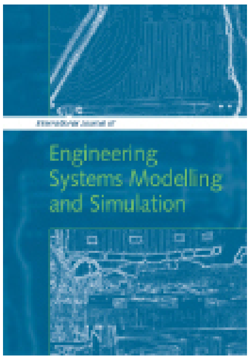

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A data transmission approach with energy reduction based on virtual machine migration technique in cloud computing

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Abstract: To provide quicker data access, database centres use virtual machines (VMs) migration to maintain regular content pages in the necessary unit. Memory sharing without downtime is ideal for offline VM migration. However, it has several problems while migrating active VMs. To improve bandwidth availability and hardware stability, it is utilised in workload balancing, low energy retains, and dynamic VM resizing. Thus, needless memory (dirty pages) moving leads in lengthy migration time and downtime. To minimise energy usage and the number of VM migration stages, we offer the NPA-FLI-EC. It combines neural prior prediction algorithm and fuzzy logic insertion of energy reduction on VMM method. Using NPA-FLI-EC, it may optimise VM placement and minimise connection loss on physical servers, while

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anticipating resource identification from each host reduces needless VM migrations. Thus, it allows for task diversification over multiple servers while saving 2/3 of total energy usage. It also saves bandwidth and improves energy efficiency by consolidating the number of VMs.

Keywords: virtual machine; VM migration; data sharing; evolutionary computing.

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1 Introduction

Cloud computing is acts as centralised resource sharing storage unit where data can be easily accessible on demand basics, without direct monitoring by multiple number of users (Choudhary et al., 2017). It is user friendly in nature and structure provides flexible to internet accessibility. The VMs migration is providing fast network data sharing by keeping regular content pages in the destination machine. Usually, it can visualise the entire hardware feasibility study by external operating system (OS). Thereby, the OS process consolidated into VMs which is to be referred as virtual machine migrations (VMM) (Deshpande and Keahey, 2017). By viewing hardware abstract, a user utilises the VMs effectively. Hence, it generates distinct equipment layer on basics of system capacity. Thereby, it has conveyed that the proper support of VMs induces significant improvement in the resource management and migration efficiency. In case of offline VMs migration, allows memory sharing between two distinct machine and support to each other at any downtime (Osanaiye et al., 2017). However, it faces a lot of issues when it undergone with live VM migration. Because it seems to be live for all time until the client stops their perspective and it may come difficult to hold the entire data in concurrently used in workload balancing, low energy retain and dynamic VM resizing to enhance bandwidth availability and hardware stability (Duggan et al., 2017). Sometime, data centre uses advance tools to transfers OS instantly over multiple machines. Thus, suffers large number of unnecessary memory transferring which results in conquering long migration time and downtime (Masdari et al., 2016). In addition to this, locality information of different data centres is being identified in order to turn effective VMs migration and shared most common data page towards destination machine (e.g., Google and Amazon file scheme). Further, user's authentication for faster VM migration present closer to other VMs access location (Bittencourt et al., 2015). The most attractive features of the VMs migration is to identify the system locality (more especially in WAN). Generally, existing VMM techniques significantly decrease system reliability and increase the transmission end-to-end latency of the huge volume of the VMs. In order to resolve the above-mentioned problem, reduce unnecessary pre-copy of repeated content page and minimise number of VM migration. In this regard, proposed a new intelligent automated VM migration approach, called NPA-FLI-EC, which utilises neural prior predicting algorithm and fuzzy logic insertion of evolutionary computing for reducing energy consumption and number of VM migrations phase (Takagi and Sugeno, 1985). It can induce optimistic way of acquiring pre-copy of pages which in turn minimise unnecessary transfer of repeated content pages and it combined neural prior predicting algorithm and fuzzy logic insertion of energy reduction on VMM technique. For performance analysis of the proposed approach, the SPEC power standard benchmark that involved evaluating the characteristic behaviour on power mode at single server and multi-mode server respectively. Planet Lab is used for creating a server environment on demand basic, though, multi-fashion services are accommodated. It supports to develop multi-scale network services. The simulation results are being compared with the other existing methods present in Salimi et al. (2012) and Singh and Gupta (2016) respectively, where, analysis parameters are VM varying size and number of migration number. As result shows that the proposed approach provides the flexibility of workload distribution over many servers on spending 2/3rd of total energy consumption. Further, it can be accessible by repeated data users by consuming less bandwidth and improving energy robust exhaustion through limited consolidated number of virtual machines (VMs). The main contributions of this paper:

- To design a new intelligent automated VM migration NPA-FLI-EC, this utilises neural prior predicting algorithm and fuzzy logic insertion of evolutionary computing for reducing energy consumption and number of VM migrations phase.
- Using NPA-FLI-EC, create an optimum VM configuration and minimise connection breakage on physical servers. To find prior prediction of resource identity from each host through neural prior predicting algorithm which reduce unnecessary VMs migrations.
- The organisation of paper is follows. Section 2 discusses related works. Section 3 presents a brief background of utilises neural prior predicting algorithm and fuzzy logic insertion of evolutionary computing. Section 4 describes the proposed NPA-FLI-EC technique for optimising energy consumption and minimising VMs migration time. Section 5 conveys simulation results and finally, conclusion has been made in Section 6.

1.1 *Research challenges on VMM*

VMM is being an important process of centre database unit for providing continues data accessibility to the customer at any point of time from cloud server. However, the process of changing should be kept to a minimum in terms of the number of machines being migrated and the amount of energy used. In this section, covers the challenging issues that often arias during VMM are discussed as follows (Jang and Mizutani, 1996):

1. In the world-wide, internet usage for data research as well data sharing is now increasing significantly. Due to this, centre server suffering with heavy workload of data distribution and controlling the storage ability of data in the respective server location. As a result, consuming huge power and it may reduce the performance efficiency of the service providing database centres (Baker, 1985). It is the most primary challenging issue occurs because of increasing VM migrations.
2. It suffers lack of memory due to page accumulation of repeated content after failure occurs in the recent data

transfer. That means, source machine initiates the search engine for specific data, if it is breakdown in the service unit, data may not find in the source machine that is referred as downtime. Hence, it creates accumulation of repeated content page in the destination machine. Thereby, it affects the major percentage of total quality of services (QoS) and bandwidth utilisation (Beloglazov et al., 2012). Therefore, it is considered as second challenging issue that needs to be resolved by keeping downtime and migration time as low as possible.

3 Whenever the VM migration is occurred, then, the database centre can update the content page in the destination machine after received dirtied pages. It may take more bandwidth and wastage if resource utility includes CPU cycle and memory unit. Consequently, it failed to predict prior number of dirtied pages within downtime.

4 Sometime, database centre can transfer the past content page during post-copy migration phase. However, if the traffic congestion arias, then, again this leads to create dirtied pages which form another scenario of wasting the available bandwidth. It is highly degrading the service quality in order to retain service level agreement (SLA). Hence, it is mandatory need of considering parameter to minimise violation level for increasing QoS in VM migration process.

5 It is subjected to have VM migration process on wireless platform of wide area network (WAN) and local area network (LAN) to understand characteristic behaviours in which bandwidth utilisation efficiency and downtime analysis is carried in both environments. It is very much indeed to know how much of percentage goes down due to network traffic and other parameters (Malhotra, 2018).

6 The VM size and bandwidth are playing significant role of evaluating the energy consumption on various wireless framework and varying VM machine numbers (Dhanoa, 2017). Furthermore, optimistic VM migration techniques are introduced to increase quality of service of data centres in terms of cost and energy utilisable.

2 Related works

In this section, describes the various VM migration reduction methods are introduced by several researchers and understand their steps followed to minimise the VM migration time and energy consumption (Suresh et al., 2020). At the same time, SLA violation is adjustable over certain threshold limits, which balance the trade-off between optimum mapping and VM movement. Kalidas et al. (2021) presented a novel approach based on memory accessibility on direct basics that increases the efficiency of reducing VM migration time and enhance the usage of bandwidth. It can reduce the workload over heading problem by direct accessibility of users without involving stack (TCP/IP) processing at the O/P devices. Suresh et al. (2021) discussed a prior prediction of the dirtied pages accumulations over certain period before and after completion of iteration process which in turn minimise the unnecessary copying of repeated content pages in the destination machine respectively. Here, they used page prediction based on time-series strategy which is very much effective for identifying past and future pages. Markkandan et al. (2021a) developed the statistical modelling for advance prediction on VM migration numbers and time that supports allocation producer of the resource management principle. Thus, shown the high impact on resource availability in the live VM migration and indeed minimum process time occurred at the VM migration. Markkandan et al. (2021c) presented a new framework for VM migration in an optimistic approach by using space compression algorithms with limited layered copy which reduced the time complexity problem in the real-time scenario. Proposed the pre-and post-copying strategy for minimising total migration time during live VM migration process. It has involved a dynamic self-ballooning is used to reduce unnecessary usage of free memory pages. Hence, it has minimised the duplicated copies of pre and post content pages through active pushing phase. Markkandan et al. (2021d) introduced an application-based architecture in which estimated the best time of VM migration in the live moment. It can obtain the database of transferring specific content page on fixed time whose information is extracted by using migration evolution metric. The VM migration time by combining time-series and two-phase techniques. According to this, effective reduction of migration time is achieved but it shown exponential decaying attitude of downtime as number of VM migration increases. As a result, compared with existing pre-copy approach, where downtime is linearly increasing as many migrations established in the live migration. The presented a novel approach for VMs migration based on hybrid combination of pre-copy and memory delta compression in which reduced the total migration time period and maximised the throughput ratio at the migration session. The page placement method based on WS clock pre-copying page approach in order to reduce the total number of VM migration as well as migration time required at the live VM phase. As compared with traditional methods, the proposed method has retained standard results of migration time and number of VM count. Gustafsson discussed the reduction of VM migration time by allocating separate time slot for crucial page transferring through assigned subsets over the WAN network. It has not created storage copies on the disc space and capable of re-transferring discarded pages again when the VM migration has resumed by the new user. The performance of various resource reservation methodologies in terms of migration time cut-off and parallel execution of source and destination machine. It has reduced workload overhead by distributing different time slot for downtime in order to retain the performance efficiency of VM migration strategy. The migration time is directly proportional to the memory utilisation factor present in the virtualisation system. A derived migration control strategy under influence of linear soft computing programming by formula consolidation in the dynamic migration control. It conveyed the priority consideration for VM migration in the steady flow that controlled number of migrations by paying penalty to the physical serve layer. VM migration reduction process by using dynamic threshold constraints, which is initiated a self-decision-making algorithm that reduced the number of VM migrations proposed energy aware adaptive VM migration with load balancing approach. In this method, they have considered fixed bandwidth and specific speed of RAM which minimised the execution process of the CPU memory stack that provides effective VM migration numbers and consumed low energy. Online VM migration estimation algorithm that design supports the betterment of risk overload, promote sufficient VM migrations and maintain compact space memory between specific VMs.

3 Proposed methods

3.1 Intelligent learning automated (ILA) VM migration

An ILA is a mathematical model to find optimistic solution for decision making after understanding the position of VM migration based on continuous interaction with the environment by keep sending reinforcement signal. The control action can be taken from probability vector which obtained through evolution migration metric (EMM) applied at the initial state (automaton). The function description of the EMM is expressed as four tupelos such as p, q, r, TF [p, q, r]. Where p represents set of actions to be initiated, q be the response received from environment set and r give the probability vectors of consolidating action response at the initial state (automaton) respectively. Sequentially, TF indicates the transfer function of reinforcement algorithm, which conveys the modified values of probability vector, received response and completed action. Let as consider an EMM values lies between 0 and 1 in the migration environment. That is, if $q = 0$ then, reward is assigned to the probability vector at every i^{th} instant values. The control action is initiated with optimistic decision. Otherwise, update the probability vectors according to the response obtained from the environment (i.e., $q = 1$) along with the penalty. The updating sequence of probability vector is identified, and its pseudo code is given as follows:

ILA-probability vector updating

#1 **Initialise**: p, q, r and TF [p, q, r]

#2 **Iteration starts**

#3 If $q = 0$, then assigns **rewards**

#4 $P_n(i + 1) = P(i) + \alpha [1 - P(i)]$

#5 $P_n(i + 1) = (1 - \alpha) P(i)$

#6 If $q = 1$, then assigns **penalty**

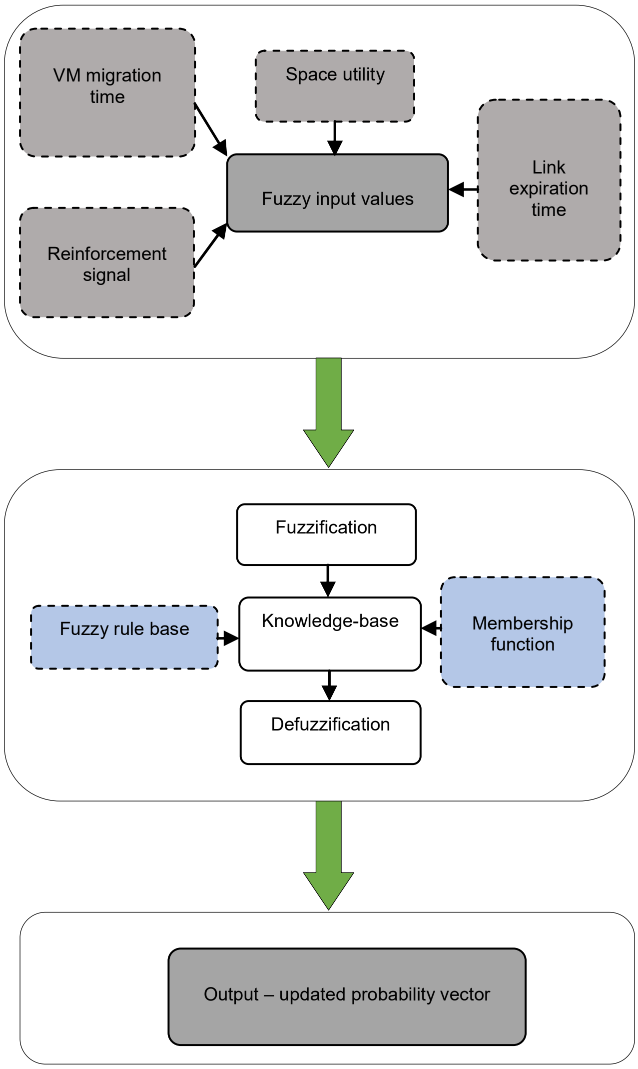
#7 $P_n(i + 1) = (1 - \beta) P(i)$

#8 $P_m(i + 1) = (\beta/\alpha - \beta) + (1 - \beta) P(i)$

3.2 Hybrid fuzzy based neural inference system

It is an integration of neural prior predicting and fuzzy logic insertion of a single framework that acquire advantages of both of them. It is referred as HFNI system, which is based on modified version of fuzzy inference system, it follows usual training samples as human undergo for learning phase in that controlling ability can identified to make perfect decision-making technique. Fuzzy decision rules are made by fuzzifying the input parameters and the scheduling probability is assessed based on the outcome of the rule. In Figure 1 represents hybrid fuzzy based neural inference system. Fuzzy rules defined as order-based interference which is given as follows:

Figure 1 Hybrid fuzzy based neural inference system (see online version for colours)



Step 1 The crisp input is transformed into a linguistic parametric variable, which may then be mapped to its matching fuzzy set rules, which are then appraised. Fuzzification is the term for this procedure.

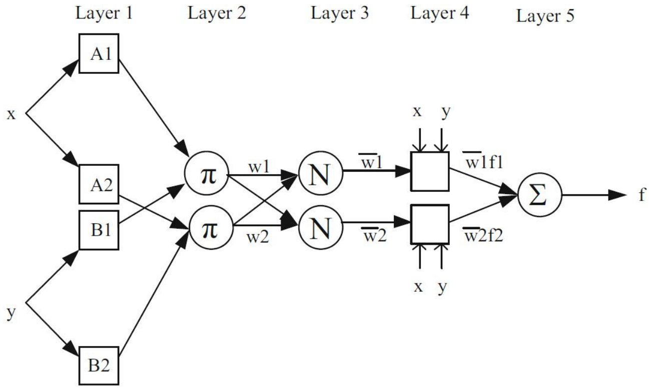
Step 2 The fuzzifier inputs are accepted by the antecedents of the fuzzy rules, which are then applied to the subsequent carried out by triangular and trapezoidal membership functions. Rule evaluation is the name given to this procedure.

Step 3 Fuzzy parametric variables are used to define the fuzzy rule (i.e., input and output linguistic terms). The hazy guidelines gathered here lead them to the next stage.

Step 4 Convert the language parametric variable into crisp probability inputs once again. It is known as defuzzification. In other words, input is acquired as a collection of fuzzy outputs with a single crisp number assigned to them.

The HFNI system is functionally quit similar to traditional fuzzy inference system. That is, multilayer network (feed-forward) connection between artificial neurons and synaptic weights. It is clearly shown in Figure 2. Describe an HFNI system in detail in the next section. Consider two inputs, one output, and two fuzzy rules to help you comprehend. The functional operation of each layer is given below:

Figure 2 Multilayer network (feed-forward) architecture



- *Layer 1:* the crisp data is transformed into linguistic parametric variables, each of which may be mapped to a set of fuzzy set rules. Each set of values is properly obtained by effective utilisation of the membership function of the input and output values are assigned from the expression given below equation (1).

$$\begin{aligned}&\text{Rule } (j)\\&\text{If } x_1 \text{ is } A_1^j \text{ AND } x_2 \text{ is } A_2^j \text{ AND } x_3 \text{ is } A_3^j\\&\quad\text{AND } x_4 \textit{ is } A_4^j \text{ AND } x_5 \text{ is } A_5^j\\&\text{Then, } y_1 \text{ is } B_1^j \text{ AND } y_2 \text{ is } B_2^j\end{aligned} \tag{1}$$

Where j represent j^{th} fuzzy rule and its fuzzy set of x_1, x_2, …, x_5 that corresponds to A_1, A_2, …, A_5. It generates 243 rules based on a fuzzy inference system to produce optimised results. The centroid of area (COA) is estimated by using the below expression for each intra-cluster group equation (2).

$$COA = \frac{\int \mu_{A1}(x).xdx}{\mu_{A1}(x).dx} \tag{2}$$

- *Layer 2:* each neighbour node knows about route information which has been sent from data carrying centre. In every round, the routing table is stored with the updated values of node id, residual energy and distance.
- *Layer 3:* at regular time interval, each node chooses the relay node from the probability function. Next, find the shortest route from neighbour node to database centre. The probability function is given by

$$P_{i,j} = \frac{(\tau_{i,j})^{\alpha}(\eta_{i,j})^{\beta}}{\sum_{j\in N}(\tau_{i,j})^{\alpha}(\eta_{i,j})^{\beta}} \langle \therefore \tau_{i,j} = \frac{1}{d_{i,j}} \tag{3}$$

where $\tau_{i,j}$ is the data transferred to next centre selected from source machine node, $\eta_{i,j}$ the energy level indicator of each node and $d_{i,j}$ the distance between source node i and its associated database centre.

- *Layer 4:* let f_i is the most attractive solution of component i and S being the total number of partial solution component that can be selected by the database centre.

$$p_i = \frac{f_i}{\sum_{j=1}^{S} f} \tag{4}$$

- *Layer 5:* the attractiveness of a path is determined in this manner, with values ranging from 0 to 1. The more appealing the marketed route is, the higher the computed value. Partially solved problems are compared using the notion of partial solution badness. Assuming that we are dealing with a minimisation problem, we define the badness of a partial solution L_k in the following way:

$$L_k = \frac{L^{(k)} - L_{\min}}{L_{\max} - L_{\min}} \tag{5}$$

where $L^{(k)}$ be the objective function value of the partial solution discovered by the k^{th} centre, $L_{\min}$ be the best partial solution and $L_{\max}$ be the worst partial solution given by k^{th} centre from the beginning of the search process.

4 Experimental results

The qualitative analysis of the proposed NPA-FLI-EC technique has performed through open-source Planet Lab in which VM migration environment is created to identify improvement process in terms of VM migration time reduction and energy consumption. Thereby, nearly more than 300+ database centres, VM migrations is collected and monitor the utility factor of CPU for every five minutes. The simulation results are being compared with the other existing methods presented. A respectively, where analysis parameters are VM varying size and number of migration number. The simulation setup is considered for VM migration database centre is collected for 15 days randomly.

The collected dataset consists of number of rows, each represents the accumulation of migration time and note down the migration needs are required for at instant process. The CPU utilisation factor is plays major role to find the migration time and first few rows' values are training samples which will be updated for every cycle. So that, migration need, and time requirement is minimised. That means, threshold limit is fixed based on the previous migration history and update the row values by assigning 0 and 1 after verifying the values lies whether the value is greater than or less than threshold limit. If it is greater than, then, assign 1 to its row value which conveys the need for VM migration. Otherwise, row value assigned with 0, which conveys the no need for VM migration. In order to understand the improvements of the proposed NPA-FLI-EC technique, the training dataset is applied to the multilayer network (feed-forward) architecture which consists of 15 neurons present in the intermediate layers. The simulation is executed for 1,000 iteration for consolidating the results. It influences the CloudSim simulator with specification of (i5 processor at the frequency of 2.30 GHz and 8 GB RAM).

Figure 3 clearly shown that the proposed NPA-FLI-EC technique produced better result than other existing approach given in respectively in terms of CPU utilisation and usage ability. It needs only few numbers of migration and monitors server location for every ten minutes. Figure 4 give the comparison results of mean values of migration numbers of the proposed NPA-FLI-EC technique is being compared with as per results noted in the respectively. This result shows that the minimum number of migrations is achieved by proposed technique that means, neural prior predicting and fuzzy logic insertion algorithm, finds the accurate prediction of number of migration should be required for future (for 30 minutes duration, right from ongoing migration instant). Thus, it has induced the high CPU utilisation capability which in turn enhances the energy consumption of the database centre. It improves prior prediction capability of the migration needs from 80% into 92%. That means, probability of migration reduction is changed from 21% into 17% as compared with as per results noted in the respectively.

Figure 3 CPU utilisation comparison of proposed NPA-FLI-EC (see online version for colours)

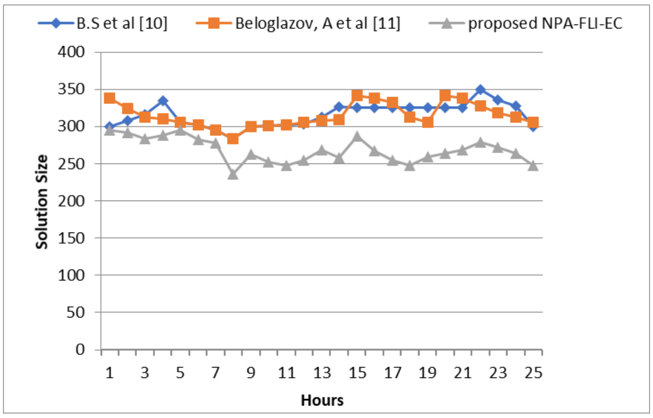


Figure 4 Average migration number of proposed NPA-FLI-EC (see online version for colours)

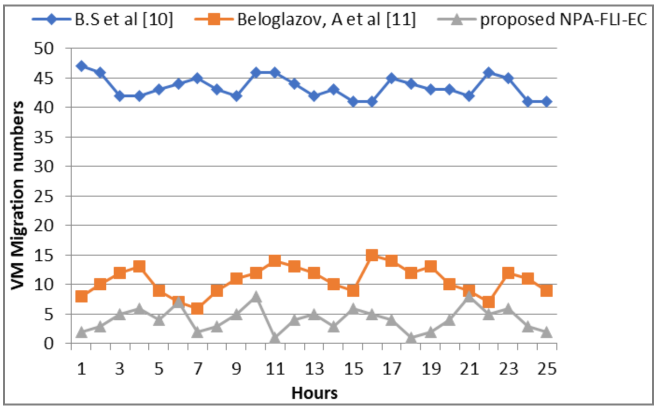


Figure 5 Average energy consumption of proposed NPA-FLI-EC (see online version for colours)

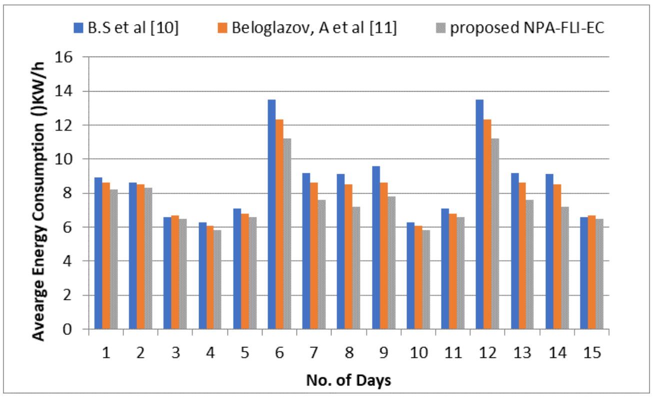


Figure 6 Slav of proposed NPA-FLI-EC (see online version for colours)

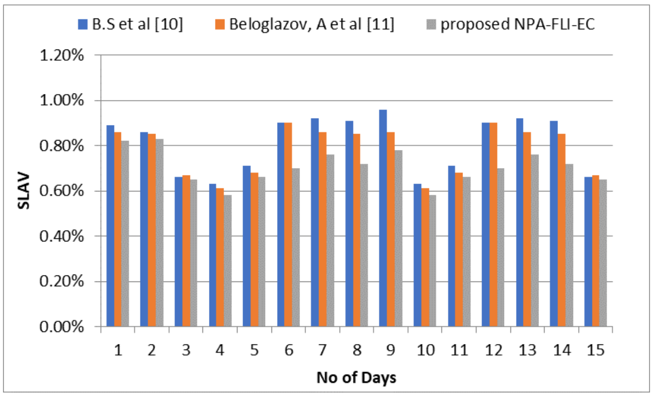


Figure 5 gives the average energy consumption of the proposed NPA-FLI-EC technique as compared with algorithm. There are three important VM selection policies are influence in the proposed technique such as random choice (RC), minimum migration time (MMT) and maximum correlation (MC). According to the findings, the suggested method reduces overall energy usage by 6.5% in 15 days when compared. As a result, it can be concluded that the suggested NPA-FLI-EC method has resulted in higher quality VM selection policies. As a result, Figure 6 indicates that the mean value of SLA violation for the MMT method is 0.00473, while the mean value of SLA violation for the suggested approach is 0.00086, implying that the proposed approach can reduce the mean value of SLA violation by 72.85%.

5 Conclusions

In this article, the authors present NPA-FLI-EC, a novel ILA VM migration method that uses a neural prior prediction algorithm and fuzzy logic insertion of Evolutionary Computing to reduce energy consumption and the number of VM migration phases. It integrated neural prior prediction algorithm and fuzzy logic insertion of energy reduction on VMM method to induce optimistic manner of obtaining pre-copy of pages, which in turn minimises needless transfer of repeated content pages. It is mainly focus on two factors vis.

1 getting an optimal VMs arrangement and reduce connection break on physical servers by using NPA-FLI-EC

2 prior prediction of resource identity from each host through neural prior predicting algorithm which reduce unnecessary VMs migrations.

Hence, it has provided the flexibility of workload distribution over many servers on spending 2/3 of total energy consumption. Further, it provides accessible by repeated data users by consuming less bandwidth and improving energy robust exhaustion through limited consolidated number of VMs. The simulation results conveyed that the minimum number of migration is achieved by proposed technique that means, neural prior predicting and fuzzy logic insertion algorithm, finds the accurate prediction of number of migration should be required for future (for 30 minutes duration, right from ongoing migration instant). Thus, it has induced the high CPU utilisation capability which in turn enhances the energy consumption of the database centre. It improves prior prediction capability of the migration needs from 80% into 92%. That means, probability of migration reduction is changed from 21% into 17% as compared with as per results noted in the and respectively.

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