

Retraction

Retracted: A Deep Learning-Based Framework for Human Resource Recommendation

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] L. Ming, "A Deep Learning-Based Framework for Human Resource Recommendation," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 2377143, 12 pages, 2022.

Research Article

A Deep Learning-Based Framework for Human Resource Recommendation

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Recently, small- and medium-scale organizations have gained favorable responses due to the dramatic economic growth in China. This rise is due to international collaborations and social-economic growth by providing good quality and quantity services. However, when compared with other developing countries, small- and medium-scale organizations in China face many restrictions considering size and contributions. Few organizations are still facing a challenge because of the difficulties and lesser quality and also with lack of human resources. The prime objective of this study is to identify the current scenario of human resources for small- and medium-scale organizations, the factors affecting it, and the steps that can be effective in overcoming these challenges. In this study, human resource data is analyzed and managed using deep learning. The functionalities of human resources are realized by the deep learning approach, and further, business volume is reduced for enhancing the efficiency of human resources. The forecasting model is proposed and tested in human resource data by implementing a gradient descent process. Additionally, a deep neural network is implemented to enhance the accuracy of the proposed model. Experimental analysis is conducted by considering several neurons at the hidden layer, iteration count, and different types of decent gradient processes. The training accuracy and validation accuracy of the proposed model by implementing a deep neural network are observed as 95.67% and 94.53%. The experimental observations reveal the potential and significance of the proposed model.

1. Introduction

Human resource management is one of the most important tools which plays a significant role in the development of an organization [1, 2]. HRM (human resource management) follows three different stages, and its first generation is experienced in 1960. During the early days, the prime goal of the HRM system is to calculate the salaries of staff using computers. This system does not include data analysis of salaries and other nonfinancial information [3]. The main reason behind that negligence is a lack of resources and other less technical necessities. The second generation of HRM systems was experienced during the 1980s. The shortcomings of first-generation HRM systems are addressed in second-generation systems with the evolution of database systems. In the second generation, other missing necessities of the first generation were also addressed [4]. These systems present improvement in terms of considering payment data

analysis and nonfinancial information, thereby increasing the operability of the HRM system in the organization. However, there still exist some issues with the second-generation system like the information processing methods are not complete and even the management process is not consistent. The third-generation HRM systems are introduced in the late 1990s. During that time, due to the intense industrial competition, the HRM system rises to the next level and gains the topmost priority [5]. The growing popularity of computer systems and technologies such as the Internet and cloud databases gained much progress in HRM systems. These technologies with the growing age become more practical and popular by creating integrated data resources and management and making data sharing and analysis easier. In the modern era with the growing technologies and a large number of interconnected devices, a huge amount is generated that requires to be managed, stored, and analyzed efficiently in an organized manner

[6]. The management and analysis of such huge data in real-time is a very challenging task that is indeed an impossible task for a human being. Therefore, IMS (information management system) came into existence which is a management service and provides the capability of data gathering, database making, and management [7]. The management of data includes data extraction and storage; hence, IMS offers the analysis of a large amount of data. The HRM system together with IMS provides an efficient solution for information management and processing of a large amount of data. HRM system not only offers data processing but also provides efficient resource management. The main task of the HRM system is the normalization of human resource business processes and information processing through the system and to enhance HRM transparency. HRM system plays a significant role in the overall development of the organization by providing functionalities for business process optimization, efficient management, and better work efficiency [8]. The process quality is immediately linked to the performance of the organization which ultimately affects the development and survival of an organization. Recently, there is a spike in collecting data from an organization which is noticed because of the growing number of connected devices. The data processing capacity of the HRM system is exceeded with the generation of a huge number of data which leads to the failure of conducting data analysis and its management normally [9]. This particular condition is termed as rich data but poor information due to the analysis failure. Additionally, the HRM system at the organizational level has still not been fully explored, because simple data collection and storage without its effective analysis and management leads to no utilization of a huge amount of data effectively [10], thereby wasting limited resources of the organization along with the opportunity of using big data to grow quickly.

The conventional HRM system was not capable of fulfilling organizational requirements for big data; as for making the system work efficiently, it must automatically process search a huge amount of data for its volume reduction [11]. Such kind of data processing is similar to processing where data is processed manually and results in poor work efficiency. Data mining methods provide the solution for reducing the amount of data to be processed [12]. The objective of data mining is to find and analyze significant patterns in huge raw data and transform useful insights and knowledge from original data. The emergence of big data brings a revolution in various applications such as industrial, healthcare, government, industries, social media, defense, and agricultural. It changes the complete scenario and terms of the human resource management system. The conventional HRM system is capable of determining the functionality of data entry and its statistics, but they are not capable of identifying the relationship among data samples efficiently [13]. Moreover, previous HRM systems are not capable of predicting the future growth of organizations as per the existing data. Data mining technology provides an efficient solution for extracting and analyzing a huge amount of data. Machine learning is one of the important tools for realizing data mining, and it offers several applications in various

fields including HRM organizations. The most significant roles of machine learning in HRM systems are hiring talent, effective management, precise management of human resources, and preventing brain drain. Data mining approaches play a critical role in the decision-making process of a human resource management system. Liu et al. [14] propose a method for assisting the organization to predict employees' future performance and also assigning highly relevant personnel for the appropriate position. In this study, an adaptive genetic algorithm is proposed based on a fuzzy clustering approach. The proposed approach is designed for providing effective data analysis of employee appraisal performance in the HRM system of modern organizations. Additionally, the potential of artificial intelligence in HRM systems is studied in more detail for various scenarios such as candidate data collection and information extraction [15, 16], turnover prediction through ANN (artificial neural network) [17], and personnel scheduling through genetic algorithm and emotion analysis [18]. The main contribution of this study is described as follows:

- (i) A machine learning-based model is proposed for matching human positions to guarantee effective human resource allocation
- (ii) The effective evaluation of candidates during the recruitment process is using a machine learning algorithm. A new process is proposed based on regression for the prediction of organization demands
- (iii) The staff turnover issue is resolved by using the XGBoost (extreme gradient boosting) process for the prediction of employee turnover value. The experimental analysis shows the effectiveness of the proposed model over other classification models for predicting employee turnover
- (iv) Furthermore, by analyzing various factors that affect the retirement of an individual, this study creates a retirement prediction model by using a machine learning algorithm

The rest of the article is arranged as follows: the most recent work done in the field of the human resource management system is presented in Section 2. Section 3 describes the application of a deep neural network in wage forecasting. The experiment analysis of the proposed model is described in Section 4 which is followed by the conclusion of the study in Section 5.

2. Related Work

In the early 1970s, the term "human resources" first came into existence when the important labor relations work was recognized. The concepts of motivation, selection procedure, and organization atmosphere begin to emerge. Taamneh et al. [19] have described human resource management in terms of "organization administrator such as human and staff" which are opposed by the material and financial

resources of an organization. Machine learning is the approach that helps for improving the overall performance of a system by using experience and evaluation. According to studies, organizations with executives who are regarded to have a lack of behavioral integrity and ethical conduct do not succeed. Machine learning transforms useful information from raw data through evaluation, which is generally termed the model created from training and testing. The study shows poor ability to learn new things [20]. There is a significant improvement that has been noticed in human resource tasks with the integration of computer systems in the early 1980s. Initially, the professionals of human resources utilized such a system for keeping the records of simple operations such as storing job applications and accepting them considering their requirements. The questions they ask might not be related to the job or meet legal requirements [21]. However, with the introduction of information technology, human resource professionals started implementing several sophisticated computer systems to accomplish their day-to-day tasks and make effective decisions. One of the limitations of blockchain is not a distributed file system of computers [22]. The advanced information technology results in the simplified procedures of human resource management. Information technology is recommended in human resource management, and machines are required for making both internal and external tasks like performance analysis, compensation, recruitment, outsourcing, development, business to employees, remuneration, and strategic analysis. The advancement in science results in the generation of various advanced technologies such as big data, deep learning, and artificial intelligence which bring positive changes; one of the drawbacks of the study is they used a black-box nature [23]. Recently, with the emergence of AI technology, there has been a significant shift noticed in HRM systems. The used algorithm was a biased one; it makes the concept weaker [24]. These important advancements and shifts in technology are worth investigating. The industrial revolution plays a significant role in causing a shift in organizations and economics.

In the 20th century, manufacturers of various industries have witnessed scientific management that promoted the performance of standard production for achieving maximum profit. The employers were more focused on production from the employee rather than employee satisfaction, considering the scientific management approach and because of a lack of good policies and government regulations. The worldwide competition among large organizations and the study of human behavior as well as the sudden changes in the structure had significantly affected personnel management techniques during the end of the 20th century, and thereby, HRM systems emerged. The used method does not have enough sustainment from the upper edge [25]. In the early 1980, the HRM system turned out to be the most standard approach for managing people in an organization. HRM has been studied as the most important approach for designing a management system that efficiently addresses human competencies for the growth of the organization. Internet technology provides a professional platform, and with the rise in other technologies, human

resource information becomes the most significant hub for HRM systems. The computer technology that is used for HR is termed as electronic HR. The mechanism of one-way connection makes the proposed method weak [26]. Over the last two decades, the electronic human resource management system has gained attention and is referred to as virtual HR or electronic enabled HRM system. In such systems, comprehensive HR tasks are achieved by using information technology in an organization. Since its evolution, it provides significant improvement in HR efficiency, making strategies and planning simple, and empowering various HR practitioners to become business or strategic partners in different associations.

Fındıklı and Beyza Bayarçelik [27] presented an article, which claims that electronic HRM may not be that cost-effective. However, the transaction of organizations from conventional HR procedures to the latest electronic HRM is becoming the most necessary practical and theoretical phenomenon. Electronic HRM is expected to revolutionize current HRM in organizations, by making it more strategic and administrative. Data losses occur in the case of electronic HRM. Gramberg et al. [28] suggest that the HRM transaction faces two technological and business challenges. The first challenge is the ability of HR for guiding business leaders in making a digital mindset or developing a digital way of leading, organizing, and managing things. The second challenge is the ability of HR for transforming the complete employee experience by converting HR systems and processes through digital platforms and applications. The study shows recruiting and keeping high-quality employees overcome the limitation. Ahmed and Ali [29] presented a study for curing allergic rhinitis through traditional medicines. Information technology is the most crucial commercial tool that is used by various professionals and academicians. There are several underway efforts for the improvement of IT qualities by using the artificial intelligence which is known as cognitive computing. The used algorithm shows the drawback like when there are a lot of classifications; it is tough to evaluate them. According to one study, it is analyzed that approximately 150 artificial intelligence start-ups are recognized as IT behemoths. The AI shows drawbacks such as there is no need for human replication and time of implementation [30, 31]. These start-ups attempt for integrating artificial intelligence with computer systems for producing experiences at the time of technology installation. AI attempts for making the machine more efficient and capable of making decisions in the same way as humans do. Garg [32] has introduced an approach for improving personalized healthcare. The main drawback of a digital twin is that globalization and new production technology are among the issues at hand. Duan et al. [33] introduced a project intending to make social improvement. According to this project, the cabinet is aimed at achieving human-machine interaction to the next level. The goal of this project is to connect people's computers and things in cyberspace by using several sensors and artificial intelligence for execution. This project is not limited to industrial applications but the overall growth of social life with the integration of the Internet of Things, AI, and robotics. Following

are the disadvantages of the used algorithm such as shelving life confined, restricting the number of trades that may be processed by a blockchain, and the improved image sharpness is insufficient because it does not give structural parameters of the tiny agents or habitat analysis [34–37]. A case study presents the discussion of multiple odontogenic keratocysts [38]. Shahabaz and Afzal [39] proposed a study for curing cancer disease through the implementation of brachytherapy. Li [40] presented a study on rural development by improving the sewage system. Salihu and Iyya [41] presented an article on the analysis of physicochemical parameters and pesticides in vegetables. The main drawback of GCMS is that it can examine the high thermal stability substance only. Table 1 depicts the summarised related works.

In this study, a new human resource recommendation algorithm based on a hidden semantic approach and deep neural network is proposed. The proposed model can provide a better recommendation about the interesting leads for the users. There are several attempts from different authors for understanding the effective machine learning process for the potential assessment for replacing the human resource managers. The machine learning approach is widely implemented by various researchers for effective decision-making. In this study, a gradient descent algorithm and deep neural network are used for the prediction of employee turnover. This prediction provides an opportunity for an organization for solving various problems and improves the rate of retention. The supervised machine learning approach is used for the prediction of appropriate human resources to fill the technical vacancy. From this study, the influence of machine learning in the application of human resource management is analyzed which is expanding and promised great potential for improving the performance and efficiency of HRM systems.

3. Proposed Methodology

Machine learning can be categorized as learning from observation and discovery, learning through examples, learning through instructions, and learning from problem-solving [42]. Meaningful learning occurs when learners make a connection between a newly taught environment and something they already understand while studying new topics. This is particularly true in inquiry learning, as students make a connection between common and nonintuitive scientific settings. With the emergence of AI technology, machine learning is now categorized as inductive learning, mechanical learning, analogy learning, and teaching learning [43]. The proposed flowchart for training neurons is depicted in Figure 1.

Currently, the most widely implemented learning approach for machine learning is inductive learning. There are three different categories of inductive learning, namely, statistician, semiotic, and connectionist learning through neural networks. Connectionist learning is a machine learning model based on neural networks which simulate neuron functionality of the human brain and represent perceptron, even though the concept of connectionist learning is derived

earlier and tackled several obstacles. This is because neural networks are initially not capable of solving a linear problem or even a simple operation of XOR, which ultimately leads to the learning and development of neural networks.

Semiotic learning was introduced through the mathematical standard, and its main objective is result prediction through the process of deduction or inverse direction of signs that represents logic-based learning and decision tree. Statistical learning is the process to observe statistical knowledge through machine learning techniques such as support vector machine and kernel method. A neural network is defined as a parallel-connected network that is composed of several adaptive units, and their organization processes the interaction of the neural system with actual objects. In a neural network definition, a unit refers to the neuron model. In a neural network, initially, the neurons observed signals through the environment which are multiplied by the network considering the corresponding weights of edges. The output of one neuron serves as the input for another neuron, and the same process continues till the last layer is reached. This process enables neurons to calculate the overall input signal by the multiplication of corresponding weights at edges with itself. The result is then compared with the neurons threshold value, and hence, neuron output is obtained as depicted in Figure 2.

A neural network follows a topological structure that comprises various functional interconnected neurons. Neural network models are categorized as hierarchical models and interconnection models based on neurons' hierarchical structure. In a hierarchical model, neurons are hierarchical and further categorized into different layers as per their functionality and every year is interconnected. In a hierarchical model, the connection of neurons has input, middle, and output layers, whereas in the interconnection model, any two neurons are connected and provide randomness. The easy analysis and good structure of the hierarchical model make it the most widely implemented model.

The neural network learning process is achieved by implementing BP (backpropagation) algorithm, for adjusting neuron values. This algorithm uses the concept of gradient descent strategy, which computes the target's negative gradients as search directions for adjusting a parameter and achieving convergence through continuous hydration and parameter updating. This algorithm is most advantageous among other algorithms and is widely implemented in several applications. Additionally, BPNN (backpropagation neural network model) is referred to as a multilayer feedforward neural network model trained through a backpropagation algorithm as depicted in Figure 3.

3.1. Selection Process. The prediction of payment is one of the regression problems. The commonly used regression models for prediction in machine learning are linear regression, elastic network regression, neural networks, polynomial regression, and ridge regression. Linear regression is one of the most widely used models which is composed of linear variables. In a linear regression model, the relationship between dependent and independent variables must be satisfied. It makes the linear regression model to be

TABLE 1: Summarised related works.

Sl. no.	Name of authors	Algorithm used	Description	Limitations of the study
1	Taamneh et al. (2017) [19]	—	To assess work-related ethics and their impact on HRM functions among Jordanian university administrators.	Lack of behavioral integrity and ethical conduct does not succeed.
2	Wei and Jin (2021) [20]	Machine learning	An optimized GM model and a backpropagation neural network model are combined to improve the HRM system.	Poor ability to learn new things.
3	Stone et al. (2006) [21]	—	How well do these systems work and are accepted at each step of the hiring process, including job description, job applications, well before testing, interviews, producing hiring decisions, evaluating and validating, and examination and recognition?	The questions they ask might not be related to the job or meet legal requirements.
4	Onik et al. (2018) [22]	Blockchain-based recruitment management system (BcRMS) and blockchain-based human resource management system (BcHRMS)	For hiring people and managing HR for industry 4.0, they used blockchain technology.	Blockchain is not a distributed file system of computers.
5	Berhil et al. (2020) [23]	Artificial intelligence (AI)	To analyze, the problems of HR researchers face and how computer scientists try to solve them.	Black-box nature.
6	Vrontis et al. (2022) [24]	AI	To organize what academics have learned about intelligent automation so far and to make clear what its main contributions to HRM are and what challenges it poses.	Biased algorithm.
7	DeCenzo et al. (2016) [25]	—	The authors give a solid overview of the most important parts of human resource management, as well as a clear explanation of how HRM fits into business strategy.	Not enough sustainment from the upper edge.
8	Stone et al. (2015) [26]	—	Examine the current effects of technology on HR operations, evaluate the literature on the subject, and discuss the benefits and drawbacks of employing these technologies.	Mechanism of one-way connection.
9	Fındıklı and Beyza Bayarçelik (2015) [27]	—	To investigate HR managers' attitudes on e-HRM, their viewpoints on selecting system applications, and their observed organizational outcomes in Turkey's leading enterprises.	Data losses.
10	Van Gramberg et al. (2014) [28]	—	Illustrate the tension between HR as a strategic partner and employee champion.	Recruiting and keeping high-quality employees.
11	Ahmed and Ali (2020) [29]	Chi-square test and Tukey test	The study compares the populations and medical applications of people with allergic rhinitis who got all three therapies.	When there are a lot of classifications, it is tough to evaluate them.
12	Tewari and Pant (2020) [30]	AI	Examines the work of several notable experts to determine how AI is changing the field of HRM.	There is no human replication.
13	Samarasinghe and Medis (2020) [31]	AI	The strategic HRM theory of resource advantage theory was used to build the "AI-based Strategic HRM for Industry 4.0" (AISHRM) model.	Time of implementation.

TABLE 1: Continued.

Sl. no.	Name of authors	Algorithm used	Description	Limitations of the study
14	Garg (2020) [32]	Digital twin	This has the potential to provide enormous societal advantages by enabling comprehensive normalizing enhancing initiatives.	Globalization and new production technology are among the issues at hand.
15	Duan et al. (2019) [33]	AI	To address the issues connected with the use or effect of revitalized AI-based ruling networks, as well as to propose a list of research questions for data systems experts.	No morals.
16	Singh and Sharma (2022) [34]	Sensor	It describes a platform for managing agricultural crop data gathered by multirotor unmanned aerial vehicles (UAVs).	Shelving life confined.
17	Zeng et al. (2021) [35]	Blockchain	The convergence of the Internet of Things and blockchain is used in this study for a reasonable amount of farmlands.	It restricts the number of trades that may be processed by a blockchain.
18	Sharma and Singh (2021) [36]	Image processing	The use of unmanned aerial vehicles for the detection of fire is highlighted.	The improved image sharpness is insufficient because it does not give structural parameters of the tiny agents or habitat analysis.
19	Sharma et al. (2020) [37]	Image processing	Using the notion of a sensor network and unmanned aerial vehicles (UAVs) technology, they try to design an early fire detection system to eliminate fire incidents.	Based on the option employed, the initial cost is substantial.
20	Salihu and Iyya (2022) [41]	—	Physiochemical properties and organophosphorus pesticides in the ground from the chosen vegetable fields in Zamfara were described.	The examination of high-thermal stability substances is possible.

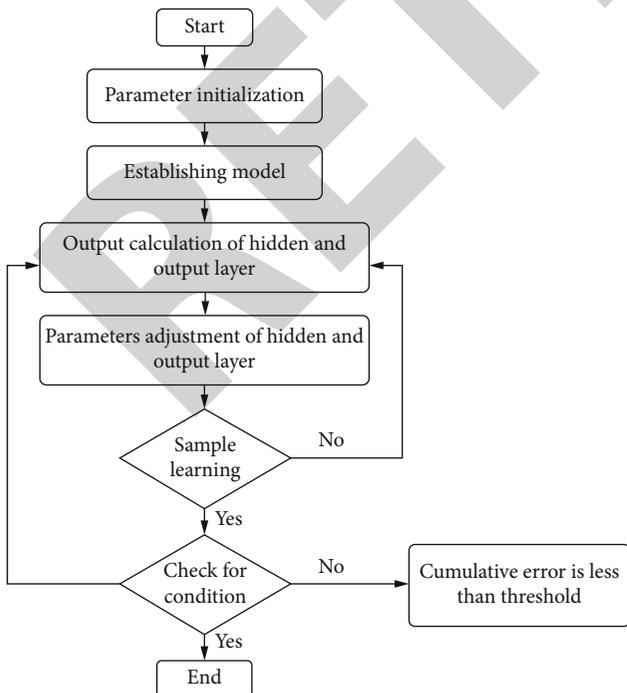


FIGURE 1: Flowchart of the training process of the proposed model.

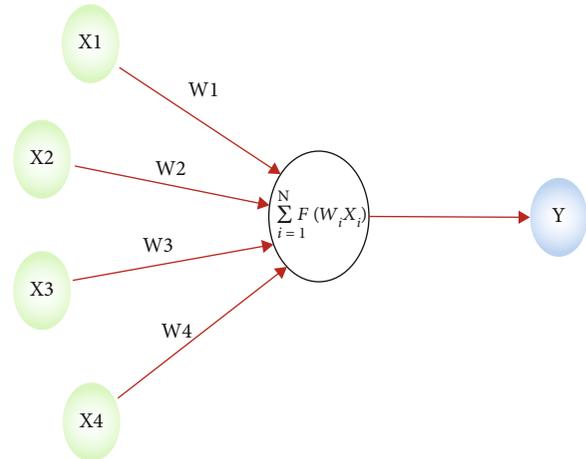


FIGURE 2: Perception model.

applicable only for solving linearly separable problems. This model estimates linear relationships among variables which results from low calculation complexity and high speed of training. The disadvantage of using a linear regression model is its sensitivity towards outliers. The model accuracy is directly affected by any outlier among data. Polynomial

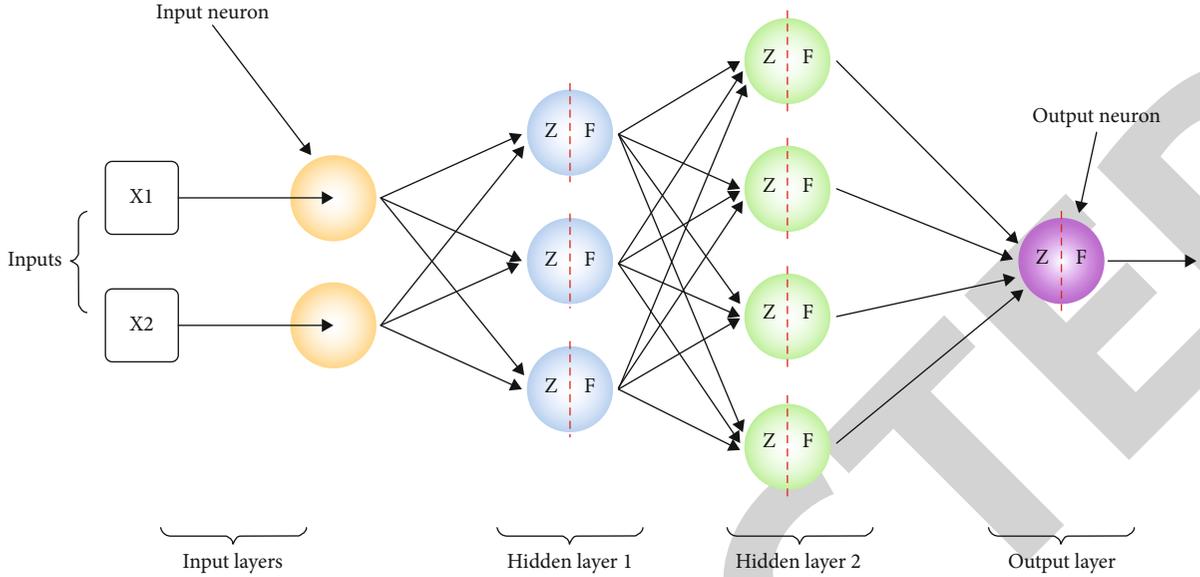


FIGURE 3: Deep neural network architecture.

regression refers to the model with an index greater than 1 and has independent variables. It is an extension of a linear regression model. The equation of polynomial regression degenerates when the independent index turns to 1 and transforms into a linear regression equation. Considering the majority of scenarios, where dependent and independent variables are nonlinear, polynomial regression is preferred that can solve complex and nonlinear problems more effectively. The disadvantage of using polynomial regression is difficulty in achieving the best index and a high index easily causes fitting, whereas a low index causes underfitting. The ridge regression is an optimal solution that is implemented when data features of linear and polynomial regression suffer multiple collinearities. The elastic network regression is a combination of ridge and lasso regression. For the regression estimation function, this model adds both the absolute value of the set and square bias value to accomplish the common effect of ridge and lasso regression. The backpropagation neural model is the most implemented form of neural network. The three-layer structure of the BP neural network is capable of approaching any continuous function with good precision and offers strong learning capability and takes lesser time for calculations. However, neural network model suffers from some drawbacks as well. Topological structure, optimization approaches, and parameter initialization are a few of the commonly faced issues in neural networks. A neural network impacts training results directly if the selection of input parameters is not up to the mark; it affects the performance of the model.

3.2. A Deep Neural Network-Based Payment Forecasting Model. A deep neural network presents generalization, fault tolerance, and nonlinear mapping. Additionally, 3 layered architectures of a deep neural network can precisely approximate the nonlinear function. For making a payment predic-

tion model through a deep neural network, it is important to solve issues like topology, parameter initialization, and activation function. The design of a hierarchical structure depends upon the nature of the problem. Mostly, the nature of the problem and previous experience decide the selection of network parameters. Payment prediction is a model of mapping several inputs and giving one output. Considering the data format in demand analysis, it is analyzed that in a network, there are 16 input layer neurons and only 1 neuron in the output layer. There is no definition for calculating several neurons in the hidden layer. Some approaches can estimate the approximate range, and therefore, the model can be trained continuously using the hit and trial method. Considering the performance of the model, the number of neurons in the hidden layer is estimated. There are several mathematical formulas for the calculation of neurons in the hidden layer. Two of the most commonly implemented formulas for the calculation of neuron in the hidden layer are represented by Equations (1) and (2).

$$N_h = \sqrt{n_I \times n_O}, \quad (1)$$

$$N_h = \sqrt{n_I \times n_O} + K. \quad (2)$$

In Equations (1) and (2), the numbers of input and output layer nodes are represented as n_I and n_O . According to Equation (2), the number of estimated neurons is in the range of [6, 16], and during training, slight expansion is observed in space, i.e., in the range [4, 18], and the deep neural network is supposed to train continuously. The sum of neurons evaluated in the input, hidden, and output layers are 16, 17, and 1. Sigmoid functions are represented by the neuron activation function, and the quadratic mean square value is observed as the error function. The initial weights are considered as mean value 0 of Gaussian random variable along with standard deviation as 1. Equation (3) represents the calculation of training for the forecast model by

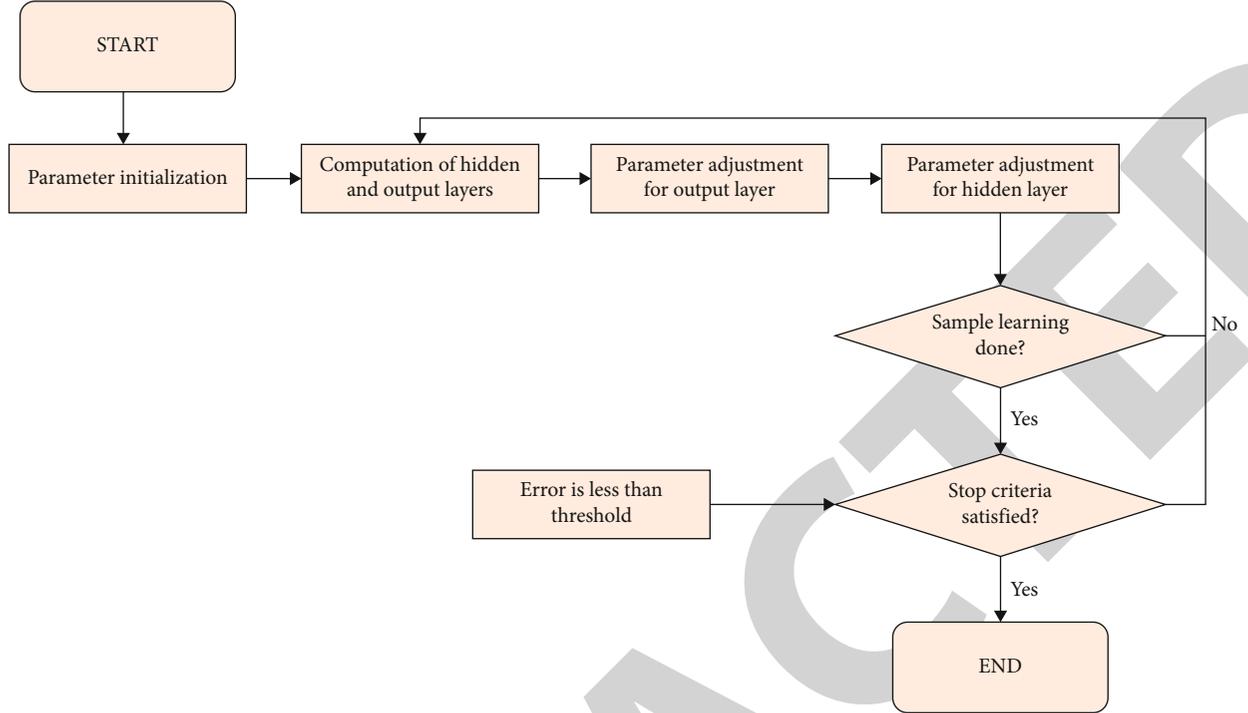


FIGURE 4: The complete cycle of training a payment prediction model.

TABLE 2: Accuracy outcomes obtained for the proposed payment prediction model using a varying number of neurons.

A varying number of neurons	Iteration count	Accuracy for a training set	Accuracy for testing set
1	30	86.76%	80.67%
2	60	87.62%	80.14%
3	90	88.54%	81.45%
4	120	89.43%	82.65%
5	150	90.67%	83.67%
6	180	90.87%	84.87%
7	210	91.69%	85.95%
8	240	92.78%	86.74%
9	270	92.54%	87.65%
10	300	93.65%	88.62%
11	330	94.75%	89.84%
12	360	94.86%	90.78%
13	390	94.97%	91.62%
14	420	95.46%	92.78%
15	450	95.54%	93.67%
16	500	95.67%	94.53%

TABLE 3: Loss outcomes obtained for the proposed payment prediction model using a varying number of neurons.

The varying number of neurons	Iteration count	Loss of the training set	Loss for testing set
1	30	0.0099	0.01017
2	60	0.0098	0.01016
3	90	0.0097	0.01015
4	120	0.0096	0.01014
5	150	0.0095	0.01013
6	180	0.0094	0.01012
7	210	0.0093	0.01011
8	240	0.0092	0.01010
9	270	0.0091	0.01009
10	300	0.0090	0.01008
11	330	0.0089	0.01007
12	360	0.0088	0.01006
13	390	0.0087	0.01005
14	420	0.0086	0.01004
15	450	0.0085	0.01003
16	500	0.0084	0.01002

evaluating the target and output values.

$$\gamma_j = F'(net_j) \sum_K \delta V_{jK} = L_j(1 - L_j) \sum_K \delta V_{jK}. \quad (3)$$

Here, target value and the output value of K nodes are represented as γ_j and jK . Once the model is created, the

deep neural network initiates training. The deep neural network implements a gradient learning approach for neuron updating and reverses propagation. This approach is categorized into three forms considering the data used for the update. These three categories are batch-based, random-based, and small-batch-based gradients decent approaches. Every update is termed batch gradient descent because each update is using every sample. For each iteration, the batch

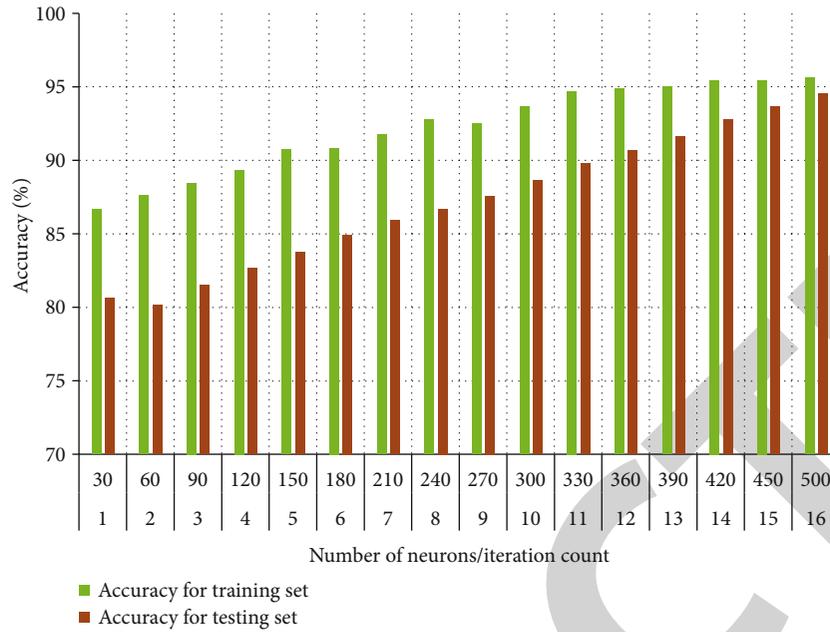


FIGURE 5: Graphical representation of accuracy outcomes obtained for the proposed payment prediction model using a varying number of neurons.

gradient descent system requires all samples and when the dataset of training samples is huge, the updating time of each iteration is higher. Therefore, it results in a decrement in cumulative error for all the samples and hence degrading the training process. This is the reason that global optimization cannot be achieved and the training process reaches the local optimal value. SGD (stochastic gradient descent) is the approach where only a single sample is updated at once. It causes the frequent updating of parameters, and this update among several samples may result in an offset between them. Due to this, overall optimization is not achieved and the oscillation phenomenon triggers. The resulted oscillation enables it to reach global optimization from local optimization. The existing shortcomings of batch gradient descent and stochastic gradient descent are addressed by the small-batch gradient descent approach. The process includes the division of large datasets into smaller sample datasets. This approach considers estimation value from the cumulative error gradient of a small sample in the dataset. The value of the local error gradient is observed as equivalent to the overall value of the error gradient when the sample size is large.

4. Experimental Analysis

The experimental outcomes obtained after several experimentations are analyzed in this section. The experimentation was performed on Python software using a computer environment equipped with Intel Core 5 processor having 16GB RAM and Windows OS. Various subexperiments were performed to evaluate the effectiveness of the system. The complete cycle of training a payment prediction model is depicted in Figure 4.

4.1. Outcomes Obtained for the Payment Prediction Model. The simulation outcomes are demonstrated for the payment prediction model utilizing BP neural network. The experimentation was performed for varying numbers of neurons and iterations, which are depicted in Tables 1 and 2, respectively.

Table 2 illustrates the accuracy values for training and testing sets, where 750 samples are considered for training and 250 samples are taken for testing. Each of the hidden layer neurons is trained 25 consecutive times, and the final average value of accuracy outcomes is observed. The total number of 500 iterations is evaluated before the execution is terminated.

Table 2 depicts that the training and testing accuracy increases with the increasing number of neurons in the hidden layer. Further, Figure 5 graphically presents the training and testing accuracies for the payment prediction model using BP neural network.

The graphical representation of Figure 5 illustrates that upon increasing the number of iterations, there is a gradual improvement in training and testing accuracies.

Training accuracy refers to the training sample identifying separate pictures which were not used in testing, whereas accuracy rate refers to the training sample identifying separate visuals which were not used during training.

The maximum value of accuracy attained for the 500th iteration is 95.67% for the training set and 94.53% for the testing set, respectively.

Further, the loss values obtained for the payment prediction model using BP neural network are depicted in Table 3. It is observed that with the increasing number of hidden neurons, the training and testing loss values are reduced. This loss value is depicted in Figure 6 graphically to depict the reduction in loss value with the

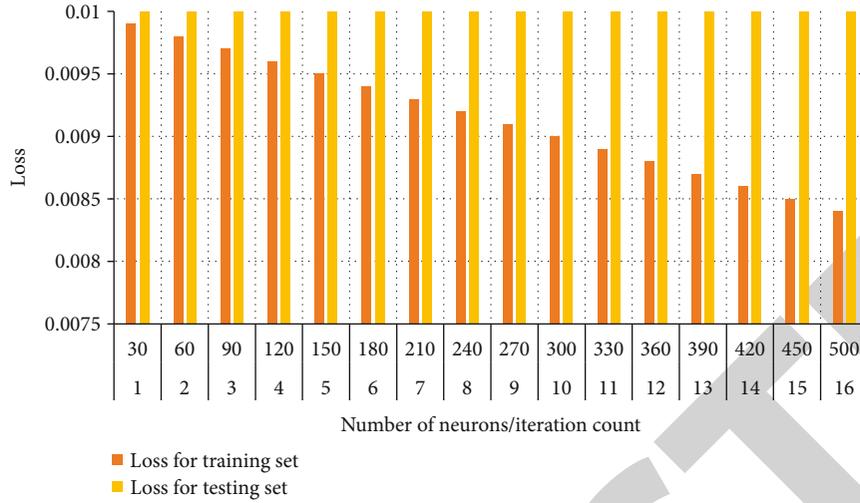


FIGURE 6: Graphical representation for loss outcomes obtained for the proposed payment prediction model using a varying number of neurons.

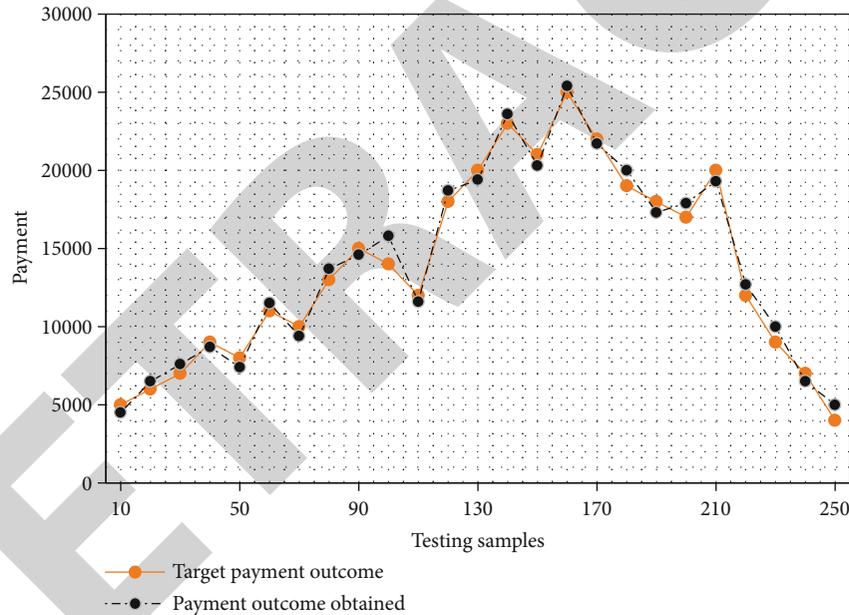


FIGURE 7: Comparative fitness curve for a proposed payment prediction model.

increasing number of neurons. Because adding a hidden neuron increases the number of values, it is best to employ the fewest possible hidden neurons to complete the job. Using more hidden neurons than necessary can increase the level of diversity.

4.2. Comparative Analysis of the Proposed Payment Prediction Model Using BP Neural Network. To reflect the reliable performance of the proposed payment prediction model, a comparative analysis is done for the proposed approach and other machine learning- (ML-) based algorithms. For this experimentation, 750 training samples are considered along with a testing sample size of 250. Further, each of the algorithms is tested several times, the best test

outcome obtained is evaluated, and a comparison of the target and output obtained is depicted in Figure 7.

Figure 7 depicts that the fitness curve for the proposed payment prediction model is higher compared to the other ML-based techniques. However, there can be some sort of imperfection due to the nonnormalization of the payment dataset, but still these minute errors are controllable and do not have much impact on the effectiveness of outcomes obtained for the proposed payment prediction model. Further, it was observed that a faster convergence rate was obtained for the proposed model along with higher accuracy and prediction efficiency. This ultimately results in a very accurate, practically useful payment prediction model.

5. Conclusion

The economic development of a country depends upon globalization and worldwide economic integration. This results in inconsistencies in numerous aspects of business tasks and exchange, such as business perceptions, social culture, payment prediction, and customer psychology. Accordingly, for sustainable and versatile advancement in the new technology, every small- and medium-scale organization must efficiently influence arrangements and solutions from the government, web-based platforms, and small- and medium-scale organizations themselves. The prime focus of this study is on the application and development of the flooring network paste payment forecasting system. To check the effectiveness of the proposed system, various experiments have been conducted. The experiments are performed using several numbers of neurons at a hidden layer for different iterations for the validation of the proposed model. The gradient descent algorithm and several types are also implemented to validate the proposed model. The experimental analysis reveals the better performance of the proposed model in comparison with other methods. The deep neural network-based model for the payment prediction achieves a training accuracy of 95.67%, and the validation accuracy is observed as 94.53%. The proposed deep neural network-based payment prediction model is expected to be of incredible assistance in HRM systems. Limitations and future study objectives have long been a mainstay in the reporting of scientific findings by social scientists, and they were included in the vast majority of the research articles we materially reviewed for our study. We spent at least a few words identifying each study's flaw and putting investigators in the right direction to potential research directions. We had suggested as a consequence of our analysis. A list of guidelines intended to go around the institution for writers, readers, and editors. There is indeed a problem in how these portions are reported. We believe that these suggestions may assist in maximizing the importance of these portions so that they can act as effective accelerators for technological discovery in business administration and associated disciplines.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that no conflict of interest is associated with this study.

Authors' Contributions

This study was done by the author named in this article, and the author accepts all liabilities resulting from claims which relate to this article and its contents.

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