Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Advanced Neural Networks for Software Data Classification and Recognition

Smitha GV[1], Aishwarya S[2], B. Latha[2], Niranjan Mahabaleshwar Hegde[2]

[1]Assistant professor, Master of computer Application, Dayananda Sagar college of Engineering, Bengaluru, Karnataka
[2]Master of computer Application, Dayananda Sagar college of Engineering, Bengaluru, Karnataka
Email: smitha-mca@dayanandasagar.edu

A highly self-learning computing method that can handle multivariate and nonlinear data, neural networks offer significant benefits for increasing data processing efficiency. Neural networks may efficiently prevent potential faults in algorithm training by continuously modifying parameters. The goal of this work is to look into the application of neural networks when classifying information. As the study begins by introducing the model of artificial neurons and its creation process. Second, the impact regarding the signal feature value extraction of the BP (Back Propagation) layer procedure and the causes of the identification the rate decline are extensively covered in this study. Next, A software system for categorizing and recognizing information is designed in this work, and its recognition and classification capabilities are tested functionally. The test results show that the hardware operation requirements can be met by the system and that it is not bloated since only 1% to 3% of memory is used by the categorization data and recognition system. Applications of neural networks for the classification and recognition of software data show how well-suited these networks are to solving common artificial intelligence issues. A neural network is a system replicates the function of artificial neurons signal transmission mechanism within the human brain. It is gains accuracy over time by learning based on the training set. In an input, hidden, and output layers of a neural network are usually its components. Every node, or artificial neuron, communicates with other nodes by means of the weight and threshold of the link.

Keywords: Neural Network, Information Classification, Information Identification, and Software Information.

1. Introduction

Numerous neurons are connected to form the neural network. It possesses strong cognitive, learning, and recognizing skills. By categorizing and processing information, humans are able

to comprehend natural language more fully. Artificial neural networks can be used in computer applications to automate processes like analysis and prediction by storing data into various sample kinds. Since people cannot directly watch things, adopting Neural Network Technology can resolve a great deal of difficult or even unsolvable issues. When compared to the convention method of studying human behavior characteristics.

In the domains of data classification and information processing, neural networks are crucial. Researchers both domestically and internationally have worked hard on artificial neuron optimization algorithms in the past few years, with some encouraging findings. A novel pattern design idea called BP neuron adaptive training mimics the composition features of the neurological system in the human brain to achieve automatic recognition. In the areas of developing and designing neural network systems,

predictive learning process control, and other practical applications, it offers excellent application value. In order to increase the dependability of information transmission, Furthermore, the input signal can be processed in an unpredictable surroundings as well as produce instantaneous results[1-2].with use of simultaneous and annealing methods, some researchers have had the BP neural network model trained and compared. They have discovered that higher weights are obtained as the quantity of output layers and profundity increase, and that a relatively ideal result can be obtained if the distance of the input vector is 0.25 [3–4]. As as a consequence, this study does extensive research on the neural network-based categorization and identification of software information.

The primary objective of this research aims to better understand how Neural networks are used in information processing. To this end, ANSYS software is employed to imitate the structure and training that of artificial neurons. This essay begins by presenting the BP algorithm's principles and features before analyzing and summarizing the method's parameter selection principle. In conclusion, this study provides the test reports, experimental findings, and further data along with an application method for implementing a neural network in the signal preprocessing module utilizing a recognition-based system.

It demonstrates the viability of the research presented in this work and the efficiency with which artificial neurons may be used for tasks for classifying and recognising information features. As the following benefits come from the extensive use of the brain networks in the detection and classification of software information:

(1) By learning vast amount that of training data, neural networks can increase the precision of information classification in software. In order to better discriminate between various kinds of software information, a neural network can be trained to recognize.

(2) sophisticated data structures, including words, picture, additionally sound data, are frequently found in software information. When working When dealing with intricate data structures, the neural net model effectively transmits ideas and adapt to various input data kinds and formats.

(3) Without requiring human feature design, neural networks are able to automatically extract the greatest important additionally pertinent characteristics of the initial data. Neural networks are highly suited for the detection and classification of software information because of their automated learning of representations and feature extraction capabilities, particularly in cases

when hard.

(4) By applying the knowledge gained from the training set to the test data that has not yet been seen, the neural network is able to accurately categorize and recognize the newly discovered software information. Because of their strong capacity for generalization, neural networks are more available and adaptable in real-world settings.

2. Literature review

Neural networks, especially superior neural networks, have proven titanic capability in dealing with complex statistics, automating tactics, and solving intricate problems in numerous domain names. This literature survey examines the current improvements in neural networks.

Evolved a multi-course characteristic extraction model using a convolutional neural network (MRFE-CNN) for breast tumor segmentation in mammograms. This version has proven huge improvements in segmentation accuracy, contributing to higher diagnostic consequences [1].

The deep neural community designed for image area detection. This model reduces computational complexity whilst preserving high accuracy in detecting edges in pictures, making it appropriate for numerous picture processing programs [2].

Set of rules the use of deep neural networks (DNN) for extremely-brief wave verbal exchange squelch. This technique improves signal processing and communique first-class by using accurately filtering out noise, demonstrating the flexibility of DNN in verbal exchange technology [3].

The usage of deep neural networks (DNN) for extremely-brief wave communique squelch. This method improves sign processing and conversation great by correctly filtering out noise, demonstrating the flexibility of DNN in communication technology.Transnet, which mixes CNN with transformer architectures for scientific image segmentation. This hybrid version enhances the accuracy and performance of scientific photograph analysis, providing better equipment for scientific diagnostics [4,5].

Proposed a latency-flexible floating-point engine designed to optimize the overall performance of deep neural networks. This engine balances computational latency and throughput, improving the efficiency of neural community training and inference, mainly in high-overall performance computing environments. Deep neural network architecture for computerized gentle surgical talents assessment the use of objective established assessment of technical abilties standards[6,7].

3. Talk about Networks of Neural for Details of Software Recognition and Classification

A. Classification of Details of Software

It is first required to properly separate the target object's attributes, characteristics, and characteristics before classifying software information. This means that in order to ascertain how many neurons are present within every neuron inside the brain network, a suitable method must be selected. Generally speaking, there are two sorts of target systems: a single with a

reasonably rapid rhythm of movement and the other Using a specific amount of time but none visible consistency. Conventional classification techniques can be applied to the training data in this scenario.

However, to be able to properly retain and handle data, it is important to divide the investigated item to some amount while performing software information classification, particularly in the event that the target system is malfunctioning or when the unique defined item is not able to determined. It might be categorized into several groupssuch as image category, document category, and so forth, based on the various kinds of information [5–6]. They can be classified as processed written records or immediate documents, depending on how they are expressed. These categories might be referred to as hierarchical code categorization challenges based on the network topology. The division of multi-attribute schema sets or mixed model domains, like multi-level exchange relations, is the term used to describe this kind of issue. The three primary information components of software in computer applications are data, storage, and processing. An important and useful technique for assessing a chosen study object is to use a classifier. In the conventional meaning, the input signal is splittable into various amounts to satisfy individual functional needs. Similarly, various production tiers and their associated It is possible to divide function values based on varying degrees to fulfill particular functional needs. splitting up based on various data required levels: The data must be processed and identified within the advanced application system, and speech and picture data can be hierarchically classified using the object-oriented layer. The input category should also be determined, and it should be divided into multiple sections as output test specimen prediction and further procedures, taking into account variables such kind of output, type of input, and quantity of practice examples [7-8]. The procedure of classifying software information is shown in Figure 1.

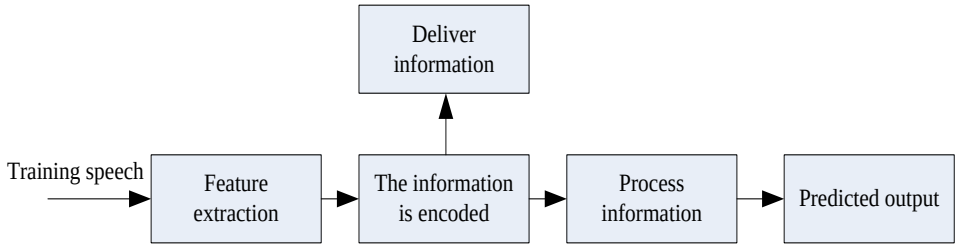


Figure 1 The process of classifying software information

The method accomplishes this through processing, departing, and encoding data. In order to identify and analyse the relationship between information and additional features, it makes advantage of the connections between various types of neurons. It may be stated that this approach is mostly utilized to address a few difficult problems, such output form and input pattern recognition. Several scenarios can result in incorrect categorization or loss of sample items. As a result, ongoing research into new guidelines is required for practical application ns in order to effectively improve.

4. Information

Information recognition is a computer system pattern recognition technique that uses a

particular language to extract, classify, and characterize data sets. Using this method, the vector input is transformed transforming it into an output vector and the training sample set is learned through the backward neural network to produce the corresponding relationship matrix between the weight value and how many nodes are in the input layer. Two categories of information recognition can be distinguished using various techniques: self-coordinating

phase, in order to produce a set of output outcomes, the input samples are first classified. The characteristic parameters can be changed in accordance with various output structure features, and a neural algorithm with high degree of accurateness along with fault resilient can be determined, which can accommodate provides robust processing capabilities and is adaptable to the system environment. Also, information that is obtained following the analysis and identification of the noise data in the input image near the true worth and includes fewer significant It is possible to extract qualities [11–12].

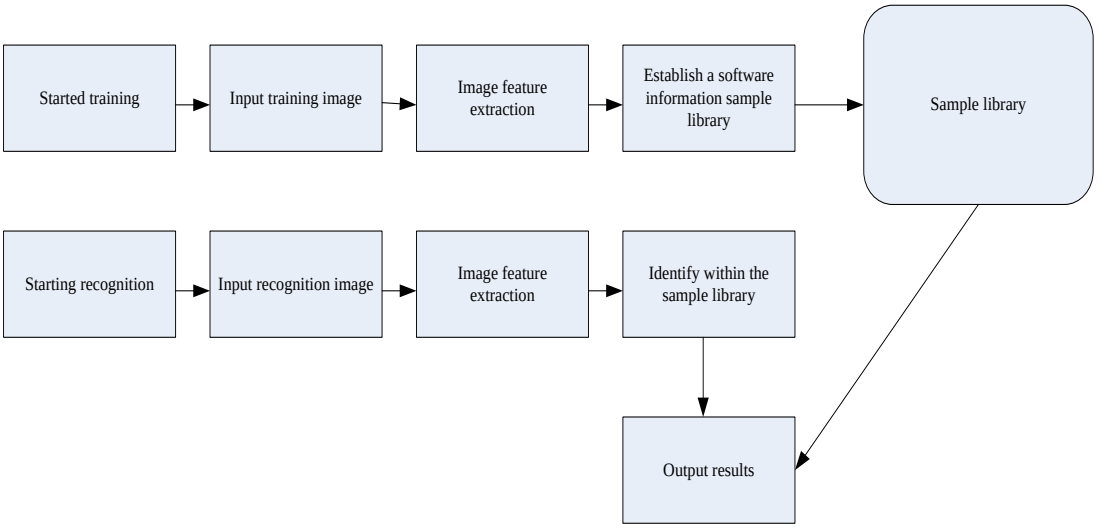


Figure 2. Identification of information

It's required to categorize the numerous examples of input data and diverse output outcomes in the process of recognition (Figure 2 shows the process). because of this. Techniques like Semi-supervised training techniques, supervised learning, and unsupervised learning can be applied, based on the requirements. It mostly consists of support vector machine techniques and forward coding, depending on the input layer. The two categories of pattern recognition techniques that result from the division of output channels are both backward base parallel mapping and global mapping. The network element, multilayer, and single layer layers are some of the divisions that are commonly used to describe network topology. A window for handling straightforward data with lots of feature vectors is present in each layer. Although each layer is separate from the others, each are related in some way. In order to create a a collection of data sets, comprising sample sets for information recognition training, each level typically comprises of several neighbouring levels of input sets [13–14]. Different algorithms can be used to construct synthetic neural networks or non-autonomous systems for categorization in the information recognition process. But because they use distinct models, application contexts, and data mining methodologies, there are variances. After gathering a lot

of data, information recognition involves processing a lot of text using a neural network and using a network technique to map the input to a sample space.

To assess if the input photographs are similar to each other, feature selection and matching must ascertain if the output pattern exhibits similarity, homogenous attribute values, and other markers based on the content input and various feature kinds kept in the training collection. To get accurate, efficient, and meaningful results in an information recognition system, a lot of information must be processed additionally analysed. In order to accomplish the process of translating an input vector to an output terminal, or suitable technique must be applied. Additionally, a learning rule must be established using the output weight and the training sample set must be determined as the example characteristic.

The ideal weight coefficient matrix is the one that has the best confidence and the highest classification accuracy. found, along with the highest classification accuracy and confidence are reached, and ultimately the right results are acquired. [15–16].

5. Algorithm for Neural Networks

Artificial neuron structure, which is achieved through mimicking intricate systems that are nonlinear, is the foundation of neural network technology. The model parameters and the training sample data set must be determined before the weight vector, feature vector, and error between the neural network classifier and the output of the input layer node can be calculated using the functional relationship. The ultimate conclusion is reached after comparing the outcomes based on various mistake types. The multi-layer perceptron that is the neural network with many neurons linked to it. It able to handle both input and output simultaneously additionally is capable of self-learning [17–18]. Hidden layers are used in the training process to imitate the structure of the human brain. The artificial neuron creates a flow of information and stores it within the room designated for storage when it receives information from the surroundings. Following a number of procedures, the final result A set of signal sample data is acquired after a sequence of procedures, and weight and threshold computations are used to determine the relationship of connections between neurons and input and output nodes. It is typically required in order to instruct and acquire input samples beforehand when working with complex nonlinear issues, and to link feature vectors and weights using output layer nodes one another. As the weight vector acquired through training is used to analyse the input information points' categorization outcomes.

To achieve nonlinear system identification using neural networks, the output parameters can be derived from extensive data processing. Neural networks are complex systems composed of numerous interconnected neurons for information processing. The accuracy of the output depends significantly on the types of patterns or features present in the input data used for training.

Given two samples x_1, x_2, the distance between the two

samples can be expressed as $D(x_1, x_2)$.

$$D(x_1, x_2) = \|\varphi(x_1) - \varphi(x_2)\|_2 = \sqrt{K(x_1, x_1) - 2K(x_1, x_2) + K(x_2, x_2)} \qquad (1)$$

In the linear case, the above formula can be simplified as:

$$D(x_1, x_2) = \|x_1 - x_2\|_2 = \sqrt{\sum \left(x_1^j - x_2^j\right)^2} \quad (2)$$

In this context, k(x) represents the vector resulting from mapping vector x from its basic space into a vector space with more dimensions. These boundary point sets are intended to include samples that correspond to all support vectors. This set acts as SVM training's first working set K to start the training procedure. If K contains all support vectors, then the following criteria should be satisfied for any additional samples x in the dataset that do not include the support vectors:

$$\left(y_i\left(\varpi * x_i + b\right)\text{-}1\right) > 0, i = 1,2,..., n \quad (3)$$

Various entities have the flexibility to select a network configuration that suits their requirements, enabling efficient processing and identification of valuable information, thereby establishing a knowledge repository. The fundamental concept of neural networks involves utilizing the synaptic weights between neurons to create a mathematical model that can learn, adapt, and improve the training sample set of the input layer by reflecting the real signal change trend. Because of its numerous parallel computing resources, the neural network can be used to replicate procedures like data collection, storage, and management. Different classifiers must be employed for different types of images in order to increase recognition accuracy while lowering costs and simplifying maintenance. Artificial systems can achieve learning function by mimicking human brain neurons' response characteristics to different stimuli and employing these responses and their accompanying interactions [19–20]. The human brain's high degree of self-organization, ability to perceive the anatomical features of many biological nerve systems, and sensitivity to environmental changes are all useful in practical applications.

Neural Network Experiments for Software Information Recognition and Classification

6. Software information categorization and identification system based on neural network algorithm structure

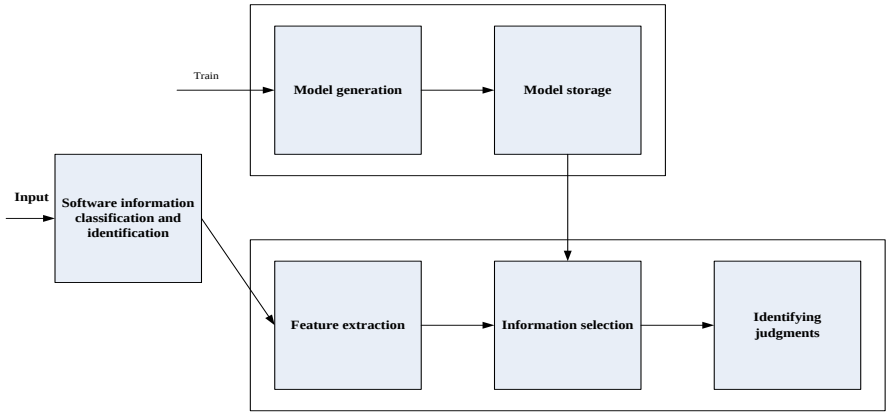


Figure 3. Software for categorization and identification of information

As illustrated in Figure 3, this research develops a software information categorization and recognition system using neural networks that includes model training, data processing, and application support services. Samples must be pre-processed and associated feature vectors created before modeling can begin. need to be made. The accuracy with which input signals may be retrieved is one of the primary topics of research for neural networks. Effectively classifying and identifying is still a challenging task at the output end. Therefore, in order to achieve the classification and identification of software information, this research uses a neural network algorithm-based approach. The neural network is a multi-input, associative memory, nonlinear dynamical system that can also learn on its own and become more general. Due to the presence of a great deal of complicated information, standard approaches have trouble effectively predicting these signals in real applications. Consequently, one of the current research areas is the training of neural networks to process pictures, assess and detect feature parameters, or build feature vectors. This issue was resolved with a three-layer

Based on the deep artificial neuron hybrid model (BP algorithm), parallel dataset support, and multi-layer perceptron hierarchical design, a development technology architecture is suggested [1]. In real-world applications, noise signals frequently interfere with training various forms of sample data because of the computer's inherent architecture, learning features, etc. This paper investigates an information categorization and recognition system for software using neural networks, which is mainly composed of the following modules: Use the module for acquiring data to link the input image and the output feature. To get the intended outcome, The target item's interference signal item is eliminated using the preprocessing step. The BP algorithm is used to reduce or eliminate the noise signal in order to improve recognition effectiveness, classification performance, and accuracy rate, as well as to make the subsequent work easier. Assessment of identification system testing and software and the software classification Information categorization and identification scheme test program primarily creates the network architecture, employs particular techniques to transform data blocks into common formats, and combines a number of data processing techniques. In particular, by analysing the training sample set, it can be fed into the neural network model for training.

as well as test outcomes. Furthermore, it is possible to split parameters like training units and classification units based on the different kinds of objects. System function modules are examined and diagnosed during software testing in order to address problems like redundancy and mistakes. The samples will be categorized by the following data processing once the input and output terminals' software code has been designed. Errors resulting from repetitive procedures are prevented by using an identification method that is easy to use, convenient, and satisfies accuracy standards. Additionally, a number of preliminary tasks are completed, including the analysis, arrangement, and output of input data. These input and output need to be converted into language signals that a computer can interpret signals for the computer to recognize them. The full software information classification and identification system is then completed by storing these signals in the computer and sending them over the network to the development platform. Lastly, a comparison between the database and the outcomes of the computer processing can be made.

7. Neural Network Experimental Analysis In Software Information Classification And Recognition

Table I. Performance Test For System Information Classification And Identification

Test information	Identification accuracy (%)	Fault tolerance rate for classification (%)	Time(s) spent processing the information
Spam advertisement	96.03	84.16	3.27
System push	92.95	85.99	4.84
Malicious pop-up window	91.05	82.90	3.34
Important notice	93.00	89.27	4.18

The neural network software system was examined and tested in this experiment. The actual output results and the data were first manually inserted from the training sample set. After that, the classification method's accuracy was assessed by comparing the results to the standard values. Furthermore, characteristics are manually taken out of the database, and similarity metrics like type and distance are used to determine how similar the features are to one another. After that, these distinctive parameters are transformed into weights using machine learning technology, creating a model from the vector of weights that corresponds. Following the acquisition of the raw data, a BP multilayer neural network is employed to process and analyze it, finally identifying [1] the intended design. The recognition system and software information classification system are displayed in the Table 1 and boasts rapid information processing times, good classification error tolerance rates, and high recognition accuracy. Building a relevant model is impossible since the artificial system cannot fully match the characteristics of the human brain's neural network architecture, ability for learning, and neural algorithm processing technique. The classic neural network model requires testing the trained samples. As a result, computer software can verify the information gathered.

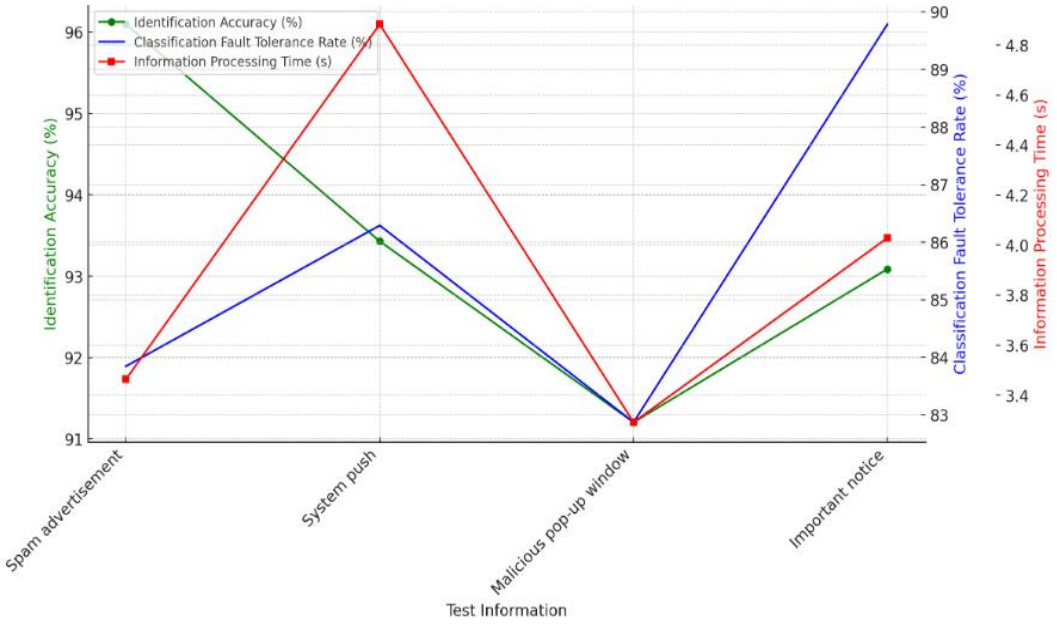


Figure 4 .System memory usage rate

Table 2. Performance Comparison Between Neural Network Algorithm And The Latest Technology

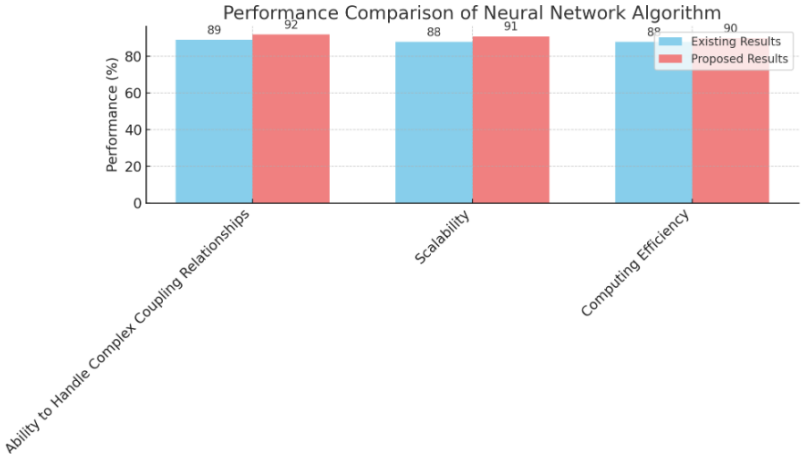
Comparison of an Algorithm	Ability to handle complex coupling relationships	Scalability	Computing efficiency
Neural network algorithm	89%	88%	88%
Latest technology	86%	85%	91%

This work examines the scalability, computational efficiency, and ability of neural networks to handle complicated coupling relationships. It also assesses the performance of neural networks using state-of-the-art technology. According to Table 2's comparison data, neural network algorithms have a 5% greater capacity than the newest technology to handle complex coupling relationships. They are also 2% more scalable, although their computing efficiency is only marginally higher.

8. Results

The Existing Results are proven in, even as the Proposed Results are displayed. The graph illustrates the enhancements inside the proposed system across all three metrics. Ability to Handle Complex Coupling Relationships: Existing at 89% and Proposed at 92%. Scalability: Existing at 88% and Proposed at ninety one%. Computing Efficiency: Existing at 88% and Proposed at ninety%. The proposed upgrades are clearly seen, indicating higher performance in coping with complicated responsibilities, scalability, and performance.

Metric	Existing Results	Proposed Results
Algorithm	Neural Network Algorithm	Back propagation algorithm
Ability to Handle Complex Coupling Relationships	89%	92%
Scalability	88%	91%
Computing Efficiency	88%	90%



9. Conclusion

With the help of the nervous system's capacity for pattern recognition and information processing, neural networks mimic how the human brain works by classifying and describing complex data. In the realm of computers, it frequently uses the BP algorithm and the neuron tree model. This study presents a novel method for training input vector mapping in predictive systems, and it mainly examines the current status of research in deep artificial neural networks, heuristic techniques, and statistical learning. This technique can increase data mining productivity and address issues with classic neural networks' limited capacity for generalization. Simultaneously, functions including sample categorization, description, and feature extraction are accomplished through the development of an algorithm for sample space processing. Neural network applications such as text classification are good. It is capable of automatically extracting keywords and semantic elements from a vast amount of text data through analysis, enabling text classification and acknowledgment. For tasks like sentiment analysis, spam filtering, and text search, this is incredibly beneficial.

Future Enhancement

Algorithm Optimization: To improve the algorithm's capacity to manage even more complicated coupling relationships and to further boost scalability and computational efficiency, future study may concentrate on tweaking the algorithm's architecture and training procedures.

The integration of advanced techniques, such as transformer-based models or hybrid neural networks, may result in improved performance metrics and handle certain difficulties that are not fully addressed by existing methods.

Increased Datasets: The generalizability and robustness of the method can be enhanced by using larger and more varied datasets for training and validation, which will enable it to handle a wider range of real-world events more effectively.

Hardware Acceleration: Using cutting-edge hardware accelerators, like GPUs or TPUs, can improve computing scalability and efficiency while cutting down on processing times and resource usage.

References

1. Ramin Ranjbarzadeh, Nazanin Tataei Sarshar, Saeid Jafarzadeh Ghoushchi, Mohammad Saleh Esfahani, Mahboub Parhizkar, Yaghoub Pourasad, Shokofeh Anari, Malika Bendechache:MRFE-CNN: multi-route feature extraction model
2. for breast tumor segmentation in Mammograms using a convolutional neural network. Ann. Oper. Res. 328(1): 1021-1042 (2023).
3. Abdullah Al-Amaren, M. Omair Ahmad, M. N. S. Swamy: A low-complexity residual deep neural network for image edge detection. Appl. Intell. 53(9): 11282-11299 (2023).
4. Yuanxin Xiang, Yi Lv, Wenqiang Lei, Jiancheng Lv: Ultra-Short Wave Communication Squelch Algorithm Based on Deep Neural Network. Big Data Min. Anal. 6(1): 106-114 (2023).
5. Nabila Sid, Meriem Djezzar, Mohammed El Habib Souidi, Mounir Hemam: New Game-Theoretic Convolutional Neural Network Applied for the Multi-Pursuer Multi-Evader Game. Comput. Informatics 42(3): 546-567 (2023).
6. Zhixin Zhang, Shuah Jiang, Xuhui Pan: Transnet: Convolutional Neural Network Combined

with Transformer for Medical Image Segmentation. Comput. Informatics 42(2): 392-410 (2023).
7. Yun-Chen Lo, Yu-Chih Tsai, Ren-Shuo Liu:LV: Latency-Versatile Floating-Point Engine for High-Performance Deep Neural Networks. IEEE Comput. Archit. Lett. 22(2): 125-128 (2023).
8. Malik Benmansour, Abed Malti, Pierre Jannin: Deep neural network architecture for automated soft surgical skills evaluation using objective structured assessment of technical skills criteria. Int. J. Comput. Assist. Radiol. Surg. 18(5): 929-937 (2023).
9. Velu A., N. Chellammal:An Optimization-Based Neural Network for Estimating Regenerative Braking Force in EVs for Maximal Energy Recovery. Cybern. Syst. 54(8): 1375-1396 (2023).
10. Songwen Pei, Jie Luo, Sheng Liang, Haonan Ding, Xiaochun Ye, Mingsong Chen:Carbon Emissions Reduction of Neural Network by Discrete Rank Pruning. CCF Trans. High Perform. Comput. 5(3): 334-346 (2023).
11. Sabahi-Kaviani Z, Ghassemi F .Behavioral model identification and classification of multi-component systems. Science of Computer Programming, 2019, 177(MAY 15):41-66.
12. Sida Lin: Automatic recognition and detection of building targets in urban remote sensing images using an improved regional convolutional neural network algorithm. Cogn. Comput. Syst. 5(2): 132-137 (2023).
13. Hallison Paz, Daniel Perazzo, Tiago Novello, Guilherme G. Schardong, Luiz Schirmer, Vinícius da Silva, Daniel Yukimura, Fabio Chagas, Hélio Lopes, Luiz Velho: MR-Net: Multiresolution sinusoidal neural networks. Comput. Graph. 114: 387-400 (2023).
14. Sudhin Chandran, R. Rajesh, M. Dev Anand: Laser Beam Welded Aluminum-Titanium Dissimilar Sheet Metals: Neural Network Based Strength and Hardness Prediction Model. Comput. J. 66(5): 1053-1068 (2023).
15. Valter Augusto de Freitas Barbosa, Anderson Félix da Silva, Maíra Araújo de Santana, Rian Rabelo de Azevedo, Rita de Cássia Fernandes de Lima, Wellington Pinheiro dos Santos: Deep-Wavelets and convolutional neural networks to support breast cancer diagnosis on thermography images. Comput. methods Biomech. Biomed. Eng. Imaging Vis. 11(3): 895-913 (2023).
16. Runnan Tan, Qingfeng Tan, Qin Zhang, Peng Zhang, Yushun Xie, Zhao Li:Ethereum fraud behavior detection based on graph neural networks. Computing 105(10): 2143-2170 (2023).
17. Yingji Li, Yufeng Qian, Qiang Li, Linna Li: Evaluation of smart city construction and optimization of city brand model under neural networks. Comput. Sci. Inf. Syst. 20(2): 573-593 (2023).
18. Morgan M. Caudle, Andrea D. Spadoni, Dawn M. Schiehser, Alan N. Simmons, Jessica Bomyea:Neural activity and network analysis for understanding reasoning using the matrix reasoning task. Cogn. Process. 24(4): 585-594 (2023).
19. Mahesh Kumar Morampudi, Nagamani Gonthina, Nuthanakanti Bhaskar, V. Dinesh Reddy:Image Description Generator using Residual Neural Network and Long Short-Term Memory. Comput. Sci. J. Moldova 31(1): 3-21 (2023).
20. Mohammad Reza Falahzadeh, Fardad Farokhi, Ali Harimi, Reza Sabbaghi-Nadooshan:Deep Convolutional Neural Network and Gray Wolf Optimization Algorithm for Speech Emotion Recognition. Circuits Syst. Signal Process. 42(1): 449-492 (2023).