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Significance of Artificial Intelligence and Machine Learning Techniques in Smart Cloud Computing: A Review

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Abstract: ***Realization of the tremendous features and facilities provided by Cloud Computing by the geniuses in the world of digital marketing increases its demand. As customer satisfaction is the manifest of this ever shining field, balancing its load becomes a major issue. Various heuristic and meta-heuristic algorithms were applied to get optimum solutions. The current era is much attracted with the provisioning of self-manageable, self-learnable, self-healable, and self-configurable smart systems. To get self-manageable Smart Cloud, various Artificial Intelligence and Machine Learning (AI-ML) techniques and algorithms are revived. In this review, recent trend in the utilization of AI-ML techniques, their applied areas, purpose, their merits and demerits are highlighted. These techniques are further categorized as instance-based machine learning algorithms and reinforcement learning techniques based on their ability of learning. Reinforcement learning is preferred when there is no training data set. It leads the system to learn by its own experience itself even in dynamic environment.***

Keywords: Cloud Computing, Load Balancing, Optimal Solution, Artificial Intelligence and Machine Learning Techniques, Instance-based Learning, Reinforcement Learning

I. INTRODUCTION

In today's world, businessmen at various levels have realized the necessary of automated decision making systems to learn their customers' behaviour and lead their business successfully. It makes the researchers and industrialists to turn towards the analysis of applicability of Artificial Intelligence (AI) and Machine Learning (ML) techniques in their field of interest. The automated intelligent system should be capable to analyze the heterogeneous data generated in multiple sources and identify the underlying patterns and knowledge to support decision making. The generated model is trained with training data, and tested with validation data. Further, the model has to analyze the newly arrived data, and identify their pattern or the hidden knowledge. ML algorithms are categorised as supervised, unsupervised, reinforcement, and deep learning algorithms. This list is extended with fuzzy logic and other evolutionary computations.

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Supervised learning algorithms use discrete or continuous quantity of labelled data. It consists of classification and regression methods which can be used for data categorization and prediction. The unsupervised learning methods are used to find the efficient representation of unlabelled data. Clustering and dimension reduction are the two basic unsupervised learning methods. In vehicular wireless network, the efficient routing algorithm is proposed with clustering technique alone. It is used to find the cluster of nearby vehicles and identify the central system of each cluster. It supports the formation of risk free communication system. Data aggregation is done by using dimension reduction method [5].

Reinforcement Learning (RL) interacts with the dynamic environment in a trial-and-error manner, and maps the situations and actions based on maximized reward value. The Markov Decision Process (MDP) followed by RL utilizes Q-Learning (QL) function to estimate the expected sum reward based on the policy before taking any action. The optimal QL function estimates the maximum expected reward value. Based on these alone, the suitable action for the current state is decided.

Another popular ML technique is the deeper version of Neural Network (NN), known as Deep Learning (DL). It makes the system to learn from the data represented by any other category of ML algorithms. Evolutionary computations such as evolutionary algorithms are classified as Genetic Algorithm (GA), Meta-heuristic Algorithms and Swarm Intelligence Algorithms.

II. LITERATURE SURVEY

In [1], Hemlata, et.al considered the support of Cloud Computing in the analysis of big data and their concerns during the migration process for load balancing. As per their research results, their proposed algorithm, EAMLB, Enhanced Active Monitoring Load Balancing algorithm was performed well than that of Round Robin method which was equated to deep learning.

In [2], Bakul, et.al. were applied regression technique to predict VMs load and for queue updation.

Based on the comparison of VMs load with the upper and lower threshold values, separate queue of under-loaded and overloaded VMs were formed by the Queue Manager which was considered in further VM allocation.

In [3], Mousa et.al. were addressed VMs allocation concerns with classification technique. It classified the users requested VMs based on their CPU and RAM requirement. The applications type needed by the classifier was collected from user's log files. Group mapping was done among the set of tasks and appropriate VMs group. It increased the performance with reduced response time and jobs rejection.

In [4], Renu Choudhary, et.al., was proposed the new load balancing algorithm based on k-means clustering algorithm to cluster the available VMs based on their engaged CPU time and memory. Their approached throttled algorithm had updated and sorted the VMs information based on their throughput value. The updated values were referred by the Data Center Controller (DCC) to update its hash map index value to manage further scheduling.

Hao, et.al. in [5], were developed an intelligent vehicular transportation system to support the establishment of smart cities. ML algorithms were used as data-driven approach, and Poisson Regression Tree (PRT) method was used to correlate two tasks in order to predict the communication connectivities and vehicles traffic. DL method was applied in stacked auto-encoder model to increase its performance. In the formation of communication connectivity, next data carrier vehicle was selected with the support of Fuzzy Logic which was further refined with RL technique. k-means clustering mechanism was used to cluster the traffic data to control network congestion. The highly dynamic nature of vehicular networks needed to learn even when the small change had occurred in the system. RL technique was found as boon to face such challenges of learning from unknown environment. The user association problem in dynamic vehicular environment was also addressed with RL. The dynamic demands of resources were catered with the support of Deep RL (DRL) approach. DRL could deal decentralized resource allocation environment also.

In [6], Mohammad, et.al. were proposed the development of Aarhus City Smart Traffic IoT application. It was framed with the support of Supply Vector Machine (SVM) algorithm to get traffic information for the entire day. They were also analyzed the usage of various ML algorithms in the development of smart cities.

Nothing in this world is individual. All are interrelated. The knowledge attained in one thing can be applied to another thing, but may be in different angle. In this perspective, evolutionary computations were revealed under AI techniques. When the researchers were inspired with the hidden intelligence in swarm and other sort of natural resources, they were realized that their admired knowledge of these resources were suitable for their research problems also to get optimal solutions. Such kinds of algorithms applied in load balancing area of Cloud Computing were analyzed by the authors Dalin, et.al in their survey paper [7]. Their applied areas, and their merits and demerits were discussed in this paper. Dynamic Load Balancing with effective Bin Packing and VM Configuration (DLBPR) in a deadline based job scheduler, Fuzzy decision based TOPSIS algorithm to select appropriate VM for migration, GA for proper distribution of load, Stochastic Hill Climbing algorithm to improve VM allocation, Honey Bee Behavior Inspired Load Balancing (HBB-LB) algorithm to maximize the throughput, Multi Agent (MA) system who debited the knowledge from Ant, dealt with dynamic load balancing issues, and Hybrid Fruitfly optimization algorithm to get optimum solutions in load balancing. Results depicted that many of the algorithms which were applied with swarm intelligence, performed well in resources utilization, and reduced response and execution time.

In [8], Stelios Sotiriadis, et.al., were proposed a Self-managed VM Placement (SVMP) algorithm. This model was used real-time resource usage data to train the system. The collected data were applied with classification and regression techniques to define the actual behaviour of PMs as well as VMs. Based on the results, it was known that there was a significant improvement in the placement of VMs.

Mohammadreza, et.al, in [9], were surveyed the Cloud load balancing techniques under three different categories, namely, General Algorithms-based, Architectural-based, and Artificial Intelligence-based load balancing mechanisms. Under the AI part of survey, they had analyzed the significance of Ant Colony Optimization (ACO), Bee Colony Algorithm (BCA), and an improved ACO in balancing of peak time load, power consumption reduction.

In [10], XIAOFEI WANG, et.al were considered AI techniques to deal with the technical issues in mobile Heterogeneous Network (HetNets). They were used GA, ACO, and Particle Swarm Compensation (PSC) algorithms to set right the self-configuration HetNets, by improving its self-healing and self-optimization capabilities. Fuzzy Neural Network Optimization based on RL technique was used for autonomous reconfiguration.

Amandeep Kaur, et.al. in [11] also surveyed the applicability of AI algorithms in Cloud load balancing process. FUGE, the load balancing algorithm was combined with the knowledge of Fuzzy Logic and GA. It increased the performance of job scheduling round robin method. ACO-VMM algorithm was implemented in VM Manager (VMM) system to improve its migration process. Utilization of BABC, the Binary Artificial Bees Colony algorithm provided flexible ranking strategy for balancing the searching and utilization processes. The comparison report revealed that GA was performed well than other algorithms.

III. RESULTS AND DISCUSSION

Thus this proposed review reveals the researchers and industrialists interest in the utilization of

AI-ML techniques to enhance their system in interest. Recently, Vehicular Transportation System, mobile Heterogeneous Networks (HetNet), Cloud Computing, are the major systems which are applied with the ML techniques Classification, Regression, Poison Regression Tree, Supply Vector Machine, Fuzzy Logic, Ant Colony Optimization, Deep Learning, and Reinforcement Learning in different concerns to make them as self-configurable and self-learnable smart systems. In some of the researches [5][7][10][11], the Fuzzy Logic is combined with their chosen heuristic or meta-heuristic algorithm. The review report is summarized in Table 1.

Table 1
A Survey Report – Utilization of various AI techniques in different Areas of Interest

Ref. No.	AI Techniques	Applied Area	Purpose	Merits
[1]	Enhanced Active Monitoring Load Balancing (EAMLB) method	Cloud Computing	Migration of VMs	Performed well than Round Robin method
[2]	Queue Manager with Regression Technique	Cloud Computing	Identify the VMs whose load is above upper_threshold or less than lower_threshold value	Improved VM allocation
[3]	Classification Technique	Cloud Computing	Grouping the VMs based on CPU and RAM utilization and Grouping of Users task using log files information	Groupwise mapping of users task and VMs
[4]	K-Means Clustering Algorithm	Cloud Computing	Clustering the VMs based on CPU and memory utilization	Data Center Controller System utilizes that information to update its Hash map index value to support scheduling process
[5]	Poisson Regression Tree, Deep Learning, Reinforcement Learning, Deep Reinforcement Learning, Fuzzy Logic with Reinforcement Learning	Development of Smart Cities	Intelligent Vehicular Transportation System	Prediction of communication connectivities and vehicles traffic
[6]	Supply Vector Machine (SVM) technique	Development of Smart Cities	Provision of Traffic Information	Traffic information is provided for the entire day

[7]	Dynamic Load Balancing with effective Bin Packing and VM Configuration (DLBPR) Fuzzy decision based TOPSIS algorithm Genetic Algorithm Stochastic Hill Climbing algorithm Honey Bee Behavior Inspired Load Balancing (HBB-LB) algorithm Multi Agent (MA) system with the knowledge of Ant to deal with dynamic load balancing issues, and the knowledge of Hybrid Fruitfly was applied with the optimization technique to get optimum solution.	Cloud Computing	Load balancing processes	Deadline based job scheduler, Chosen of appropriate VM for migration, Proper distribution of load, Improved VM allocation Maximizing the throughput Deal with dynamic load balancing issues optimization technique to get optimum solution with improved performance, resources utilization, and reduction in response and execution time
[8]	Classification and Regression Techniques	Cloud Computing	Self-managed placement of VMs	Defining the actual behaviour of PMs and VMs
[9]	Ant Colony Optimization (ACO) Bee Colony Algorithm (BCA) Improved ACO	Cloud Computing	Load balancing processes	Migration of overloaded VMs into under-loaded PMs Shifting of under-loaded PMs load to reduce power consumption
[10]	Genetic Algorithm (GA), Ant Colony Optimization (ACO) Particle Swarm Compensation (PSC) algorithm Fuzzy Neural Network Reinforcement Learning	Mobile Heterogeneous Network (HetNet)	Self-configuration Self-healing and Self-optimization	Planning and placement of resources Reconfiguration with the newly identified resources Centralized cell management scheme Autonomous reconfiguration Optimization method

[11]	Fuzzy Logic and Genetic Algorithm – FUGE Ant Colony Optimization Algorithm Binary Artificial Bees Colony algorithm Genetic Algorithm	Cloud Computing	Load balancing processes	Job scheduling Support VM manager system to handle migration process Balancing searching and utilization processes

The above review depicts that the ability of RL technique, i.e., self-learning from dynamic environment opens a new vision of wisdom in various research areas. The RL, combination of RL with other ML methods [5][10], and DRL [5] are in emerge usage of research interest. In this era, the revolution of Industry 4.0, is in the need of intelligent, self-manageable automated systems everywhere. The auto learning RL method is applicable for Cloud load managing process to make it as smart self-load-management system [1][7][9].

IV. MACHINE LEARNING TECHNIQUES

The system modelled with ML technique is trained with the existing data set. Further, the learning ability of the model is verified with the validation data set. There are numerous categorization of ML techniques exists. In this study, the ML techniques are categorized based on their learning ability, i.e., Instance-Based Learning ML (IBL-ML) algorithms, and Reinforcement Learning (RL) techniques. Consider the figure 1.

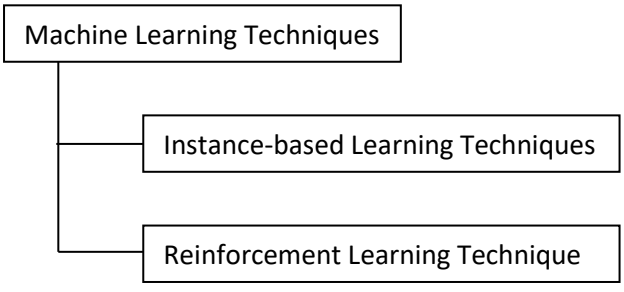

Figure 1. Categorization of Machine Learning Algorithms

A. Instance-based Learning Techniques

IBL-ML algorithms are also part of the supervised learning category, but it can deal with the fuzzy data set also. With the obtained data, the model is formed either with the classifier or regression method. The model's resultant information are more useful to improve the decision making process. It is known that the trained model will be able to easily predict the relation between the observed data and the system behaviour.

It enforces the selection of suitable prediction algorithm that should be computationally light and obtain good results. It needs efficient training data set to improve the system performance.

B. Reinforcement Learning Techniques

RL enforces the system to learn by its own experience itself. It can handle the dynamic environment of the system. At the beginning, in trial-and-error manner, it interacts with the system. Two main strategies approached by RL are searching the space of behaviours in order to identify the one which performs well in that environment, and defining the statistical function in dynamic programming to estimate the reward value of the action which may be planned to occur in the current state of the environment.

The second strategy can be applied with the self-management approaches to easily adopt with the drifts and environmental changes in the system. The RL learning process identifies the suitable set of policy and action. To estimates the returns, function can be executed repeatedly for the determined number of times. It updates the ranking of the chosen set. The decision is taken place based on the best ranked set. The evaluation pair is defined as <status s, action a>.

MDP followed by RL utilizes the learning Q classic function. It is a model free learning function which can start learning without any knowledge about the environment. It estimates the expected sum of reward whereas the optimal Q function finds the expected and achievable maximum sum of reward by following the particular policy on choosing the actions for specific states. Consider the equation (1).

$$Q(s,a) = \sum_{s'} E[R|s',\pi]P(s'|s,a) \text{ ---------- (1)}$$

where s is current state of the system, a is the action to be taken, π is the policy, s' is the expected state of the system when it is applied with the action, a. P is the probability of state changes, and E is the expected reward based on the learned policy.

The expected reward is defined as the reward of the current state (R|s) as well as the weighted (γ) reward of its subsequent state which is formulated in the equation (2).

$$E[R|s] = r + \gamma E[R + s'] \text{ ---------- (2)}$$

When the search space is large, MDP reduces the space and time with the support of this Q learning function. Figure 2 depicts RL method.

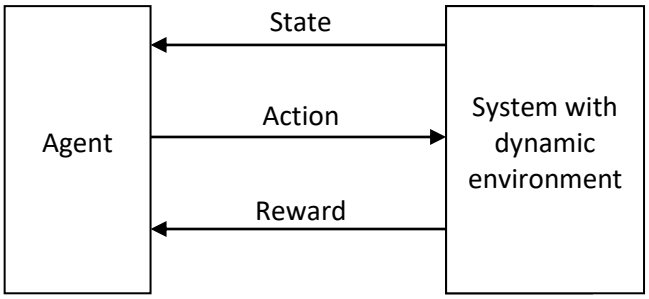

Figure 2. Reinforcement Learning Method

Acquiring of correct data as training data as well as validation data are most important to get exact prediction results. When the observed data is huge in size, it would have noise and irrelevant data. Filtering of such unwanted data from the data set is most important one to get accurate results.

V. CONCLUSION

Thus the survey reports that the recent urge on the provision of self-managed, self-healing, and self-configured autonomous systems. It is somehow managed with the available AI-ML techniques. Review reveals the significance of various AI-ML techniques in setting right Smart Cloud. IBL-ML supervised learning techniques are suitable for fuzzy data set. RL techniques are for making the system to learn by its own experience and start its learning process in trial-and-error manner. It can deal with the system's dynamic environment by estimating the reward value with suitable policy and action. It attracts the researchers more to enhance their system as intelligent. RL stands itself as individual, and act as the companion of other heuristic as well as meta-heuristic algorithms.

VI. FUTURE WORK

Even when the RL and other AI-ML algorithms are applied in various areas of research interest, still there is a demand for refinement in these algorithms to get optimal results. Refinement in RL method and finding of its applicable areas in Cloud Computing are the future works in plan.

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REFERENCES

1. Hemlata Joshi, Farha Naaz, and Anurag Shrivastav (2019). Implementation of Load Balancing Algorithms for Performance Improvement in Cloud Computing. International Journal of Science and Research (IJSR) ISSN: 2319-7064, 7.426 Volume 8 Issue 1, January 2019, Paper ID: ART20194194 10.21275/ART20194194 649
2. Bakul Panchal, and Smaranika Parida (2018). An Efficient Dynamic Load Balancing Algorithm Using Machine Learning Technique in Cloud Environment. IJSRSET, Themed Section - Engineering and Technology, Volume 4, Issue 4, Print ISSN: 2395-1990, Online ISSN : 2394-4099.
3. Mousa Elrotuba, and Abdelouahed Gherbib (2018). Virtual Machine Classification-based Approach to Enhanced Workload Balancing for Cloud Computing Applications. 9th International Conference on Ambient Systems, Networks and Technologies (ANT 2018), ScienceDirect, Procedia Computer Science, 130 (2018) 683–688.
4. Renu Choudhary, and Dr.Abhay Kothari (2018). A Novel Technique for Load Balancing in Cloud Computing Environment. iJournals: International Journal of Software & Hardware Research in Engineering, ISSN-2347-4890, Volume 6 Issue 6 June, 2018.
5. Hao Ye, Le Liang, and Geoffrey Ye Li (2018). Machine Learning for Vehicular Networks. arXiv:1712.07143v2 [cs.IT], 26 Feb 2018
6. Mohammad Saeid Mahdavinejad, Mohammadreza Rezvan, Mohammadamin Barekatain, Peyman Adibi, Payam Barnaghi, and Amit P. Sheth (2017). Machine learning for internet of things data analysis: A Survey. Digital Communications and Networks Journal, accepted on 9 October 2017, 2352-8648/© 2018 Chongqing University of Posts and Telecommunications. Production and hosting by Elsevier B.V. on behalf of KeAi.
7. Dr. G. Dalin and Mrs. V. Radhamani (2018). Load Balancing Techniques in Cloud: A Review. JETIR August 2018, Volume 5, Issue 8 www.jetir.org (ISSN-2349-5162).
8. Stelios Sotiriadis, Nik Bessis, and Rajkumar Buyya (2017). Self managed virtual machine scheduling in Cloud systems. Elsevier-Information Sciences Journal, 433–434 (2018) 381–400.
9. Mohammadreza Mesbahi, and Amir Masoud Rahmani (2016). Load Balancing in Cloud Computing: A State of the Art Survey. I.J. Modern Education and Computer Science, 2016, 3, 64-78.
10. Xiaofei Wang, Xiuhua Li, and Victor C. M. Leung (2015). Artificial Intelligence-Based Techniques for Emerging Heterogeneous Network: State of the Arts, Opportunities, and Challenges. Special Section on Artificial Intelligence Enabled Networking, IEEE Access, VOLUME 3, 2015, 2169-3536 2015, Digital Object Identifier 10.1109/ACCESS.2015.2467174.
11. Amandeep Kaur, and Pooja Nagpal (2016). A Survey on Load Balancing in Cloud Computing using Artificial Intelligence Techniques. International Journal of Multidisciplinary Research and Modern Education (IJMRME) ISSN (Online): 2454 - 6119 (www.rdmodernresearch.com) Volume II, Issue II, 2016 418.

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