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Artificial Ant Colony System for Load Balancing in Cloud Computing

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Abstract
The present scenario is to present computing resources as applications that is made available to people as services. Such features when are dispersed at geographical separated sites is called Cloud computing. Today most of the technical researches are in the field of Cloud Computing due to its advancement. This paper covers a very familiar issue of request-response failure experienced in clouds due to overloaded servers and thereby authors suggested a novel approach of balancing the unbalanced nodes across the networks which has been termed by the authors as Artificial Ant Colony System.

Index Terms

Ant Colony Optimization, Cloud Computing, Clustering, Load Balancing, Scheduling

I. INTRODUCTION

Cloud Computing is the amalgam of two comprehensive terms in the domain of advance technology where the first is 'cloud' which describes the cluster of different resources which works in coordination and the second is computing that stands for the framework. Cluster of resources includes servers, brokers, clients and framework stands for the services that are provided to the end users while maintaining the systematic and coordinating hybrid combination of hardware and software which imparts those services to them. Cloud is highly distributed computing environment that contains a collection of coordinating and virtualized systems that are all dynamically connected according to the prior agreements of services between the provider of services and receiver of services [1]. Since cloud computing is latest trend today it ensures online resources and storage services to the user. It ensures the data at a lowest cost because users could access resources anytime through internet by paying for only their demand. Cloud computing environment today represents a trending way to curb the recent response and request model for IT services based on the Internet, by providing highly scalable and also virtualized resources as a service [2, 3, 4]. To date, there are a numerous commercial and individual cloud services, like Amazon, Google, Microsoft, and Yahoo that can be easily used and accessed [5]. Below is the pictographic presentation of the typical cloud computing environment where various dedicated users are involved:

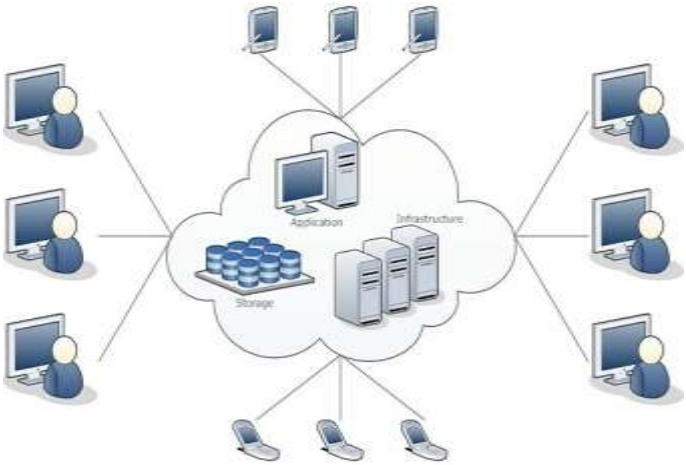

Fig 1.1: A Typical Cloud Computing Environment

Load Balancing in cloud computing environment is a technological advancement that imparts capability to distribute the non uniform workload in a uniform fashion on all the computing nodes so that every node can be saved from a situation of getting flooded with tasks or just remaining idle. It is deployed to achieve far better services, resource utilization and incrementing the throughput, performance of the system [6]. So the focus of this paper is to device an efficient framework that could create coordinating nodes which are neither overloaded nor deficient, and a system where overhead is minimized, the error rate is lesser and the traffic is under a controlled situation which in turns promises for highest possible overall throughput and performance. Thus a Novel Ant Colony System for Load Balancing in Cloud Computing environment called as Artificial Ant Colony System is presented as an approach for balancing the imbalanced nodes all across the network which also ensures proper scheduling of tasks.

II. LITERATURE SURVEY

Cloud computing is a technology for ensuring ubiquitous, easy to use and one click away service to access deployed computing resources on the web of networks that could effectively be selected and released with minimum overhead

and communication between user and premises [7]. Actually it is a computation style where highly scalable IT capabilities are provided application across the World Wide Web to multiple users using internet technologies [8]. Gartner [9] described cloud load balancing as the technology which makes reduction in costs with management ease and it maximizes resources availability.

A. Artificial Ant Colony System

Artificial ants belong to the Ant colony optimization technology which is a methodology for well optimization. It was introduced by Marco Dorigo and colleagues in the early 1990 as a research work in his PhD thesis [10, 11, 12]. The gradual growth of this algorithm was a biological inspiration of ant colonies. This behavior is exploited by artificial ant colonies for finding approximate solutions to difficult optimization problems. Actually ACO is a population based met heuristic that can be used to find approx yet proper solutions to difficult optimization problems. In ACO a finite cluster of software broker called artificial ants search for solutions to a given optimization problem [13].

B. Biological Inspiration

In the twentieth century, the French entomologist Pierre-Paul Grasse [10, 11, 12] observed that some species of termites react to what he called "significant stimuli". He observed that the effects of these reactions can act as new significant stimuli for both the insect that produced them and for the other insects in the colony. Grasse used the term stigmergy [14] to describe this particular type of communication in which the workers are stimulated by the performance they have achieved. The two main characteristics of stigmergy that differentiate it from other forms of communication are the following:

- Stigmergy is an indirect and non-symbolic form of communication mediated by the environment insects exchange information by modifying their environment.
- Stigmergic information is local and can only be accessed by those insects that visit the locus in which it was released or its immediate neighborhood.

Deneubourg et al. [8, 9, 10, 11, 12, 13, 14] thoroughly investigated the pheromone laying and the follow up of conduct of ants through an experiment termed as Double Bridge Experiment. In the mean path to the destination of food and source of ant they go on depositing pheromone. In the initial stage each ant in the random fashion chooses one among the two ways. But due to gradual fluctuations in the course of time one among the two ways becomes flooded with a higher concentration of pheromone chemical than the other way and hence the ants are attracted towards it and causing other ants to get stimulated too. This model given by Deneubourg and his co-partners for explaining the foraging conduct of ants was the main idea of inspiration for the innovation of new concept Ant Colony Optimization.

C. Artificial Ant Colony System for Load Balancing

Ant colony optimization (ACO) deploys the biological inspiration from the behaviour of ant species. The ant deposits a substance or a chemical called as pheromone on the ground to make an optimum path that must be followed by other members of the colony for gathering their food. This concept could be easily deployed on a simulated network models and represents a typical distribution of calls among neighbor nodes. The one node which carries extra traffic become congested soon and causes the calls to fail or entire system crash. The performance and throughput of the network is counted by the ratio of calls that fail. The Ant colony based system drops lesser calls than the corresponding methods. It also exhibit exciting features of distributed control system. This system thus can be successfully applied to achieve excellent Load Balancing. The main objective of this literature review is to find the gaps in research work and formulation of problem on which this work is based. Some of the referenced papers have been reviewed below:

Jio Zhao et.al [15] implemented a Heuristic Clustering based Load Balancing in Cloud using Bayes Theorem as shown in figure 2.2. Since almost existing load balancing technique are comparatively complex so this paper aimed on the problem of physical host selection for the deployment of tasks and proposed an efficient and heuristic approach called Load Balancing based on Bayes and Clustering (LB-BC). LB-BC represents the approach of achieving the effective load balancing for a longer term despite of load balancing approaches in the current literature scenario. This marks limited constraint on corresponding physical hosts focused to achieve deployment of requested tasks along with the global search ability in the confinements of the performance and throughputs. The Bayes theorem here is combined with the clustering process to get the optimum clusters of physical hosts. This paper also has deployed a heuristic idea that relied on Bayes theorem with the clustering process for effective load balancing. Zenon Chaczko et.al [16] proposed a model that uses Extensible Messaging and Presence Protocol or (XMPP). It is actually a protocol based on communication which is based on XML or Extensible Mark-up Language for effective load balancing. It provisions real platform for instant communication. It carries XMPP client that sends the information of its presence to XMPP servers along with the XML streams that contains detailed information of clients generated by these xml servers. By software called load balancer in XMPP servers request coming onto it are given a priority and resolved by generic application service. R.

Stanojevic et.al [17] proposed a mechanism CARTON for cloud control. It unifies the combination of load balancing (LB) and distributed rate limiting (DRL). Load balancing uses equal distribution of the tasks to various servers in order to minimize the DRL and to effectively use the online resources which are dispersed in some way to do non partial allocation of the resources. Due to less computation and communication overheads, it is simple and easy to implement algorithm. Zhao et.al [18] proposed this technology in response to the issues in intra cloud load balancing in the physical hosts by adaptive movement of virtual machines. A load balancing scheme is implemented to reduce virtual machines transfer time by online shared storage to balance the load among servers in accordance to the processing and input/output optimized to keep virtual machine in about minimal process. A distributive load balancing algorithm compare and balance is also proposed by the authors that rely on sampling technique and approaches to equilibrium quickly. This algorithm ensures that the transfer of virtual machine is always from costly physical hosts to cheap host in the terms of memory. V. Nae et.al [19] proposed an event-driven load balancing algorithm for real time massively multiplayer online games (MMOG). This algorithm takes capability events as input parameters then analyzes its components in the view of the online sharing resources and the global state of the game session and hereby creating the load balancing decisions in game session. This is able of scaling game session to be up and down on resources accordingly to the different loads with limited QoS parameters. Meenakshi Sharma et.al [20] proposed the scheme on load balancing of Virtual Machine resources that use past data and current state of the system to make actions. This scheme achieved the most efficient load balancing by employing genetic algorithm. It helped in solving the problem of load unbalancing and costly migration and thus attaining improved resource utilization. M. Randles et.al [21] devised a decentralized Honey Bee Based Load Balancing Technique that itself is a biological inspiration algorithm for better organization within itself. It achieved global load balancing by local server decisions. The performance of the system is enhanced with incremented system diversity. Here throughput is not enhanced as system size increases. It is best suitable for the situations where the diverse service types are required. He also investigated a highly distributive and scalable load balancing approach that employs a Biased Random Sampling of the system to gain self organization and thus balancing the load across all neighbour nodes of the system. The system constraints speed up with similar resources and thus resulting into incremented throughputs by effective utilization of the system resources. Hardeep Uppal et.al [22] presented a model in which he used an open flow switch. Open flow switches resembles to standard switch with a flow table that performs packet forwarding and lookup. The difference is in the insertion and updation of flow rules inside the flow table of switch. T.R.V. Anandharajan et.al [23] presented an efficient Particle Swarm Optimization (PSO) based Virtual Machine scheduling of variable resources in simulated cloud computing environment. Since Cloud Computing enables several resources to be shared globally in distributive manner the resource scheduling is furnished efficiently and accurately. In this paper Particle Swarm Optimization (PSO) technique is implemented for the on-demand sharing and scheduling of online resources. The particle swarm optimization is employed to obtain the optimum solution in minimum time. The experiments reveal that this improved algorithm could provide effective solutions than the original over clouds. Ratan Mishra et.al [24] proposed a system where artificial ants conduct is much similar to natural insects. Ants have very less memory and exhibit a conduct that appears to be a large random part. As a collective conduct ant manages to perform a variety of tasks.

Fig 1.2: Ant Colony Optimization

Gogulan et.al [25] implemented a Multiple Pheromone algorithm for scheduling in Cloud Computing Environment for various QoS Requirements. By observation performance parameter of virtual machine and the overload can be easily detected as it exceeds the threshold value. The neighbour idle node is detected by the ant colony algorithm. This thus achieves the focus of load balancing on the unbalanced nodes. Divya Rastogi et.al [26] proposed the hierarchical complex data centre and multi dimensional resource pool on cross servers. The network switches with storage in a data centre has discontinuous server and virtualization in memory. Vector Dot employs dot product to differentiate the nodes relied on the item and help in getting rid of overhead on servers as well as switches and storage nodes.

D. Research Gap

Load balancing is one of the main challenges in cloud computing because it is duly required to distribute the load evenly at every node for an easy going online access. A highly congested provider may fail to provide efficient services to its customers. So, with proper load balancing algorithm system response, service and throughput can be increased. Because of this reason in recent past decades it has gained attention of researches and scholarly articles. As a result of which various

useful algorithms exists but still there is lot of scope for improvement due to some loopholes. Such untapped gaps have been listed below:

- The methodology for the Load Balancing over cloud should be the one which is capable to deal with the modern scenario of excessive use and network traffic.
- The complexities of the algorithm for the real time implementation must be as low as possible.
- The system must deal to tackle the situation of the failure of sites or escaping from the risk of system crash.
- The problem in today's scenario is also to maintain the deployment of the tasks with the minimum span time.
- The issue of higher energy consumption have also been identified in the literature survey.

III. PROPOSED METHODOLOGY

The detailed literature survey has yielded identification of certain gaps in the research domain. Those gaps have been formulated into specific problems in accordance with the existing methodology implemented for the Load Balancing using Bayes Theorem over cloud. The scenario contains following issues that need to work upon:

- Heuristic approach based on Bayes theorem is a highly complex algorithm for the real time implementation.
- It also provisions lower throughputs since the risk of failure in tasks is more.
- It provides more make span time for more tasks.
- The used algorithm utilizes high energy consumption.
- Efficient scheduling strategy is not involved for proper Load Balancing in this adopted approach.

The proposed approach can be considered as a framework model for creating simulation environment and then deploying the framework to balance the unbalanced nodes in the simulated cloud environment. It begins with the theme of imposing Ant based clustering on the extensions of Ant colony optimization for proper scheduling technique that can efficiently cope up with the balancing of unbalanced hosts. It can be described in following sub points:

A. Creation of Artificial Ant Colony System Simulation Environment

For this idea to be a methodology in the created cloud simulation environment the quantity or the number of users named as "Ui" along with the number of resources in cloud named as "Ri" are set and initialized first. Each ant or node is associated with a table that contain important data and information about neighbour nodes where the table entries are null initially. The table entries are updated with the help of pheromone value updation.

B. Pheromone System in Artificial Ant Colony System

Real ants actually become capable to generate the shortest available path from its source or nest to the destination or food. This process becomes valid to the whole colony by an indirect form of communication between these ants which is termed as Stigmergy. With resemblance to such a system in artificial ant colony system ant or the nodes of the graph is taken into the consideration. The time after which each ant proceeds to its neighbor node and deposit pheromone is set respectively. Further ant traverse the graph by the path probability which depends on the decision policy which says that at each node ants reads or senses the local information stored on the explicit memory allocated to it and use it in variable way to decide the next node. This local information is the stored partial paths and their cost in its initial stage with a feature of storing upcoming paths. After this step the next step is the deposition of pheromone which in its initial stage is set to some constant value. After which it is updated according to the following formula:

Pheromone Deposition is equal to,

$$C_p = L_p + D_p$$

Cp = Current Pheromone value at Node 'Ni'

Lp = Last Pheromone value at Node 'Ni'

Dp = Value of Deposition of Pheromone according the Setup.

These values are stored in the explicit memory provided to the ants in the form of table entries. In Artificial ant colony system pheromone evaporation is equal to value of time set during evaporation setup simulation. After such an arrangement now the actual approach divides itself in two parts first being the selection o0f shortest route whereby the extensions of Ant Colony System chooses the shortest path through following steps:

If N number of packets needs to be send from source to destination, then repeat step (i) to step (viii)

(i) For each N packet to traverse from Node 1 to Node 2

(ii) Check if Vp on Node 2 > Vpon Node 3 (Where, Vp= Value of Pheromone)

(iii) Store the path in table. Else If,

(iv) Vp on Node2 = = Vp on Node 3, Then Check if Rp on Node 2 > Rp on Node 3 && Rp on Node 3 < Rp on Node 4

(v) Store the path in the table, Else If, Vp on Node 2 = = Vp on Node 3 & & Rp on Node 2 = = Rp on Node 3

(vi) Compute the value using Objective function.

(vii) Store the path in the table.

(viii) Traverse the path, End If

End.

After the selection of shortest path the next step towards the efficient load balancing is the efficient Scheduling strategy in which a proper schedule for the task allotment to the respective host and the resource is determined. This is achieved by imposing the algorithm of shortest path in the main algorithm through following steps:

Input:

Number of Packets that needs to be send be N, Value of Pheromone Deposition be Vd, Value of Pheromone Evaporation be Ve, Time of Evaporation be T, Table of pheromone value based on maximum-minimum value be Tm, Table of pheromone values based on Rank value be Tr, Table of intermediate values of pheromone based on objective function Tf.

Output: Shortest Path from source to destination is S, Total Pheromone deposited in shortest path (Ts), and Time to send Packets (Tp)

Algorithm:

(i) Initialize the parameters.

(ii)For N number of packets to send follow step (iii) to step (x)

(iii)Calculate initial Tp

(iv)Set the value of pheromones on Node 1 and Node 2.

(v)Calculate Time to send packets Ts =Ts + Vd

(vi)If there are multiple paths from Node1 to Node 2

- Check Tm Else If Tr Else If Tf and select shortest path
- Add shortest path S = Vd + S
- Time to send packet Tp = Tp + Vd;

(vii)Count Time after sending N packets Ts

(viii)Total time Tt= Ts- Tsd

(ix) Apply Scheduling through Clustering

(x) End If

(xi)End

IV. Result Analysis

There is a nice saying that any work cannot be termed as good without the proper evaluation of its performance and utility. So by inheriting the saying this subsection stresses on a detailed analysis based on evaluation, interpretations and experimentations of proposed methodology and existing approach. Since the existing approach of load balancing using Naive Bayes theorem as described by Jia Zhao,Kun Yang [15] describes that their approach of balancing the unbalanced nodes through the concepts of Naive Bayes balances the nodes in a more proper manner for a simulated cloud computing environment so the proposed methodology and algorithm challenges the issue and proves that the work presented in this dissertation work is more efficient than the existing one through which is done on the basis of number of requested tasks and thereafter Make Span time is computed for the existing and the proposed methodology. Following figure 1.3 displays such scenario:

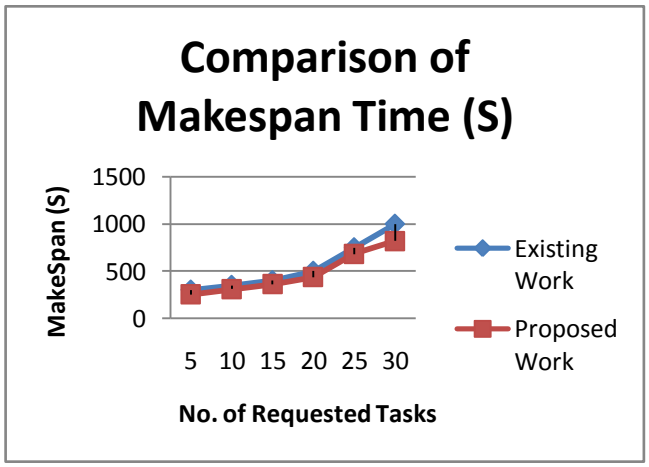

Fig 1.3: Analysis of Make Span Time of Existing and Proposed Approach

Similarly the capacity of handling the user requests and then fetching the resources for obtaining the response to its request is called as Energy. This consumption of energy is based on the capacity to access the resource 'Ri'. It is given by following formula:

$$E= 2.H.P+ (H-C)$$

Where, H is the number of user requests, P is the capacity of consumed energy by resources, and C is the processing cost.

When coming to the existing approach the consumed energy by the resources are much more than the proposed approach. In the table 1.1 below is the comparison of energy consumption between the existing load balancing technique and the proposed methodology. This analysis in table 1.1 is done on the basis of number of hosts:

Energy Consumption (Kwh)			
Number Of Hosts	Number of Virtual Machines	Existing Work	Proposed Work
10	5	1.54	1.2
10	10	1.57	1.3
10	20	2.34	2.1
10	30	2.78	2.5

Table 1.1: Analysis of Energy Consumption of Existing and Proposed Approach

As from above analysis it can be well analyzed that consumed energy of proposed scheme is much more less than the existing approach. After this analysis the next comparison of existing load balancing and proposed approach is on the basis of throughput. This in turns also explain that the proposed scheme is much more efficient in terms of make span time, energy consumption and throughput as well. The figure 1.4 below displays such scenario:

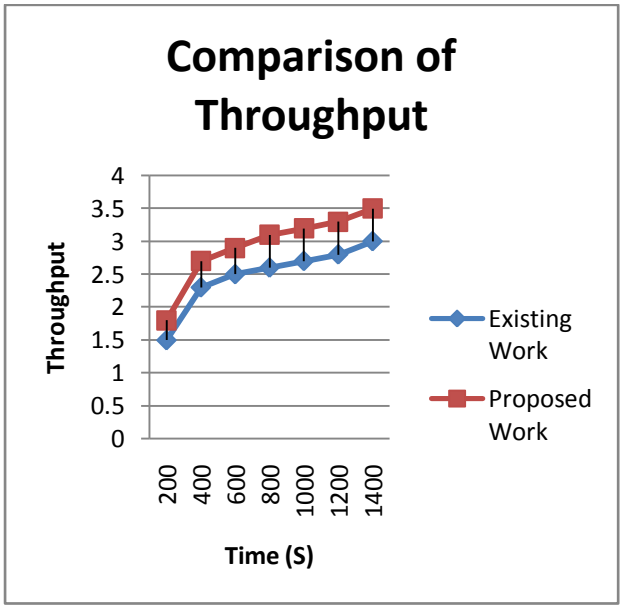

Fig 1.4: Analysis of Throughput of Existing and Proposed Approach

V. Conclusion

This paper focuses on the concept of load balancing through the extensions of Ant colony Optimization and justifies the work over the implemented heuristic approach by the results analysis. The authors have critically examined the issues and suggested this novel methodology. Also in the near future to make this proposed methodology to be adopted in real time environment exploration on the scheduling methodology and task deployment approach can also be taken into area of interest. Further incorporating the concepts of efficient and secure data sharing with this novel artificial ant colony system for load balancing in cloud computing environment would be taken as the future work.

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