OPTIMIZATION OF LOAD BALANCING IN CLOUD USING SWARM INTELLIGENCE: A SURVEY

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Abstract
Cloud computing is a process which provides on-demand and paid access to distributed resource. This cloud services is used by everybody to reduce the cost of infrastructure and maintenance, this leads to increase in load on cloud day by day. Thus balancing the load on cloud is one of the serious problems in the cloud computing. Therefore the research was carried to balance the load and the proper load balancing can reduce the energy consumption and carbon emission. Load balancing can be achieved by task scheduling, also it facilitate the efficiency on cloud. This task scheduling results in suitable allocation of best resources to the task in execution. Load balancing can be done by using Genetic Algorithm (GA) but there was a problem of complexity and convergence leads to increase in response time. Thus a new algorithm called Particle Swarm Optimization (PSO) resolves these problems. The objective of this paper is to compare a particle swarm optimization technique with round robin, Ant colony and honeybee foraging load balancing algorithm. Comparatively PSO shows a better result.

Keywords: Cloud Computing, Load balancing, Swarm Intelligence, Virtual Machine Migration.

1. Introduction

1.1 Cloud Computing and Virtualization:

Cloud computing is a recent technology that concern with online distribution of computing resources and services. In cloud computing, end-user knowledge about the configuration of service delivering system may not be required because client just use services on pay per model where all system configuration and resource management is taken care by cloud system automatically. The most important issue associated in cloud computing is dynamic load balancing or task scheduling [1]. The main objective in cloud computing is to efficiently assign the tasks to the Cloud nodes, which will reduce the effort in processing the request processing and to make it efficient as possible. Even though the cloud computing process is an efficient and scalable it faces a very complex problem in balancing the user load. Cloud computing provides a distributed computing, parallel processing and grid computing. Cloud system is an interconnection of number of servers, virtual machines, data centers, storage devices etc. Nowadays, virtualization is the most important technology in cloud to make the servers feasible for independent applications. Virtualization provides power efficiency over the data centers. Also, virtualization provides online sharing of computing resources. Virtualization support in cloud allows better flexibility and customization to specific application, software, and programming environment.

1.2 Load Balancing:

Load balancing in cloud is the process to improve the performance of a both parallel and distributed computing system by distributing the load among the processors [2]. Load balancing results in effective resource sharing and utilization. Load balancing algorithm has two meanings: firstly, allocates a huge number of data traffic on multiple nodes respectively in order to reduce the waiting time of users; second, it reschedule the load from a single heavily loaded node to the multiple nodes to

improve the resource utilization of each node. These algorithms solve the problem between heavily loaded and idle nodes. Load balancing is a distribution of work dynamically and uniformly across all the available nodes in the cloud. Results in carbon emission if the resources are not used properly. As we utilize the resource properly a carbon emission can be minimized which is achieved by load balancing. Usually virtual machine in the cloud system processes the same amount of work. Hence, load balancing will be needed to maximize the throughput by minimizing the response time. Load balancing results in reduce of energy consumption [4], hence reduced carbon emission. This helps in achieving Green computing. Load balancing Improves overall performance of the system, higher user satisfaction, Faster Response, System stability, Reducing carbon emission.

1.3 Swarm Intelligence:

Swarm intelligence [5] is a natural and artificial intelligence has many individuals and is coordinated using decentralized control and self-organization. This works on collective behaviors which is nothing but interactions between individuals and with their environment. Colonies of ants and termites, schools of fish, flocks of birds, herds of land animals, human artifacts like, multi-robot systems are some examples for this technique. Swarm intelligence is marked as multidisciplinary systems.

1.4 Virtual Machine Migration:

Migration is the important feature provided by modern virtual machine technologies in order to equally balance the load of all virtual machines. Migration is nothing but moving a work from one node to another physical node without interrupting any hosted services on operating system. It provides efficient online system maintenance, load balancing, reconfiguration and proactive fault tolerance in clusters and data centers. The dynamic reallocation technique of VMs in a virtualized [6] datacenters is termed as dynamic server consolidation. Migration takes place from heavily loaded machine to lightly loaded machine usually. This allows the least utilized machines and highly utilized machines to equally utilize the available resources. Thus the best way to balance the load on datacenters is by virtual machine migration.

2. Load Balancing Algorithms

Effective load balancing algorithm will intelligently determine which device within a given server farm is best able to process an incoming data packet. This algorithm is programmed to distribute loads in a specific way. Algorithms vary widely, depending on whether a load is distributed on the network or application layer. Algorithm is selected based on the effectiveness of load distribution mechanisms, performance and business continuity. Some of the loads balancing algorithms are discussed below.

A. Round Robin Load Balancing Algorithm

It's a static algorithm, best only in homogeneous and stable systems. But, static algorithms doesn't consider the dynamic changes and also not flexible. The static load balancing algorithms [7] will not check the state and functionality of the node while assigning the tasks. A fixed quantum time is given to the job in this algorithm and allocation of jobs to all nodes is in a circular fashion. Assignment of processors in a circular order results in no starvation. Here in this algorithm if load is distributed equally then the response is fast. But some machines are heavily loaded while others remain idle and under-utilized.

1) *Algorithm:* steps for weighted round robin.

1. Find the capacity of all virtual machines and assign weights to each virtual machine according to the capacity.
2. Find the load on all virtual machines.
3. Check whether the load on virtual machines are balanced or not.
4. If balanced Exit
5. Else If load>capacity
   VM=OVM (Overloaded Virtual Machine)
6. Else if load<capacity
   VM=UVM (Under loaded Virtual Machine)
7. If priority exist
8. Assign weight to VM's based on computing power
9. Execute the high priority tasks with suitable VM's according to the weight.
   Else Assign weight to each VM's based on computing power.
10. Use Round Robin scheduling policy and assign the tasks to VM's according to resource requirements.
11. Update the load on VM's.

*2) Advantages of Round Robin in Load Balancing:*Simple and easy to implement.

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Round Robin works fair if every process gets an equal share of the CPU. Every process will be executed in fixed interval of time by the CPU, this will reduce the process waiting time.

B. Honeybee Foraging Behavior Load Balancing Algorithm

This is a dynamic load balancing algorithm in heterogeneous environments [8]. These algorithms consider dynamic changes and are more flexible. However, it is more complex. Main advantage of this algorithm is that the selection of task is based on current state which improves the system performance. This algorithm was derived from the behavior of real honey bees in finding their food sources. After finding the food sources, the honey bees come back to the bee hive to inform the food source. They do this by performing group movement. This group movement is also known as "waggle Dance". They perform waggle dance to inform other bees of the exact location of the food source. This waggle dance shows the quality, quantity of the food and the distance of the food source from the bee hive.

1) *Algorithm:* Basic Steps for Bee Colony Optimization

1. Initialize the population randomly distributed over solution space
2. Assess the fitness value of each and every individual
3. Calculate the out looker bee movement probability.
4. Check for the fitness value for repeated iteration
5. If fitness value is not improved then do
    a. Discard all food sources
    b. Convert employee bees to Scouts bees
6. Select the best fitness value and its position
7. Check for stopping criteria, if satisfied then stop and exit else go to step 1.

2) *Advantages of Artificial Bee Colony in Load Balancing:* initially proposed for numerical optimization, then used in combinatorial optimization problems, and also for unconstrained and constrained optimization problems. It expects user to determine only three control parameters i.e, population size, maximum cycle number and limit.

C. Ant Colony Load Balancing Algorithm

Real ants usually select a shortest path in search of its food. This is a dynamic algorithm. In the group of ants an individual behavior of a particular ant appears as a different element. Ant will performs communal technique to achieve a variety of difficult tasks with good steadiness and reliability, which has become the field of ant colony optimization (ACO) [9]. They have restricted memory and show entity activities which is a casual section. Ants perform different difficult tasks reliably and consistently. Though it is basically essential that self organization, they use phenomenon that similar to overtraining in techniques of support learning. The complex social behaviors of ants have been much studied by science, and computer scientists are now finding that these behavior patterns can provide models for solving difficult combination optimization problems.

1) Algorithm: Basic Steps for ACO

1. Initialize the pheromone
2. While criteria not satisfied, then repeat
3. Initially set locations of all ants on an entry state
4. Selection of next state
5. While not reached to the final state then repeat from step 4, if reached then Step 6.
6. pheromone stages(deposit, daemon and evaporate pheromone
7. Check whether criteria satisfied or not, if satisfied then end, if not then repeat from step 2.
8. End.

2) *Advantages of Ant Colony Optimization in Load Balancing:* ACO has a number of advantages with some critical issues that to be determined in order to enhance reliability of the cloud system. Such problems are associated with the fault tolerance, load balancing and variety of security issues in cloud. The load can be memory capacity, load of cpu, network load, network delay etc.

D. Particle Swarm Optimization (PSO)

PSO is a swarm based heuristic optimization technique[10]. Developed by observing the social and biological behavior of swarm intelligence i.e. movement behavior of bird flocks and fish flock. The birds are scattered throughout the searching process for food[11]. While the birds are searching for food from one source to other one, there is always a bird from the bird flock that can sense the food source very well. That bird is detectable of the lay where the in the flock are transmitting the

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information about their location for the food, it helps them to move nearer towards the food source. Regarding the PSO technique[12], solution swarm is evaluated to the bird swarm. Better information of the solution from the solution space is equal to the most optimal solution, and the resources of food are equivalent to the most optimal solution throughout the process [13].

1) Algorithm: Basic Steps for PSO

1. Initialize population of particles with random position and velocities[14].
2. Calculate the fitness function value for each and every particle.
3. Compare current particle's fitness value with each particle's fitness value and find Pbest value.
4. Compare population's overall previous best and fitness evaluation and obtain Gbest.
5.Using (1) and (2), update position and velocity of the particle.
6. Check whether maximum number of iteration is completed or not, if not then repeat from step 2.

2) Advantages of Particle Swarm Optimization in Load Balancing: In PSO algorithm [15] task will be assigned to the virtual machine in best fit manner i.e. task will check all the virtual machine and assigns the task to the proper virtual machine which will have least memory wastage.

3. COMPARISON BETWEEN VARIOUS LOAD BALANCING ALGORITHMS

This Section shows a comparison table of round robin, Honeybee Foraging Behavior, Ant Colony and particle swarm Intelligence load balancing algorithms, which include its advantages and disadvantages of each of this algorithm respectively.

Algorithm	Advantages	Disadvantages
1. Round Robin Load Balancing Algorithm	1. Simple and fair. 2. Fast response in the case of equal workload distribution. 3. There is no starvation. 4. Fixed time quantum. 5. Fairness	1. Each node is fixed with a time slice. 2. It is not flexible and scalable. 3. Some nodes are heavily loaded and some nodes are idle. 4. Does not save the state of previous allocation of a VM. 5. less efficient
	Performs better for short CPU burst.	
2. Honeybee Foraging Behavior Load Balancing Algorithm	1. Self organizing and nature inspired algorithm. 2. Performance will be achieved by increasing the system size. 3. Suitable for heterogeneous environment. 4. Increases throughput and Minimize response time	1. Increase in resources will not increase the overall throughput. 2. High priority tasks can't work without VM machine. 3. Lack of use of secondary information. 4. Requires new fitness tests on new algorithm parameters. 5. Higher number of objective function evaluation. 6. Slow when in sequential processing
3. Ant Colony Load Balancing Algorithm	1. Decentralized. 2. Virtual machine allocation is better which eventually results in efficient usage of physical resources.	1. Network overhead 2. Delay in moving forward and backward. 3. Provides single optimal solution to the user at the end. 4.

		Probability distribution changes for each iteration. 5. Theoretical analysis is difficult. 6. Random decisions is dependent. 7. Uncertain time convergence .
4. Particle swarm optimization	1. Simple to implement. 2. Uses only few parameters to adjust. 3. Parallel computations. 4. Robust in nature. 5. High probability and efficient in finding the global optima. 6. Do not overlap and mutate. 7. Have short computational time.	1. Difficult to define initial design parameters. 2. Not suitable for scattering problems. 3.Convergence and can be locally trapped in complex problems

4. CONCLUSION

Cloud computing is becoming more and more popular among the business institutions and research institutions, from some time. The main objective is to use the computing resources in virtualization. Also with the load balancing mechanism running the focus is to distribute the resources in data centre virtualization. It has focused on the different swarm intelligent based techniques, Particle swarm optimization based techniques comparison which has benefits and limitations so comparing this algorithm with the other load balancing technique in survey i.e. Round Robin, Bee Colony and Ant Colony we saw many benefits and limitations on analyzing these algorithms theoretically they tend to generate poor results. In order to overcome these constrains Particle swarm optimization for cloud computing environment will enhance the computation and efficiency.

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