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NATURE INSPIRED VIRTUAL MACHINE ALLOCATION AND MIGRATION UNDER CLOUD ENVIRONMENT

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Abstract

Cloud Computing is a rapidly expanding computing platform that is seen as the foundation of supercomputing. There will come a day when everybody will be connected to the cloud network, and then it will be critical for the cloud infrastructure to run properly during that period. In the current scenario, with the rising popularity of cloud computing, the network virtualization is gaining attention thorough out the world. The network virtualization functions to balance the work load of servers by distributing the task among various virtual machines without compromising SLA conditions. However, this idea has an adjoining challenge of energy consumption. In the present paper, authors had proposed a CS optimized VM allocation and migration architecture which takes advantage of multi-layered neural architecture. The identification of the best VM using CS the information is passed to SVM and the trained support vectors are fed to the neural network. The simulation analysis conducted over 90 VMs had demonstrated that the proposed design proved to minimize the energy usage by reducing the number of VM migrations while exhibiting least SLA violations. The modeling analysis is carried out in Matlab, and it demonstrates that this research leads in a greater decrease in energy usage than previous research.

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1. Introduction

The convergence of IT effectiveness with flexibility in the form of cloud computing is a significant development. There are no limits on how much information may be stored in the cloud, and it can also be hidden from other users. There are several advantages of cloud computing, including on-demand resource distribution, Qality of Service (QoS), and flexibility that make it appealing to both academics and businesses [1]. Cloud computing allows cloud consumer and cloud - based data centers to share resources. A Cloud Service Provider (CSP) manages the server and distributes the services to customers. The internet acts as a middleman between the consumer and the cloud - based data centre, sending the client requests to the data centre and returning the user's reply. Large amount of data can be sent simultaneously using CSP [2].

Everything in cloud computing is offered as a service. The paradigms into which the services fit include IaaS (Infrastructure as a Service) [3-4], PaaS (Platform as a Service) [5-6], and SaaS (Software as a Service) [7-8]. Cloud storage is getting more accessible and cheaper as the cloud becomes more widespread [9]. IaaS is a cloud computing service that provides virtualized computer resources via the internet. When users don't need to buy or maintain infrastructure to run any workload, then may use the IaaS service. Using PaaS is a way to buy licenses for software that relies on the cloud. As a result of PaaS's lack of control over VMs, security vulnerabilities have increased [10]. Rather than relying just on software, SaaS relies on the internet to provide a full platform for its customers. SaaS does not have any say in how user data is processed. There are so many people using the programme [11] that this is unavoidable.

Regardless of the fact that several optimization approaches have been created for cloud systems in the past, there is always opportunity for improvement, given the cloud's continually expanding popularity. Ever more servers are being added to the public cloud because more and more people sign up, but this extra utilization also increases the load, energy usage, and resources necessary. During allocation of resources or distribution in cloud computing, there are several problems. So, in cloud computing, virtualization is employed to alleviate the problem of resource allocation [12]. In the cloud, Virtual Machines (VMs) are used to do virtualization. The goal here is to move running VMs from high-traffic nodes to low-traffic nodes in an efficient way. VM migration strategies are used by the cloud virtualization approach to improve quality and energy effectiveness.

The VMs are interacted with using Physical Machines (PM). Maintaining QoS and reducing energy usage are only some of the benefits of virtualization technology for CSPs [13]. In a cloud environment, there are many VMs. Each VM has a specific job to accomplish. Several problems can emerge in the cloud computing environment, but the most prevalent ones include energy usage, VM migration frequency, and Service Level Agreements (SLAs) that are not being met. In order to deal with the complex difficulties raised by cloud computing, a variety of methods are employed. It is possible to achieve some degree of improving energy efficiency through VM migration, but human selection of nodes in both input and output layers is required [14-15]. Incorporating bio-inspired techniques to develop a relatively close solution for the datacenter is another possibility [16].

The main contributions of this paper are:

1. It provides the extensive review of the work that has been done in context of VM migration in terms of nature inspired approaches.

2. It highlights the modified algorithms that are proposed (MBFD, CS and ANN) under the cloud computing constraints.

3. It provides the comparative analysis of the proposed combination approaches under the factors like SLA, energy and migration count with existing model.

The paper is divided in to the sections as per their relevance. The work already done in the context VM migration has been elaborated in 2^{nd} section. The proposed techniques are defined in section 3rd. Results and the inference drawn has been defined in section 4th. Conclusion is highlighted in section 5^{th} of the paper.

2. Related Work

The work that has been done by the researchers in context of the VM migration along with the usage of bio-inspired approaches has been highlighted in this section.

The efficient implementation of many apps with the lowest power usage is the most significant component of energy-efficient cloud computing [17]. Much cloud computing research being done to lower power usage in data centres in order to solve this [18-21]. It has recently been recommended to reduce power usage by reducing the amount of VM migrations among VMs and PMs. As a result, the overall energy usage is greatly lowered [22]. In order to deal with the problems of datacenters, evolutionary algorithms are also used. The family gene technique is used for experimental research, and the migration rate and power consumption are significantly reduced [23]. Using a cloud server's energy consumption as a starting point, authors have developed alternative ways. Enhanced Cuckoo Search (ECS) has been the algorithm proposed by the researcher. Energy utilization, workload, and SLA breaches are the parameters that are used to evaluate the outcomes. This may be enhanced by using a fuzzy approach with unique criteria for VM selection.

Using a work scheduling methodology built for cloud VM distribution, the authors in [26] describe a machine learning method based on this approach. It is the author's primary goal to allocate VMs in a way that consumes the least amount of energy. Similarly, in [27], the authors described an approach based on the VM placement task allocation procedure. During the suggested algorithm's job scheduling procedure, it begins at the beginning of the job and finishes at the conclusion of the task. The solution uses a Cuckoo Search (CS) algorithm that also tracks the data in cloud server to determine even if it is not overburdened. Using goal parameters inspired by nature, the authors of [28] conducted an in-depth study on multi-objective VM allocation methods that included detailed mapping of virtualized datacenters. Researchers found that most VM allocation and migration strategies in recent times focus primarily on allocation of resources and energy conservation owing to the high number of VM migrations, according to the study results. A hybrid approach [29] combining an Artificial Bee Colony (ABC) with the Bat algorithm has also been proposed to reduce VM migration power consumption. Naive Bayes (NB) classification is employed in the suggested study. Using the random key CS, they developed an algorithm that reduces energy usage and decreases SLA violations. [30] Detection of the future state, which corresponds to a reduction in VM migrations, is the goal of the study.

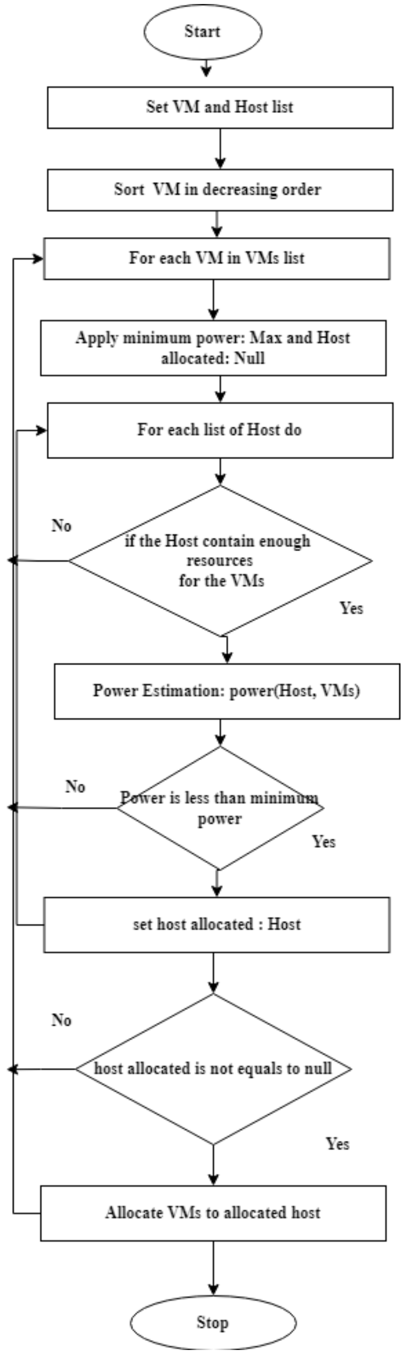
In the cloud computing context, QoS is a major issue. QoS metrics such as reduction of virtual machine migration duties, make-span, price, and security are discussed in [31]. Requests will be processed according to the suggested algorithm without disrupting the SLA. Later on authors offered a work [32] to minimize energy usage with the amount of VM migrations, SLA breaches, and QoS that is particularly developed for this purpose. EABC (Enhanced Artificial Bee Colony) is a new approach to VM migration that is designed to use as little power as possible. A meta-heuristic approach to AntPu led in the dynamic placement of VMs inside PM to maximize resource utilization while minimizing SLA violations in datacenters [34]. As a further aspect of this notion, it comprises selecting the most efficient VM for migration. An energy-efficient situation may be achieved by reduction in the count of VM migrations and thus it is necessary [35-36]. Several recent research works are done to optimize the VM migration processes, QoS, quality of experience (QoE) and energy [37-41].

One of its earliest cloud computing ideas that has gained a lot of traction is the idea of overutilization. At first look, the algorithm employs the Modified Best Fit Decreasing (MBFD) method to allocate the VMs over the PMs. CS, SVM, and ANN are all used to implement the suggested work. Rule sets and resource allocation utilizing VMs are both possible with MBFD.

MBFD is primarily used for scheduling restrictions that are arranged in highest to the lowest. The MBFD algorithm is used in this study. The VM may be moved between data center and the needs of the user, and the ability to adapt to those needs is provided. Because of the rising need for datacenters, this is a critical consideration. Keeping the server's load under control is impossible. As a result, the server is constantly being overwhelmed and under loaded. This means that MBFD allows the server to automatically assign resources in order of decreasing. The MBFD produces VM allocation as its result. A total of 90 VMs has been employed in this work. Figure 1 illustrates the proposed MBFD's workings.

Swarm intelligence, the foundation of CS, is utilized to identify the optimal solution to a wide variety of issues. System performance and quality can be improved through optimization. The CS technique is mostly used to handle scheduling issues for work. The CS technique is used in the suggested study. CS-SVM is used in the proposed work. Linear and non-linear issues are solved using the Support Vector Machine (SVM). It is able to classify datasets in a variety of ways. The SVM algorithm's primary objective is to determine the appropriate decision criterion for categorizing n-dimensional space. Hyperplanes are also recognized as the best choice boundary. Support vectors are the hyperplane points selected by SVM for the formation of SVM.

ANNs may be used to train any system based on the task at hand. SVM and CS are used to implement ANN in the proposed study. A threshold value is kept in the hidden layer of an ANN, and weights are used to alter the signal accordingly. Figure 2 depicts the suggested ANN's operation.



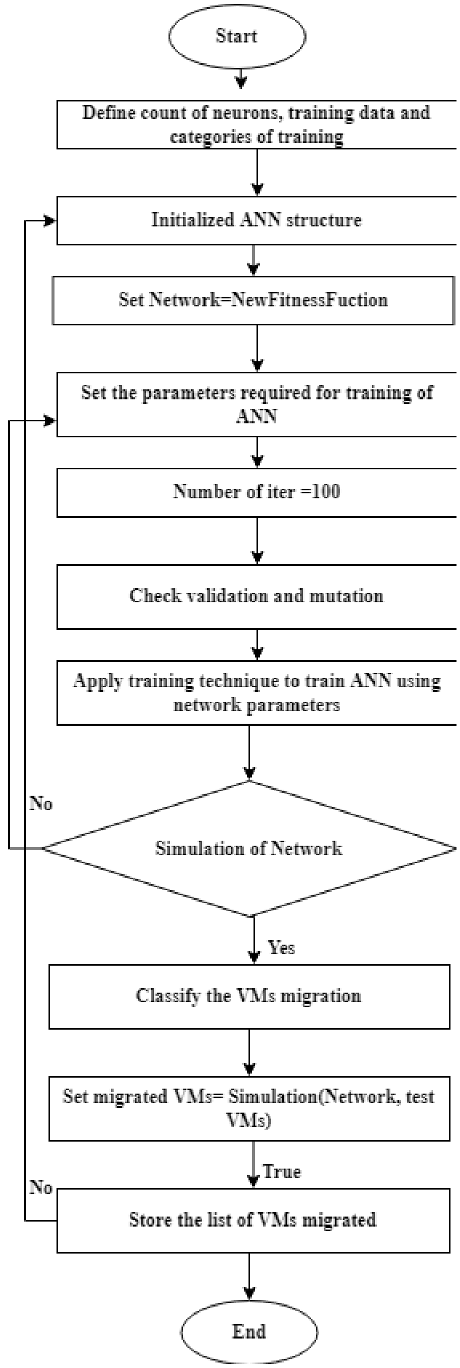


Figure 1. Proposed MBFD approach. **Figure 2.** Proposed ANN approach.

4. Results and Discussion

Matlab has been used to conduct the experimental investigation of the suggested method to handle the energy, migration, and SLA concerns of the cloud centre. The algorithm has been tested in a simulated environment in order to better understand how it works in the real world. The MBFD technique is used to assign VM resources to their relevant hosts during the placement process. The main metric examined in this study is the decrease in the count of VM migrations and the associated energy usage.

VM migrations, breaches in SLA, and energy use are all covered in the proposed research. Proposed scenarios include CS-SVM, CS-SVM-ANN, and the existing one is EA-ABC + SVM. Table 1 lists the various VM migration, SLA breaches, and energy use metrics. In the following image, one can see how much progress has been made as a result of the suggested work. As previously stated, the variance of metrics, as well as the VM count, is being analyzed under the increasing VM count from 10 to 90.

The variation of the VM count with respect to the migration count has been depicted in figure 3 for the approaches CS-SVM, CS-SVM-ANN, and EA-ABC + SVM. In the similar manner variation of the VM count with respect to the SLA violation count has been depicted in figure 4.

At last the VM count variation in context of energy usage has been depicted in figure 5.

Table1. Analysis of the proposed approaches under the VM count for metrics.

VM Count	Migration Count			Violation Count			Energy Usage		
	Proposed CS-SVM	Proposed CS-SVM-ANN	Existing (EA-ABC +SVM)	Proposed CS-SVM	Proposed CS-SVM-ANN	Existing (EA-ABC +SVM)	Proposed CS-SVM	Proposed CS-SVM-ANN	Existing (EA-ABC +SVM)
10	10	8	9	23	22	24	25	24	30
20	12	11	12	28	27	30	32	31	38
30	14	11	12	70	71	74	70	69	73
40	24	21	22	92	90	93	91	89	95
50	26	22	23	102	100	106	106	99	112
60	41	37	39	118	116	120	124	120	128
70	53	50	52	120	121	124	150	145	155

80	61	56	59	128	126	130	152	140	158
90	71	67	69	155	150	162	194	184	198

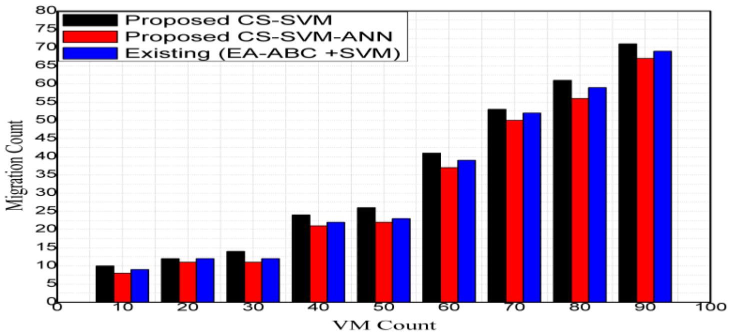


Figure 3. VM count effect on migration count.

Figure 3 above describes the VM count effect on the VM migrations count. The graph's x-axis shows the range of VMs from 10 to 90. The graph's y-axis represents the count of successfully executed VM migrations. The average of CS-SVM for migration count is 3.33 % and 1.66% higher than of CS-SVM-ANN and EA-ABC+SVM respectively. But CS-SVM-ANN is having migration count on average 1.66% less than that of EA-ABC+SVM. As the quantity of VMs increases, the number of nodes and migrations increases proportionately. It's because SVM, ANN, and CS employ faster coverage speeds to detect global optimization to select more precise hosts for VM allocation with decreased detection time.

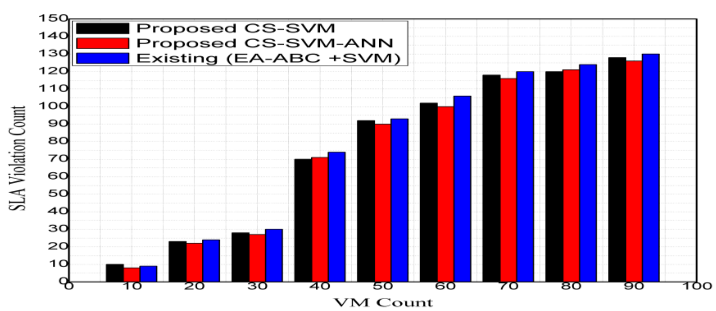


Figure 4. VM count effect on SLA violation.

VM migrations in the cloud necessitate a reduction in SLA breaches. The above figure 4 shows the improvement in terms of SLA violations for the CS-

SVM, CS-SVM-ANN, and EA-ABC+SVM approaches. There are 90 VMs used that are described in the x-axis of the graph. The average of CS-SVM for SLA violation count is 1.44% higher than of CS-SVM-ANN and 3% lesser than EA-ABC+SVM. But EA-ABC+SVM approach is having violation count on average 4.44% higher than that of CS-SVM-ANN. The CS-SVM-ANN provides better results as compared to other approaches as having less violation count.

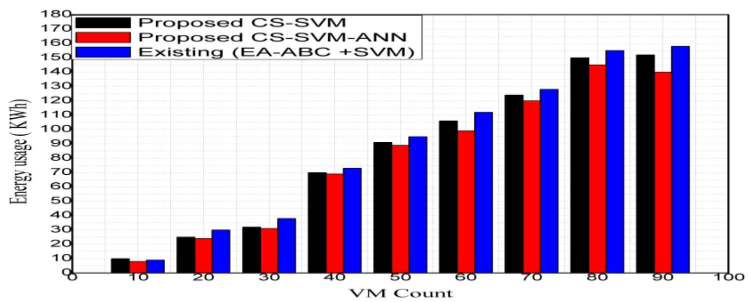


Figure 5. VM count effect on energy usage.

VMs have been shown to have a significant impact on total energy usage. Figure 5 describes the improvement in terms of energy usage for the CS-SVM, CS-SVM-ANN, and EA-ABC+SVM approaches. The average of CS-SVM for energy usage is 4.77% higher than of CS-SVM-ANN and 5.22% lesser than EA-ABC+SVM. But EA-ABC+SVM approach is having energy usage on average 9.55% higher than that of CS-SVM-ANN. The CS-SVM-ANN provides better results as compared to other approaches as having minimal energy usage.

Here, the process of highly efficient VM allocation and migration design is undertaken without sacrificing energy resources and shows the least SLA breaches.

5. Conclusion

To help minimize the total number of migrations, this paper details a novel technique that leverages nature-inspired algorithms to more accurately determine which VMs should be relocated. The CS method is combined with SVM and ANN in this article's proposed solution. VM migration count, SLA breaches, and energy usage are just a few of the indicators that have been used to evaluate efficiency in three different ways. Comparison results have shown that the proposed CS-SVM-ANN algorithm outperforms the CS-SVM and EA-ABC+SVM. The average values of the VM migration count, SLA violation count, and energy usage for the CS-SVM-ANN as 1.66%, 4.44%, and 9.55% lesser than EA-ABC+SVM respectively. Similarly CS-SVM-ANN approach is effective than CS-SVM for the VM migration count, SLA violations, and energy usage. In the future, it is possible to optimize additional characteristics such as complexity, security assaults, and federated learning in order to enable data centers achieve better outcomes in the cloud environment.

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