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Allocation and Migration of Virtual Machine using ABC and SVM based Optimization Strategy

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Abstract
Cloud computing is one of the widely used technology to handle massive data generated at the cloud data center. To analysis this big data number of VMs are generated at the server end to balance load of PMs. When VMs are allocated to PMs resources are utilized to power this system. This process at times involves wastage of resources such as energy and Service Level Agreement (SLA) that drastically increases when unnecessary migrations occur to balance the overloaded PMs. Therefore, in the paper author proposes an energy efficient VM allocation and migration framework that is wise enough to minimize the number of migrations and reduces the instances of SLA violations. The idea here is to rank the available VMs according to their current load while considering the dynamics of energy and SLA violations using hybrid optimization involving Artificial Bee Colony (ABC) and Support Vector Machine (SVM) followed by machine learning architecture. The simulation analysis using 1000 iterations demonstrated reduced energy consumption and SLA violations achieved by minimizing the required number of migrations for load balancing of the PMs. This proved to achieve an effective resource management of cloud data centers.
Keywords: VM allocation, VM migration, SLA, energy consumption, cloud data centers.

1. Introduction

In the present era, the cloud computing has become a necessity of information technology industry. The data and information sharing over the internet has become a day-to-day activity.The applications are generating huge amount of data that is constantly channelized over the internet, that need to be stored. To resolve the issue of storage space, various types of so-calledbig data are collected and stored on the cloud server to enable the data access from anywhere using internet. The Microsoft, Google, IBM and Amazon had emerged as some of the key cloud service providers. However, the computing performance of cloud data centers is challenged in terms of storage space and limited energy resources [**Rathod and Reddy, 2017**].

It a study it was analyzed that the average resource utilization of a cloud data center approximates to around 30% however, the energy consumption under idle state may even reach70% of the total power consumption of the data center. Hence, lots of energy gets wasted unnecessarily. Moreover, the server cannot be even left with small work load. [**Zhang et al., 2019**]. Hence, researchers had proposed various methods such as consolidation, task mapping, virtualization and migration to identify the under loaded and overloaded machines to conserveenergy.

1.1. Virtualization in cloud computing

The paper takes the advantage of the virtualization technology. The power management issuehas been resolved with the concept of virtualization which allows the overloaded servers to divide their task among various virtual machines without compromising the performance levelof the service [**Moon et al. 2017]**. Hence, an efficient VM utilization has become a necessity to deliver cost effective service to the customers **Bouzerzour, 2020; Keller et al., 2020].** In current scenario, cloud computing plays an important role to provide large amount of data storage. In public clouds virtual machines (VM) are used to provide the virtual application resource to many users at a time. VM provides facility to any business for run an operating system that works like an totally separate computer with the help of using app window of a desktop. The working method of VM is depends upon its historical data that is used for server utilization. The most powerful advantage of VM is its cheap cost and it provides flexibility. Figure 1 shows the generalized VM architecture used in cloud computing.

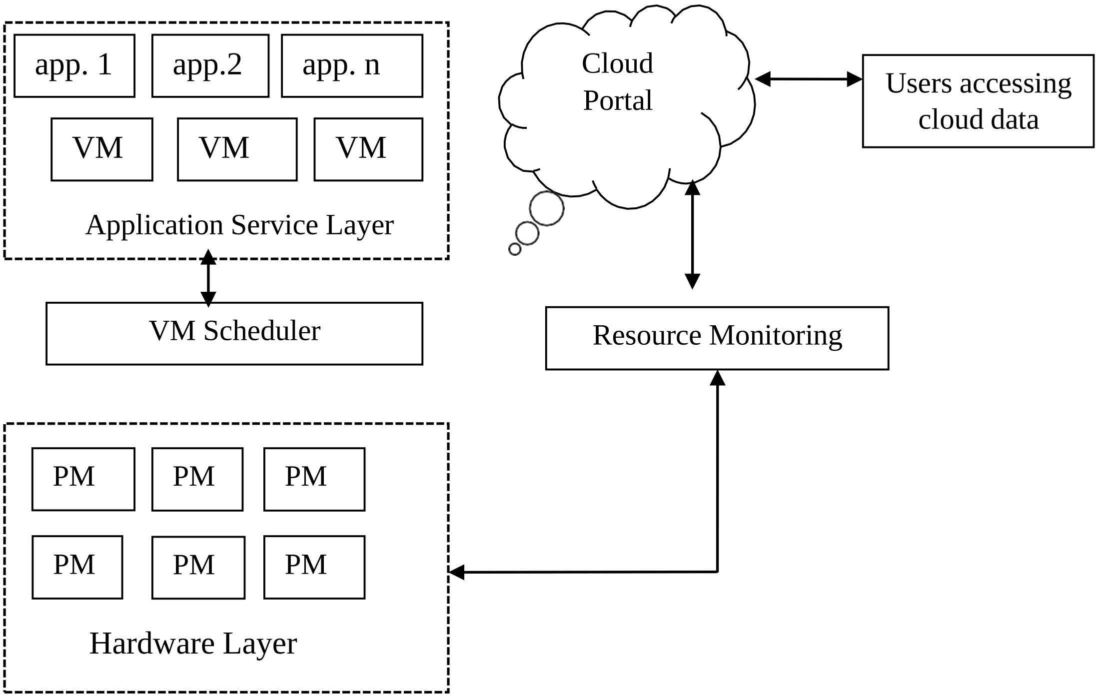

Figure 1 VM architecture in cloud computing [Sun et al., 2020]

The virtualization technology allows to balance the load of the server machine by migrating the application deployment to comparatively less or moderately loaded machines. This process,involves installation of number of virtual machines to relax the task performed by the physical machine. Here, the number of migrations, number of hosts, energy consumption and SLA are the key terms that need to be wisely balanced and managed. Any unbalance among these parameters may deteriorate the service quality and performance of the service delivered by thedata centers. This means that one should be able to precisely identify the underutilized and over utilized machines [**Ghobaei-Arani et al., 2018**]. The investigation of the physical and virtual machines in this respect is a cumbersome task. Therefore, machine learning architecture had proved to be a promising solution. In addition tothis, Swarm Intelligence had been integrated with the Artificial Intelligence techniques in orderto wisely manage the key parameters governing the quality service [21][22][23][24].

Inspired from such research works, the author had presented a intelligence VM allocation and migration framework in which a hybrid optimization strategy is involved[22][23][24]. The two well-knownbio inspired algorithms namely, ABC and CS are combined to identify the optimal VM for loadbalancing while fulfilling the energy requirements and SLA constraints.

1.2 The Border Line Problem (BLP)

Any allocation process follows context awareness policy. The content awareness policy takes care that the demand of the asking unit is at-least the base requirements are satisfied. As for example, if a VM has a RAM demand of 500 MB and the host has 520 MB of RAM, the VM can be assigned to the Host but the host will suffer from a border line problem as it will be leftwith 20MB RAM only. The real time simulation does not only run based on content awareness.It is always observed that, run time entities uses more resources than the demand which was made at the time of allocation. In such a situation, the VM will be either migrated from the current host or it will have to wait for the resource to be free in case the resource is engaged with any other task. This will produce un-necessary delay and expenditure in the network whichis not suitable for any processing environment.

The allocation process is mainly dependent upon the resource utilization of the demanding VM.

The allocation process follows the following set of rules:

a) Sort the VMs as per the requirement of the CPU Utilization
b) Check Physical Machine (PM) for the resource availability
c) If Physical Machine satisfies the resource requirement, assign VM to PM
d) Reduce the PM resources as by the allocated VM demands

The allocation process faces the border line problem and hence it is observed often that the borderline problem leads to VM migration which further results into trust managementproblems.

The major contributions of the work can be summarized as follows:

- Identify optimal VMs using hybrid optimization performed by ABC and CS.
- The strategy lead to 50% energy conservation justified with wiser VM allocation.
- VM migrations are supported by energy and SLA constraints.

This justifies the success of integrations of two SI techniques to resolve the local and global optimization problem in VM allocation.
The paper is broadly divided into five sections. The section 1 provided the concept of primaryand the virtual machines and their requirement in delivering the quality service using big data at cloud centers. Section 2 discusses the distinguishing research performed to minimize energywastage while using virtualization concept in cloud computing. Section 3 discusses the proposed strategy implemented for wiser VM allocation and minimising migration. Section 4 discusses the experimental setup and the simulation outcomes. Finally, the section 5 concludesthe paper with list of references used in the paper.

2. Literature Review

It has been analyzed that the cloud data centers consume lots of energy in switching between the servers and computation. VM migration no doubt requires energy but it enhances the overallexecution efficiency of the data centers. The major part of virtualization is the machine allocation followed by migration. To minimize the energy wastage in completing this process of virtualization, a number of researchers had implemented various strategies to identify best VM to support minimal migrations. **Ahmad** had presented a review that discussed the state of art live and non-live virtual migration techniques. The author discussed about the multiple applications and parameters that affects the VM migration process. Various challenges faced during the VM migration that are memory size of memory, system workload, heterogeneous nature of cloud resources, inexpensive VM migration. One more big challenge is seen in VM migration is that security threat [**Ahmad et al., 2015]**. The efficient resource management wasachieved by identifying the over utilized hosts by Yakhchi using Cuckoo Search (CS) optimization algorithm. This was followed by the Minimum Migration Time policy to migratefrom over utilized to under or moderately utilized machines. The simulation analysis had demonstrated an average energy consumption of 19.95 kWh with minimal number of migrations [**Yakhchi et al., 2015**]. A hybrid algorithm was proposed by Dhanoa and Khurmi to achieve power efficient VM migration. The work integrated genetic algorithm to optimize the response time, VM migrations, energy consumption and SLA violations. The work was evaluated to optimize live migrations to achieve minimal power consumption in variable environments. The simulation analysis had demonstrated that the hybrid VM allocation had proved to be 72% power saving in comparison to the base algorithm in delivering quality service [**Dhanoa and Khurmi, 2015**]. **Jiang** had proposed a DataABC (Ant Bee Colony) energy model that is used to get a decision of VM consolidation based upon global optimization. The proposed model works with CPU and GPU utilization rates. There are two policies for live VM that are consider by the researcher; first policy name as VM selection and second policy name as VM allocation. The proposed ABC model save 25%-35% energy as compare to it with other models [**Jiang et al., 2017]. Perumal et al.** have presented a technique called fuzzy hybrid bio-inspired meta heuristic technique that is used to solve the VMs placement problem. The researcher mainly focused upon the power consumption, resource wastage and VMs placement in cloud data centre. The experimental result shows thatthe hybrid algorithm provide better results as compare to ACO, Firefly, MMAS and FFD [**Perumal et al., 2017]**. **Barlaskar et al.** proposed a VM placement algorithm known as Enhanced Cuckoo Search (ECS) inspired through cuckoo Search (CS) algorithm that mainly target to the issue of energy consumption in cloud data centre The workload of the ECS algorithm is traced with the help of PlanetLab. A comparison result of ECS against Genetic Algorithm (GA), Ant Colony (AC) algorithm and Optimized Firefly Search (OFS) algorithm is evaluated as ECS consume less power consumption and maintain performance of SLA and VM migration [**24]]**. Ruan had proposed a VM allocation and migration strategy based on the performance to power ratio. This ratio was computed based on the sampling of machine utilization levels. This information was used to ensure that the computersare running on in power efficient manner without ignoring the performance levels. The comparative analysis demonstrated that the VM allocation and selection frame work had successfully reduced the energy consumption upto 69.31% that was achieved due to reduced number of migrations, shut downs with minimal performance degradation [**Ruan et al., 2019**].**Kumar et al.** introduced a Cuckoo Search with Firefly (CS-FA) algorithm that is specially used for load balancing (LB) in cloud computing. It is used to calculate the capacity and load of virtual machine. The main purpose of the CSFA algorithm perform two main task; first select the best Virtual Machine (VMs) for assign the task and second perform migration to convert overloaded VMs task into under loaded VMs task. The experimental result shows that when the number of load is equal to 40 the CSFA algorithm migrate only two tasks where existing algorithm migrate six tasks [**Kumar et al., 2020].** Karthikeyan had addressed the energy constraints using hybrid optimization. The Artificial Bee Colony (ABC) and Bat Algorithm were integrated by the researcher followed by the Naïve Bayes classifier to allocate the VM in order of energy requirements. The model achieved the energy consumption between 1000-1200kWh with 97.77% accuracy and failure rate of 0.2 [**Karthikeyan et al., 2020**]. Jangra had integrated the Cuckoo Search based optimization approach with the Artificial Neural Network (ANN) to achieve efficient resource utilization by minimizing the energy consumption. In the process, authors had sorted the VMs based on their CPU utilization that was computed using Modified Best Fit Decreasing (MBFD) approach. The comparative analysis of the proposed CS based approach against the existing SI techniques-based approach demonstrated a 13.15% less energy consumption [**Jangra, 202**1]. Talwani and Singla had proposed an Enhanced Artificial Bee Colony (E-ABC) distributing the load equally among various virtual machines. E-ABC reduced the work load of the VM by migrating the task from overloaded VM to under loaded host in order to conserve the energy. The simulation analysis demonstrated the E-ABC performed better in terms of scalability and reduced number of VM migrations. The energy conservation of 15% to 17% have been achieved using E-ABC with 10% reduction in the number of migrations in comparison to existing work [**Talwani and Singla, 2021].**

3. Proposed Work

The proposed work is divided into two sections. The first section illustrates the issue of BLP along with the modified MBFD algorithm and the second section signifies the VM selection process for false migration prevention architecture. The selection process is done utilizing the Swarm Intelligence architecture. The mathematical architecture of the proposed architecture is illustrated as Algorithm Proposed Selection Algorithm (PSA). PSA uses the current load over the selected host to allocate a VM over the host. The load is evaluated by using equation (1)

$$\text{Host Load (HL)} = \frac{\text{Total Executed Jobs}}{\text{Total Supplied Jobs}} \quad (1)$$

$$\text{Average HL(AHL)} = \int_0^t \frac{Active_{host}.HL}{Host\ Count}\,dt \quad (2)$$

AHL is the average load over all hosts in a given interval of time as shown by equation (2).Algorithm PSA

Input: VM List(VML) , Host List (HL)

SECTION I.

Step 1. SVML = Sort(VML. VM. CPU_Utilization)//
Sort VMs as per the decreasing order of CPU utilization //

Step 2. Foreach VM in the SVML

a. Possible List = [ ]//
For every vm in the list, there is a possible list of hosts where the //vm is to be allocated //

Step 3. CPU_Utilization = VM. CPU_Utilization (); //Identify the current demand of the cpu//

Step 4. AHL_current = HL. AHL( ) // Calculate AHL using (2) Step 5. Foreach host in HL // Identify each and every host // Step 6. HL_host = Host. Load(); //
Extract the current load over the host by using (1) //

Step 7. If$_1$ HL_host $\geq$ AHL_current // If host is overloaded

Step 8. // do nothing, pick next host //

Step 9. Else$_1$

1. If$_2$ host. resource( ) $-$ .15(host. resource) > VM. demand( ) // Applying border line portion //
2. Evaluate Power_Consumption ( )
3. Add host to Possible List.

Step 10. End If$_2$

Step 11. End If$_1$

SECTION II.

Step 1. Calculate minimum power consumption and allocate VM to the host.
Step 2. Start Execution of jobs over the host until time t_execution
Step 3. Activate ABC( ) // Activate ABC definition
Step 4. Definition ABC ( )
Step 5. Bee_index = Overloaded_Hosts // Identify all hosts that are overloaded/

Step 6. Employed_Bee = Bee_index. VM. Index //
Identify the VM in the overloaded list //
Step 7. Onlooker_Bee = Scanned bees till now.
Step 8. Onlooker_Food = $\int_{i=1}^{vm_{allocate}}$ p dt //
Total consumed power by other bees in the list //
Step 9. Travel_degradation = Heterogeneous //
The travel variation is considered to be hetrogenous in nature//
Step 10. If Employed_Bee. Bee_food $*$ Travel_degradation $<$ Onlooker_Food
Step 11. False migration + +
Step 12. Else
Step 13. True migration + +
Step 14. End If

Create list of false migration and identified and true migrations identified and classify using SVM. If classified sample is true then put the VM into the current list where it is placed whetherit is a true migration or a false migration and vice versa.

4. Results and Discussion

The simulation analysis is performed to illustrate the real time execution behavior of the proposed model. The simulations are carried on in Matlab simulator. In case of number of host analysis, it is observed that with increase in the number of VMs the number of hosts also increases irrespective of the optimization algorithm implemented during simulation analysis. However, the average value for the number of hosts using Naik and Jangra work is 34, Talwani and Singla work is 33 while using proposed work is 32. The average % improvement of 5.7% is observed against Naik's work, 5.6% is observed against Jangra's work and 4.3% is observed against Talwani and Singla's work. It means that the proposed ABC with resulted in significant improvement of 4% to 5%. The next parameter analysed here is the number of VM migrations. An average number of VM migrations observed using Naik's, Jangra's and Talwani and Singla's work are 21, while the using proposed work the average number of VM migrations are 20. The proposed ABC+CS work requires less number of VM migrations than the existing works. This shows that the implementation of proposed ABC+SVM optimized model will conserve the resources to someextent in comparison to the existing works. It is also observed that at higher number of VMs the improvement is comparatively less as compared to the improvement observed when the number of VMs are less. In initial stages, the % improvement of 7% to 8% is observed however, as the number ofVMs reaches to 200 to 300 the % improvement decreases to 3%. It is observed that over 300 VMs the average improvement observed using proposed work is 6.6% using Jangra's work, 7.0% using Talwani and Singla's work and 7.8% using Naik's work. In other words, % improvement of around 7% is observed using hybrid optimization achieved with ABC and CS. As the number of migrations decrease the energy consumption is also expected to show some decline. The energy consumption shows that despite of the fact that with the increase in the number of VMs the energy consumption increases for all the implemented techniques. However, this rise in the energy consumption is minimum for the proposed work with an average energy consumption of 60KWh, 63.66KWh using Naik's work, 63.111 KWh using Jangra's and Talwani and Singla's work. The % improvement analysis illustrates the variation in the improvement observed over variable number of VMs used for the experimentation. The average % improvement observed for the proposed work against Naik's work is 5.14%, Jangra's work is 4.72%, Talwani and Singla's work is 4.85% in terms of energy consumption. The cloud data center work on the basis of service agreements that determine the quality of service to be delivered to the customers. Hence, the SLA violations should be minimum to satisfy the cloud service users. The SLA analysis is performed for variable number of VMs upto300 VMs. It shows that the proposed work exhibited reduced SLA violations accounting to an average value of 25 violations followed by Talwani and Singla's work with 26 violations followed by Naik's and Jangra's work with 27 violations. The comparative analysis of % improvement is that the average improvement exhibited by the proposed work against three existing works lies between 6% and

9%.

The execution time is the run time required by the proposed model to complete the simulation rounds. This parameter should also be less as also depicted by the parametric values. The average execution time of 0.696s is observed using proposed work, while Naik's work required an average execution time of 0.723s, Jangra's work required 0.711s and Talwani and Singla's work required 0.713s. This means that average execution time using proposed work is comparatively less than the three existing studies. The analysis means that the proposed work exhibited improvement over the three existing works even when higher number of VMs are used in the network. The average % improvement exhibited by the proposed work in terms of execution time is 3.93%, 2.25% and 2.72% against Naik's, Jangra's and Talwani and Singla's work, respectively.

5. Conclusion

A hybrid optimizations strategy using Swarm Intelligence techniques namely, ABC and SVM is proposed in the paper. The number of VM migrations are minimized with the integration of hybrid optimization to identify the best suitable VM in accordance to the energy constraints, work load, SLA, etc. This is followed by the machine learning techniques to migrate the VMs from over utilized to under or low utilized PMs. The effectiveness of the proposed work is evaluated against three existing studies addressing similar constraints. The simulation analysis using 300 VMs means that the proposed work exhibited an overall average improvement of 3% to 6% while considering parameters such as energy consumption, SLA violations, number of VM migrations and execution time.

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