

Neural Network Applications : A Review

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ABSTRACT

Neural Network(NN) as the name implies is a computer tool used for solving different practical problems. It offers the best solutions to many problems in image recognition, natural language processing, and speech recognition. The basic idea of neural networks(NN) is to simulate brain cells that are interconnected inside a computer so it could learn new things all by itself, for it to be able to recognize patterns, and make decisions just like the human brain. One of the advantages of using a Neural Network(NN) is its learning ability. Neural network learning provides an efficient ability in recognition. They are widely used in earthquake prediction, agriculture, and medicine, time series analysis for predicting future values. Neural Network(NN) was a useful tool in solving practical problems; its only shortcomings were in the area of robotics because it required lots of learning algorithms to be able to perform like humans, this shortcoming made it not to be accepted as a general learning tool.

Keywords : Neural Network, Artificial Intelligence, Learning Algorithms, Architecture

I. INTRODUCTION

Neural networks are computational analysis methods that depend on mathematical models that, unlike traditional computing, have a structure and operation that resembles that of the mammal brain. They are a set of algorithms, modeled loosely after the human mind, to recognize patterns. Their primary function was to interpret sensory data through a kind of machine perception, labeling or clustering raw input. They could also be seen as biological neural networks because they consist of biological neurons or neural networks, which were used for solving artificial intelligence (AI) problems. Artificial intelligence(AI),

cognitive modeling(CM), and neural networks(NN) are information processing methods that are inspired by the way these neural systems process data. Both Artificial intelligence and cognitive modeling tried to simulate some properties of biological neural networks. With the aim of checking their effectiveness In the synthetic intelligence field, Artificial Neural Networks(ANN) were applied in speech recognition, image analysis, and adaptive control, to construct software agents (in computer and video games) or autonomous robots.

Furthermore, digital computers could also be said as having evolved from the von Neumann model and

operated via the execution of explicit instructions via access to memory by several processors. Furthermore, the origins of neural networks depend on their ability to model information in their system. Also, unlike the von Neumann model, neural network computing does not separate memory and processing. Neural network theory tried to identify better how neurons function in the brain and also provided us with the basic platform to create artificial intelligence. Artificial neural networks(ANN) or Neural Networks(NN) or connectionist systems or parallel distributed systems or adaptive systems because they contain a series of interconnected processing elements that operate in parallel. Neural networks (NN) lack centralized control in the classical sense since all the interrelated factors change or “adjust with the influx of information and adaptive rules in other for them to function well. Jürgen Schmidhuber(2015); Foram S. Panchal, Mahesh Panchal(2014).

II. METHODS AND MATERIAL

Types of a neural network:

There are several types of neural networks: Feedforward neural network, Radial Basis Function (RBF) neural network, and Recurrent neural network

Feedforward neural network

A feed-forward neural network begins with an input layer. This input layer is also linked with another hidden layer. This invisible layer is connected with other buried layers. Foram S. Panchal1, Mahesh Panchal, (2014)

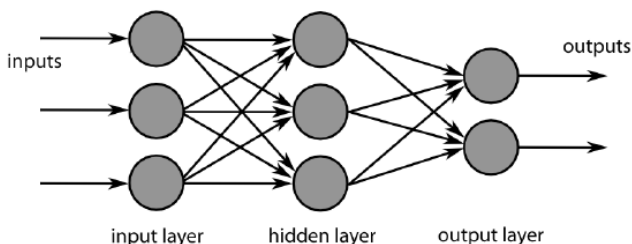


Fig.1 Feedforward neural network[Foram S. Panchal, Mahesh Panchal,2014]

Radial Basis Function Network

Radial basis function (RBF) systems are feed-forward networks systems that are trained with the algorithm. This network was configured with single hidden layer of units whose activation function was selected from a class of services called basis functions. While similar to backpropagation in many respects, radial basis function networks have several advantages. They usually train much faster than backpropagation networks

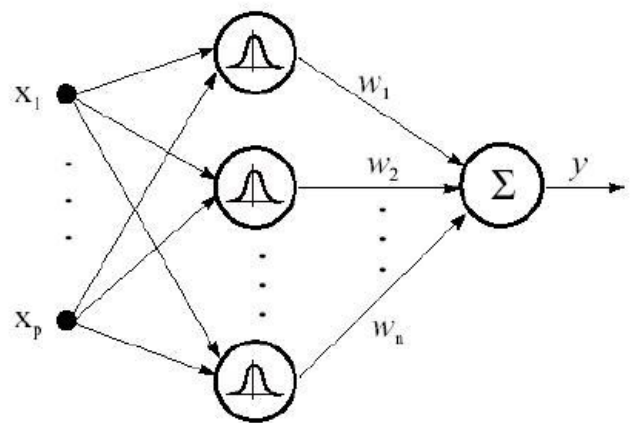


Fig.2 Radial basis function neural network[Foram S. Panchal1, Mahesh Panchal,2014]

Recurrent Neural Network(RNN)

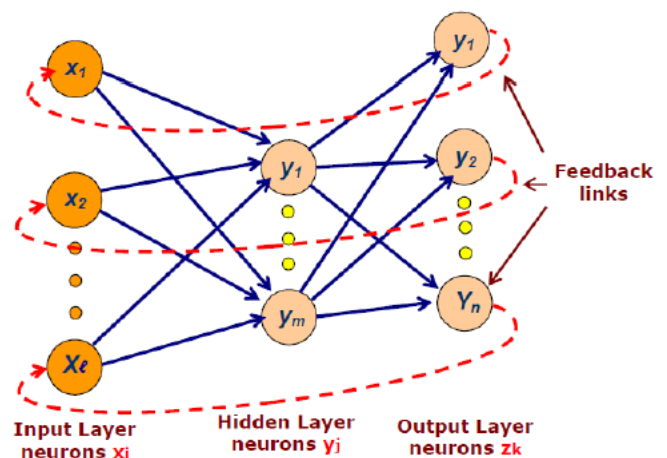


Fig.3 Recurrent neural network(RNN) [Foram S. Panchal, Mahesh Panchal 2014]

The main feature of a recurrent neural network is that the system has at least one essential feedback connection. There could also be numerous neurons with the self-feedback links; it means the output of a neuron is feedback into itself as input.

Neural Networks for Classification

Guoqiang Peter Zhang(2010), Saravanan K, and S. Sasithra(2014) stated that classification was the most active research and application areas of neural networks. Their literature was vast and growing. They summarized some of the most critical developments in neural network classification research. The aim was to provide a synthesis of the published research in this area and stimulate further research interests and efforts in different areas such as internet traffic classification. Tom Auld et al. (2017), genetic algorithm, and backpropagation comparison. Randall S. Sexton and Robert E. Dorsey(2015)

BackPropagation Approach

Backpropagation is a standard method to train an Artificial Neural Network(ANN) on how to perform a given task. The objective of the training is to find the set of weights between neurons that determine the global minimum of the error function. The Backpropagation algorithm was used in the layered feed-forward ANNs. Signals are forwarded from one layer to another layer, and errors are propagated backward. G.Preethi, B.Santhi(2011)

Learning Methods of Neural Networks

They are classified into three basic types :

- 1) Supervised Learning Neural Network
- 2) Unsupervised Learning Neural Network
- 3) Reinforced Learning Neural Network

Supervised Learning Neural Network needs the help of an instructor to supervise its operations while the

Unsupervised Learning Neural Network does not need the services of an instructor.

In the Reinforced Learning Neural Network, a supervisor is present, but the expected output is not currently in the work

III. RELATED WORK

Several reviews were made on neural networks and reported as follows:

Harshita Tuli, Sanjay Kumar (2014) stated that the most important feature of neural networks was their ability to generalize and predict events. Neural networks approximate with high accuracy. Neural networks can be used when only limited data sets are available. Surender Syahfinash Binti Shafii (2016), reported that the neural network is a system that was inspired by human brain function; consists of neurons connected in parallel with the ability to learn. A basic design of the neural network has an input layer, a hidden layer, and output layer. The use of neural network can improve the quality of recognition while achieving good performance Haruna Chiroma et al. (2017); Sumit Das et al. (2015); Safa S. Ibrahim and Mohamed A.Bamatraf (2013); Alanoud M. et al. (2019): Reported Neural networks and genetic algorithms as the two most sophisticated machine learning techniques which are still attracting attention from scientists, engineers, and statisticians, among others. Their optimization was aimed toward deviating from the limitations attributed to neural networks to solve complex and challenging problems. Rashi Aggarwal, Rajendra Kumar (2013), Abhishek Saxena et al. (2015) reported that it is difficult for researches to predict the weather accurately. Vikas Poonias et al. (2018) that ANN models are an efficient and perfect tool for forecasting mainly for Rainfall-runoff prediction, groundwater, water quality, streamflow prediction, etc. In many of the complex hydrological problems, the most widely used method is Feed-Forward-Back-Propagation (FFBP) method. However, in the case of

rainfall-runoff prediction models such as multiple-input single-output (MISO) models are also used, in case of modeling cascade system, a correlation artificial neural network (CCANN) model is used, in case of low stream modeling, recurrent neural network (RNN) is employed and so-on. For designing the perfect ANN model, a deep understanding of the hydrological process would impart a great help. As ANN is gaining acceptance among researchers, it should produce improved models with good results

G.Preethi, B.Santhi(2011); Roy Lachica et al. (2014) stated that a fuzzy optimization algorithm should be applied to different time series data and predict the future values of predicting the earthquake. Satanand Mishra et al. (2014), examined various approaches of neural networks for the hydrological forecast with their potential as well as a limitation and proposed an approach for neural network model building for a hydrological forecast. Future work should be based on simulating and predicting results using backpropagation for runoff forecasting and comparing predicted forecasting result accuracy with current forecasting techniques, which ultimately provide a more reliable data mining approach. Hayder H. Abbas, Adnan Khashman (2016) stated that this means that the prediction system requires more climatological data during training, which is conceivable, and thus can be used successfully in real-life applications. Future work will focus on predicting solar radiation in other locations of this Mediterranean island. Hamid SadAbadia, Masood Ghasemia, Ali Ghaffari (2006) Using artificial neural networks for noise and baseline removal was also used in many articles, e.g., a neural network-based adaptive algorithm for ECG denoising. T. Logeswari, M. Karnan(2010); Saurabh Shah, N.C. Chauhan(2015); Alaeldin Suliman, Yun Zhang(2015); T.Daslinponsanthosh,P.Kannan (2014); Sachin Padmanabhan (2016) reported that image segmentation was an important and challenging factor in the medical image segmentation. They said that the segmentation method was made up of two phases, the

first and second phases. In the first phase, the brain image was acquired from patients' database in that film, artifact, and noise were removed after that H Som was applied for image segmentation. The H Som is the extension of the current self-organizing map used to classify the image row by row. In this lowest level of the weight vector, a higher value of tumor pixels, computation speed is achieved by the H Som with vector quantization. In the future, the system should be improved by adopting more segmentation algorithms to suit the different medical image segmentation. Mahesh Yambal, Hitesh Gupta (2013); M. Egmont-Petersen et al. (2010); Lilia Lazli (2013) further explained image segmentation, in their report, they said that Fuzzy C-(FCM) algorithm was the most popular fuzzy clustering methods widely used in various tasks of pattern recognition, data mining, image processing, gene expression data recognition, etc. modifying and generalizing the FCM algorithm is a steady research stream in fuzzy clustering in recent decades. Furthermore, a hybrid technique based on clustering algorithms and classifiers like Neural Networks, etc. can be combined to work on input data set for better results, and previously designed algorithms can be modified to work for color image segmentation. S N Kumar. Lalitha Kumari (2016) reported that the local and texture features extracted are normalized and provides as input to neural networks. During the testing stage, the backpropagation neural network classifies the pixels into the liver and non-liver regions. The post-processing operation modifies the neural network response, and the segmented liver is obtained from the abdomen CT image. A localized region-based active contour model did the tumor boundary detection. The efficiency of the neural network-based liver detection is determined qualitatively by the expert radiologist and quantitatively by the similarity and success & error rate metrics. The future work will be the classification of various liver anomalies using neural networks based on association rules for diagnostic purposes. H.Sadjadian et al. (2015) alternatively, polynomial

neural network, which was introduced based on the paradigm of a group method of data handling, is applied to solve the forward kinematic problem of this parallel spatial manipulator. It was observed that the polynomial network has better performance with acceptable prediction errors for general robotic applications with much less training time required compared to the above classical structures of neural networks.

S. Janpong, K-L. Areerak and K-N. Areerak (2011) reported that neural network, as claimed in several papers, is a dual – algorithm – oriented learning, which enhances the simple architecture of the system. Moreover, there are lots of tool and technology which support a large number of neural network applications. Therefore, the neural network is prevalent in all forms. In the future, artificial intelligence (AI) techniques will be applied to design the NN controller for shunt active power filter. Duarte Trigueiros and Richard Tamer (2010); Dionicio D. Gante et al. (2015); Shorouq E-letter, Saad Ghaleb Yaseen(2010) The majority of neural network studies in the business area to date have been classical financial forecasting applications.' Accounting applications Are more limited and tend to be of a classification nature. Applying neural network methodology in areas already well served by conventional statistical techniques, where the main concern is the comparative performance of the new method. Igbiosa, Sunday Osaretin(2011)The study developed an artificial neural network model for Benin- Lagos based on which property features and characteristics that have a significant impact on market values of real estate properties from the markets were identified. Also, the study gave a strong indication of a high level of approximation of input property characteristics/features to property market values.

Kumar, Rupinder Kaur (2015) stated that Plant leaf was also classified based on their morphological features with the help of different classification techniques such as PCA, SVM, and neural network. S. Savanna et

al. (2012) The results showed that the use of ANNs led to more accurate results than linear models (MLR and PCR). The electricity consumption is involved with multiple influencing factors, so regular prediction models do not work well for its prediction due to the account of nonlinearities. Meghan Jain, KK Pathak (2014) neural networks(NN) are introduced as a promising management tool that can enhance current automation efforts in the construction industry, including its applications in construction engineering. C. Bhanuprakash et al. (2017) stated that the FeedForward NeuralNetwork approach was to bring together staff members in an institution. The results showed the psychological imbalances among staff members because this matters a lot during their annual increments and other promotions. A.Jaganathan1 & S.Kuppuraj (2016) neural network was also used to predict happenings in the milk industry. S.S.Kharel, A.R. Gajbhiye (2013). The most likely applications of neural networks are to simulate physical systems that are best expressed by parallel networks involving classification, association, and reasoning rather than sequential arithmetic computing

Applications of neural network

There are various types of forms of neural networks.

System identification and control

Game-playing and decision making (backgammon, chess, poker)

Pattern recognition (radar systems, face identification, object recognition and more)

Sequence recognition (gesture, speech, handwritten text recognition)

Medical diagnosis

Financial applications (e.g., automated trading systems)

Data mining (or knowledge discovery in databases, "KDD")

Visualization and e-mail spam filtering

IV. RESULTS AND DISCUSSION

System identification and control

The primary way to tackle process control is the ability to develop a mathematical model that would describe or analyze the dynamic system for it to be controlled or monitored. This method often fails because the process model was not accurate as a result of its complex nature. Kazuhiko Takahashi (2018). For process control, the neural network was used to solve two problems. The first was that it explicitly provided key results for neural networks for control situations because the targeted outputs correspond to the appropriate control inputs that give desired responses. In the robotic system, once a robot was made in the factory. They are subjected to training before implementation. Thus both the in-operability during training and the learning speed would not serve as critical factors. Panos J. Antsaklis (2013), Feedback control has to measure the output signals first from a system or plant and then use the difference between the measured values and the prescribed values. F.L. Lewis, Shuzhi Sam Ge (2015)

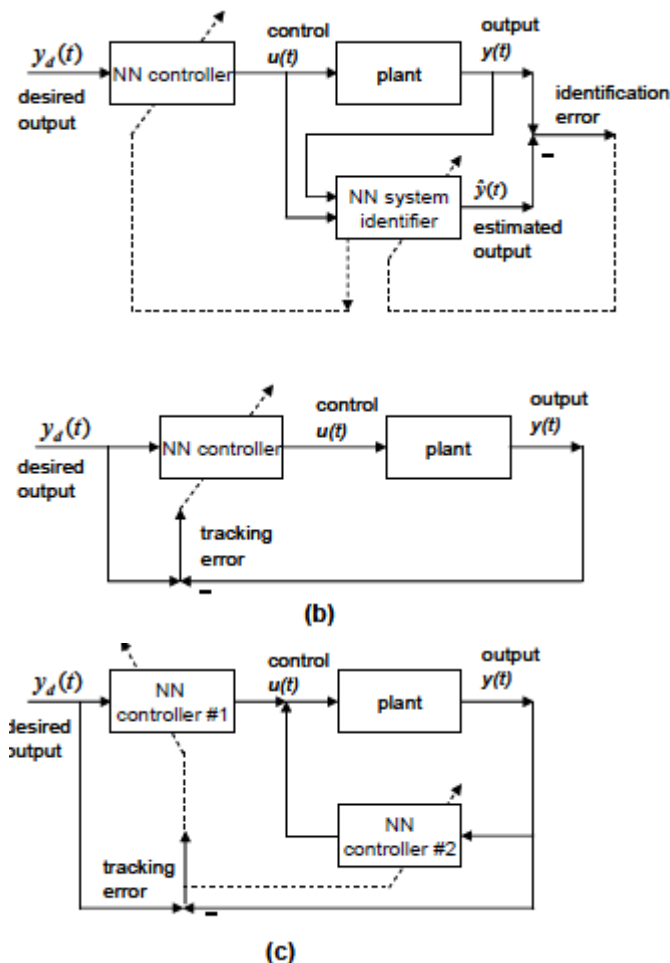


Fig. 4: NN Control Topologies. (a) Indirect scheme. (b) Direct scheme. (c) Feedback/feedforward scheme. Kenneth A. Marko (2013)

Diagnosis of faults in complex or real-time control systems is a complicated task that has resisted solutions by traditional/native methods. We have shown that neural networks can be successfully employed to diagnose faults in digitally controlled powertrain systems. Their research discusses the means they used to formulate the best database for training and testing to select the optimum network architectures and to provide reasonable estimates of the classification accuracy of these networks on new samples of data. Kenneth A. Marko (2013); Takashi Torigoe et al. (2015); Yahia Kourad et al. (2013)

Data mining

F.L. Lewis, Shuzhi Sam Ge (2015) classification is defined as the process or way of ascertaining a model that describes and distinguishes data classes or concepts based on the analysis of a set of training data. Researchers developed models called classifiers which were used to predict categorical class labels and also used in predicting the types of labels for which the class label was unknown. Nida Shahid et al. (2019)

Satanand Mishra et al. (2014), presented a survey paper that was focused on the data mining technique using an artificial neural network (ANN) and its application in runoff forecasting. The long-term and short-term forecasting model was developed for runoff forecasting using various approaches of Artificial Neural Network techniques. Their study compared the approaches available for runoff forecasting of artificial neural networks (ANNs). Based on this comparative study, they tried to ascertain a better approach in perspective of research work

Medical Diagnosis

Neural Networks (NN) are best at identifying patterns or trends in data, and they are well suited for

predicting or forecasting. Hence neural networks are extensively applied to biomedical systems. An analysis was carried out to motivate neural network applications in medical diagnosis. A special note was made on neural network effort on cancer diagnosis. Filippo Amato et al (2013); A. Maithili, et al (2018); Sarfaraz Ahmed (2014); Elda Xhumari, Petrika Manika (2016)

Health care systems in developed nations transform towards a value-based, patient-centered model of care delivery faced new complexities relating to improving the structure and management of health care delivery; for example, improving the integration of processes in care delivery for patient-centered chronic disease management.

Margarita Sordo (2012); Zribi M and Boujelbene Y (2016). stated that Neural networks have been applied within the medical domain for clinical diagnosis, image analysis, and interpretation signal analysis and understanding, and drug development. Neural Networks currently is a 'hot' research area in medicine, particularly in the fields of radiology, urology, cardiology, oncology, etc. It has a vast application in many areas such as education, business, medical, engineering, and manufacturing. Neural Network plays a vital role in a decision support system. , an attempt was made to make use of neural networks in the medical field (carcinogenesis /pre-clinical study). In carcinogenesis, neural networks were successfully applied to the problems in both pre-clinical and post-clinical diagnosis. Dr. N. Ganesan, et al. (2010), that Qeethara Kadhim (2010) Stated Artificial neural networks are widely used in medical problems. Neural networks were used for disease diagnosis. A feedforward backpropagation neural network is used as a classifier to distinguish between infected or non-infected with two types of urinary disease. Inflammation of urinary bladder and nephritis of renal pelvis origin are diagnosis by the artificial neural network.

Heart disease is the most threatening issue, which is more dangerous than the other kind of illness. Most of the people in the world are caused by heart disease, which increases the death rate of humans considerably. Hybrid Differential Evolution based Fuzzy Neural Network (HDEFNN) for heart disease diagnosis. In this method, DE is hybridized with the FNN algorithm to ensure the better performance of heart disease diagnosis. The proposed method guarantees the accurate and reliable identification of heart disease with the help of neural network-based learning. Here the performance of the neural network is enhanced by introducing the genetic algorithm, which will update the initial weight values hidden layers; thus, the learning prediction accuracy can be improvised. O. Bhaskaru, M.Sree Devi (2019)

Pattern recognition

Detection and classification of radars based on pulses they transmit is an essential application in electronic warfare systems. In this work, we propose a novel deep-learning-based technique that automatically recognizes intra-pulse modulation types of radar signals. Re-assigned spectrograms of measured radar signal and detected outliers of its instantaneous phases filtered by a particular function are used for training multiple convolutional neural networks. Automatically extracted features from the systems are fused to distinguish frequency and phase-modulated signals. Fatih Cagatay Akron, et al. (2018); Peibei CAO, Weijie XIA, Yi LI (2018)

They investigated the processing of sonar signals using neural networks for robust differentiation of commonly encountered features in indoor robot environments. The distinction of such functions is of interest to smart systems in a variety of applications. Different representations of amplitude and time-of-flight measurement patterns acquired from a real sonar system are processed.

Sequence Recognition

The speech was regarded as the most efficient mode of communication between peoples. The statement was seen as the best way of communication; it could also be a user interface to communicate with machines. Therefore the popularity of automatic speech recognition systems has been dramatically increased. There are different approaches to speech recognition like Hidden Markov Model (HMM), Dynamic Time Warping (DTW), Vector Quantization (VQ), etc. Their research produced a comprehensive study of the use of Neural Networks (ANN) in speech recognition. The article focuses on the different neural network-related methods that can be used for speech recognition and compares their advantages and disadvantages. Bhushan C. Kamble(2016)

Their survey aimed to obtain an understanding of the state-of-the-art in the use of neural networks for speech recognition. Their goal was to find out about different neural network-related methods that can be used for speech recognition and which compared the pros and cons of each one of them. Veera Ala-Keturi(2013) reported the new deep learning methods had made significant progress in multi-talker mixed speech separation. Moreso, most existing models, adopt a driftless strategy to separate all the speech channels rather than selectively attend the target one. Jing Shi et al. (2016)

Wouter Gevaert et al. (2010), Zhenhao Ge, Ananth N. Iyer (2017); In this paper has presented an investigation of the speech recognition classification performance. This investigation on the speech recognition classification performance using two standard neural network structures as the classifier. The utilized standard neural network types include Feed-forward Neural Network (NN) with a backpropagation algorithm and a Radial Basis Functions Neural Networks. Automatic speech emotion recognition is also a challenging task as a

result of the gap between acoustic features and human emotions, which rely strongly on the discriminative acoustic features extracted for a given recognition task. They proposed a novel deep neural architecture to obtain the informative feature representations from the heterogeneous acoustic feature groups, which may contain redundant and unrelated information leading to low emotion recognition performance in this work. After obtaining the educational features, a fusion network was trained to learn the discriminative acoustic feature representation jointly, and a Support Vector Machine (SVM) is used as the final classifier for the recognition task. Wei Jiang et al. (2013)

Financial applications (e.g., automated trading systems)

Finance and investing are some of the most common areas of neural network (NN) applications. Some of the most representative problems being solved by NNs are bankruptcy predictions, risk assessments of mortgage and other loans, stock market predictions (stock, bond, and option prices, capital returns, commodity trade, etc.), financial prognoses (returns on investments) and others. Chase Manhattan Bank, Peat Marwick, American Express are only a few of many companies that efficiently apply NNs in solving their financial and investing problems. Dimitrios Maditinos, Prodromos Chatzoglou(2016); Muhammad Mohsin Ali et al. (2019)

Vincenzo Pacelli (2012) Their research was aimed to analyze and compare the ability of different mathematical models, such as neural networks (NN) and ARCH and GARCH models, to predict the daily exchange rates of Euro/U.S. dollar (USD), identifying which, among all the models applied, produces more accurate results. By comparing the different mathematical models developed in their research, the traditional indicators for assessing the relevance of the models showed that the ARCH and GARCH models, especially in their static formulations, are better than the Neural Network for analyzing and forecasting the dynamics of the exchange rates. Roli Pradhan, K.K.

Pathak, V.P. Singh(2011); 1Adebiyi Ayodele et al. (2012); Xu Jiawei, Tomohiro Murata(2019)

This work illustrates an approach to the use of Artificial Neural Networks for Financial Modelling; we aim to explore the structural differences (and implications) between one- and multi-agent and population models. In one-population models, ANNs are involved as forecasting devices with wealth-maximizing agents (in which agents make decisions to achieve a utility maximization following non-linear models to do forecasting), while in multi-population models agents do not follow predetermined rules, but tend to create their own behavioral rules as market data are collected. Crescenzo Gallo(2010)

The basic model for learning in neural networks (NN) is learning from examples where a set of input-output standards was used to teach the system the primary function. Frank Z. Xing et al. (2018)

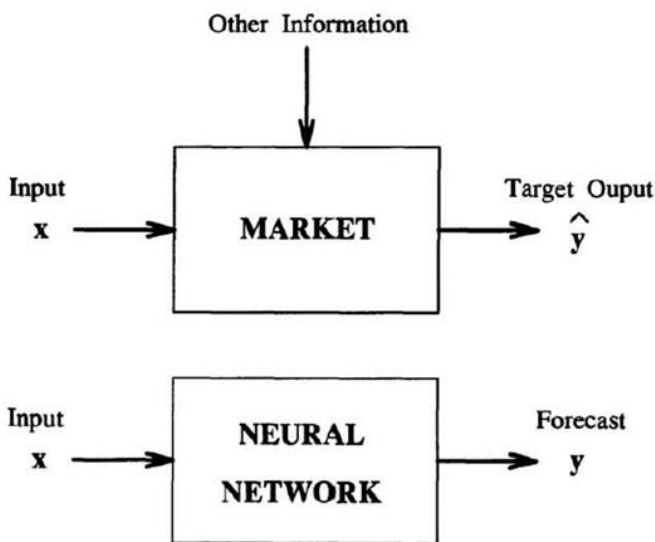


Figure 5 : Diagram showing the nature of noise in financial markets (Yaser s. Abu-Mostafa,2012)

They investigated the ability of neural networks, specifically, the backpropagation algorithm, to integrate fundamental and technical analysis for financial performance prediction. Furthermore, to compensate for data noise and parameter misspecification as well as to reveal prediction logic

and procedure, we apply a rule extraction technique to convert the connection weights from trained neural networks to symbolic classification rules. The performance of neural networks is compared with the average return from the top one-third returns in the market (maximum benchmark) that approximates the return from complete information as well as with the overall market average return (minimum benchmark) that approximates the performance from highly diversified portfolios. Paired t-tests are carried out to calculate the statistical significance of mean differences. Monica Lam (2003)

V. CONCLUSION

Neural networks(NN), for instance, are in the dock not only because they have vast to high heaven, but also because they could create a successful net without understanding how it worked: the bunch of numbers that capture its behavior would in all probability, be "an opaque, unreadable table. Valueless as a scientific resource.

One of the main criticism of neural networks, particularly in robotics, is that they require a vast training for real-world operation. Dean Pomerleau(2016), in his research, presented a paper on Knowledge-based Training of Artificial Neural Networks for Autonomous Robot Driving, using neural networks to train a robotic vehicle for it to move on different types of roads (single lane, multi-lane, dirt, etc.). These issues are common in neural networks, and they must decide from a variety of responses but also can be dealt with in different ways.

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