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# An ENERGY EEFICIENT VM ALLOCATION USING GENETIC ALGORITHM

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***Abstract*— Cloud computing depicts a real paradigm nature and is deployed in the way systems should be. With the popularization of the internet, cloud computing systems came into evolution. In Cloud computing technology, Energy efficiency is becoming important due to increase in power consumption and carbon emission. In this paper, Modified Best Fit Decreasing (MFBD) algorithm is used which allocates VM on the basis of CPU utilization and we focus to improve the existing algorithm by applying novel optimization technique, a genetic algorithm for VM migration. The behavior is based on natural phases and its function adapts very well in virtualization. We used MATLAB for simulations and the parameters like Power consumption, VM migrations, and SLA violations are performed by comparing with the existing parameters. The experimental result shows better improvement in both VMs placement and migration and the ability to achieve significant energy savings when compared to the existing algorithm.***

***Keywords— Cloud computing, Power Consumption, SLA agreement, Virtual Machine Migration, Energy efficiency.***

## 1. INTRODUCTION

The cloud computing is the current most popular and on-demand delivery of applications and IT resources through the internet. It is highly scalable and universally available systems. With the provision to increase performance, virtualization plays a vital role in cloud computing. The cloud infrastructure resources can be used by virtualization technology which thereby allows creating a number of VMs on a physical host and hence reduces the use of hardware thus resource utilization can be significantly improved.

[1] NIST defined Cloud Computing as a model for ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. As one of the important resource provider through internet cloud computing has been fulfilling its provision since its inception. Although it is not-so-new technology, its demand has captivated the era of technology. Users can easily access the applications and the resource is provided by the Cloud Service Provider (CSP). Cloud computing is taken as 5th utility computing after electricity, water, gas, and telephony because of its pay per use functionality making the consumers pay only for what they use. The cloud repository called data centers houses several servers and also other facilities took an important role in servicing cloud resources. A nowadays data centers with a pool of servers overcomes 100,000 hosts around 70% of communications are performed internally [2]. Some of the top cloud computing companies with large data centers consist of Amazon Web Service (AWS), Google Cloud Platform, VMware, Microsoft Azure, Rackspace, Dropbox, IBM cloud and Oracle Cloud.

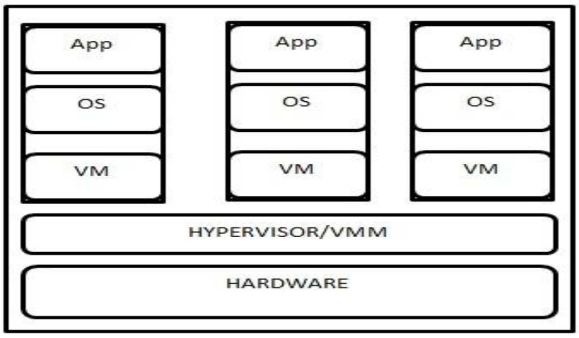



Fig:1 Virtualization[3]

The remainder of the paper is organized as follows. A problem formulation is presented in Section 2. In section 3 we describe the proposed methodology. Section 4 and 5 shows experimental set up and result analysis briefly. Finally, Section 6 and 7 presents our related work and conclusion.

## 2. PROBLEM FORMULATION

Allocating VM is one of the tasks in fulfilling virtualization techniques. A physical machine is whenever not able to fulfil the entire requirement of the virtual machine then VMs are required to migrate from the other hosts. Moreover, if the VM is not selected appropriately, it may violate SLA and may result in a manifold number of migrations which may further impact the energy consumption negatively or may require new host which may further affect the environment. Therefore, VM allocation and migration has been considered to be a challenging task. So, a different set of threshold values have been considered in order to minimize the Service Level Agreement (SLA) violation and many algorithms like ABC (Artificial Bee Colony) and particle swarm optimization have been utilized. Somehow, previously implemented algorithms show nature complexity and time consumption. In our research work, we proposed Genetic Algorithm technique for VM migration and to place VM in the physical machine we used MFBD Algorithm. The migration process is further crosschecked along with Support Vector Machine (SVM) classification. The performance parameters are given below:

i. Number of migrations against a Lower threshold
ii. SLA violation against the Lower threshold
iii. Energy consumption against a Lower threshold

## 3. PROPOSED METHODOLOGY

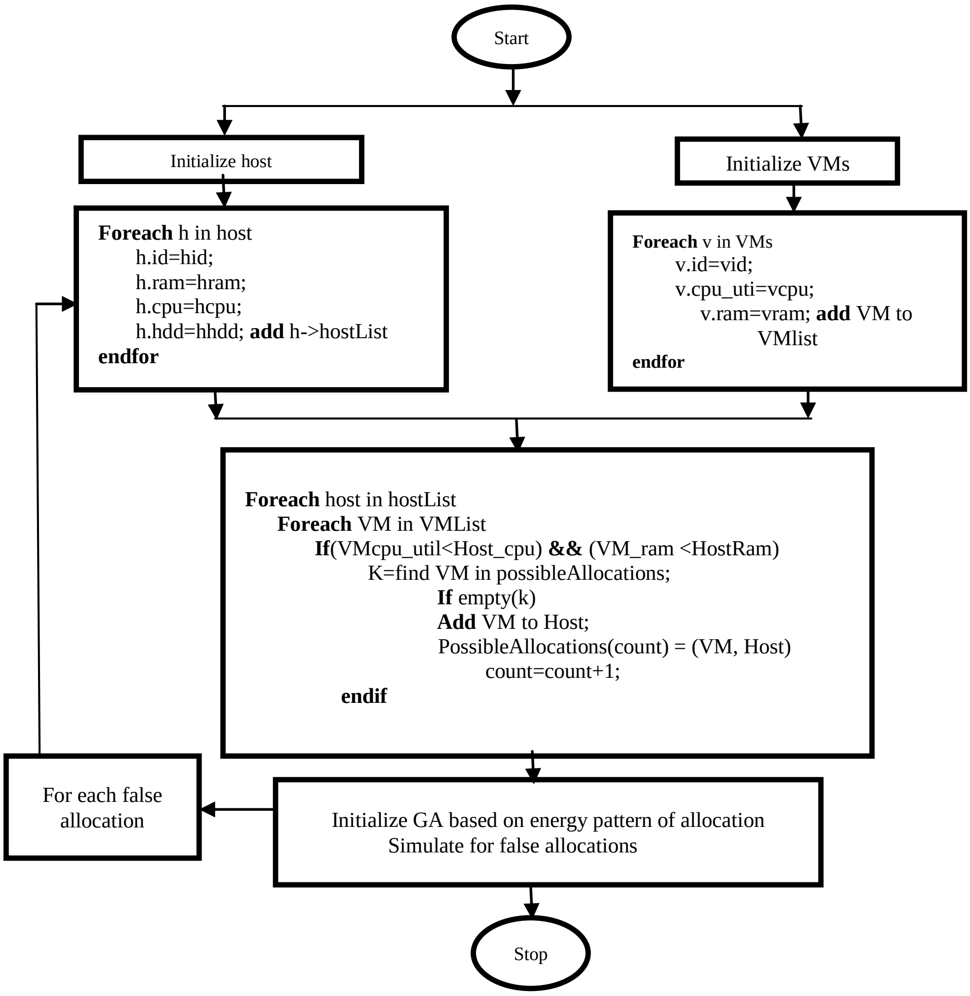



Fig 2: flowchart of the proposed methodology

Above figure represents the flow diagram of proposed VM allocation work based on the genetic algorithm. The procedural steps of the proposed work are given below in the form of steps:

**Step 1:** Design a simulator for the proposed genetic algorithm based VM allocation system.
**Step 2:** Initialize the N number of VM and Host for the Simulation of proposed work.
**Step 3:** Initialize the basic properties of VMs and Hosts like

- Host Id
- VM Id
- Host RAM
- VM RAM
- Host CPU
- VM CPU
- Host HDD
- VM HDD

**Step 4:** Apply the MBFD algorithm for the sorting of energy pattern of allocation.
**Step 5:** Define and initialize the operators and function of genetic algorithm with a novel fitness function according to the condition.
**Step 6:** Evaluate each VMs according to the requirements and allocate host with the help of a genetic algorithm and if false allocation occurs the repeat step 4 to step 6.
**Step 7:** At the last step, calculate performance parameters of proposed VM allocation based on the genetic algorithm.

## 4. SIMULATION SETUP

To evaluate our proposed allocation algorithm, we conduct simulations in an event driven environment, MATLAB.

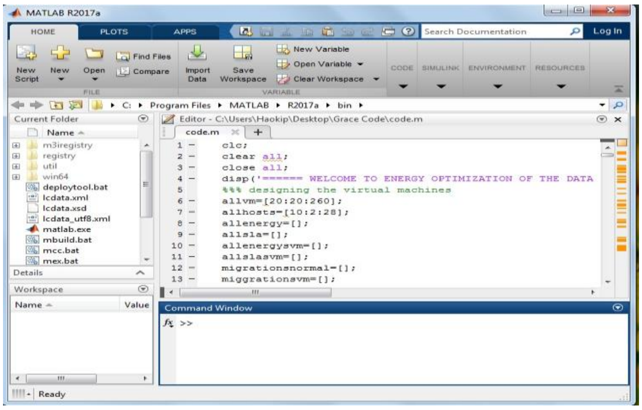



*Fig 3: Matlab R2017a (9.2.0.538062) Of 64-Bit.*

| | |
|---|---|
| TOOL | MATLAB R2017a |
| NO. OF HOST | 255 |
| NO. OF VM's | 260 |
| ITERATIONS | 20 |
| NUMBER OF DATA CENTRE | 1 |
| HOST CAPACITY | 16 GB |

TABLE I: PARAMETERS USED FOR SIMULATION

## 5. RESULT ANALYSIS

In this section, various parameters and validating the proposed work are evaluated to obtain the results and compare with existing approaches. The parameters that have been measured are:

### 5.1 PERFORMANCE PARAMETERS

The parameters particular to the evaluation and estimation of the proposed algorithm are selected in such a way that the effectiveness of the process involved can be determined. Following are the parameters that are measured in the research work:

### 5.1.1 SLA violation

SLA is an abbreviation for Service Level Agreement.

SLA violation is defined as the agreement between the client and the cloud service provider. Higher the value of SLA means the quality of services provided to the user is better.

### 5.2.1 Number of migrations

It is defined as the job to move a virtual machine from one physical machine to another PM.

### 5.3.1 Energy consumption

It is defined as the total energy consumed by each server within the system.

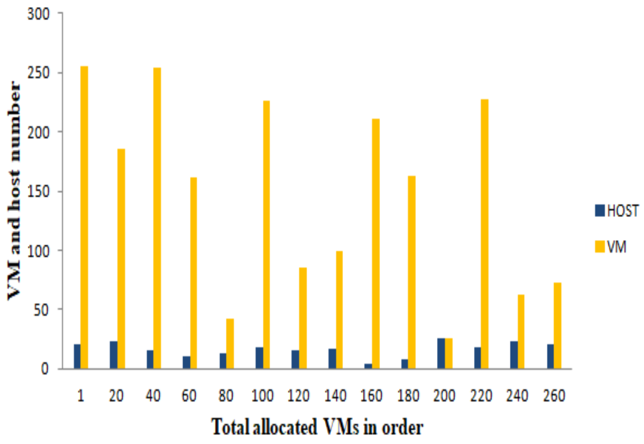



*Fig 4: VM vs Host Number*

The graph plotted between VM and host number with respect to the total allocated VMs in order is shown in the figure above. The total allotted VMs are ranged from 0 to 260 represented by the yellow bar line. The y-axis represents the VM and Host number ranges from 4 - 255.

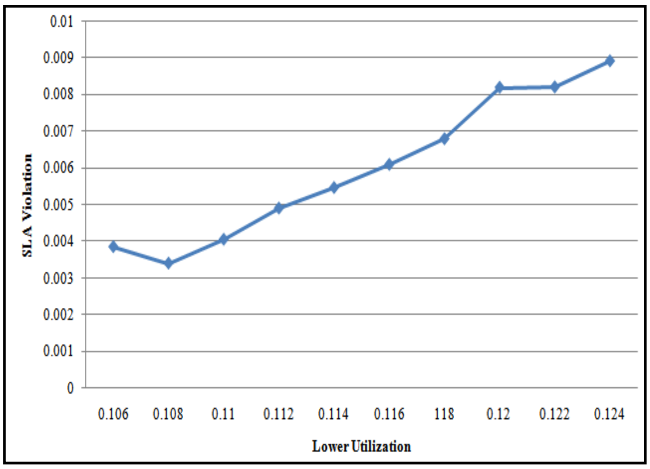



*Fig 5. SLA violation against Lower utilization*

The above graph represents the SLA violation values observed for different lower utilization. The average value of SLA obtained for the proposed work using genetic algorithm is 0.005984.

| Lower utilization | Total number of migration |
|---|---|
| 0.106 | 242.0385 |
| 0.108 | 73 |
| 0.11 | 117 |
| 0112 | 52 |
| 0.114 | 37 |
| 0.116 | 63 |
| 0.118 | 119 |
| 0.12 | 53 |
| 0.122 | 5.28 |
| 0.124 | 35 |

TABLE II: PARAMETERS MEASURED FOR THE PROPOSED WORK

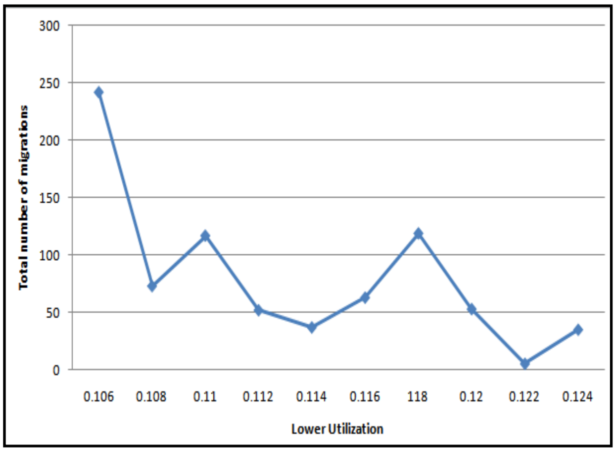



*Fig 6. Total numbers of migrations against Lower utilization*

The above figure represents the graph plotted for the total number of migrations observed during simulation of the proposed work. The lower utilization values are represented along the x-axis and the values of a total number of migrations are represented along the y-axis. From the above graph, the average values of a total number of migrations measured are 79.63. When the value of lower utilization is 0.106 then we will obtain the maximum value of VM migrations which is equal to 242.0385. As the value of lower utilization increases the number of migrations decreases.

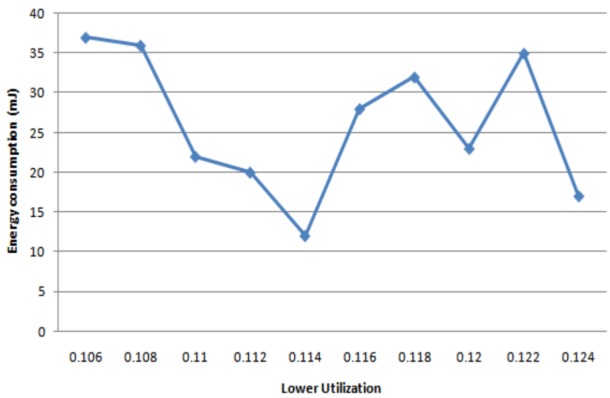



*Fig 7. Energy consumption against a Lower utilization*

The above figure represents the energy consumption with respect to lower utilization observed for the proposed work. The graph is plotted between energy consumption and lower utilization values. From the above figure, it is clear that as the values of lower utilization increases the value of energy consumption decreases. The average value of energy consumed by the VM is 26.2 mJ.

TABLE III: SLA VIOLATION VS LOWER UTILIZATION

| Lower utilization | SLA violation |
|---|---|
| 0.106 | 0.00385 |
| 0.108 | 0.0034 |
| 0.11 | 0.00405 |
| 0112 | 0.0049 |
| 0.114 | 0.00546 |
| 0.116 | 0.00609 |
| 0.118 | 0.00679 |
| 0.12 | 0.00819 |
| 0.122 | 0.0082 |
| 0.124 | 0.00891 |

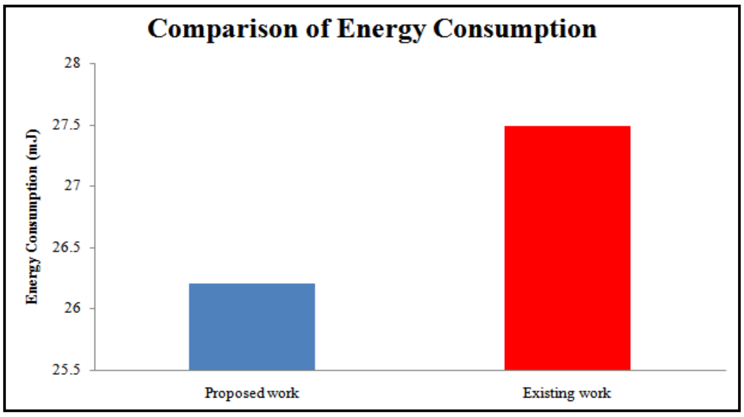
5.2 Comparison of Proposed Work With Existing Work

In this section, the parameters measured after the simulation of existing work with the proposed work have been discussed.

Table IV
COMPARISON OF ENERGY CONSUMPTION FOR PROPOSED WITH EXISTING WORK

| Proposed work | Existing work |
|---|---|
| 26.2 | 27.49 |

*Fig 8. Comparison Of Proposed Work With Existing Work*




The above figure signifies the comparison of energy consumed during the migration of VMs. Here, blue bar and the red bar represent the average values of energy consumption for the proposed work and for the existing work performed by Ali et al. [2016]. In this paper, the author presented a VM allocation technique to obtained more energy efficiency. The author used DVFS (Dynamic Voltage and Frequency Scaling) algorithm to reduce energy consumption. It has been observed that the average energy consumed by DVFS is 27.49 mJ. The energy consumed by using GA along with SVM as a classifier is 26.2 mJ. Thus, it is clear that when GA along with SVM as a classifier is used in the proposed work the energy consumption is reduced by 4.69% from the existing work. This is because the fitness function of GA helps to optimize the properties of VM and SVM is used to select an appropriate VM that consume less energy.

## 6. RELATED WORK

According to SLA, it does not only provide quality of service to the customer rather it allows the service provider to efficiently manage their infrastructure. **Gouzardi et al** [4] an SLA based resource allocation problem have been explained for multi-tier applications in the cloud. Moreover, an upper bound on the total profit is considered and to solve the resource allocation problem an algorithm force-directed search is proposed. Parameters such as processing, communications and memory requirements are considered. A simulation result shows effective results of the proposed heuristics.

**Liu et al** [5] introduced the first kind of work for estimating VM live migration cost in terms of performance and energy level

**Anton Beloglazov and Rajkumar Buyya** [6] this paper stated to improve the existing PABFD (power aware Best Fit Decreasing) allocation in order to minimize increasing power on each VM.

**Mustafa et al.**[7] explained an algorithm of BFD (Modified Best fit decreasing) which is based on the bin packing problem. In Modified BFD the Virtual machine is sorted in decreasing order based on their utilization of CPU. After sorting, all Virtual machines are deployed to the hosts based on the power or energy consumption. According to which it is checked that how much change in power consumption of the hosts after placement of specific VM.VM is placed on a host which shows very less change in power consumption.

**Anton Beloglazov and Rajkumar Buyya**[8] explained that to reduce the power consumption VM migration is done for two reasons, One when new request comes which can be served by MBFT(Modified best fit algorithm) and another on Optimization of existing VMs which are done by migrating the VM based on upper threshold value for CPU utilization. Also, three policies are adopted for migration i.e. minimum migration because to reduce the migration cost, migrating VM which has lowest CPU utilization and migrating the necessary no. of VMs according to a uniformly distributed random variable. SLA is relaxed then energy consumption is further reduced to 1.14KWh.

**Minu et al.** [9] present the energy efficiency approach using the dynamic VM migration. Here the CPU utilization is considered as a parameter to migrate the VM according to the dynamic workload of any CPU. When any machine is overloaded then CPU utilization increases and generates the heat and requires more energy or power. So workload is shifted to under loaded machine from the overloaded machine. Also under loaded VMs can be consolidated by migrating them to other hosts thus reduces the power consumption by switching off the few hosts. Performance is analyzed by using the CloudSim simulator. Also, results are compared by two approaches with migration policy and without migration policy.

**Anton Beloglazov and Rajkumar Buyya**[10] also analyzed that as compare to NPA ( non-power aware algorithms) DVFS (dynamic voltage frequency scaling) works better with respect to energy saving. Single threshold technique shows almost two times better results than DVFS. But double threshold with Minimum of migrations (MM) has a significant reduction in energy consumption with a minimum number of migrations but little increase in SLA violation.

**E. le Sueur and Gernot Heiser** [11] discuss DVFS as that platform which gives understanding on older and newer platforms as compared to AMD processors. It moreover says about factors for effective DVFS is well put forward as having features to bring huge changes in power aware.

**Y. Shi et al**[12] work on dynamic resource allocation by considering utilization analysis and prediction. Linear predicting method (LPM) and Flat Period Reservation-Reduced Method is used for obtaining useful information from resource log. Overall minimize in energy consumption and violation rate is reduced as well. For future work, this algorithm can be applied with open Nebula which is open source cloud manager.

**A. Beloglazov et al.** [13] presented different VM selection policies for VM migration allowing less VM to be migrated, thus reducing the migration overhead. They described various energy-efficient policies for the virtualized data center to reduce power consumption. It proposed optimal online and offline deterministic algorithms for single and dynamic virtual machine consolidation problem. They explained Adaptive heuristics for dynamic VM consolidation using Median absolute deviation, a Robust local regression-based approach for host overload detection, Maximum correlation policy for VM selection. The experimental results depicted performance gain and energy reduction than other traditional dynamic VM consolidation algorithms.

**M. Ghamkhari and H. Mohsenian-rad**[14] discussed that energy consumption can be reduced by the optimal distribution of workload among the different data centers. They also profoundly explained that energy cost can be reduced and so does carbon footprint. Location diversity is the proposed technique in which the workload is distributed geographically.

Table V

COMPARING DIFFERENT EFFICIENCY TECHNIQUES

| Proposed by | Algorithm used | Description | Outcome |
|---|---|---|---|
| **Nguyen Hoai et al**[15] | a Genetic algorithm for Power-Aware (GAPA) is used | a static virtual machine allocation problem (SVMAP) is introduced in the scheduling of resource allocation | Gives an optimal solution for VM allocation. |
| **Manan et al** [16] | different load balancing algorithm such as Round Robin Algorithm, Throttled Load Balancing Algorithm. | The used algorithm with load balancing is preferably to choose efficient VM for allocating as per users requirements. | VM configurations are decidable on the basis of RAM, no. of CPU and space required by the users. |
| **Kliazovich, D, et al**[18] | The approach is based on a genetic algorithm | Discuss on power-efficient resource allocation algorithm for tasks. the jMetal show is done by using an open source genetic multi-objective framework | they are able to perform the static allocation on numerous tasks within the same data center. |
| **Jin. H et al** [17] | proposed a novel memory compression based virtual machine migration approach (MECOM) | Used for fast VM migration while predicting virtual machine to be affected. Also for balancing the performance and the cost of migrating they used an adaptive zero aware allocation algorithm. | The simulation shows downtime is reduced by 27.1% during 32% of total migration as compared to Xen. |
| **F. Holger et al**[19] | presented a special Genetic algorithm | The algorithm helps in optimization for comparing existing algorithms such as Relief-F, Fisher criterion score and Recursive Feature elimination resulting in time-saving when determining kernel parameters. | works well with support vector machine (SVM) to find generalization error of feature selection, moreover, cross-validation is performed traditional as well as another existing algorithm. |
| **Cheng-lung hang and Chieh-Jen wang** [20] | used the Genetic algorithm approach | which optimized the parameters and feature subset without losing SVM classification accuracy | The algorithm shows significant improvement in classification accuracy and has fewer input features when compared with Grid algorithm. |

## 7. CONCLUSIONS

In this work, by applying the MFBD algorithm we used a genetic algorithm (GA) for selecting along with Support Vector Machine for VM allocation in cloud computing. GA is used for selecting the number of possible physical machines and

SVM classifies certain class. In this study, VM placement is considered as an NP-Hard problem. With our meta-heuristics algorithm, GA is applied and the performance of all metrics has been comparing imperatively with the existing work in terms of energy consumption, migrations and SLA violation.

The future aspect may include utilization of different optimization algorithms like Particle Swarm Optimization (PSO) instead of a genetic algorithm. The migrations can be checked by using Artificial Neural Network (ANN) in conjunction with fuzzy logic.

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