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A Survey on Honey Bee Foraging Behavior and Its Improvised Load Balancing Technique

Tanvi Gupta[1], Dr.SS.Handa[2], Dr. Supriya Panda[3]
[1]*Assistant Professor,* [2,3]*Professor Manav Rachna International University SRM University Manav Rachna International University*

Abstract: ***Load balancing is one of the important concept of cloud computing, which helps in making the system stable by migrating the task from overloaded virtual machine to under-loaded machine .There are various load balancing techniques based on nature –inspired algorithms like genetic algorithm and ACO algorithm, which has certain limitations. This paper presents the survey on honey bee foraging behavior algorithm for load balancing in cloud computing. There are many advantages of it over other nature-inspired algorithm. For instance, there is a direct communication amongst bees about direction and destination of quality and quantity of food, also bees can calculate their present location from their past trajectory continuously, etc.***

Keywords: Load-balancing, virtual machine, honey-bee foraging, nature-inspired algorithm

I. INTRODUCTION

A. Cloud computing provides three major types of services:

1) Software as a service(SaaS
2) Platform as a service(Paas
3) Infrastructure as a service (IaaS)

The cloud service provider (CSP) provides on demand provisioning of Hardware like processing power, I/O, large amounts of storage etc. By utilizing virtualization, each user accesses the services of cloud through a virtual machine, where number of virtual machines share~~s~~ a single physical server. Cloud computing provides a service oriented platform for cloud users. Cloud is heterogeneous and dynamic in nature, and also servers of different capacity are available at data center. So, load balancing becomes one of the important concept of cloud computing. There are various challenges that need to be considered for load balancing in cloud computing:

a) *Overhead Associated:* Overhead is caused due to movement of tasks, inter process communication and this should be reduced so that load balancing algorithm works well.
b) Throughput: It is the number of tasks executed in fixed interval of time.
c) *Performance :* Performance can be defined as efficiency of the system, and it must be improved
d) *Resource Utilization:* This is used to test the utilization of resources. This should be maximum for an efficient load balancing algorithm
e) *Scalability:* The quality of service should be same if the number of users increases. The more number of nodes can be added without affecting the service.
f) *Response time:* can be defined as the amount of time taken to react by a load balancing algorithm in a distributed system. For better performance, this parameter should be reduced.
g) *Fault tolerance:* In spite of the node failure, the ability of a system to perform uniform load Balancing.

B. Load balancing can be broadly classified into two as:

1) Centralized Load Balancing(CLB)
2) Distributed Load Balancing(DLB)

In CLB, the single node takes care of the allocation of resources and scheduling decision whereas in DLB single node is not responsible for the allocation and scheduling decision.

Also, there are certain advantages of Load Balancing, such as scalable performance, secure application delivery, and stress free deployment. There are various nature–inspired algorithms; one of them is honey bee foraging algorithm. It states that a colony of honey bee[7] can extend itself over long distances as to find many food sources such as flower patches and then these bees harvest nectar or pollen from these sources. A small fraction of the colony finds the environment looking for new flower patches. When

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food source is encountered the scout bees go in the field surrounding the hive and check for quality beneficial. When they return to the hive, the scouts collect the food harvested. There is an area in the hive called as the "dance floor", where waggle dance is performed by the bees that found a very beneficial food. Through the waggle dance a scout bee passes the position of its search to idle spectator, which helps in the using of the flower patch. Here the duration of the dance is according to the scout's rating of the food source, to harvest the best rated flower patches more foragers get recruited. When dance is done, the scout return to the food source it found to see more food. Till the food is profitable, food sources will be posted by the scouts when they return to their hive. Foragers who are recruited recently may waggle dance as well, which will step-up the recruitment for highly profitable flower patches. This autocatalytic process will go on to find most beneficial flower patches.

C. There are also various advantages of honey bee over other nature-inspired algorithms [11]

1) The communication is direct. Bees employ a direct strategy by dancing in the nest (waggle dance). Their dance communicates distance and direction towards a destination and Quality and Quantity of food.

2) Bees are able to compute their present location from their past trajectory continuously. They can return to their starting point by choosing the direct route rather than retracing their outbound trajectory. (Path Integration).

3) For navigation they wander randomly and record the direction and other details along the path.

4) BCO algorithm is strong robustness, fast convergence and high flexible which allows adjustments and it represent specific knowledge of the problem by observing nature.

5) It can be used for solving multidimensional and multimodal optimization problems.

6) It is efficient when finding and collecting food, as it takes less number of steps.

7) It has ability to explore local solutions.

8) It is time saving process by structuring favorable parallel processing algorithm.

II. LITERATURE SURVEY

Honey bee behavior inspired load balancing of tasks in cloud computing environments (2013):L.D. Dhinesh Babu [10] states that Scheduling of tasks in cloud computing is an NP-hard optimization problem. Load balancing of non-preemptive independent tasks on virtual machines (VMs) is an important aspect of task scheduling in clouds. Whenever certain VMs are overloaded and remaining VMs are under loaded with tasks for processing, the load has to be balanced to achieve optimal machine utilization. In this paper, the proposed algorithm named honey bee behavior inspired load balancing (HBB-LB), aims to achieve well balanced load across virtual machines for maximizing the throughput. The proposed algorithm also balances the priorities of tasks on the machines in such a way that the amount of waiting time of the tasks in the queue is minimal. This paper illustrates that there is a significant improvement in average execution time and reduction in waiting time of tasks on queue.

1. Find capacity and loads of all VMs based on equations (2),(3),(4) and (5) Check system is balanced or not:
   If $\sigma <= Ts$
   System is balanced
   Exit.
2. Load Balancing Decision:
   If L > maximum capacity
   Load Balancing is not possible
   Else
   Trigger Load Balancing.
3. Group VMs based on load as LVM,BVM and OVM
4. Load Balancing:

Supply of Each machine in UVM is

$$Supply\ of LVM_j = Maximum\ capacity - \frac{\text{Load}}{\text{Capacity}}$$

Demand of Each machine in OVM is

$$Demand\ of\ OVM_j = \frac{\text{Load}}{\text{Capacity}} - Maximum\ Capacity.$$

Sort VMs in OVM by descending order.
Sort VMs in LVM by ascending order.
While LVM≠φ and OVM≠φ
For s=1 to # (OVM) do
Sort tasks in VMs by selection criterion (priority)
For each task T in VMs find machine $VM_d \in$ LVM such as
If(T is non preemptive)

$$T_h \rightarrow VM_d | min(\sum T_h) \in VM_d \text{ and } Load_{VM_d} \leq Capacity_{VM_d}$$

$$T_m \rightarrow VM_d | min(\sum T_h + \sum T_m) \in VM_d \text{ and } Load_{VM_d} \leq Capacity_{VM_d}$$

$$T_l \rightarrow VM_d | min(\sum T) \in VM_d \text{ and } Load_{VM_d} \leq Capacity_{VM_d}$$

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If (T is preemptive)

$$T_h \rightarrow VM_d | min(\sum T_h) \in VM_d$$

$$T_m \rightarrow VM_d | min(\sum T_h + \sum T_m) \in VM_d$$

$$T_l \rightarrow VM_d | min(\sum T) \in VM_d$$

Update the number of tasks assigned to VM_d.
Update the number of priority tasks assigned
Update Load on both VMs,VM_d.
Update sets OVM,LVM,BVM
Sort VMs in OVM by descending order.
Sort VMs in LVM by ascending order.

Figure1: Algorithm by L.D. Dhinesh Babu[10]

A. Honey bee Behavior Inspired load balancing (HBB-LB)(2014)

Harshit Gupta.et.al [7], state that to find food over long distances a colony of honey bee can extend itself and then from these sources the bees harvests nectar or pollen. A small fraction of the colony finds the environment looking for new food sources. So, scout bees go in the field surrounding the hive when the food source is encountered and check for quality beneficial. The scouts collect the food harvested, when they return to the hive. There is an area called “dance floor” in the hive , where waggle dance is performed by the bees that found a very beneficial food. A scout bee passes the position of its search to idle spectator through the waggle dance. Here the duration of the dance is according to the scout’s rating of the food source, to harvest the best rated food sources more foragers get recruited. the scout return to the food source it found to see more food, when dance is done. Till the food is profitable, food sources will be posted by the scouts when they return to their hive. Foragers who are recruited recently may waggle dance as well, which will step-up the recruitment for highly profitable food sources. This autocatalytic process will go on to find most beneficial food sources.

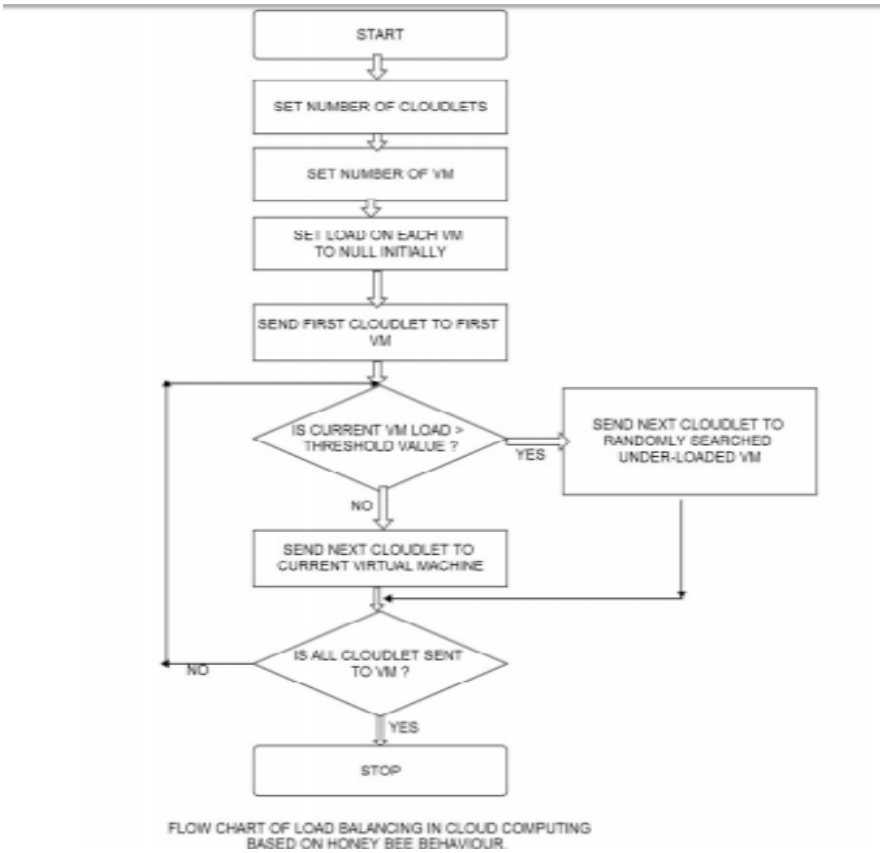


Figure 2: Flowchart of load balancing in cloud computing based on honey bee behavior[7]

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In the above Figure2, threshold value taken by author is 75. The above figure depicts that the tasks are to be send to the under loaded machine and like foraging bee the next tasks are also sent to that virtual machine till the machine gets overloaded as food sources exploitation is done by scout bees. Honey bee behavior inspired load balancing [7] improves the overall throughput of processing and priority based balancing focuses on reducing the amount of time a task has to wait on a queue of the VM. Thus, it reduces the response of time of VMs.

B. Randomized Honey bee foraging behavior for load balancing(2016)

Monika Rathore.et.al [8] proposed the Honey bee behavior galvanized load balancing (HBB_LB). It ignores the idle condition of virtual machine then finishes up within the wastage of interval. In this paper, accumulated honey bee forage technique with random stealing is used for task allocation and load leveling. Current load is calculated once tasks area unit is assigned to the virtual machines. For this a threshold value is decided, if the load value is below threshold, the task from the overloaded virtual machine is migrated or transferred to the neighbor virtual machine. Figure 3 below shows the flow chart of VM programming and cargo balancing victimization rudiment. Also, there are 3 management parameters in rudiment:

1) Population size (SN) is that vary of food sources (or solutions) inside the population. Metal is capable the number of used bees or spectator bees.
2) Most Cycle vary (MCN) refers to the foremost vary of generations.
3) Limit is utilized to diversify the search, to examine the amount of allowable generations that each non-improved food offer is to be abandoned.

Let= {V1, V2, V3… VN} is a set of N virtual machines and Task= {T1,T2, T3, … ,TK} of K task to be regular and processed in VM. All the machines are unrelated however are paralleled. Programming is non-preemptive which suggests that the process of the tasks on VMs can't be interrupted.

C. Algorithm

1) Get the available virtual resources from data center.ie, V1, V2… Vm, and list of tasks T=T1, T2…Tn by the user.
2) When a request comes, the scheduler finds the Expected computing capacity for tasks
3) Compute the average computing capacity for each task using the equation,
4) Find the load of VM
5) Compute the average system load
6) Compute Load

The probability value is checked for confinement within the range 0 to 1 as,

a) If (0< P()<1)
b) Under loaded list []=VMi
c) Els
d) Overloaded list[]=VMi

7) Select Under loaded VMs and compares its Average computing capacity with Expected computing power of tasks. Check if (ACAP< =ECAP), then VMs are marked as Fittest and tasks are allocated to it.
8) After task allocation to VMs, some VMs remains underutilized. This leads to wastage of processor time Check.

If (system load < = TRS_LOW) Perform Randomization
Select VMs with (system load > TRS_HIGH) Randomly Select jobs from those VMs and allocate to VMs with (system load < = TRS_LOW)
The algorithm will make
(N-1/N) attempts on an average to steal a job, if there are "N" VMs.

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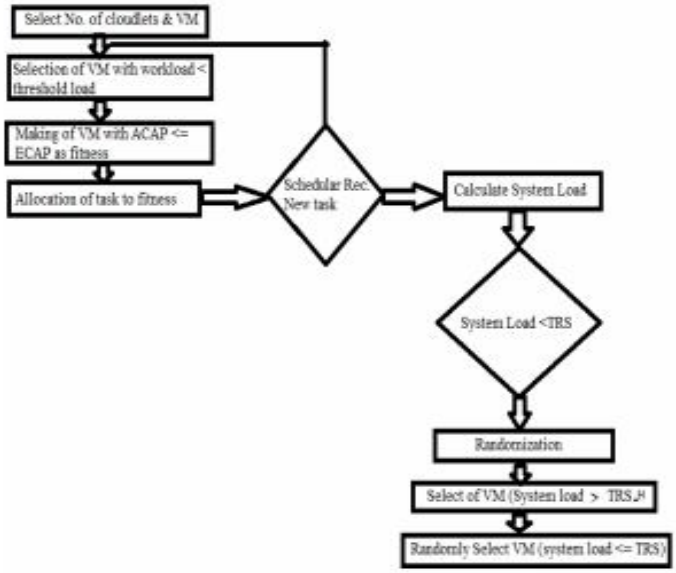


Figure3 : Flow chart of VM programming and cargo balancing victimization rudiment.

D. Artificial Bee Colony Load Balancing (2014)

Artificial Bee Colony (ABC) algorithm [1] was proposed by Karaboga [4], [5], [3], [6]. Also, this algorithm is inspired by honey bee foraging algorithm. In ABC model, there are three kinds of honey bee to search food sources, which include scout bees search for food source randomly, employed bees search around the food source and share food information to the onlooker bees, and onlooker bees calculate the fitness and select the best food source. Let $VM = \{V1, V2, V3, \ldots, VN\}$ be a set of N virtual machines and $Task=\{t1, t2, t3, \ldots, tK\}$ be a set of K- tasks to be scheduled and processed in virtual machines. All the machines are unrelated but are paralleled. Scheduling is non-preemptive which means that the processing of the tasks on VMs cannot be interrupted. The flowchart of the VM scheduling and load balancing using ABC algorithm is shown in Figure 4.

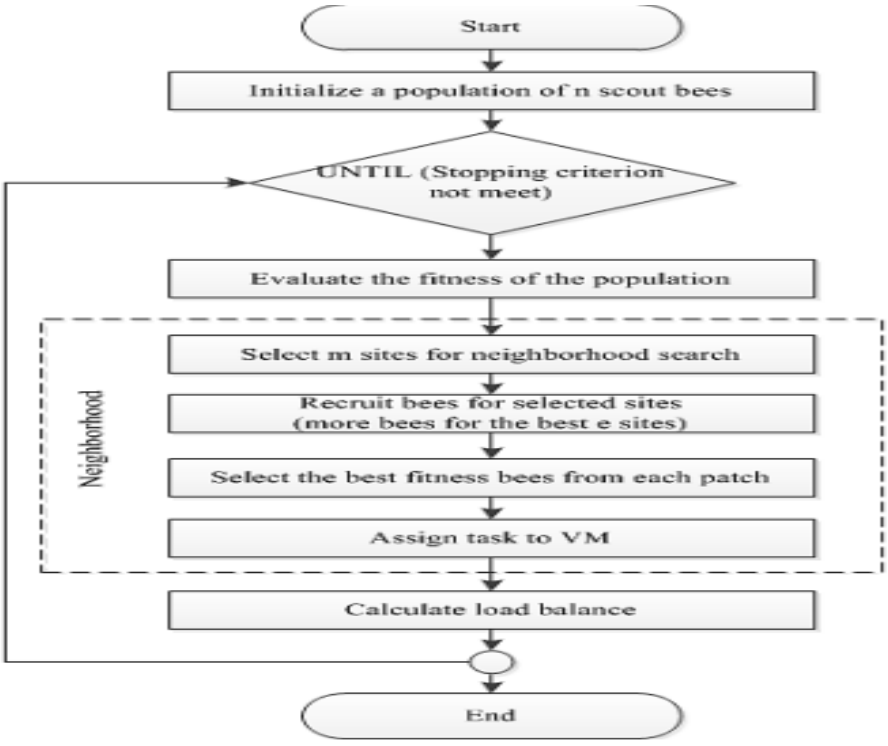


Figure 4: Flowchart of VM scheduling and load balancing using ABC algorithm

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E. Novel Honey Bee Inspired Algorithm for Dynamic Load Balancing In Cloud Environment (2015)

Honey bee inspired load balancing [2] is a dynamic load balancing algorithm. But, there are some limitations in traditional Honey bee inspired algorithm such as:- 1)uncertainty in quality parameters and Also throughput of the system is not improved as expected. tasks are scheduled in non-preemptive manner. So, to overcome above problems proposed algorithm is developed which supports other QOS parameter while selecting optimal VM at IAAS level and can also work with preemptive tasks. The proposed algorithm works in preemptive manner and considers tasks priority while migrating them from one node to another. This algorithm considers multi-objective optimization for selecting optimal VM for load balancing and for assigning priorities to the task. Results are evaluated in Cloud Sim simulator.

F. Multi-objective –optimization

Multi-objective optimization is a part of multi-criteria decision making problem, which involves more than one objective function that can be optimized at the same time. The multi-objective optimization problem can be stated as , min[f1(x),f2(x),...,fn(x)], x∈S, where the integer n is the total number of objectives and the set x is the feasible set of decision vectors. The feasible set is generally assigned by constraint functions.

Figure 5 shows the algorithmic steps of novel honey bee optimization.

G. Load Balancing Algorithm

Step1: Find capacity and load of all VMs. Then check the value of 'σ' and determine whether the system is balanced or not. If balanced then exit.

Step2: Take load balancing decision based on load. If load> max.capacity then exit.

Step3: Group VMs based on loads.

Step4: Apply Load balancing and find demand of each VM in OVM

1) Sort VMs in OV

2) Sort VMs in UV

3) If there are more than one VM in UVM

4) VMd=Call Pareto optimal VM finding ------ A Preemptive scheduling of the tasks- --------B

Step5: Update the no. of tasks assigned to VMd

Step6: Update sets OVM, BVM and LVM

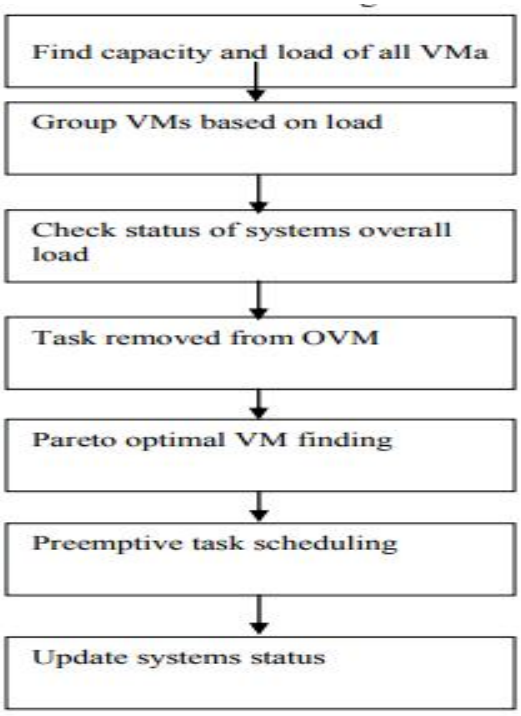


Figure5: Algorithmic steps of novel honey –bee foraging algorithm

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H. Load Balancing of Virtual Machine Using Honey Bee Galvanizing Algorithm in Cloud(2015)

Within the proposed methodology [9], with random stealing, increased honey bee forage technique is employed for cargo leveling and task allocation. Current load is calculated, once tasks are allotted to the VMs. The task is transferred to the neighborhood Virtual machine; if the VM becomes overloaded whose load worth is below threshold. Honey Bee forage technique employs suburbanized load balancing methodology and task transfer are disbursed on the fly. The formula so ensures performance of the system and avoid system imbalance.

Figure 6 shows the Flow sheet of VM algorithm and cargo balancing victimization rudiment.

Additionally, there are 3 management parameters in rudiment:

1) Population size is that the range of food sources (or solutions) within the population. Metal is capable the quantity of utilized bees or spectator bees.

2) Most Cycle Range (MCN) refers to the most range of generations.

3) Limit is employed to diversify the search, to see the quantity of allowable generations that every non-improved food supply is to be abandoned.

Let VM = {VM1, VM2, VM3,…, VMN} be a set of N-virtual machines and Task= {task1,2, task3, … ,K} of K-tasks to be regular and processed in VM. All the machines are unrelated however are paralleled.

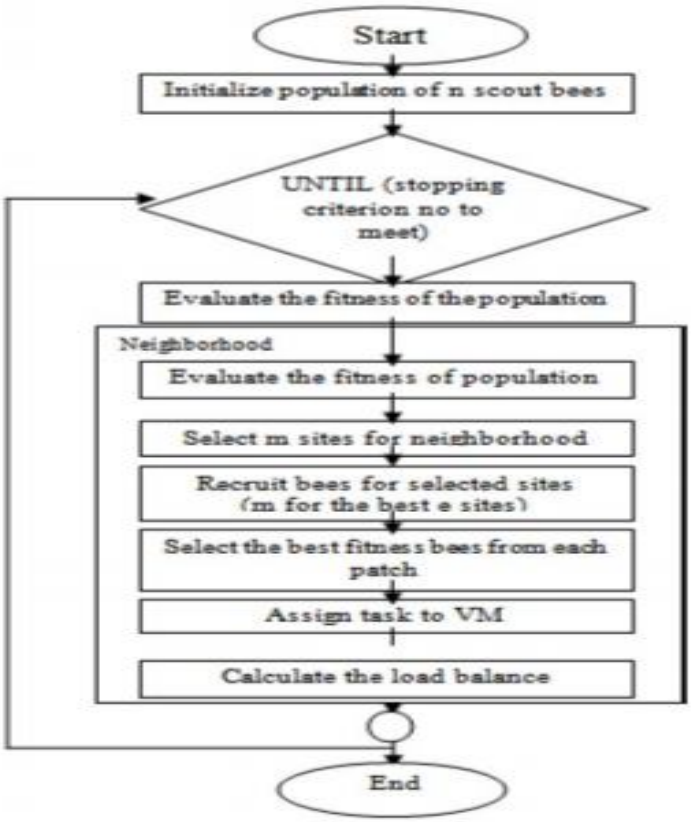


Figure6: Flow sheet of VM algorithm and cargo balancing victimization rudiment

Distributed Load Balancing in Cloud using Honey Bee Optimization (2016): S.Jyothsna.et.al [11] states that In the dynamic load balancing algorithms, there is continuous variation in the workload. So there were some decision making algorithms are required. In this decision making system, there were firstly central decision maker, so no other node is decision maker except central node in view of that that if the central node becomes fail, subsequently the total system fails and hence the reliability becomes less. Secondly organization decision maker in which the total system should be not speaking in to groups hence that the communication cost becomes shortened. But taking decision without considered the mass system load therefore that global optimization explored a major suffering. The advantage of proposed algorithm is efficient load addition mechanism, excited distributed decision maker, migration selection model and full of zip file migration algorithm for a bigger load balancing. The disadvantage is degradation of the amass system due to the migration side effect.

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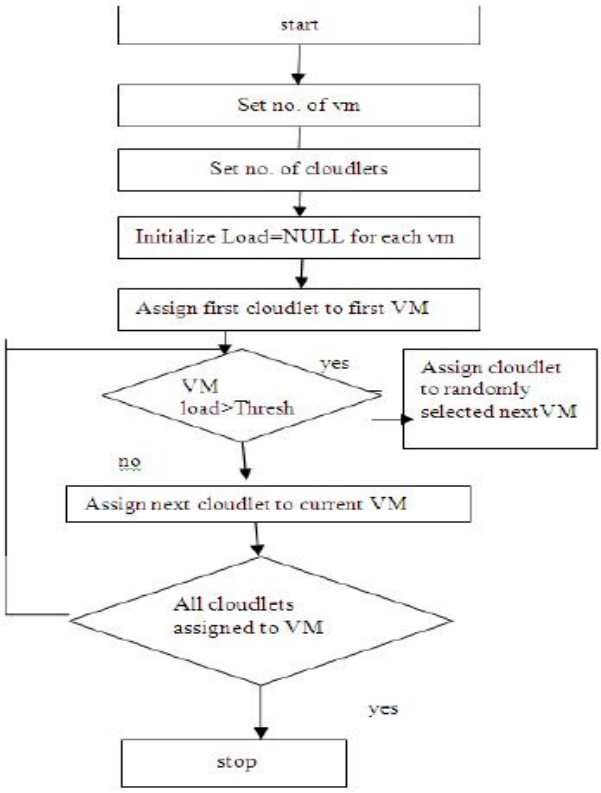


Figure 7: Flowchart for dynamic load balancing using honey –bee optimization

Above Figure7 states that The task can be considered as a bee and it is searching for a less loaded VM(food source),when it finds the suitable VM assignment of task to VM takes place, and the next task also tries to assign to the same VM ,this assignment continues until the load on the VM reaches threshold value. Once the threshold value is reached, the search starts to find another less loaded VM and the task is redirected to that VM.

III. CONCLUSION

Table1 below represents the summary of the honey bee foraging technique for load balancing. This survey highlights that there are lots of research being done on this technique and lot more can be done for further improvement.

S.No	Algorithm name in the year	Author name	Abstract	Proposed work for which type of task	conclusion	Future work
1.	Honey bee behavior inspired load balancing of tasks in cloud computing environments(2013)	L.D. Dhinesh Babua , P. Venkata Krishna	Aims to achieve well balanced load across virtual machines for maximizing the throughput.	Non-preemptive independent task	This algorithm balances the load, and also takes into consideration the priorities of tasks that have been removed from heavily loaded Virtual Machines. It also improves the overall throughput of processing and priority based balancing focuses on	Plan to extend this kind of load balancing for workflows with dependent tasks and considering other QoS factors also.

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					reducing the amount of time a task has to wait on a queue of the VM. Thus, it reduces the response of time of VMs.	
2.	Honey bee Behaviour Inspired load balancing (HBB-LB)(2014)	Harshit Gupta , Kalicharan Sahu	improvement in average execution time and reduction in waiting time of tasks	Non-preemptive independent task	improves the overall throughput of processing and priority based balancing focuses on reducing the amount of time a task has to wait on a queue of the VM. Thus, it reduces the response of time of VMs	Plan to improve by considering other QOS factors.
3.	Randomized Honey bee foraging behavior for load balancing(2016)	Monika Rathore, Sarvesh Rai, Navdeep Saluja	To optimize answer and higher latent amount the load ought to be balanced among full and below loaded virtual machines.	Non-preemptive independent task	algorithm is minimizing the complete execution time of giving tasks. The algorithms in applications with the number of tasks varied from fifty to k evaluated.	considering different QoS factors of tasks, hybridized with whole completely different meta-heuristic algorithms and components makes it robustly viable for continued utilization for additional exploration and improvement prospects in additional years to come back
4.	Virtual Machine Scheduling Management on Cloud Computing Using Artificial Bee Colony (2014)	B. Kruekaew and W. Kimpan	to analyze the difference of VM load balancing algorithm and to reduce the makespan of data processing time.	Non-preemptive independent task	solve the Virtual machine scheduling management under the environmental changing of the number of VMs and requests on Cloud computing	the preemptive Virtual machine scheduler operating with independent and heterogeneous tasks on Cloud computing will be focused.
5.	A Novel Honey Bee	Chandrakanta	uses the concept	Pre	follows the foraging	this honey bee

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	Inspired Algorithm for Dynamic Load Balancing In Cloud Environment (2015)	Korat1, Piyush Gohel	of pareto dominance‟s weighted sum approach for selecting optimal VM and also work with preemptive task scheduling., to maximize the throughput	emptive, independent task	behaviour of honey bees for allocating VMs to the tasks and uses preemptive task scheduling. Pareto dominance concept is used for both selecting optimal VM and for setting priorities to the tasks and here multiple QOS parameters are considered	inspired load balancing algorithm can be extended for dependent tasks .Calculation of assigning priority of task and finding optimal VM can be improved by considering other QOS parameters. There are many others method for getting pareto optimal solution. Algorithm can be develped for those methods
6.	Load Balancing of Virtual Machine Using Honey Bee Galvanizing Algorithm in Cloud(2015)	Monika Rathore, Sarvesh Rai, Navdeep Saluja	to improved load balancing in cloud to utilize its resources on cloud, is applied to optimize the scheduling of Virtual Machine (VM) on Cloud. The most focus is to research the distinction of Virtual Machine load scheduling to cut back the makespan of processing time that is total length of the schedule.	Non-preemptive and independent task	presents implementation formula which can resolve the Virtual machine programming management at a lower place the dynamic atmosphere of the amount of VMs and requests on Cloud computing	by considering alternative QoS factors of tasks. The performance of the given algorithms can even be augmented by variable totally different parameters.

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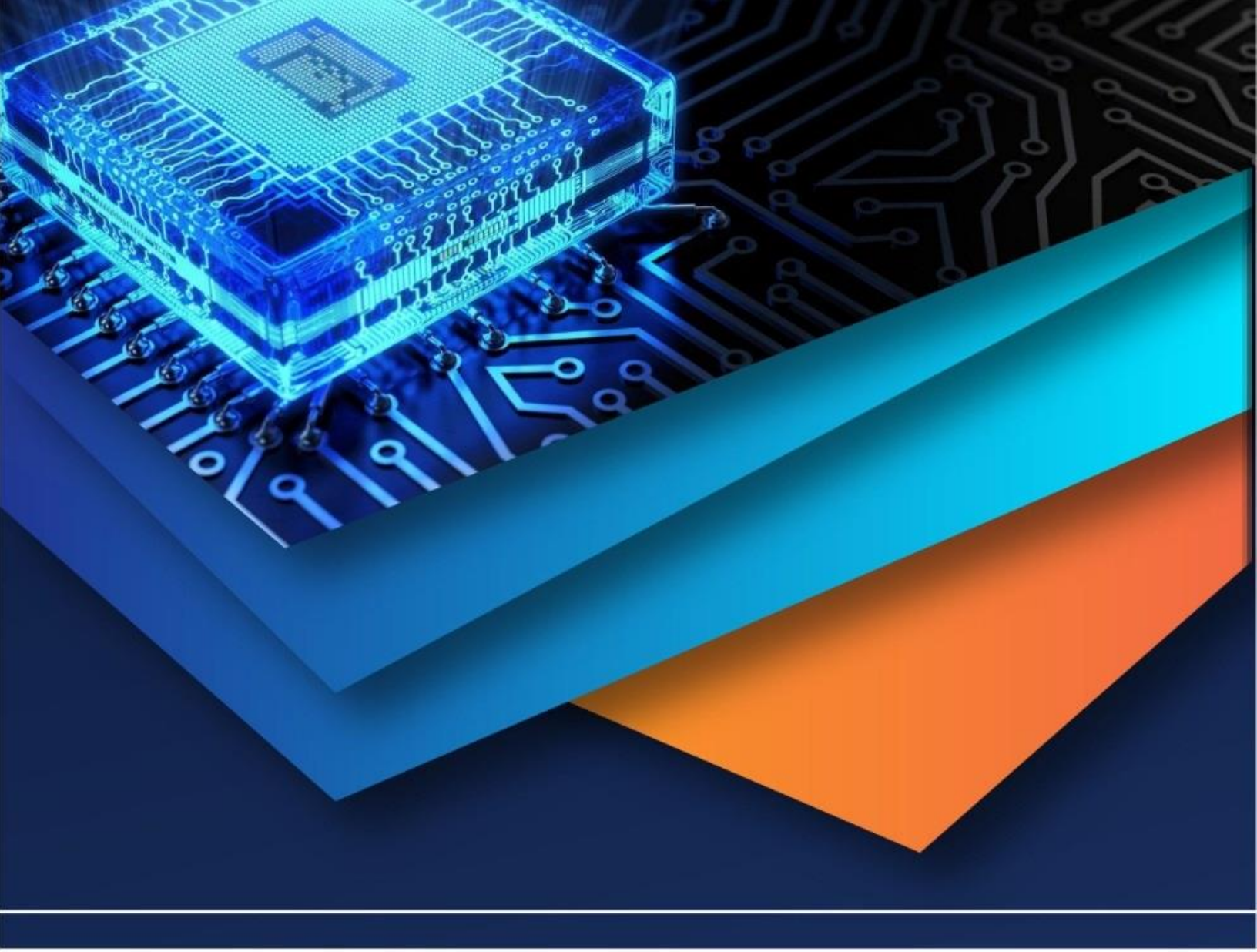
7.	Distributed Load Balancing in Cloud using Honey Bee Optimization(2016)	S.Jyothsna	presents the application of honey bee optimization for load balancing in cloud computing and compares with genetic and ACO algorithms. comparatively this is the most suitable algorithm as the cloud is dynamic nature.	Non-preemptive and independent task	improves the overall throughput of processing and priority based balancing focuses on reducing the amount of time a task has to wait on a queue of the VM.	----------

Table1: Summary of the survey done on honey bee foraging technique for load balancing

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