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Research Article

UNDERSTANDING THE THEORY, MODELS, AND APPLICATIONS OF ARTIFICIAL NEURAL NETWORK

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ABSTRACT

The primary objective of the Artificial Neural Network (ANN) is to build useful 'computers' for serious challenges and to reconstruct intelligent data methodological approaches like pattern recognition, classification, and generalization through using simple, distributed, and robust processing units known as artificial neurons. ANNs are parallel implementations of non-linear static-dynamic systems that are fine-grained. The considerable degree of interconnectivity that provides neurons their great computing capacity through their vast parallel-distributed structure gives ANNs their intelligence and ability to tackle difficult issues. The recent spike in demand in ANN is primarily due to the fact that ANN algorithms and architectures may be deployed in real-time applications using VLSI technology. The scope of ANN applications has exploded in recent years, fueled by both theoretical and practical accomplishments across a wide range of fields. The theory, models, and applications of artificial neural networks are briefly discussed.

Keywords: Black Box Modeling, Neural Network models, Neural Network applications

INTRODUCTION

Contemplating public political behavior [2] will show the future landscape of a society in which anyone can virtually perceive the future space and commence to programmer and create policy of his or her job career, political, economic, military, and other sections affairs while being made aware regarding obtainable characteristics, parties, and applicant's perspectives. Because so many political theorists struggle to predict public political behavior in these types of elections and are unable to do otherwise precisely utilizing statistical tools and social and political analyzing methods [1], data mining methods like artificial neural networks have been used to look for potential rules in these types of data by collecting data and necessary documents from voters.

Artificial neural networks are a type of current mathematical-computational approach used for solving unexpected dynamic issues in established behavioral systems over an amount of time. Artificial neural networks can solve issues by evolving to detect patterns in data that other computational and statistical methods have failed to address. [3] Artificial neural networks are becoming frequently utilized because of their capacity to predict. Given that this characteristic, as well as participation predictors and election results, as some of the most intriguing difficulties for political scientists, in such cases artificial neural networks can be utilized to predict political issues, despite the fact that it would be less commonly employed by researchers in Political Science. Political scientists and academics have already been looking for large models to predict results of the election in emerging countries. [4]

A. Predict Using Neural Networks

The recent trend of utilizing artificial neural networks to predict outcomes has resulted in a significant rise in research activity in the last decade. Artificial neural networks are effective tools for predicting exchange rates, evaluating economic time - series data, and dealing with stock and stock market difficulties. In terms of performance standards for future time sequences prediction, the findings and functionality of artificial neural networks have proven that somehow this model performs better

than common techniques. Many sophisticated statistical approaches are being created and applied for the anticipating process in social contexts in recent years. Nevertheless, there seem to be two major issues with these approaches. Personal statistical problems, power, as well as some analyses for a single and multi-dimensional time series are all included. Artificial neural networks were found to be effective in removing statistical issues in multidimensional time series prediction.

Due to a lack of precise and satisfactory models in the economic area, it becomes difficult to predict macro-economic difficulties. The time series model of black-box model, which partially addresses the economy, is by far the most adequate assessment for economic analysis. High noise levels, short time series, and nonlinear effects are used to resolve time series issues using the regression approach, which has become one of the most prominent ways of solving economic forecasts in recent decades. Artificial neural networks can also be used to resolve issues and predict macroeconomic concerns using the supplied answer. The researchers were given results of the experiment to predict the criterion of industrial production in the United States by choosing sophisticated parameters in artificial neural networks, wherein the given results of their numerical simulations indicate that artificial neural networks perform much better unlike commonly utilized time series and regression approaches.

The adaptable neural network model is able to identify and anticipate the explicit relation involving democratization and universal collision theory in the political sphere, but the logical model does not. Marchi et.al proposed the logic model. Researchers found it to outperform artificial neural networks, although Nathaniel Beck et al. denied. They proceeded by analyzing Grynaviski, Gelpi, and Marchi's ideas, emphasising that their points of view are perfectly compatible with theirs. Their shared opinion is that major standards should be used to evaluate global research in order to predict out-of-sample functionalities. They also said that Marchi et al's other results are erroneous. They agreed that Marchi et al's use of the identical assessment criteria for each one of the two models was founded on logic model supremacy above the other neural networks that offered challenges and rejected their hypothesis.

In the tourism industry, artificial neural network models outperformed other common forecasting approaches such as time series and regression techniques in terms of anticipating international tourism demand. It has been authorized in a study conducted by Rob Law and Norman Au. To predict a Japanese travel to Hong Kong, the authors utilized an ordered Feed-Forward network, which is a type of neural network. The input layer of a network consists of six service pricing nodes, average lodging rates, currency rates, population, and internal gross expenditures, while the output layer of a node represents travel needs from Japan to Hong Kong. The neural network model provides amazing results than most other techniques, according to the experimental data collected from a research of the period interval from 1967 to 1996.

In the field of environmental science, neural networks may be utilized to tackle difficulties and concerns related to real-world process modelling by creating a composite architecture using meta-heuristic algorithms. Non-linear multivariate space and chaos theory are two of these issues. Even though it is hard to design neural networks for maximum efficiency, Harry Niska et al used a multi-layer perceptron model to predict Nitrogen Dioxide during the day in a densely populated traffic station in Helsinki city by combining genetic algorithms in tandem to choose input and design high-level architecture. It demonstrated that mixed networks can solve the practical difficulties of constructing neural networks for high efficiency [5].

In the realm of information technology, neural networks have proven that short-term intervals may predict traffic rate in top-

in networks superior than modified techniques of time series. Paulo Cortez et al. conducted numerous tests to measure the reliability of the aforementioned techniques' predictive performance using real-world data and associated information from internet service providers. The studies were carried out at three time intervals of 5 minutes, 1 hour, and a day. However, 1-day anticipation time series produced superior outcomes, and neural group tests have demonstrated that it can produce the greatest results for short-term time series [6].

B. ANN Theory and Models

Different types of Neural Networks (NN) have also been developed, but they all share three elements in common: the individual neuron, the architecture (connections between neurons), and the learning method. Each category limits the types of connections that can be made. It might, for instance, state that if one neuron is linked to another, the second neuron cannot connect to the first neuron again. The structure or layout of the neural network refers to the many types of connections that may be made.

One or more layers of neurons make up a neural network. The output from the units in one layer is only permitted to activate neurons in the next layer in a wide variety of NN models, including such Perceptron, Linear Associator, Multi-layer feed-forward networks using Back-Propagation (BP) learning, the Boltzmann machine, and the Grossberg model. In other models, such as Kohonen nets and the Hopfield model, meanwhile, the signal can trigger neurons in the very same layer.

The numerical strength of a synaptic connection between two neurons is known as synaptic weight or adaptation coefficient. Positive (excitory), negative (inhibitory), or zero (no connection) values can be used to describe the strength of interconnectivity. The weight influences the shape of the signal that is passed from one neuron to the next, therefore coding the network's knowledge. Whenever the cumulative excitation surpasses the cumulative inhibition by a certain amount, termed the threshold (T), usually 40 mV, the neuron fires, sending messages to neighbouring neurons. Only a few of the networks offer real-time responses. Other networks require more opportunity to answer and are defined by their time-domain behavior, which we call brain dynamics. The period of latent summation is the temporal gap between when inputs are supplied and when neurons produce output.

If a neuron's threshold and input weights can be changed, it is considered to be "trainable." Neurons are provided with inputs. If the neurons do not provide the expected output (as decided by us), then something went wrong. To account for the discrepancy, various weights and thresholds must be adjusted. The learning (or training) algorithm is the set of rules that control how well these changes will take place. The method in which the modification of synaptic weights of a neuron is stated differs amongst learning algorithms.

The network's weights are gradually changed in order to enhance a predetermined performance metric over time. The cognitive development may best be described as a "search" for an answer in a multi-

dimensional weight space that gradually optimizes a pre-specified goal function. After each iteration of the learning process, the NN has a better understanding of its surroundings.

C. ANN Applications

Since their inception, artificial neural networks (ANNs) have been used in a wide range of fields. The general uses of several ANN models are listed in Table 1 in chronological order. The following are only a handful of the many uses that have been described in the literature:

Table1. Generic applications of various ANN models

Application Area	ANN model used	Year
Typed character recognition	Perceptron	1957
Echo cancellers in telephone lines	Madaline	1960
Speech recognition	Avalanche	1967
Speech synthesis	Back Propagation	1974
Knowledge extraction from databases	Brain state in a box	1977
Handwritten character recognition	Neocognition	1978
RADAR and SONAR identification	ART	1978
Aircraft navigation	Self-Organising map	1980
Image processing	Hopfield	1982
Associative memories	Hopfield	1985
Loan application evaluation	Counter Propagation	1986

Alarm Processing

Engineers are required to swiftly assess numerous choices and adopt the best course of action in an emergency. The quantity of real-time messages (alarms) received on the VDUs, on the other hand, is far too great for the time available to evaluate them. A useful operational assistance has been discovered in the processing of such alerts in real-time and notifying the operator to the root cause or the most important of these alarms. For this type of alert processing, ANNs have been used. For this aim, Chan

[7] suggested a three-layer Perceptron network, which showed encouraging simulation results. In this application, a trained ANN's quick reaction and generalization skills come in handy.\

Eddy current analysis

The numerical solution of Integra-differential equations is required for the analysis of eddy current losses. It is computationally costly to discretize these equations and solve them using finite-element techniques. [8] Describe a cellular ANN that generated a technique for solving these equations that was quicker, less computationally costly, and simpler. As an alternative to finite-element techniques, they

suggested a cellular NN.SPICE was used to mimic the cellular networks. In a time-varying magnetic field, the cellular network computed eddy currents and eddy current losses in a source current carrying conductor. This approach allows for a wide range of structural analysis, electromagnetic field calculations, and other applications.

Harmonic source monitoring

[9, 10] describe the detection and monitoring of harmonic sources in non-linear load systems. This method presupposes that the system's harmonics can be measured directly. Multiple three-layer Perceptrons were used by these researchers. Simulation data for various load circumstances were used to train the ANNs. To locate and monitor the source of the harmonics, the ANNs were utilized in combination with a state estimator. This method proved successful in identifying a previously

unidentified harmonic source.

Applications in nuclear power plants

Researchers at the University of Tennessee explored the possible uses of ANNs in increasing the effectiveness and productivity of nuclear power reactors as part of a study funded by the US Department of Energy [11, 12, and 13]. The following topics were investigated: assessment of particular faulty situations, recognition of a change in mode of operation, signal validation, check valve monitoring, modelling of plant thermodynamics, plant parameter monitoring, plant vibration analysis, and so on.

I. OBJECTIVE OF THE STUDY

The paper's main objective is to investigate neural networks and their applications.

II. LITERATURE REVIEW

The current Special Issue, titled "Advances in Neural Networks Research: IJCNN2009," presents a current state-of-the-art assessment of neural networks. It contains 39 papers from the 2009 International Joint Conference on Neural Networks in chosen topics (IJCNN2009). The International Joint Conference on Neural Networks and Computational Intelligence (IJCNN2009) was held in Atlanta, Georgia, USA, from June 14 to 19, 2009, and it was an excellent example of collaborative efforts between the International Neural Networks Society and the IEEE Computational Intelligence Society.Computational intelligence and machine learning, hybrid methods, nonlinear dynamics and

chaos, different soft communications technology, intelligent signal processing and pattern recognition, bio-informatics and bio-medicine, and engineering applications are among the topics covered in this issue. [14]

Artificial neural networks have been shown to be extremely successful in predicting and analyzing flows that traditional techniques and statics are unable to address. In this paper, we show so using a two-layer feed forward network with such a tan-sigmoid transmission function in the input and output layers, we can predict the public participation rate in future presidential elections in the Islamic Republic of Iran with 91 percent respectively in Kohgiloye and Boyerahmad Provinces. Our assertions have been validated using participation evaluation criteria including confusion matrix and ROC diagrams.

In this study, [15] we proposed a technique that uses Artificial Neural Networks and expert systems to understand deeply for the learner model in the Linear Programming Intelligent Tutoring System (LP-ITS) for determining the learners' academic performance level so that the appropriate level of difficulty of linear programming problems can be offered to them to solve. To predict academic achievement, LP-ITS utilises a Feed forward Back-propagation algorithm that has been trained with data from a set of students. Additionally, LP-ITS employs an Expert System to determine the appropriate degree of difficulty for the learner's expected academic achievement. Numerous tests were performed to see if real-time data was adhered to. The reliability of forecasting the learners' achievement is quite good, indicating that the Artificial Neural Network is capable of making appropriate predictions.

III. CONCLUSION

Even when the training data contains flaws, the ANN can generate a generalized solution to the issue that is not the same as the one used for training and give legitimate results. These features contribute to making NN an effective tool for modelling situations involving functional connections that are unclear or likely to change over time.

Another instance where the NN technique might be beneficial is if the time necessary to create a solution is essential, like real-time applications that require a large number of solutions in a short period of time. Even when other approaches that can generate more optimum results are available, the capacity of a NN to produce rapid solutions regardless of the complexity of the problem makes them desirable. [2]

ANN do not offer a formal representation of the relationship between input and output data, in contrast to classical methods or expert systems, which seek to codify knowledge and build partial qualitative system models. As a result, stastical tests must be used to evaluate the ANN's performance.

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