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A Survey on Resource Provisioning Models for Collaborative Cloud Computing Environment

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Abstract : "Cloud computing is a network of computing resources, that are delivered to various customers as a service over internet. Resources are available dynamically to the users; On the other hand provisioning of resources in a dynamic manner makes resource provision task more complex for scientists. As a result allocation of these resources plays a vital role in management of resources. In collaborative cloud environment, various cloud resources from different cloud servers are connected together to offer undisrupted service to consumers. Enhanced resource scheduling techniques are necessary to preserve separation among resource users. We require a resource provisioning model that will improve cloud system usability and reliability along with quality of service. In our paper we will review the work carried out by various scientists in developing resource provisioning model and their challenges in cloud computing environments and also compare the characteristics features of these resource scheduling algorithms.

Keywords : Collaborative cloud computing, Optimization Algorithms, Resource Allocation.

1. INTRODUCTION

Cloud computing is a technique which delivers computing and storage capacity as a service in a virtual manner via internet to a community of end-recipients. Cloud computing is a colloquial expression used to describe a variety of different types of computing concepts that include an extensive number of computers connected through a network, for example, the web. Cloud computing refers to network-based services provided by real server hardware, which are aided by some virtual hardware, supporting cloud services from one physical server to another and also allows for efficient use of resources based on the demand from customers. Here Virtual servers are moved around and scaled up (or down) on the fly without affecting the services offered to end user. More organizations are migrating from traditional in-house infrastructure towards cloud environment for deploying wide range of business applications. Here cloud service providers outsource their computational resources to third party service providers [1].

Collaborative cloud computing is an emerging technique for sharing on-demand cloud resources in a multi-cloud environment. When a cloud service provider is not able to provide the resources demanded by its customer then it will search the availability of resources in its interconnected cloud server provider and utilizes the resources if it is available. Moving to collaborative cloud computing will offer you lower cost and improved QOS performance. Cloud customers all over the world exchange their data with high range of computing resources. Hence the on-going demand for scalable resources is popularly increasing between the cloud customers. When a customer makes a tie–up with a cloud service provider he has to avail all the services from that particular cloud service provider only, even though the service provider is not providing best quality of service. This makes the customer to enter in to a vendor lock-in kind of situation. Therefore a single cloud server could not able to provide better quality of service to the

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customers all the time. Hence the researchers are in need to build a virtual environment for connecting to multiple cloud servers. Collaborative cloud computing environments has many unique features such as resources belonging to various cloud providers are completely distributed, heterogeneous, and totally virtualized. Collaborative cloud computing has emerged as a promising solution for providing on-demand access to virtual computing resources, platforms, and applications in a pay-as-you-go manner.

2. RESOURCE SCHEDULING

Resource Scheduling is the process of allocating computing resources such as processor, storage, networking services and software for the users based on their requirement. Proper resource allocation methods profit cloud service provider en route for managing the cloud resources resourcefully which in turn provides supplementary resources to assign without delaying or declining any client demands. In contrast, cloud users are aiming for financial gains at each front [2]. By using Optimized resource scheduling techniques we can upraise these financial gains in an effective manner. Few prominent resource scheduling algorithms consist of Genetic algorithm, Ant Colony Optimization, Particle Swarm Optimization, Honey bee Algorithm, Harmony Algorithm, Artificial Bee Colony Algorithm, Cuckoo search etc. These algorithms are at present being used for a long while for resource allocation; however most of these algorithms are enhanced and improved with the objective of making them more efficient and rigorous towards their objective [3]. Here, we present a detailed study and evolution of numerous optimization algorithms used for resource scheduling in collaborative cloud environment.

3. OPTIMIZATION ALGORITHMS

Optimization plays a vibrant role in different areas such as Engineering, computer science, mathematics, statistics, empirical sciences or management science [4]. Optimization can be defined as identifying an alternate solution with the most cost effective or maximum attainable performance under the given constraints, by maximizing desired factors and minimizing undesired ones. Optimization can be proficient in various forms and by uncountable methods; nevertheless every one's intention is to attain maximal output with minimal input. Optimization algorithms are broadly classified under three major domains viz. deterministic, probabilistic and heuristic algorithms. In this paper we mainly focus on probabilistic algorithms, which provide efficient resource usage. In this the authors have deployed Monte-Carlo algorithms. Beyond numerous Monte-Carlo algorithms, the most noticeable algorithms used in cloud computing environment are Ant Colony Optimization, Genetic algorithms, Particle Swarm Optimization, Artificial Bee Colony, Honey Bee, Cuckoo Search etc.[5]. We will discuss each of these algorithms in the subsequent section.

3.1. Genetic Algorithm

Genetic algorithm is the method of progression of heuristics search and mimics algorithm in artificial intelligence domain. The working of Genetic algorithm is similar to that of progression of natural elements. The preliminary solution is reformed to achieve the nearby optimal solution [6]. The process initiates with population of strings, which are commonly referred as genome or genotype. This population of strings are called as Chromosomes, which are used to discover the candidate solutions for the problem. The candidate solutions are also called as phenotypes on individual creatures. The candidate solutions encoded inside the population string is advanced in the direction of attaining a new desired solution [7]. Evolution procedure begins with solutions that are randomly produced and advances in the direction of attaining enhanced generation. On every occasion a new generation is attained, its fitness value is verified for all individual in it. Later the best suitable fitness value is carefully selected from the current population among multiple individuals. The chosen fitness value is modified by merging (mutation) a number of individuals to create a new population of modified individual. The above process of generating the new population is repeated iteratively until it reaches the satisfactory level. As soon as it reaches the satisfactory level the algorithm terminates.

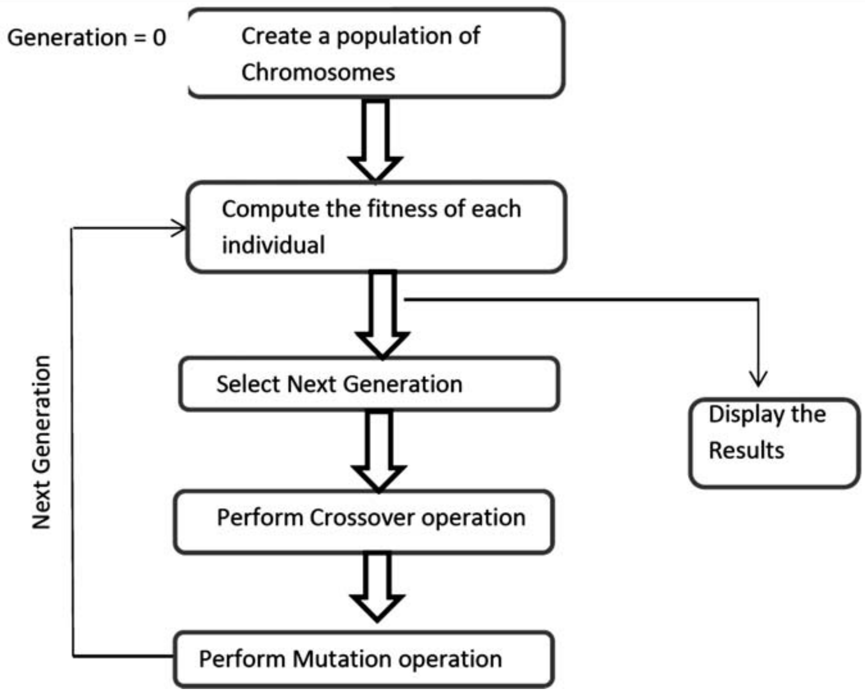

Figure 1: Workflow of Genetic Algorithm

3.2. Ant Colony Algorithm

"Ant colony optimization algorithm is a probabilistic approach, which deals with computational disputes to find the best accessible paths through graphs" [10]. This algorithm is basically a kind of swarm intelligence technique. Functioning of this algorithm is like the typical feature of an ant. Although ants are not having eyes, they can able to find their food source without any struggle and also enroute back to their homes. For finding the route ants use the idea of 'pheromone deposition' in which ants find route to the food source by emitting fluid like substance called pheromones on the ground make pheromone trails. The optimized path among the food source and the home is the route which has more pheromone intensity [11].

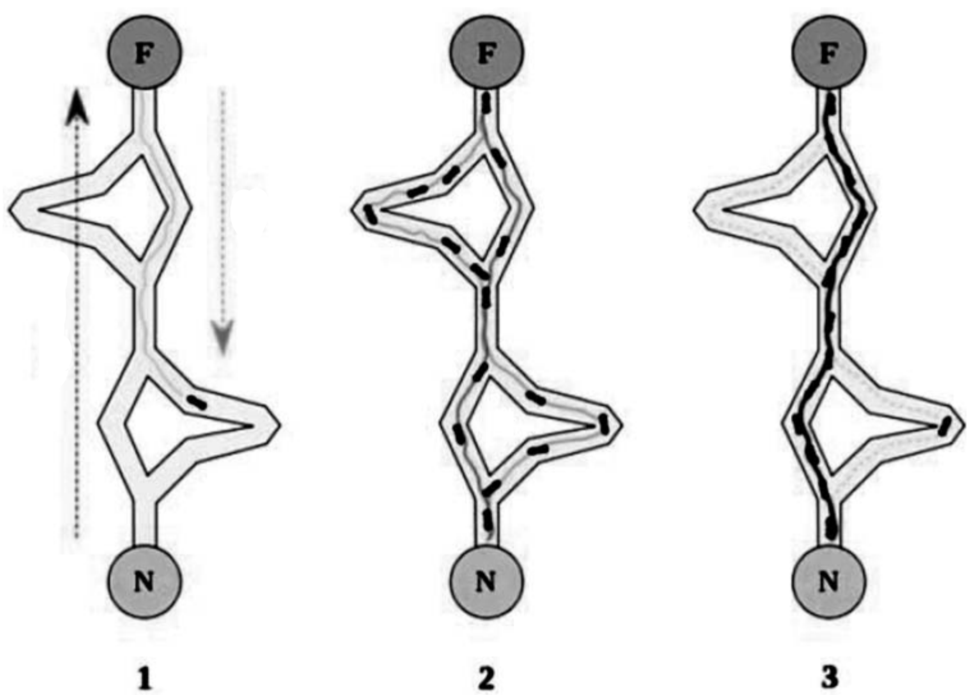

Figure 2: Ant Colony Algorithm Pheromone deposition principle

Let us discuss in detail about the application of this algorithm in cloud computing environment and its working concept. Consider a well-designed cloud computing environment; where a cloud service provider has various resources and provides these resources to various Virtual Machine's (VM's). Alternatively we have many clients who require various types of services from the service provider and the payment depends on their resource usage basis, as shown in fig 2. Cloud user requires the services offered by the service provider. In the beginning all cloud users will give their service requirements to cloud service provider. An SLA (Service Level Agreements) is signed between the cloud users and the cloud service provider which comprises resource requirements of the users such as How many virtual machines required, For how much duration the user require the virtual machines, amount of time required to complete the task, what are all the softwares required to complete the job, etc.

For accessing the cloud resources, customer/clients should register with the cloud service provider. Customers submit their needs to cloud service provider stating all the essential information needed for them. Cloud service provider accumulates all demands from various clients and assigns appropriate resources to all customers based on their requests.

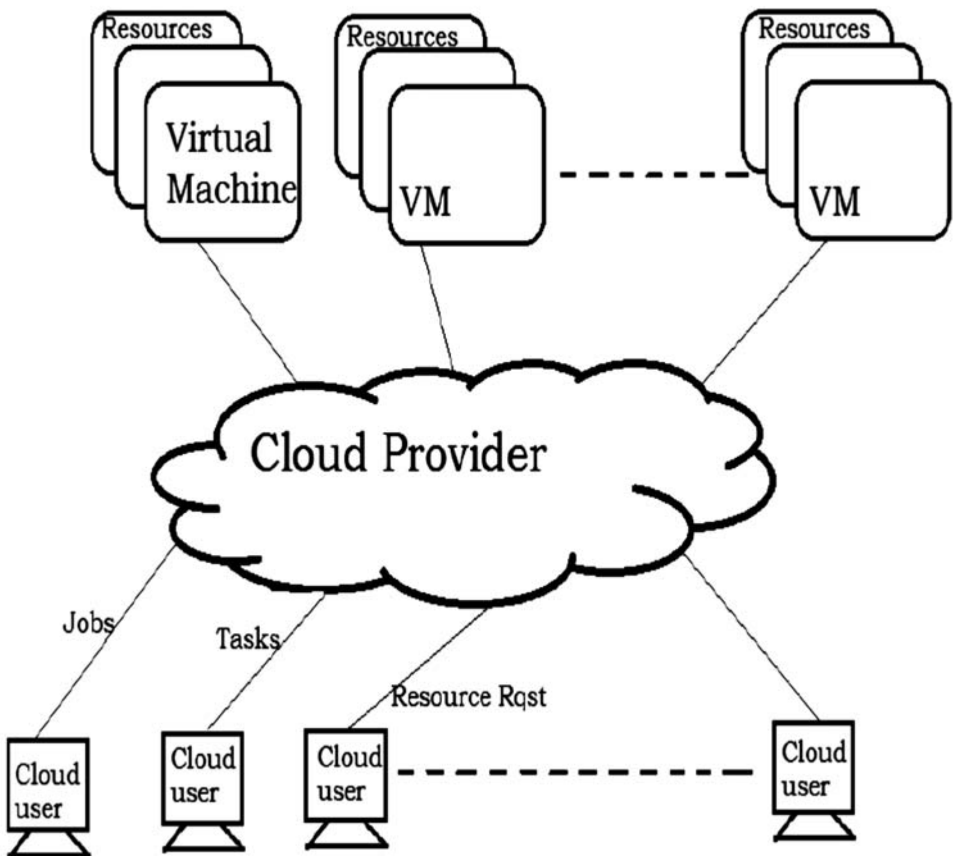

Figure 3: Architecture of basic cloud resource allocation schema

The above figure shows how jobs are allocated to various virtual machines. How jobs are scheduled to various VM plays a vital role here. In Ant colony optimization all the virtual machines are considered as a node, all ants are considered as mobile agent, and computing resources are equivalent to the food source. Ant travels amongst the nodes to allocate jobs to different resources in an enhanced way by means of Ant Colony Optimization Algorithm. Here all nodes are grouped under two main characteristics: I) Probability of acting as a destination node II) maintaining a pheromone table. In pheromone table, probable route for all destinations is represented as rows and columns represent the chance of neighbour becoming the successive node. For every node, the entries in the pheromone table are updated based on the movements of ants. Resources can be effectively managed by optimized scheduling of jobs using Ant Colony optimization algorithm at different nodes.

3.3. KBACO

Xing, Chen, Wang, Zhao, and Xiong [12] , developed a frame work called Knowledge-Based Heuristic Searching Architecture (KBHSA). This framework integrates the knowledge model and the heuristic searching model to search an optimal solution. The performance of this architecture in the instantiation of the Knowledge-Based Ant Colony Optimization (KBACO) is applied to the common benchmark problems. The experimental results of KBACO algorithm outperform the previous approaches when solving the Job Scheduling problems for resources.

3.4. ACOSS

Chen, Shi, Teng, et al.[13] proposed an proficient hybrid algorithm for resource-constrained project scheduling. This hybrid algorithm is known as the ACOSS algorithm which combines Scatter Search (SS) with ACO. Research on ACO has shown that improved performance can be obtained by stronger exploitation of the best solutions found during the search (Berrichi, Yalaoui, Amodeo, & Mezghiche, 2010; Komarudin &Wong, 2010)[14][15]. For improving the performance of ACO algorithms, the author proposes a combined and improved exploitation of the best solutions with an effective mechanism for avoiding early search stagnation. In this paper, as a first step, all ants in the ACO search the solution space and generate activity lists to provide the initial population for the SS. Then, although the SS improves all the ants' solutions, only the best solution is used to update the pheromone trails. Finally, ACO searches the solution space again using the new pheromone trails. In other words, the SS uses the previous population constructed by ACO, which subsequently updates the pheromone trails using the best solution from the SS, and searches again. In addition, a local search strategy is employed to improve the quality of solutions generated by ACO and also as an improvement method in the SS.

3.5. MOACO

Berrichi et al.[14] proposed a Bi-Objective ACO approach to optimize production and maintenance scheduling, in this paper, the author presents an algorithm based on ACO paradigm to solve the joint production and maintenance scheduling problem. This approach is focused to deal with the parallel machine case, to improve the quality of solutions; an algorithm based on Multi-Objective Ant Colony Optimization (MOACO) [16] approach is developed. The goal is to simultaneously determine the best assignment of production tasks to machines as well as preventive maintenance periods of the production system, satisfying at best both objectives of production and maintenance.

3.6. RCPSP and ACO

The authors proposed a multimode RCPSP (Resource-Constrained Project-Scheduling Problem) with discounted cash flows using ACO [17]. The application of ACO requires setting up a construction graph and designing the pheromones and heuristic information. Based on the construction graph, the serial schedule generation scheme is applied for artificial ants to build solutions. In the process of this algorithm, each ant maintains a schedule generator and builds its solution following the rules of ACS using pheromones and heuristic information. For further studies, the comprehensive survey of Herroelen, Reyck and Demeulemeestre (1998) and Brucker, Drexl, Mohring, Neumann and Pesch (1999) are better choices.

3.7. LBACO

In another research done by Kun Li, Gaochao Xu, Guangyu Zhao, Yushuang Dong, Dan Wang another technique name LBACO was discovered [5]. In contrast to other ACO algorithm, the LBACO algorithm inherits the basic ideas from ACO algorithm to decrease the computation time of tasks executing, it also considers the loading of each VM. We can carry out new task scheduling depending on the result in the past task scheduling. It is very helpful in the cloud environment.

3.8. Particle Swarm Algorithm

Particle swarm algorithm is a swarm intelligence technique within which, the candidate solutions are iteratively handled based on a certain measure of quality. In PSO, 'particles' are denoted as population of candidate solutions, which rotate all over the place in the search-space. The movement of the particle around the search space is determined by a mathematical formula, which computes particle velocity and position. Particles' local best known position guides its movement in search area. Besides it also moves in the direction of the best known positions within the search-space, which are updated as better positions [19]. The movement of the particle is well-defined with a definite velocity, magnitude and specific direction, which is interconnected with the best solution attained so far. Fitness value is computed to measure the performance of the particle. Particles movement can keep track of every position at each time instant and reach a superior solution by fluctuating the acceleration at each time step. To conclude, when the particle shields the entire search space creating them its topological neighbour the ultimate best solution is generated [21]. In this methodology the degree at which the position of the particle varies is given by a modified velocity equation [22]

$$V_{id} = V_{id} + C_1 * \text{rand}() * (P_{id} - X_{id}) + C_2 * \text{Rand}() * (P_{id} - X_{id}) \tag{1}$$

$$X_{id} = X_{id} + V_{id.} \tag{2}$$

3.9. Bees Algorithm

Honey bees colony [23] will spread out over long distances in different directions to gather nectar or pollen from various food sources, generally referred as flower patches. A little portion of the colony continuously searches the environment in search of new flower patches. These scout bees move randomly in search for food source in the neighbouring space to the hive, calculating the profitability of the food sources encountered and deposit the collected food after they come back to the hive. Those individuals which found extremely profitable food source go to an area in the hive referred to as the "dance floor", and perform a formal dance referred to as the waggle dance. The Scout bees communicate the location of its discovery to onlookers bees through the waggle dance. Since the length of the dance is proportional to the scout's rating of the food source, more foragers get recruited to harvest the best rated flower patches. After dancing, the scout returns to the food source it discovered to collect more food. As long as they are evaluated as profitable, rich food sources will be advertised by the scouts when they return to the hive. Recruited foragers may waggle dance as well, increasing the recruitment for highly rewarding flower patches. [24] [25].

3.10. Virtual Bee Colony Algorithm

Yang developed a virtual bee colony algorithm based upon intelligent behavior of honey bee swarms [26] to solve the numerical optimization problems. VBA has been introduced to optimize only the function with two variables.

3.11. ABC Algorithm

The Artificial Bee Colony (ABC) algorithm is a meta-heuristic algorithm based on swarm intelligence swarm proposed by [27] on the foraging behavior of honey bee colonies. This model encompasses three essential elements: employed and unemployed foragers and food sources. This model also describes the two leading modes of behaviour, which are essential for self-organization and collective intelligence: If the recruitment of forager bees will lead to rich food sources then it will result in a positive feedback and if it lead to poor food sources by foragers it will cause a negative feedback[28]. Artificial Bee Colony algorithm comprises three groups of artificial bees: (*i*) Employed bees, onlooker bees and scout bees. The employed bees searches for the food source and come back to their hive to perform the waggle dance. By performing the waggle dance, employed bees share the location of the food source to the onlooker bees. Based on this information the onlooker bees select the food source with high quality (*i.e* fitness value). Scout bees which has poor food source will abandon their food source and search for the new food source.

3.12. Harmony Search Algorithm

Harmony search (HS) [30] is a population based metaheuristics algorithm inspired from the musical process of searching for a perfect state of harmony. The pitch of each musical instrument determines the aesthetic quality, just as the fitness function value determines the quality of the decision variables. In the music improvisation process, all players sound pitches within possible range together to make one harmony. If all pitches make a good harmony, each player stores in his memory that experience and the possibility of making a good harmony is increased next time. The same thing in optimization, the initial solution is generated randomly from decision variables within the possible range. If the objective function values of these decision variables are good to make a promising solution, then the possibility to make a good solution is increased next time [29].

3.13. Cuckoo search

Yang and Deb in 2009 [31] developed Cuckoo Search (CS), an optimization algorithm, which is motivated by the natural life of a some species cuckoo bird family, in which cuckoo birds lays their eggs within the nests of different host birds. Some host birds will involve in direct clash with the intruding cuckoo birds. If a host bird recognizes some of the eggs in the nest are not their own, it will either throw these odd eggs away or simply destroy its nest and construct one more new nest somewhere else. Certain birds of cuckoo family such as the new world brood-parasitic tapera will grow in such a manner that female parasitic cuckoos are highly specialized in imitation of colors and pattern of the eggs of a uncommon host species [32]. Cuckoo search adapts the above discussed breeding nature, and as a result we can use this for number of optimization problems. It gives the impression that cuckoo search can outperform other metaheuristic algorithms in various applications.[33] Cuckoo search (CS) carry out the succeeding illustrations: Every single egg in a nest represents a solution, and a cuckoo egg represents a new solution. The objective is to use the new and potentially better solutions (cuckoos) to replace a worst solution in the nests. In simple, each nest has one egg. The algorithm can be further improved to more complex cases in which each nest has many eggs representing a set of solutions.

3.14. Modified Cuckoo Search

Walton et al.[33] modified the standard Cuckoo Search with the intention to speed up the convergence. The change encompasses additional information interchange among the top eggs. It was identified that Modified Cuckoo Search (MCS) out performs the standard cuckoo search and other algorithms, in terms of convergence rates, when used in a various standard optimization benchmark objective functions. As a result, the modified cuckoo search has been suitable to optimize unstructured mesh which lessens computational cost significantly. [33][34] Furthermore, one more interesting improvement to cuckoo search is the so- called quantum-inspired cuckoo search with convincing results [32].

3.15. Multi objective cuckoo search (MOCS)

A multi-objective cuckoo search (MOCS) method has been carried out to deal with optimization problems having multiple-criteria.[35] This methodology practices random weights to associate multiple objectives to a single objective. As the weights vary indiscriminately, Pareto fronts can be found so the points can be distributed diversely over the fronts.

4. CONCLUSION AND FUTURE WORK

In this paper, we have investigated a number of resource scheduling algorithms and came to a conclusion that efficient resource scheduling plays an important part with the intention of consuming the resources within the best potential manner. We deliberated numerous scheduling algorithms and their working in cloud computing environment to accomplish the desired outcomes. These algorithms were proficiently used in cloud environment and they are enriched in improved manner over the amount of time to be appropriate according to the requirements of existent cloud environment. There has been number of research going on to attain the best in effect resource scheduling algorithm and it needs to be explored further more. In yet to come years we expect to see many more algorithms which would be seamlessly appropriate to accomplish the goal.

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