A Hybrid Approach Towards Improving Performance of Load Balancing Using Genetic Algorithm and Logarithmic Least Square Technique

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ABSTRACT

Load balancing is the major issue over cloud.Many techniques have been proposed to improve performance of load balancing in cloud computing.Genetic Algorithm uses natural strategy for solving problem hence it can give optimal solution and can give better load balancing than other load balancing algorithms.Genetic Algorithm uses random selection of machines as input and perform crossover and mutation for load balancing.But Genetic Algorithm has issues such as complex cost function,VM underutilization and low performance.The proposed algorithm uses hybrid approach which combines Logarithmic Least Square Technique with Genetic Algorithm.The proposed algorithm modifies fitness function and selection strategy to solve issues mentioned above and to improve performance of Genetic Algorithm.In proposed algorithm,virtual machines are given priorities using Logarithmic Least Square Matrix Technique and then this prioritized input is given to Genetic Algorithm.

Keywords : - *Cloud Computing,Load balancing,Logarithmic Least Square Method,Genetic Algorithm,Virtual Machine,Selection,Crossover,Mutation*

1. INTRODUCTION

Cloud computing definition proposed by NIST(National Institute of Standards and Technology)says "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. network, server, storage and applications and services) that can be rapidly provisioned and released with minimal management efforts or service provider interaction"[6].

Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centers[6].

Load balancing is a technique which is used to equally distribute workload over all processors,so no processor is overloaded.Load balancing is done by load balancer which accepts multiple requests from users and distribute them across servers on cloud based on load on each machine.Thus no server will get overloaded.Thus load balancing maximizes availability of resources. For example when new user request comes to the server,at that time if some server is overloaded in executing other request,the server will not respond quickly and the client need to wait.To avoid this first load balancer checks the utilization of the server and then process the client request.So clients don't need to wait.Thus load balancing increases throughput and reduces response time.

The existing scheduling techniques used for load balancing are Min Min, Round Robin and FCFS. There has been few research on load balancing techniques in cloud computing environment.Armstrong et. al.[3] uses Minimum

Execution Time (MET) to assign order to each job in arbitrary manner to the nodes on which it is expected to be executed fastest, regardless of the current load on that node.An intelligent method for load balancing has been proposed by Yang Xu et. al.[4].It proposes a novel model to balance data distribution to improve cloud computing performance in data-intensive applications, such as distributed data mining.A few soft computing techniques have been proposed like Ant Colony[6].

Genetic algorithm uses natural strategy for load balancing.So Genetic Algorithm can perform better than other techniques of load balancing.Genetic Algorithm is a four step process:Selection,Crossover,Mutation and Termination.

2. RELATED WORK

In 2013, Chandrasekaran K. and Usha Divakarla proposed Load Balancing of Virtual Machine Resources in Cloud Using Genetic Algorithm[1].This algorithm schedules VMs such that load balancing is achieved.This algorithm reduces number of VM migrations and performs better than round-robin and greedy algorithm under stable and variable load conditions.

This algorithm assumes set of physical machines P = {P1, P2, . . . , Pn} where n is the number of nodes in the cloud and on physical machine Pi , the set of virtual machines V = {V1, V2, . . . , Vmi } where mi is the number of virtual machines on physical machine Pi . \There will be one cloud controller and several nodes having multiple virtual machines in cloud.

The Genetic algorithm uses below operations:

Genome coding

Every solution is marked as one tree or multi-dimensional list.Multidimensional list data structure is used to implement encoding.

Fitness Function

Fitness function = f (S) = 100/$\sum|C-Pi|$ where i=1 to n.

The load on the cloud after VM V is arranged to physical machine is $C = \sum pi' / n$ where i=1 to n for n physical machines.After arranging virtual machine V to physical machine, the load of every physical machine will be Pi' = Pi + V where Load of physical machine Pi is $Pi = \sum Vj$ where j=1 to m for m VMs means load of a physical machine by adding the loads of the VMs running on it.

Selection

Compute the selection probability of the individuals as below:

Pi (S) = fi (S)/$\sum$fi (S) where i=1 to n for n solutions where fi (S) = Fitness of solution i

Conduct selection of the chromosomes.Individual with the high fitness has higher probability being selected and those with low fitness also have the chance to be chosen.

Crossover

Select two parental individuals S1 and S2 according to selection strategy.Combine the two parental individuals to form a new individual solution which keeps the same VMs in two parental selections.

Mutation

Here from parental solution any two physical machines (two dimensions - cpu and memory utilization) are selected and one or more virtual machines are swapped between those selected physical machines to form new solution.

The parameters for GA are crossover rate, mutation rate, population size. The experiment gave better results for population size of 50, crossover rate of 0.6 and mutation rate of 0.3 approximately. These three parameters are dependent on one another. If one is varied, others also need to be varied in order to get optimal solutions within reasonable time. The experiment gave better result for population size in the range (15, 60). Beyond this range, it either generated sub optimal solution or took more time to generate optimal solution, which shown that depending upon the problem instance size,the population size should be within certain range to get optimal solution wherein reasonable good computing time.

In 2015, Mayur S. Pilavare and Amish Desai proposed A Novel Approach Towards Improving Performance of Load Balancing Using Genetic Algorithm in Cloud Computing[2]. For assigning the priority to the VM's in cloud environment the Logarithmic Least Square Matrix Technique is used. First of all it randomly decodes total number of processors then calculates the comparison matrices for all processors.Then it takes multiplication of all values in each row and then takes nth root of that product for all rows and normalizes these values. So by assigning the priority to the VMs and giving the prioritized input to the genetic algorithm the response time can be minimized and better load balancing can be achieved in cloud computing.This approach can also minimize the make span of given task set.

3. PROPOSED WORK

Genetic Algorithm has issues such as complex cost function,VM underutilization and low performance.The proposed algorithm uses hybrid approach which combines Logarithmic Least Square Technique with Genetic Algorithm.The proposed algorithm modifies fitness function and selection strategy to solve issues mentioned above and to improve performance of Genetic Algorithm.

In proposed work,pairwise comparison matrix is generated for all virtual machines which will compare all virtual machines in terms of cost and then priority of virtual machines are calculated using Logarithmic Least Square Method[7].Then this prioritized input is given to Genetic Algorithm.Finally jobs are assigned to virtual machines which are to be executed on these virtual machines.

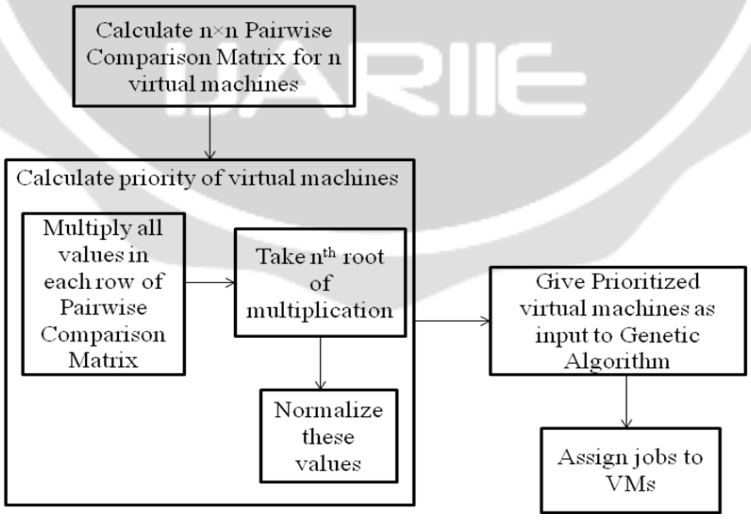

Fig -1: Flowchart of proposed algorithm of Logarithmic Least Square Technique and Genetic Algorithm

3.1 PROPOSED ALGORITHM

Step 1: [Generate priority matrix of virtual machines using Logarithmic Least Square method]

Step 1(a): Generate n×n pairwise comparison matrix for n virtual machines

Step 1(b): Multiply all values in each row

Step 1(c): Take n^{th} root of product for all rows

Step 1(d): Normalize these values

Step 2: [Genetic algorithm]

Repeat while optimum solution is found:

Step 2(a): [Crossover]

Combine two same individuals(VMs) with highest priority to form new solution

Step 2(b):[Mutation]

Virtual machines are swapped between two parental solutions to form new solution based on two dimensions(cpu and memory utilization)

Step 3: Assign jobs to VMs

Step 4 : End

4. RESULTS AND ANALYSIS

The proposed algorithm is implemented using Amazon Web Services.The experiment is performed using 2 VMs in us-west-2(Oregon) region and 1 VM in ap-southeast-1(Singapore) region.All VMs have same configuration having Instance Type T2.Micro, ubuntu operating system,General purpose SSD(gp2) as EBS Volume for storage.

Table -1: Experiment scenario and calculated overall average response time(RT) (in ms)

Sr No.	**Cloud Configuration**	**DC Specification**	**Response Time(in ms)**
1	CC1	Two regions with total 3 VMs	**12 ms**
2	CC2	Two regions with total 2 VMs	**8 ms**

5. CONCLUSIONS

This paper gives A Hybrid Approach Towards Improving Performance of Load Balancing Using Genetic Algorithm and Logarithmic Least Square Technique which solves VM underutilization and low performance issues of Genetic Algorithm. By assigning the priority to the VMs and giving the prioritized input to the genetic algorithm, response time and cost of virtual machines are minimized.

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