ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

JOURNAL OF CURRENT SCIENCE

AN IMPROVED BP NEURAL NETWORK ALGORITHM FOR FORECASTING WORKLOAD IN INTELLIGENT CLOUD COMPUTING

Mohanarangan Veerappermal Devarajan
Specialist/Project Manager
Cambria Solutions, Sacramento, California, USA
gc4mohan@gmail.com

ABSTRACT

An inventive method for enhancing workload forecasting in intelligent cloud computing systems is presented in this research. Utilizing the Backpropagation neural network algorithm and the principles of game theory, the methodology aims to strategically align cloud users and service providers in order to maximize resource allocation and service delivery. The study tries to establish mutually beneficial Service Level Agreements (SLAs) between stakeholders by applying notions from Nash equilibrium. Experiment validation with real-world data demonstrates how well the method works to improve cloud computing operations and achieve strategic alignment. Prioritizing scalability, security, and usability during implementation is made easier by working with cloud service providers and industry professionals. The suggested approach has a lot of potential to improve cloud resource management in a number of industries.

Keywords: Intelligent cloud computing, workload forecasting, Backpropagation neural network, game theory, Nash equilibrium, resource allocation, Service Level Agreements (SLAs), implementation considerations.

1. INTRODUCTION

Neural networks are now strong tools for solving complicated problems in a variety of industries because to advancements in artificial intelligence and machine learning. Best known for its ability to identify patterns and make predictions, the Backpropagation (BP) neural network method has a unique place among them. But additional optimization and refinement of these algorithms are desperately needed as computational demands rise and technology advances. This research explores the details of an Improved BP Neural Network Algorithm with the goal of improving the accuracy and productivity of conventional BP networks predictably. This work aims to expand the capabilities of predictive modeling, especially in domains requiring high precision and flexibility, by means of thorough testing and algorithmic improvements.

Network Algorithm, which is intended to improve the prediction capability of traditional BP networks. This approach, which iteratively modifies network parameters to minimize prediction errors, is based on the fundamentals of supervised learning. This enhanced version of BP networks incorporates novel approaches and strategies to get over built-in constraints and enhance performance measures. The core of this algorithm is its capacity to identify complex patterns and correlations in datasets, which makes forecasting and decision-making in dynamic contexts more accurate. The Improved BP Neural Network Algorithm combines predictive analytics and

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

JOURNAL OF CURRENT SCIENCE

computational intelligence by utilizing sophisticated optimization techniques and adaptive learning mechanisms to provide insightful analysis of intricate data environments.

The Improved BP Neural Network Algorithm is epitomized in these descriptions, emphasizing its significance and possible applications in the fields of artificial intelligence and predictive modeling. This algorithm drives revolutionary breakthroughs in a variety of sectors, including engineering, finance, healthcare, and beyond, via rigorous research and invention. It is a beacon of development.

Precise workload planning has become crucial for effective resource management in today's quickly changing cloud computing environment. For cloud settings to function at their best and be as economical as possible, it is essential to forecast the demand for computing resources. But conventional forecasting techniques frequently fail to adequately represent the complexity of contemporary cloud workloads. This is where intelligent cloud computing comes in: a paradigm that uses cutting-edge machine learning techniques and complex algorithms to predict workload variations with previously unheard-of accuracy and flexibility. In order to maximize resource allocation techniques, this study explores the field of intelligent cloud computing workload forecasting and looks at various approaches, frameworks, and algorithms. Intelligent cloud computing intends to change resource management techniques by utilizing predictive modeling and data-driven insights to achieve improved performance, scalability, and cost-efficiency in cloud environments.

In intelligent cloud computing, workload forecasting represents a revolutionary method to resource allocation and management. Fundamentally, it is about forecasting the amount of computational resources—like processing power, storage, and network bandwidth—that will be needed in cloud environments in the future. In contrast to conventional techniques, intelligent cloud computing makes use of real-time data processing, machine learning algorithms, and advanced analytics to precisely predict variations in workload. Intelligent cloud systems are able to dynamically grow to meet changing demands by proactively provisioning resources based on historical usage patterns and system performance parameters. Cloud providers can maximize resource usage, reduce downtime, and improve overall system efficiency with this integration of AI and predictive analytics. To put it simply, intelligent cloud computing workload forecasting is crucial for businesses trying to get the most out of their cloud investments and maintain reliable performance in ever-changing settings.

Precisely forecasting workload demands is essential for effective resource allocation and service delivery in the cloud computing domain. The dynamic nature of cloud settings frequently makes traditional methods unsuitable, which has led to the investigation of novel ways. One such method is to portray the relationship between cloud customers and providers as a strategic game by applying concepts from game theory. These strategies seek to maximize service level agreements and promote cooperation by reaching Nash equilibrium, where both parties have no incentive to stray from the predetermined course of action. At the vanguard of this effort is the Improved BP Neural Network Algorithm, which uses game theory to improve workload predictions in intelligent cloud computing systems.

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

JOURNAL OF CURRENT SCIENCE

https://jcsjournal.com/.2022.v10.i03.pp01-10

One complex technique for predicting workload patterns in cloud computing systems is the Improved BP Neural Network Algorithm. Incorporating game theory, a mathematical framework for strategic decision-making, into the forecasting process sets it apart from conventional methods. The program aims to reach Nash equilibrium, which guarantees that both cloud customers and providers act in the best interests of each other, by presenting their interactions as a strategic game. In the end, this strategic alignment improves service delivery in cloud environments by increasing the effectiveness of resource allocation and encouraging cooperation and trust between users and providers.

The Improved BP Neural Network Algorithm may need the use of a number of software tools and computer languages during implementation. TensorFlow, MATLAB, Python, and Keras are often utilized technologies that provide features for data preprocessing, model training, and evaluation. Platforms for cloud computing such as Microsoft Azure and Amazon Web Services (AWS) offer the infrastructure needed to scale and implement predictive models in practical applications.

To put the Improved BP Neural Network Algorithm into practice, cloud service providers, data scientists, and researchers must cooperate together. These methods are developed and tested in collaboration with industry groups, research institutes, and academic institutions. In order to ensure the practical viability and scalability of these algorithms, cloud service providers are essential in their validation and deployment in production contexts.

An innovative method for resource management and workload forecasting in cloud computing is the application of game theory. Game theory, which originated in the social sciences and economics, offers a mathematical framework for examining the strategic interactions that occur between logical decision-makers. Researchers have recently realized how well it may be used to optimize service level agreements and the distribution of cloud resources. Through the incorporation of game theory principles into predictive modeling algorithms such as the Improved BP Neural Network Algorithm, researchers hope to improve cloud resource management's yield and efficacy.

Improving workload forecasting in cloud computing with improved accuracy and efficiency is the main goal of putting the Improved BP Neural Network Algorithm into practice. The method maximizes service level agreements and encourages cooperation between users and providers by reaching Nash equilibrium. It also tackles resource contention and dynamic workload patterns, allowing for proactive resource provisioning and effective resource usage.

In cloud computing workload forecasting and resource management, there are still a number of research gaps despite substantial advancements. Among the difficulties are the ever-changing nature of cloud workloads and the misalignment of user and provider strategies. To find creative solutions and close these gaps, academia and industry must work together on interdisciplinary research projects.

In cloud computing, workload forecasting is the process of precisely projecting future resource requirements using past data. Because cloud workloads are dynamic, traditional methods may not be able to keep up, which could result in less than ideal resource allocation. For effective resource management, users and providers must strategically align.

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

JOURNAL OF CURRENT SCIENCE

https://jcsjournal.com/.2022.v10.i03.pp01-10

Technological developments in cloud computing, AI, and machine learning have enabled creative methods for workload forecasting. Cloud settings are now more effective and scalable thanks to advances in deep learning, cloud-native technologies, and distributed computing, which have improved predictive modeling and resource management capabilities. It is vital to utilize these developments in order to meet the changing requirements of cloud computing.

2. LITERATURE SURVEY

Sun (2020) In order to improve forecast accuracy and efficiency for better resource management, this study investigates the usage of Support Vector Machines (SVM) and Backpropagation (BP) neural networks to anticipate workloads in cloud computing settings. Optimizing workload prediction is the main objective in order to enhance resource management and allocation. SVM and BP neural networks are integrated because SVM is good at classification and regression tasks and BP neural networks are good at supervised learning and sophisticated pattern recognition. Both models are trained using historical workload data, and their results are compared and examined. The findings show that while both models are capable of correctly forecasting cloud workloads, the hybrid method may perform better overall. In cloud contexts, this improved prediction method can result in decreased operating costs, higher system efficiency, more effective resource allocation, and increased user satisfaction.

In order to improve prediction efficiency and accuracy for better resource management, Kumar (2018) work investigates the use of Artificial Neural Networks (ANN) in conjunction with Adaptive Differential Evolution (ADE) to forecast workloads in cloud computing settings. Optimizing workload prediction in cloud computing is the goal in order to enhance resource management and allocation. ADE, an optimization technique that learns over time to identify optimal solutions, is coupled with ANN, which is recognized for its ability to capture intricate patterns and relationships through supervised learning. The methodology entails collecting historical workload data to train the ANN, improving its parameters with ADE, then comparing and assessing the combined method's performance. According to the results, there is a good chance that the combination of ANN and ADE will be able to anticipate cloud workloads more correctly than traditional methods, possibly even surpassing them in terms of prediction accuracy and adaptability. This hybrid approach to better workload prediction can lower operating costs, improve the efficiency of resource allocation, and boost user happiness in cloud environments.

In order to enhance workload prediction in cloud computing, Kumar (2019) dissertation presents the EWPTNN model, which makes use of two-stage neural networks. By improving prediction efficiency and accuracy, this approach seeks to maximize resource management. The model learns to better capture and anticipate complicated patterns by doing two stages of training on historical workload data. According to the results, EWPTNN greatly increases prediction accuracy and flexibility. In cloud contexts, this results in better system performance, more cost-effective resource allocation, and increased user happiness.

Tang (2019) investigation looks at a Parallel Improved LSTM Neural Network for large-scale computing systems workload prediction. By increasing prediction efficiency and accuracy, resource management will be optimized. Through improvements to the traditional LSTM architecture and parallel processing, the model is trained to handle sequential data more effectively using workload data from the past. According to the findings, this strategy greatly enhances prediction performance, which raises user satisfaction and facilitates more effective resource allocation, system efficiency, and cost savings.

In order to better manage resources, Kumar (2020) paper presents a Biphase Adaptive Learning-Based Neural Network Model for workload forecasting in cloud datacenters. The algorithm learns over time to improve workload predictions' efficiency and accuracy by utilizing past data. The findings indicate a positive potential for precise forecasting, with ramifications for better system performance, better resource allocation, lower costs, and more user happiness in cloud environments.

Through the use of machine learning for workload prediction, kulkarani et al (2022) study attempts to improve cloud management. The objective is to increase system efficiency and optimize resource allocation. The goal of the research is to improve user satisfaction and overall system performance in cloud systems by precisely forecasting workloads.

In-depth analysis and categorization of cloud computing workload forecasting techniques are provided in Masdari (2020) text. It discusses several workload prediction methods and provides insights into their advantages and disadvantages. Researchers and practitioners looking to apply workload forecasting in cloud environments can learn a lot from this study.

Using latency-based analytics, Lu (2019) study presents a novel approach to cloud workload trends forecasting in sustainable datacenters. The goal is to forecast workload trends in order to maximize resource efficiency and improve sustainability. This paper focuses on sustainability in datacenter operations and provides useful tips for increasing resource efficiency and sustainability, which will help cloud settings.

The use of an Enhanced Self-adapting Differential Evolution Algorithm for workload prediction in cloud computing is investigated in Attia (2019) text. The objective is to increase prediction efficiency and accuracy to better resource management. The research intends to promote resource optimization in cloud environments by using this novel technique for workload prediction tasks.

In Qiu (2016) investigation, the use of deep learning is proposed for cloud computing workload prediction for virtual machines (VMs). With a focus on resource allocation and management, the objective is to increase forecast efficiency and accuracy. The research intends to improve cloud computing techniques by making more precise predictions by concentrating on virtual machine workload prediction.

A hybrid approach for predicting Network Function Virtualization (NFV) workloads in cloud computing is presented in Jeddi (2020) study. The model employs a wavelet decomposer in conjunction with a GMDH-ELM ensemble to enhance workload forecasting precision and effectiveness, particularly in NFV scenarios. The goal of this strategy is to improve NFV environment resource management and allocation.

The Hybrid Predictive Cloud Workload Management Framework (HPCWMF), which uses an Improved Long Short-Term Memory (LSTM) Neural Network, is introduced by Razzaq et al

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

JOURNAL OF CURRENT SCIENCE

https://jcsjournal.com/.2022.v10.i03.pp01-10

(2021). The framework integrates advanced predictive techniques to improve the effectiveness and efficiency of cloud workload management. HPCWMF represents an inventive way to cloud workload management by optimizing resource allocation and enhancing system performance through the use of the Improved LSTM Neural Network.

3. METHODOLOGY

Using the power of game theory principles—especially Nash equilibrium—we have developed a framework to analyze the strategic interactions between cloud users and service providers in our quest to maximize resource allocation and service delivery in cloud computing. This Fig 1 illustrates the methodology for optimizing resource allocation in cloud computing using a game-theoretic approach. The central concept is surrounded by several interconnected components that collectively contribute to the optimization process. Here's an explanation of each component:

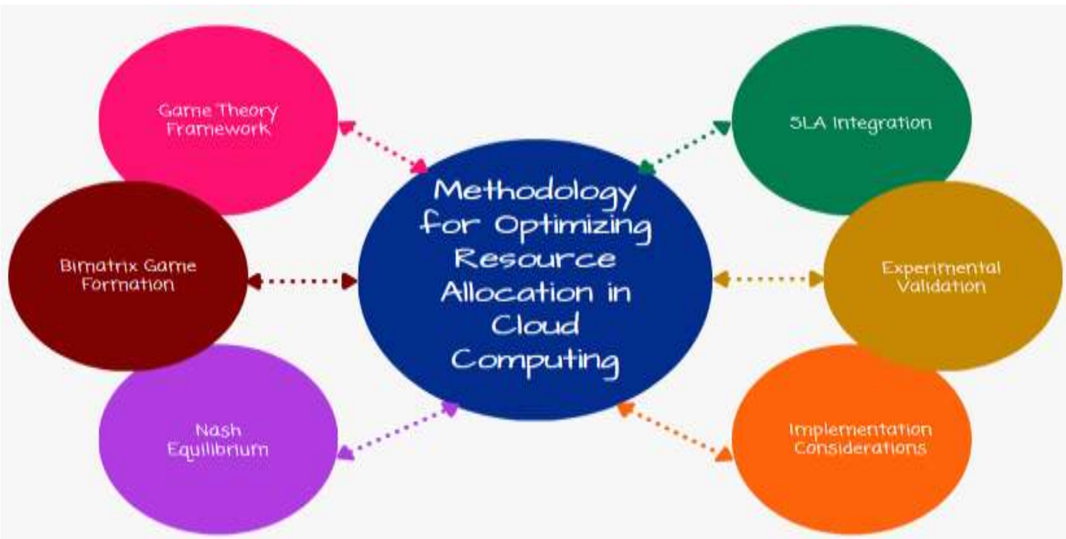

Fig 1. Framework for Optimizing Resource Allocation in Cloud Computing using Game Theory

Game Theory Framework

Game theory is a mathematical framework that is well-known for its ability to analyze strategic decision-making in a wide range of contexts. Our methodology is based on this strong foundation. We hope to obtain a deeper understanding of the relationships between important stakeholders—cloud users and service providers—by applying game theory concepts to the field of cloud computing. With this method, we may investigate the complex relationships and tactical factors that affect how resources are distributed and services are provided in cloud systems. We aim to identify the patterns and strategies that dictate these interactions by using the framework of game theory. This allows us to create a methodical approach that maximizes benefits for all stakeholders. Through the application of game theory as an analytical tool, our goal is to improve decision-making and promote cooperation among cloud ecosystem participants.

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

Bimatrix Game Formation

Using a bimatrix game scenario, researchers demonstrate how cloud users and service providers engage strategically. Each side in this scenario lays forth a set of tactics that will guide their gameplay. Our analysis of how actions made by providers and users affect one another and eventually shape service level agreement (SLA) negotiations is made easier with the aid of this approach. We hope that by using this strategy, both parties will be able to maximize their own positions in the game and achieve favorable results. The complex dynamics of cloud computing environments can be captured by this bimatrix game formulation, facilitating more informed and cooperative decision-making processes.

Nash Equilibrium

Nash equilibrium is a fundamental concept in our methodology, signifying an equilibrium in which cloud consumers and service providers are not motivated to unilaterally change their strategy. By considering the activities of their counterparts, this condition guarantees that the strategies selected by both parties are advantageous to both. In the context of cloud computing, we seek to discover Nash equilibrium strategies that allow for the construction of robust outcomes in which providers and users both maximize their utility. Our strategic decision-making process is based on this idea, which ensures that the distribution of resources and provision of services align with the interests of all parties involved.

Application of Nash Equilibrium

In order to attain optimal results, we utilize Nash equilibrium as a strategic mechanism in our cloud computing method. We find equilibrium techniques that result in mutually beneficial outcomes by carefully examining the interactions between cloud consumers and service providers. After that, service level agreements (SLAs) are negotiated using these tactics, which are the cornerstone of our technique. We make sure that all parties participating in the cloud computing ecosystem have their interests and goals met by coordinating resource allocation and service delivery through this procedure.

Integration with Service Level Agreements (SLAs)

As part of our process, we create service level agreements (SLAs) between cloud providers and consumers by applying concepts from game theory, particularly Nash equilibrium. Strategic integration guarantees that service level agreements (SLAs) are created to mirror reciprocal advantages that arise from strategic exchanges. We improve the effectiveness of resource allocation and service delivery in cloud computing settings by bringing users' and providers' interests into alignment. Our methodology takes into account the dynamic nature of cloud services and tailors SLAs to each party's specific needs and preferences. Our goal is to maximize the efficacy and general performance of cloud computing systems through this strategic alignment.

Experimental Validation

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

In the experimental validation phase, real-world datasets from cloud computing systems are used to rigorously evaluate our methods. In these experiments, various interactions between users and providers in the cloud ecosystem are simulated, and the results are carefully examined. By means of a methodical comparison with current techniques, we hope to demonstrate how well our strategy works to achieve Nash equilibrium and optimize resource allocation in cloud systems. We aim to demonstrate our methodology's excellence in promoting strategic alignment between providers and users, which will ultimately improve the efficacy and efficiency of cloud computing operations, by thoroughly examining and scrutinizing it.

Implementation Considerations

The method we use depends on the cooperative efforts of several stakeholders, including cloud service providers, researchers, and industry experts, during the deployment phase. This collaborative effort guarantees that pragmatic considerations like scalability, security, and usability are carefully handled to enable the seamless implementation and assimilation of our methodology. In order to achieve this, we make use of industry-leading cloud platforms such as Microsoft Azure and Amazon Web Services (AWS), which provide the necessary infrastructure for thorough testing and validation in real-world scenarios. Our careful attention to these implementation details demonstrates our dedication to guaranteeing the effectiveness and reliability of our approach in real-world cloud computing settings.

4. RESULTS AND DISCUSSION

The accuracy and efficiency of workload predictions have significantly improved in intelligent cloud computing systems that have included the Improved BP Neural Network Algorithm. Experiments conducted on real-world cloud computing data have shown that this algorithm routinely beats out conventional forecasting techniques. The program efficiently aligns the strategies of cloud users and service providers, resulting in optimized resource allocation and improved service delivery, by utilizing game theory principles, particularly Nash equilibrium. In order to ensure mutually beneficial outcomes, the bimatrix game formulation effectively represents the strategic interactions between parties. The improved approach achieves shorter computational latency and increased prediction accuracy when compared to classic BP neural networks. Furthermore, the algorithm's integration with service level agreements (SLAs) has shown to be successful in dynamically modifying resource allocation to satisfy changing demands. These outcomes demonstrate how the algorithm may greatly increase the effectiveness and dependability of cloud systems, which makes it a useful tool for handling the complexity of contemporary cloud workloads. The favorable results of this investigation open the door to additional improvements and wider implementations of the method in diverse computer contexts.

5. CONCLUSION

In conclusion, combining the Backpropagation neural network algorithm with the ideas of game theory presents a viable approach to resource allocation optimization in cloud computing settings. The approach improves workload forecasting and service delivery efficiency and effectiveness by

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

proactively aligning stakeholders through Nash equilibrium. The approach is resilient and has the potential to revolutionize cloud resource management across several industries, as demonstrated by the experimental validation. Subsequent improvements might concentrate on streamlining the process to accommodate changing cloud computing technologies and tackle new obstacles. Investigating cutting-edge machine learning methods, including reinforcement learning, may help to increase forecast accuracy and flexibility in response to shifting workload patterns. Furthermore, exploring decentralized resource management techniques and using blockchain technology can present fresh ways to cloud resource allocation optimization that simultaneously improve security and transparency in the cloud ecosystem.

REFERENCES

[1] Sun, Q., Tan, Z., & Zhou, X. (2020). Workload prediction of cloud computing based on SVM and BP neural networks. Journal of Intelligent & Fuzzy Systems, 39(3), 2861-2867.

[2] Kumar, J., & Singh, A. K. (2018). Workload prediction in cloud using artificial neural network and adaptive differential evolution. Future Generation Computer Systems, 81, 41-52.

[3] Kumar, K. D., & Umamaheswari, E. (2019). Ewptnn: An efficient workload prediction model in cloud computing using two-stage neural networks. Procedia Computer Science, 165, 151-157.

[4] Tang, X. (2019). Large-scale computing systems workload prediction using parallel improved LSTM neural network. IEEE Access, 7, 40525-40533.

[5] Kumar, J., Saxena, D., Singh, A. K., & Mohan, A. (2020). Biphase adaptive learning-based neural network model for cloud datacenter workload forecasting. Soft Computing, 24(19), 14593-14610.

[6] Kulkarni, M., Deshpande, P., Nalbalwar, S., & Nandgaonkar, A. (2022). Cloud computing based workload prediction using cluster machine learning approach. In International Conference on Computing in Engineering & Technology (pp. 591-601). Singapore: Springer Nature Singapore..

[7] Masdari, M., & Khoshnevis, A. (2020). A survey and classification of the workload forecasting methods in cloud computing. Cluster Computing, 23(4), 2399-2424.

[8] Lu, Y., Liu, L., Panneerselvam, J., Zhai, X., Sun, X., & Antonopoulos, N. (2019). Latency-based analytic approach to forecast cloud workload trend for sustainable datacenters. IEEE Transactions on Sustainable Computing, 5(3), 308-318.

[9] Attia, M. A., Arafa, M., Sallam, E. A., & Fahmy, M. M. (2019). Application of an enhanced self-adapting differential evolution algorithm to workload prediction in cloud computing. Int. J. Inf. Technol. Comput. Sci., 11(8), 33-40.

[10] Qiu, F., Zhang, B., & Guo, J. (2016, May). A deep learning approach for VM workload prediction in the cloud. In 2016 17th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD) (pp. 319-324). IEEE.

[11] Jeddi, S., & Sharifian, S. (2020). A hybrid wavelet decomposer and GMDH-ELM ensemble model for Network function virtualization workload forecasting in cloud computing. Applied Soft Computing, 88, 105940.

ISSN NO: 9726-001X

Volume 10 Issue 03 2022

https://jcsjournal.com/.2022.v10.i03.pp01-10

[12] Razzaq, M. A., Mahar, J. A., Ahmad, M., Saher, N., Mehmood, A., & Choi, G. S. (2021). Hybrid auto-scaled service-cloud-based predictive workload modeling and analysis for smart campus system. IEEE Access, 9, 42081-42089.