cloud deployment models)

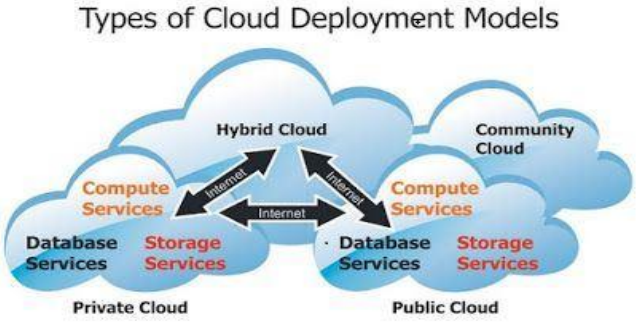

Figure 1: Deployment models in cloud

(a) Public cloud: The systems and the services offered by them are accessed easily by the public in the public cloud. Because of its openness it is supposed to be less secure.
(b) Private cloud: The services and systems are can be accessed in an organization through private cloud Because, of its private nature it is more secure.
(c) Community cloud: The services and systems can be accessed in a cluster of organizations through community cloud.
(d) Hybrid cloud: The combination of both the public and private cloud together is called hybrid cloud. It is noted here that the private cloud is used for performing important activities whereas the public cloud is used for performing trivial activities.

1.2 Service Models

The three elementary service models (Figure2[2] service models in cloud) on cloud computing are Software as a service (S-A-A-S): Software applications are provided to end users as a service by SAAS. Example: Gmail Infrastructure as a service (I-A-A-S): The access to the fundamental resources like virtual storage and virtual machines (VM's) etc. is provided by I-A-A-S. Example: Rackspace.com Platform as a service (P-A-A-S): The runtime environment for deployment tools, applications, development, etc. is provided by P-A-A-S. Example: force.com

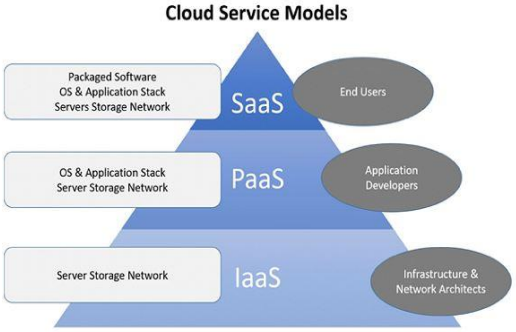

Figure 2: Service models in cloud

1.3 Cloud Characteristics

- Resource pooling (Resource management)
- Broad network access
- Self-service
- Rapid elasticity
- Measured service

1.4 Scheduling

It is the process of assigning the start and end times to a group of tasks considering certain resource parameters and constraints is called scheduling. Scheduling can be done based on various parameters such as the time, performance, cost, priority, physical distance, band width, etc. There are numerous challenges that are faced while scheduling. They can be said as follows:

- Resource overloading
- Pricing
- Resource provisioning
- Job scheduling
- Scalability
- Availability
- Load balancing.

2. VARIOUS OPTIMIZATION ALGORITHMS

There are many optimization algorithms that are in use for scheduling of the tasks in the cloud environment. These algorithms are implemented so as to improve the efficiency as well as to reduce the time for the scheduling of the tasks. Some of the algorithms that are going to be studied are the meta-heuristic algorithms which include the Ant Colony Optimization (ACO), Bee Colony Optimization (BCO), Genetic Algorithm (GA), Particle Swarm Optimization (PSO) Algorithms.

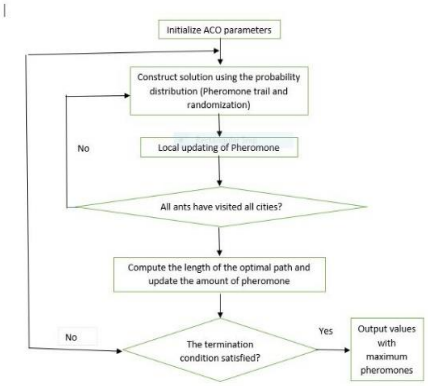

Figure 3: Basic ACO flowchart

2.1 Ant Colony Optimization

It was developed by Marco Dorigo [1] who was inspired by ant's natural behavior It is a type of genetic algorithm for finding optimized path in graphs.

There have been many improvised ACO algorithms for various purposes which offer better performance and efficiency.

Ayushi Sharma,Umang Singh[2] in their work have proposed an algorithm "Study on Load Balancing Techniques in Ant colony optimization for Cloud Computing." This work is based on the principle of movements of the ants in both forward as well as well the backward directions, where the Pheromone table is updated in order to store the information about the utilization of resources. The objective of this mechanism is to efficiently distribute the load among the nodes and to find an optimal resource allocated for every task. This has Solved issues pertaining to security and load balancing.

Kumud wasnik,Harshada Raut [3] Have proposed "Load Balancing in Cloud Computing using Ant Colony Optimization." The key principle here is based on Ca1culating both the Foraging and Trailing Pheromones, server updation of pheromone trails takes place in accordance with the overload and underload. The major objective is efficient utilization of resources and minimizing server's waiting time. It has provided better response in lesser time and efficient load balancing compared to the regular ACO.

Li, Xu, Zhao, Dong, Wang,[4] have proposed "Cloud Task scheduling based on Load Balancing Ant Colony Optimization." This was an improvised algorithm for task scheduling based on ACO. Here to improve the load balancing ability of the VM is loaded and the factor which influences the load balancing in defined. This majorly aimed to reduce the make span and for effective load balancing of the system. This work was successful in making the system adaptable to the load balancing new strategy.

Anant Jaiswal, Ratan Mishra [5] presented a solution for load balancing in cloud using ant colony optimization. That was based on the social behavior of the ants, in order to find the path that is the shortest. The key was observing the social behavior of ants to find out the shortest path. Finding the shortest path helps to find a way which is more feasible to improve the performance in balancing the load. This is a heuristic algorithm which was designed to balance the load distribution in cloud. Thus, this proposal was successfully able to provide more efficient way for load balancing in cloud.

Chiang, Chou, Lee [6] in their work have proposed "ACO for task matching and scheduling." This algorithm uses the rule of state transition so as to reduce the time taken for the process. Taguchi's Methodology has been applied for achieving higher efficiency. The main objective of this proposal is to reduce the time taken for finding the results. This work has provided a way to reduce time and also improved the local search results.

2.2 Bee Colony Optimization

It was developed by Pham, Ghanbarzadeh et al [7]. It was inspired by the behavior of bees and other techniques were developed based on the way they build their colonies. It is population-based search algorithm which is supposed to give optimal solutions.

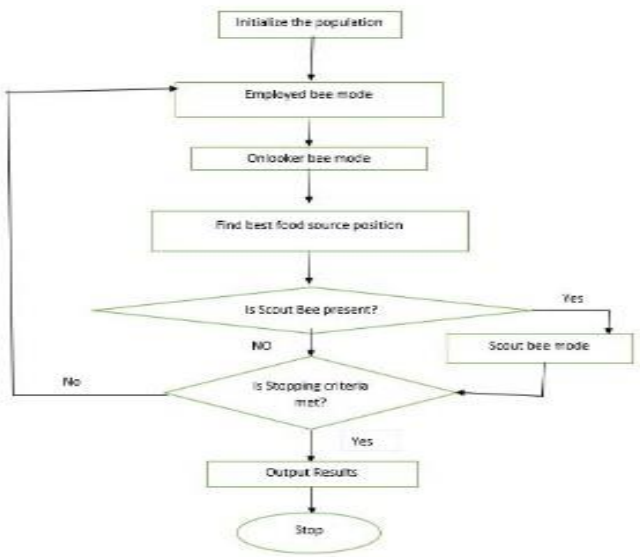

Figure 4. Basic BCO Flowchart

There are various improvised BCO algorithms for better efficiency based on various parameters.

An Gong, Yun Gao, Xingmin Ma, Wenjuan Gong, Huayu Li and Zhen Gao [8] worked to developed ,"An Optimized Artificial Bee Colony Algorithm for Clustering". It was earlier observed that the solution was trapped in the local optimum, and as to solve the problem and increase the horizons of the solution set. This Kmeans algorithm which analyzes clustering is found to be more accurate in dividing dataset, for providing better results. This is less sensitive to initial clustering and gives results with higher accuracy. The overall performance is also found to be better when compared to the previous BEES algorithm.

Guo Cheng [9] Investigated and modified Bee colony algorithm with various other theories and gave, "Investigation of Modified Bee Colony Algorithm with Particle and Chaos Theory." This study's main purpose was to modify the bee colony algorithm in

accordance with the particle and chaos theory. In this study it was told to select a food source in present source and from already existent neighbor who is at random position. By doing this it has been observed that the convergence rate of the algorithm has increased considerably and search space has been optimized. This was successful is attaining the search region optimization with reduction in search time.

Hsing-Chih Tsai [10] after his study to find a solution to optimization problems related to constraints, came up with an idea to integrate the artificial bee colony algorithm along with bee's algorithm. In their work, "Integrating Artificial Bee colony algorithm and Bees Algorithm to solve constrained optimization problems". It was observed that there is a co-existence between the Bees Algorithm and the smaller swarms of ABC, which are the sub swarms. Using the constraints of equality, it determines the function variable. Integration of ABC–BA together overcomes the limitations of ABC and BA and improves the efficiency of obtaining reasonable solutions.

Bitam[11] studied various job scheduling algorithms to over-come the challenges faced during the scheduling in cloud. He then came up with, "Bees Life Algorithm for Job Scheduling in Cloud Computing." In this cross over is implemented in order to get the global optimization. The main objective here is to get diversified solutions along with the localization of the optima. The advantages of this proposal were, optimal and consistent job scheduling with minimal make span. It has also attained greater efficiency when coming to the execution time along with diversified solutions.

Mizan, Masud and Latip [12] Modified the existing Bees Life Algorithm for Job Scheduling in Hybrid Cloud. In their work, they used greedy mechanism as a local searching procedure to attain best individual solution in the neighborhood so-as-to enhance the performance at each step. The objective was to utilize the resources properly. The major achievements of this algorithm were, it was able to give minimum makespan and also affirmative response at end users.

2.3 Genetic Algorithm

Genetic algorithm was developed by Holland, who was inspired by the concept of natural selection by Darwin [13]. It is used to obtain high quality optimized solutions.

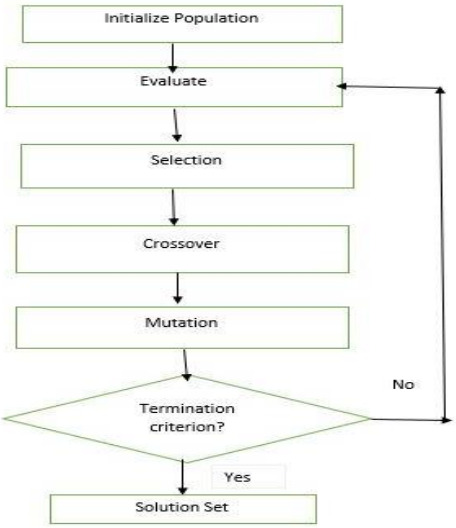

Figure 5: Basic GA flowchart

There are many developments in the GA for various performance improvements.

RajveerKaur, SupriyaKinger [14] have proposed an algorithm that is, enhancing the existing GA for Task Scheduling in Cloud Computing. It is an advanced GA with modification in fitness function. This proposed algorithm gives better performance in terms of time analysis in comparison with traditional algorithm.

Leena V. A., AjeenaBeegom A. S., and Rajasree M. S. [15] worked to develop a bi-objective Task Scheduling algorithm using GA in Hybrid Cloud Platform. The key principle involved here is the NSGAII, which is a variation of GA and uses a concept called domination in order to optimize the required multiple objectives. The objective was to optimize both execution time and cost. It was successful in achieving simultaneous optimization of both the cost of scheduling and the execution time.

Chang-Tian and Jiong [16] worked on to develop an Energy-aware GA for Task Scheduling in Cloud Computing. Here, for the selections and fitness determination double fitness method and unify were used. The main objective of this proposed algorithm was to reduce the energy consumption and make-span. By applying Dynamic voltage scheduling it was able to achieve reduced energy consumption and a balance in make-span.

Zhao, Liu, Zhang, Xie and Hu [17] for the purpose of scheduling independent tasks, developed a technique based on GA in cloud computing. It uses the competitive mechanism and, also conflict measurement for finding the best fit solution. The main objective is to schedule the independent tasks in heterogeneous systems. The advantage here is communication heterogeneity and Scheduling on computation.

Zhu, Song, Liu, Gao and Cheng [18] worked on cloud computing applications and came up with Hybrid Genetic Algorithm, used

for the cloud applications. It was based on the principle of self-learning to attain global optimization. The main objective here is the balancing the load based on various parameters. The achievements of this algorithm were Improved resource management and effective load balancing.

2.4 Particle Swarm Optimization

PSO algorithm was developed by Kennady and Eberhart [19]. It is based on adaptive global search methodology.

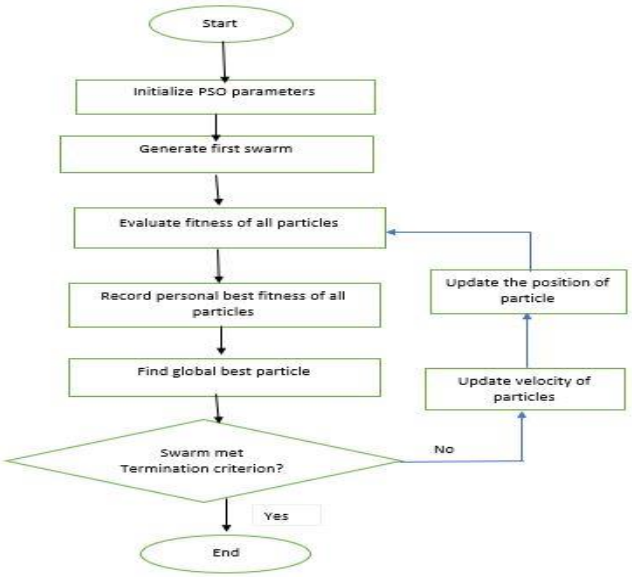

Figure 6. Basic PSO flowchart

There have been many proposed mechanisms to improve many factors and the efficiency by modifications of the existing Algorithm.

S. Jaya Nirmala, S. Mary Saira Bhanu [20] proposed a method for scheduling of scientific workflows in IaaS cloud. The algorithm here used was the modified catfish based PSO. This works on the principle, for different kinds of workflows, execution costs observed and the make-span are observed. The objective here is to meet deadline with a minimal execution cost. The performance was observed to be better than traditional PSO because of less execution cost and makespan.

A.I. Awad, N.A.El Hefnawy and H.M. Abdel Khader [21] proposed multi-objective task scheduling approach based on modified PSO algorithm. Here Task Buffer collects tasks from users whereas the task Resource Information phase collects the useful information about Tasks that arrived in cloud. The objective is to minimize round trip time and total cost. This proposal was successful in improving some factors like i reliability, minimal total cost, minimal round trip time, and task completion time with an overall decrease in the execution cost.

Shaobin, Zhan Hongying Huo [22] Proposed a mechanism for task scheduling in cloud. This mechanism added simulated annealing at iteration of PSO, this improved convergence rate, solving accuracy of original algorithm. The objective was to reduce the average running time of the task and raise the rate availability of resources. This Improved algorithm has reduced running time of tasks and maximizes the utilization ratio of the resources.

Guo, Zhao,Shen, Jiang[23] developed mechanism for Task Scheduling Optimization. It uses SPV to transform the unceasing position vector in to a dispersed value permutation vector. The main objective was to attain faster convergence. It achieved a speed up in the execution and minimized the processing time.

Pandey, Wu, Guru, Buyya[24] have proposed a mechanism for the scheduling of workflow applications. It was based on PSO algorithm It takes into account the communication cost and also other constraints for the Workflow Applications to calculate the cost for all tasks at-a-time. It mainly focused on achieving minimized computation cost and transmission cost. it has succeeded in Minimizing the of cost of communication and effective load balancing.

3. CONCLUSION

In this paper, we have made a survey on various types of the techniques that are used for task scheduling such as ACO, BCO, GA and PSO. The behavior of each of these algorithms is discussed with their improved versions. From the survey it is understood that, a good task scheduling algorithm can assign the tasks successfully without any delay and give better outputs. In our further study, we are working on improvising the performance of the Ant Colony optimization Algorithm for the purpose of task scheduling, in order to get maximum efficiency.

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