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Virtual Machine Migration in Cloud Computing using Artificial Intelligence

Kavita A. Sultanpure, L. S. S. Reddy

Abstract*: Cloud Computing is known as the most fast evolving computing platform which is the future of supercomputing. A time will come when everyone would be on the cloud network and at that time, it would be essential for the cloud network to perform well. Cloud is also a computing server and hence, it takes every order as million instruction set. These instruction sets are often referred as Jobs. Scheduling an instruction set or job requires a lot of computing and one wrong placement may lead to wastage of energy units. The proposed work has taken these matters in a very serious manner and has designed an architecture diagram which deal with the job scheduling process from start to end. The proposed algorithm covers placement of the job at server, monitoring of the server to prevent them from overloading and when they are exhausted from jobs, the creation of Virtual Machine. The presented algorithm improves the Modified Best Fit Decreasing Algorithm by introducing artificial intelligence to it. Job handling has been done by using one of the finest swarm intelligence techniques known as Cuckoo search Algorithm that monitors the performance of the servers or host in order to check that they do not get overloaded. The proposed architecture has been evaluated on the basis of energy consumption, Service Level Agreement violation and total number of migrations.

Keywords* : Artificial neural network, cuckoo search algorithm, MBFD algorithm, VM migration.

I. INTRODUCTION

cloud computing be mainly used to offer services to the users, which are linked through internet. The services are retrieved by the user from the data, which is saved into the server that is usually known as Cloud. Cloud is used to determine the complications occur in network connections and online services. The main aim is to offer the services using virtualization technology by sharing the hardware resources. It could is mainly categorized into 3 levels of services in cloud computing [1]. These services are named as the IaaS (Infrastructure as a Service), the PaaS (Platform as a Service) and the SaaS (Software as a Service) and are defined below:

- IaaS (Infrastructure as a Service): It used to deliver virtualized computing resources above the internet. IaaS service is fast and less expensive and used to operate workload without purchasing and handling the infrastructure.
- PaaS (Platform-as-a-service): It is a license purchasing paradigm whose infrastructure is dependent upon the cloud. PaaS has no control in VMs and hence, increasing the security risks [2].
- Software as a Service (SaaS): It uses software as a resource that provides a complete platform for the users via internet. SaaS has no control on data processing. This is because of the huge number of users are using the software [3].

Cloud computing allocates the computing tasks to the available resources that are prepared from a huge number of computers. In this work, the virtual machines along with their SLA parameter are described initially. A VM is a computer file that act as an actual computer. It runs similar to the other programmers and delivers the outputs same as the outputs delivers by the host operating system (OS) itself. Virtualization technique uses VM migration schemes to enhance the performance of cloud and optimizes energy efficiency. In virtualization, virtual machine monitor is used to execute the software among various hardware and operating systems (OS). The main function of virtual monitor is to allocate hardware resources, control OS instruction, OS processing and OS interrupt handling. Thus, we can say that virtualization is mostly used to minimize power consumption, IT cost and hardware [4].

A. Energy handling in cloud data centre

To minimize the consumption of energy of the server in cloud computing has now become the main area of this field. Since in cloud, there are number of nodes that are executed at the same time, therefore, a large amount of energy is consumed during the establishment of the server. The formation of large server causes to emit carbon dioxide and hence, increased the operating cost [5].Thus, it become necessary for reducing the energy consumption that is possible only by using the concept of VM migration. The sum of energy consumed in a cloud is measured by using formula defined below:

$$E_{cloud} = \int_{t_1}^{t_2} E_{nodes} + E_{s/w} + E_{storage} + E_{others} dt \quad (1)$$

Where E_{cloud} is the total consumed energy at cloud, $E_{s/w}$ is the energy consumed at the deployment of software, $E_{storage}$ is the total energy consumed in storing the data and E_{other} is the total energy consumed in other operations.

$$E = E_{CPU} + E_{mem} + E_{disk} + E_{mainboard} \quad (2)$$

E_{cpu} is the total energy consumed due to CPU utilization, E_{mem} is total energy consumed due to memory management, E_{disk} is the energy consumed due to disk storage,

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* Correspondence Author
Kavita A. Sultanpure*, Research Scholar, CSE Department, Koneru Lakshmaiah Education Foundation, Andhra Pradesh, India. Email: kavita.sultanpure@gmail.com
Dr. L.S.S. Reddy, Vice Chancellor, Koneru Lakshmaiah Education Foundation, Andhra Pradesh, India. Email: delssreddy@kluniversity.in

$E_{mainboard}$ is the consumption of energy due to mainboard processing.

The total cloud energy consumption will be equal to energy consumption of nodes represented by E_{nodes}, Storage energy consumption represented by $E_{storage}$ and other energy consumption sources. Every node takes some memory to get

stored and hence consumed some energy for sure and represented by E_{mem}. In the similar manner E_{disk} would be the disk space energy consumption.

Here, s/w represents switch and mem represents memory.

The work focuses on optimal usage of Virtual Machine over physical machine to reduce the energy consumption and SLA violation. A number of VMs are integrated into a single physical machine. This will assist for reducing the energy consumption by putting the idle server into an active mode. For every migration, there is a possibility of SLA violation [6].

B. Green cloud computing

The concept of green cloud computing is introduced for lessening energy consumed by the PCs connected to the servers. Green word means environment friendly and the idea is developed in 1987[7]. By using the concept of cloud computing, the nodes in the network keep track of total energy consumed in order to fulfill the requirement of user. Green cloud computing mainly consists of two elements such as carbon emission directory along with green cloud offers [8]. These two elements consider the efficient energy of every cloud provider and hence, make their services green [9]. On the user side, the Green Adviser has a significant role in the observation and choosing the Cloud services based on the user QoS (Quality of Service) requirements, and guaranteeing lower carbon emission to provide service to the user.

Fig. 1 represents the green cloud architecture in which user U wants to send its request to the central server and the central server gets its done using the green cloud manager which performs the desired operations with the help of virtual machine considering efficient energy management architecture.

Generally a user uses some of the services (SaaS, IaaS, Paas) provided by the users and the process for serving them must be energy efficient. Similarly on the cloud side, every cloud layer must be green conscious [10].

A comparative analysis of VM migration has been shown in Table I in the form of table defining the proposed methods, tools used with the outcome being achieved.

The research paper mainly contains four sections. Section I is the introduction section which briefs about the research areas, core development patterns in green cloud and a glance of existing techniques. Section II briefs about the material and methods used. Section III evaluates the results and compares it with different scenarios and section IV concludes the paper.

II. MATERIAL AND METHOD

A. Modified best fit decreasing algorithm (MBFD)

The MBFD algorithm is used to set schedule rules to migrate the VMs (virtual machines) between data center, which adapts to changes in demand. In cloud computing, load balancing becomes an interesting topic because the user demand increases day by day. But the load balancing is not

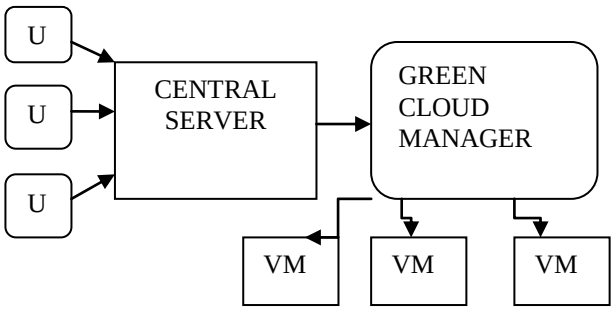

Fig. 1. Green Cloud Model

controlled then it leads to wastage of resources and hence, the problem of overloaded and under loaded host would be in the server. Therefore, to overcome this problem, the techniques through which the resources are allocated in the cloud server dynamically are needed. Hence, MBFD algorithm is used in this research for virtual machine sorting in the decreasing order.

Fig. 3 shows the flowchart for the modified best fit decreasing algorithm.

Algorithm 1: Modified best fit decreasing
Input: host list and VM list
Output: Allocation of VMs
VM list sort reducing utilization ( )
For each Vm in VMlist do
minPower$\leftarrow max$
if Allocated host$\neq null$**then**
Allocate VM to allocated host
Return Allocation

B. Cuckoo search algorithm

It is a swarm intelligence based algorithm used to solve the optimization problems. Optimization is the process in which a system is modified in order to make features to work more effectively and obtained better performance of the system. Cuckoo search algorithm is developed in 2009 by yang and Deb. The algorithm is motivated with the bird cuckoo and used to resolve NP problem. The cuckoo birds cannot make their nest and hence they place the eggs in other birds' nest [19].

Few of host birds may link directly with the interrupting cuckoo. If the egg which is recognized by the host bird has not their own egg, then the egg built a new nest. The egg in the nest shows a solution with the cuckoo egg that depicts a novel and better solution. In simple words, it is being concluded that the egg in which every nest may have numerous eggs represents a set of solutions along with a cuckoo egg. This work has utilized cuckoo search algorithm for solving job scheduling problem [20]. Fig. 4 shows the flowchart for the Cuckoo search algorithm

Algorithm 2: Cuckoo search algorithm
Begin
Objective function g(x)
Create preliminary population for n host nest
Calculate fitness and rank eggs
While (u>MaxGeneration) or End Criterion
u = u + 1
Obtain a cuckoo arbitrarily and create novel solution

Table- I: Comparative analysis of existing techniques in virtual migration

Reference	Proposed methods	Tool used	Outcomes
[11]	An online algorithm to solve the problem defined under the problem title has been proposed. This algorithm is being utilized for reducing the amount of energy cost which is drawn by the main grid.	MATLAB (Matrix Laboratory)	Minimize energy cost that comprises of electricity bill and battery. The cost of conventional generators is less.
[12]	Minimum Migration and DVFS.	.NET platform	Metrics, namely, energy consumption, SLA violation and number of VM migration is being used. The research has attained SLA violation with 40% interval among thresholds.
[13]	SCAVP (structural constraint ware virtual machine placement), Grouping of Minimum Maximum Virtual Machines.	JAVA platfor m	The research has executed the VMs from ranges from 20 to 100. The issue of huge data size has been determined. The time-complexity of the planned algorithm has been calculated. Application with accessibility constraint is less composite as compared to no constraints. The complexity has been reduced by 30 % for both type of constraints.
[14]	ProfminVmMaxAvaiSpace is utilized for increasing the profit by less number of VMs that have most accessible space. ProfminVmMinAvaiSpace is utilized for reducing the profit by reducing the cost by lessening Virtual machines that have least accessible space.	CLOUD SIM	SLA violation of presented algorithm has been reduced up to 13% and the migration is being lessened up to 49 %.
[15]	MPC Algorithm designed for Dynamic Capacity Control	MATLAB (Matrix Laboratory)	The outcome has shown that the proposed work is efficient for more dynamic conditions where the variation in terms of demand takes place.
[16]	For task scheduling, the research has considered two algorithms, namely, Dynamic Cloud min-min scheduling and dynamic cloud list scheduling.	CLOUD SIM	The research has dealt with the reduction of energy consumption that has been achieved. It has been seen that the dynamic cloud min-min scheduling has performed better as compared to dynamic cloud list. Dynamic cloud min-min scheduling has less execution time as compared to Dynamic Cloud list algorithm
[17]	The research has proposed three novel algorithms, namely, first fit decreasing algorithm, and the other two are dependent on the algorithm of better fit decreasing.	JAVA	The power degradation up to 3.24% has been shown. The problem of energy efficiency take place in VM migration by utilizing three original algorithms has been determined.

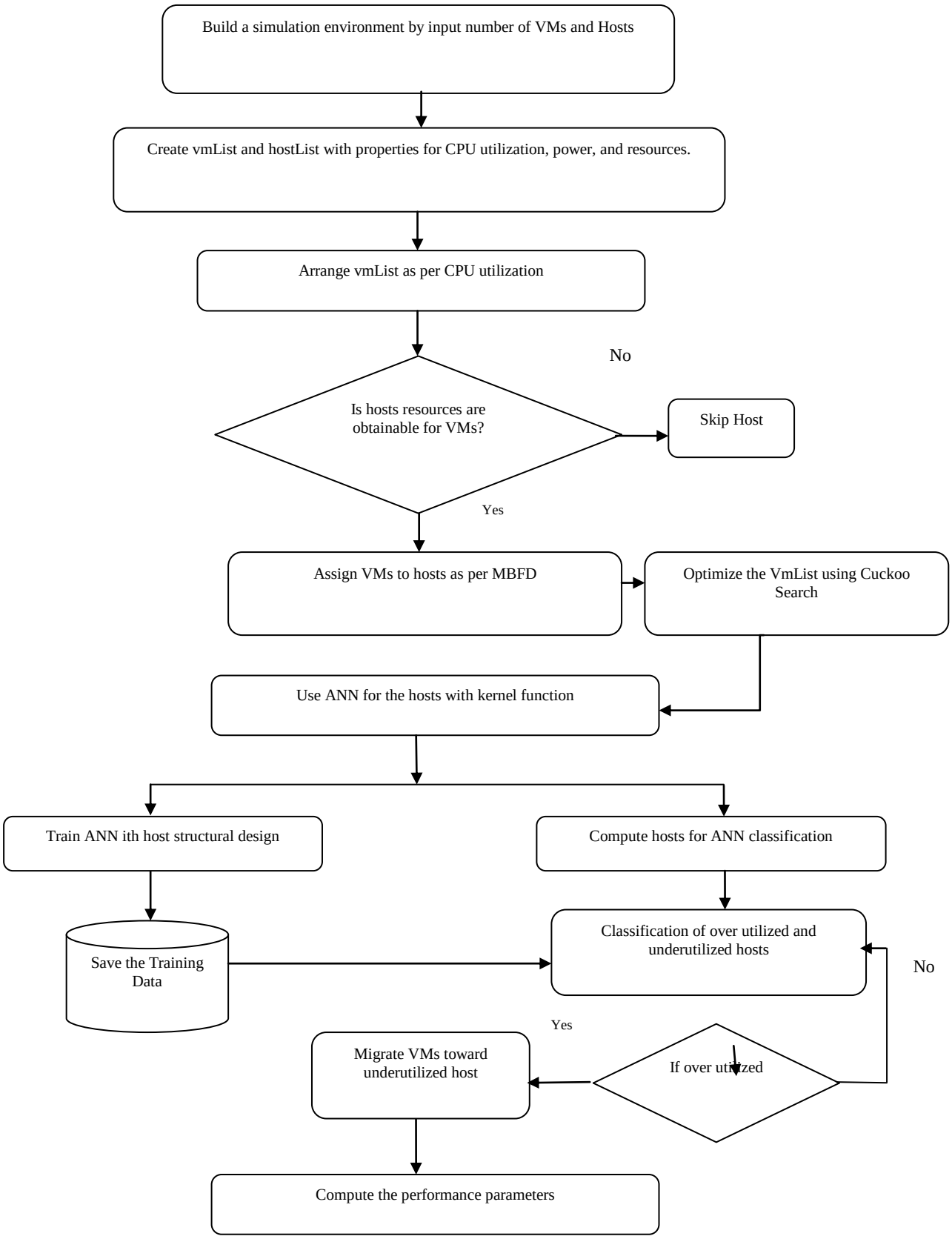

Fig. 2. Proposed work flowchart

allocated host ← *null*
for every *host in host list* ***do***
If host *has sufficient resource for Vm* ***followed by***
power ← ***estimatepower*** (***host***, ***Vm***)
If *power<manpower* ***then***

Allocate host ← *host*
Mini power ← *power*
Calculate quality for fitness, G_i
Decide an arbitrary nest j

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if (G_i>G_j) *Change j with novel solution*
end if
Worst nest is abandoned by probability P_b *and novel nest is generated*
Calculate Fitness and grade the solutions and calculate the existing best
end ***while***
Post process outcome and visualization
end begin

C. Artificial neural network algorithm (ANN)

ANN is a defined as a computational model being inspired from neural network. In this, a number of nodes are interconnected to each other through a wire which is used to transmit the signal from one node to other. ANN mainly consists of three layers named as input layer, hidden layer as well as output layer. In the hidden layer, weight is used to adjust the signal strength according to the threshold value [21]. The signal is entered into the network via input layers and travels through the hidden layer to reach at the output layer. The aim of neural network is to resolve the problem in the similar fashion as that a human brain would [22]. Fig. 5 shows the flowchart for the ANN algorithm.

Algorithm 3: *ANN algorithm*
Initialize *the ANN*
Net= newff (Training Data, Group, Neurons)
Where, TRAINING DATA=All data
GROUP= No. of classes
Neurons=50
Initialize *the training parameters*
Epoch*=1000*
Levenbergmarquardt Algorithm
Performance*= MSE, gradient, mutation, and validation checks*
Net= Train (NET, TRAINING DATA, GROUP)
Retur*n Net as output of ANN*

III. RESULTS AND DISCUSSION

For executing the above mentioned algorithms such as MBFD, CS and ANN, some hardware and software are needed. During the placement process of VMs, the Virtual machines are allocated to their respective host according to the resources (CPU utilization, Memory) as per MBFD algorithm. After that, VMs are migrated from over-utilized host towards under-utilized host; number of migrations would be less by using SVM technique with kernel function. With the reduced energy consumption, number of migrations and SLA violation would be less.

The Fig. 6 and Table II depict the SLA violation obtained for previous as well as for the proposed work. X- Axis represents the lower utilization whereas the Y-axis depicts the SLA violation. From the above figure, it is clear that the SLA violation for the previous work is more whereas for the proposed work when Cuckoo search and neural network is used SLA violation reduced. The SLA violation after applying the proposed algorithms is reduced by 52 %. SLA has been calculated using the below formula:

$$SLA\ violation = \sum_{i=1}^{q} SLA_v\ (host, VM)$$

Where, q is the number of iterations.

Table- II: SLA violation comparison

Lower utilization	Rajkumar- Anton	Swarm neural
0.117	0.09	0.01
0.120	0.04	0.015
0.125	0.15	0.02

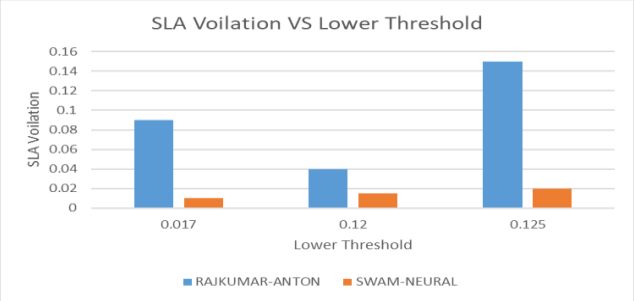

Fig. 6. Comparison of SLA violation

Fig. 7 and Table III shows the energy consumption values obtained for previous as well as for the proposed work. X-Axis represents the lower utilization whereas the Y- axis shows energy consumption. From the figure, it is concluded that the energy consumption value obtained for the previous work is more than the value obtained for the swarm neural algorithm. When cuckoo search algorithm along with neural network is applied, the energy consumed is reduced by 73.17%. Energy Consumption has been computed using the below formula:

$$Energy\ consumption = \sum_{i=1}^{n} VM_e + \sum_{i=1}^{k} host_e$$

VM_e – Signifies the energy of VM

$host_e$ - Signifies the energy of host

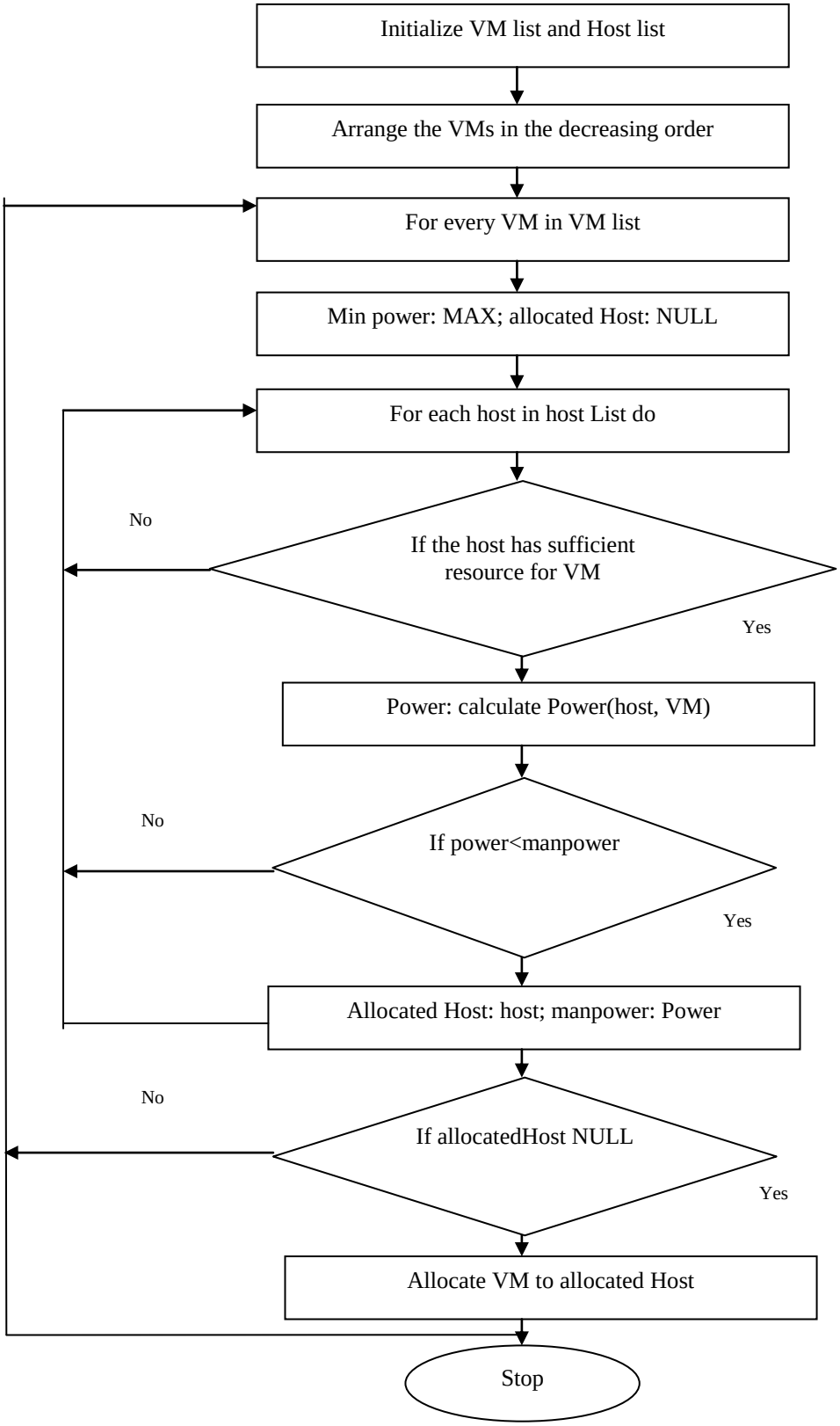

Fig. 3. MBFD Algorithm Flowchart

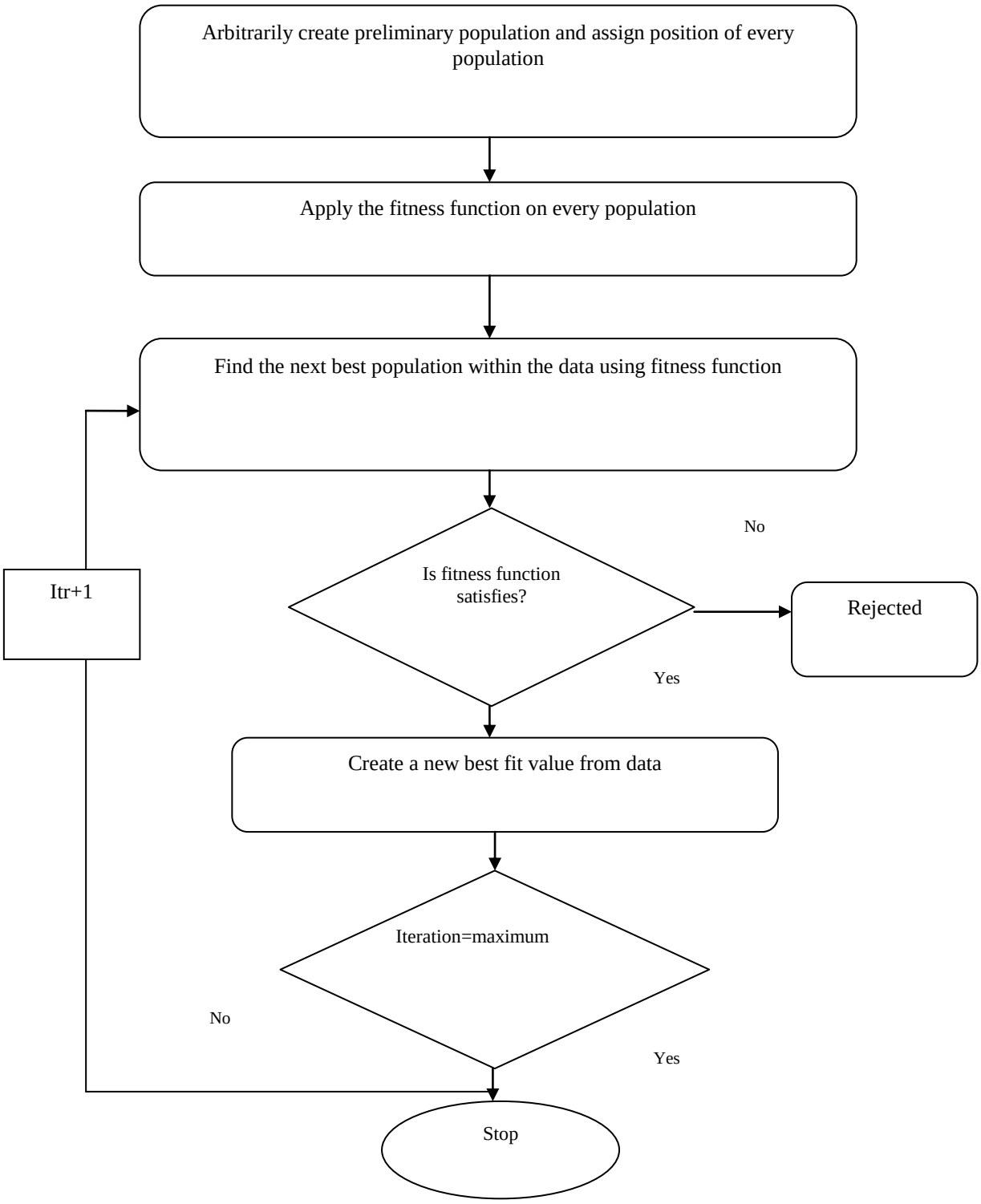

Fig. 4. Cuckoo search algorithm flowchart

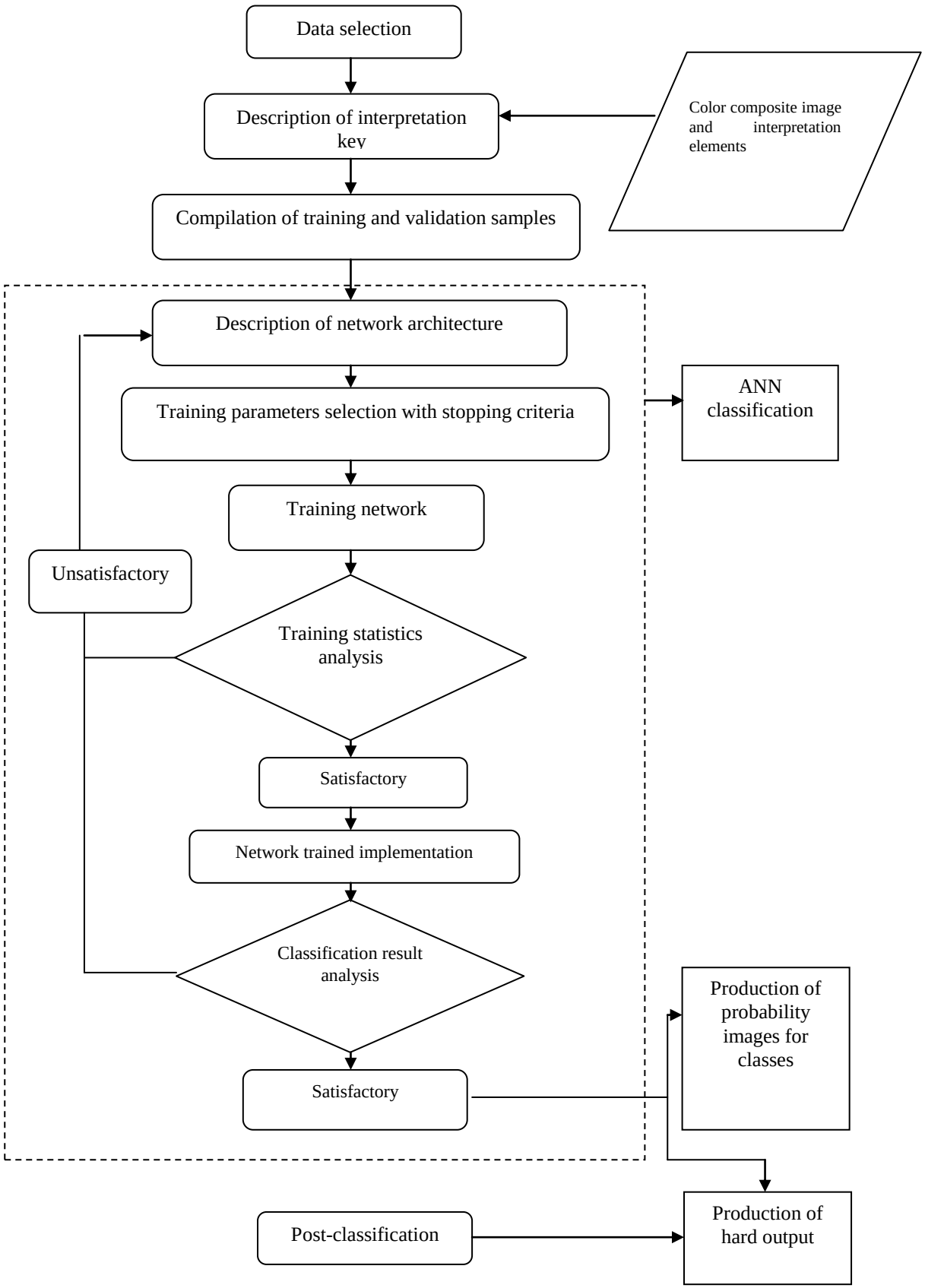

Fig. 5 ANN algorithm flowchart

Table- III: Energy consumption comparision

Lower utilization	Rajkumar-Anton	Swarm neural
0.117	41	0
0.120	20	1
0.125	65	35

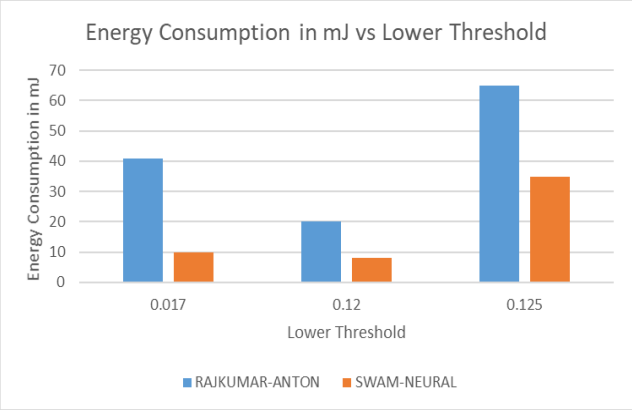

Fig. 7. Comparison of Energy consumption

Fig. 8 and Table 4 represent the amount of migration values obtained for previous as well as for the proposed work. X-Axis represents the lower utilization whereas the Y-axis shows total number of migration. From the figure, it is concluded that the number of migration value obtained for the previous work is more than the value obtained for the swarm neural algorithm.

When cuckoo search algorithm along with neural network is applied, then the number of migration is reduced by 11%. Mathematically, total number of migration can be represented as:

$$Energy\ consumption = \sum_{i=1}^{n} VM_e + \sum_{i=1}^{k} host_e$$

Table- IV: Total number of migration comparison

Lower utilization	Rajkumar-Anton	Swarm neural
0.117	11	10
0.120	4	3
0.125	12	11

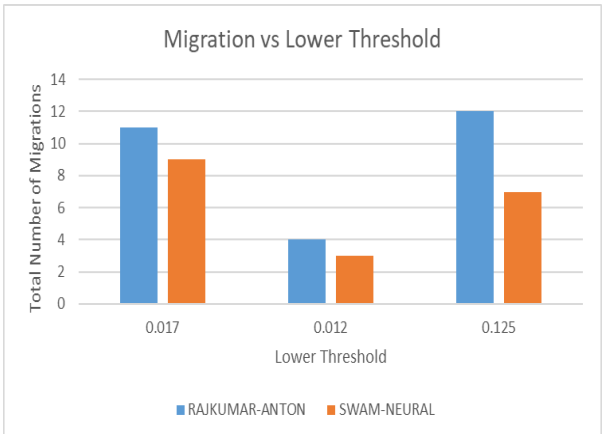

Fig. 8. Comparison of total number of migration

IV. CONCLUSION

VM is migrated from an under-utilized server for a resource-rich server in order to power off the existing effective resource utilization. Throughout this process, VMs are migrated without disturbing the job in the running state. In this research paper, to sort VM list in decreasing order as per the CPU utilization, MBFD algorithm has been used and later the VMs to host has been allocated according to MBFD algorithm. MBFD algorithm is used to minimize the SLA violation, energy consumption and the number of migration along with ANN. ANN is used whenever migration is required, it must be migrated to some Host. Hosts are already occupied, so, it provides the load mechanism of servers to the NN input Layer and understands the completion pattern of host from time t=0 to t=n. It is concluded that the QoS metrics like SLA violation, energy consumption and total number of migrations are reduced by 52%, 37%, and 11 % respectively. The current scenario opens a lot of futuristic approaches for the researchers. The future research workers may try their hand in performing hybridization over swarm intelligence and natural computing algorithm. The future approaches may also contain the variation of neuron architecture in the proposed machine learning scenario.

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AUTHORS PROFILE

Ms. K. A. Sultanpure is Research Scholar in K L University, Andhra Pradesh, India. She is working as an Assistant Professor in Pune Institute of Computer Technology, Pune, Maharashtra. She has done BE in Computer Engineering, ME in Computer Engineering from Pune. University.

Dr. L.S.S. Reddy is Vice Chancellor at Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India. He has done Ph. D. in Computer Science from Bits Pilani, India. He has total 12 honors and awards. His areas of interest are cloud computing, parallel computing.