WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Artificial Neural Network and its Types

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ABSTRACT –

A neural network is a type of data processing system whose architecture is modelled after the cerebral cortex region of the brain. It consists of numerous simple, highly interconnected processing components. Therefore, neural networks are frequently capable of tasks that humans or animals excel at but which conventional computers frequently struggle with. In the recent years, neural networks have become a field with remarkable opportunities for research, development, and application to a variety of real-world issues. In fact, neural networks display traits and powers that no other technology can match. Reading typewritten text, correcting robot alignment issues, interpreting extremely "noisy" signals (like electrocardiograms), modelling complex systems that cannot be mathematically modelled, and determining whether proposed loans will succeed, or fail are some examples. This article provides a succinct introduction to neural networks and briefly discusses a number of applications.

Key words: Feedforward neural network, identity mapping, neural networks, backpropagation, bottleneck.

1. INTRODUCTION

ANNs are massively parallel computing systems made up of a very large number of basic processors connected in numerous ways, and they were inspired by biological brain networks. Numerous ANNs are employed for engineering tasks like pattern recognition, forecasting, and data compression in addition to modelling real neural networks and studying behavior and control in animals and machines. Auto associative neural networks are one of the ANN subtypes.

Associated with auto the sort of neural network known as a neural network is one in which the input and output vectors are identical. These particular neural networks are used to model and investigate the associative process. Association in this architecture results from the guidance of components known as units.

Through weighted connections, which are connected.

A feedforward neural network is a type of artificial neural network where the connections between the nodes are circular. The inverse of a recurrent neural network is a feedforward neural network, in which some pathways are cycled. Due to the input only being processed in one direction, it is the most basic type of neural network.

2. Evolution of Neural Networks

The basics of the neural network come from the biological neural networks. Neurologist Warren McCulloch, with mathematician Walter Pitts in **1943**, wrote a paper on how neurons work. They developed a mathematical model of an artificial neural network using threshold logic.

In **1958**, Frank Rosenblatt created the “Perceptron” model. This was the only model of such type which was used for pattern recognition purposes.

Later in **1975**, Paul Werbos developed the Back Propagation. This was developed to solve the XOR problem in the perception model.

Max introduced 3D object recognition – Pooling in **1992**. This helped with the least shift invariance and tolerance to deformation.

From **2009** to **2012**, the recurrent neural network and deep feed neural network were created by Jurgen Schmidhuber and his research team.

At present the artificial neural network is developed at a great level. Today people, knowingly or unknowingly, use the ANN in every task. The recently developed chatbots are the best examples of ANN.

3. LITERATURE REVIEW

(2008) Ceylan, in this investigation, a heat pump dryer that operated around-the-clock was used to dry poplar and pine wood. All of the timbers in the drying room had their weight changes tracked, and drying was stopped when the proper weight was reached. Poplar woods had a starting moisture level of 1.28 kg water/kg dry matter, which was reduced to 0.15 kg.

Water/kg dry matter moisture content after 70 hours and 0.60 kg after 50 hours for pine wood, respectively. The drying air temperature, relative humidity, and stack weight were all recorded, saved, and then reviewed on a computer. In order to analyze the moisture ratios in the Stratigraphic computer application, semi-theoretical models and empirical data were used.

Kuo (2016), This study uses convolutional neural networks (CNNs) to address two major problems with its architecture. As a result, all intermediate layers must have a nonlinear activation function at their output. Which system, the one with a single layer or the one with a two-layer cascade system, offers a higher benefit? For these to be resolved. Difficulties, the "Rectified-Correlations on a Sphere" (RECOS) mathematical model is introduced. Following the CNN training process, the converging filter weights define a set of anchor vectors in the RECOS model. Anchor vectors, also known as spectral components, are used to express the most typical patterns. The need for adjustment is demonstrated using the RECOS model. Lastly, the effectiveness of a two-layer RECOS system is evaluated.

(2016) Shanmuganathan, using brain models that have already been developed by scientists in neuroscience, medicine, and high-performance computing, Knowledge Engineers in computer science have had considerable success incorporating heuristics into computational algorithmic modelling. to create treatments for diseases now considered incurable. It's crucial to understand the architecture, structure, and function of human brain/nerve cells in order to treat brain and nervous system illnesses including Alzheimer's and epilepsy. Although medical researchers have made significant strides over the past few decades, they are still far from understanding how people think, learn, and remember, as well as the connections between cognition and behavior. Based on current research, we address ANN topologies, components, associated terminology, and hybrids in this context.

Kilickap and others (2017) This study investigated the effects of cutting parameters, including cutting speed, feed rate, and depth of cut, on cutting force, surface roughness, and tool wear while milling Ti-6242S alloy using 10 mm diameter cemented carbide (WC) end mills. The Response Surface Methodology (RSM) and the ANN were utilized to define the (RSM) experimental data. The network was trained using an ANN's weights and Levenberg-Marquardt (LM) algorithm. The mathematical models employed by RSM were developed using the Box Behnken design. The findings of the ANN and RSM and the experimental data showed a good agreement. The lowest cutting force and surface roughness were attained at high cutting speeds and low feed rates and depths of cut. minimal cutting.

(2018), **Pavlenko et al.** This article's goal is to offer a systematic and scientific strategy for using artificial neural networks (ANNs) to address problems in real-world mechanical engineering. Analytical research techniques based on mathematical modelling, including ANN, contemporary numerical analysis tools (such the finite element approach), and this method makes use of the dynamic state of mechanical systems. Conceptual approaches for the application of the aforementioned methodology are offered for a number of multidisciplinary topics, such as the dynamics of rotary machines and the hydro-aeroelastic interaction of gas-liquid mixtures with deformable structural components. The data from physical experiments and computer simulations can be used to train and improve the ANN design and to address nonlinear problems of parameter identification for mathematical models.

Elkatatny and others (2018) Compressional (P-wave) and shear (S-wave) velocities can be used to determine dynamic geomechanically properties like the Poisson's ratio, Young's modulus, and Lamé parameters. These factors are used to estimate the in-situ stresses and the static properties of the formation rocks. Older wellbores can benefit from sonic. Logs might not be reachable. If the sonic logs are available, it's probable that gaps in the well records will change the study's conclusions. Since well log data alone cannot be used to accurately estimate P- and S-wave travel times, the authors are appreciative of this novel approach. Most established correlations estimate the S-wave velocity using the P-wave velocity.

Vo and others (2019), The steam methane reformer (SMR) is becoming more and more alluring as natural gas-based hydrogen generation becomes more and more relevant. As a result of this investigation, models for an SMR's reactor, wall, and furnace were created. Utilizing reference information such as temperature, pressure, mole fraction, and average heat transfer with a minuscule inaccuracy (less than 4%). When the catalyst's specs and operating conditions were changed, it was demonstrated that the model's predictions were accurate. The suggested model was used with four main operating variables: the intake flow rate, temperature, S/C ratio, and the inlet flow rate of the furnace side—to create the SMR performance data. The generated dataset was assessed using singular value decomposition to reduce its dimensionality. An artificial neural network (ANN) trained on 81 datasets was used to map the relationship between operational variables and expected outputs via feedforward back propagation. More than 98% accuracy is achieved in its outputs (temperature, velocity, pressure, and mole percent of components). Additionally, by using a dynamic simulation (ANN), the computing time was reduced from 1200 s to just 2 s. online business and using the techniques suggested in this paper, high-precision reformer optimization may potentially be utilized to build a hydrogen production system at a low computer cost.

In recent months (AI), **Mohamadou et al. (2020)** have studied the dynamics and early identification of COVID-19 using mathematical modelling. We anticipate that this study will serve as both a comprehensive assessment of the investigational methods and a repository for open-source COVID-19 datasets. This study's analysis of 61 articles from peer-reviewed journals, publications, information sheets, and websites. The study found that while most AI implementations used convolutional neural networks (CNN) trained on X-ray and CT images, the majority of mathematical modelling was based on the SEIR and SIR models. Only a few of the statistics that are easily accessible include case reports, medical images, treatment strategies, demographics of healthcare workers, and the spread of epidemics. Artificial intelligence and mathematical modelling can be used to address this disease. Additionally,

the COVID-19 has been the focus of several open-source datasets. In terms of growing the databases, there is still a ton of work to be done. Further research into healthcare-related AI and modelling applications should be done in light of the COVID-19.

4.SYSTEM ARCHITECTURE

An example of a function that links inputs and outputs is a neural network. Theoretically, neural networks ought to be capable of estimating any kind of function, regardless of how complicated it is each input to an artificial neuron is given a weight. A bias is subsequently introduced to the result after the inputs are multiplied by their weights. The weighted sum is then sent via a non-linear activation function after that.

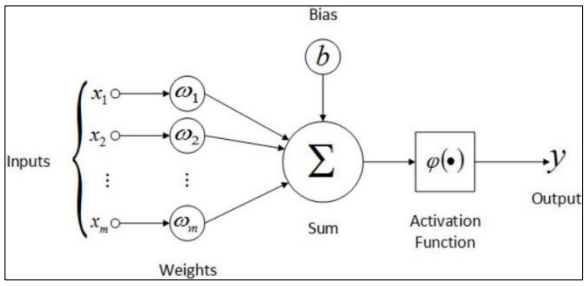

Fig 1

A Feed-Forward Neural Network is a single layer perception in its most basic form. In this model, a set of inputs are multiplied by the weights before entering the layers. The total is then calculated using the weighted input values added together. The output value is typically 1 if the sum of the values exceeds a predefined threshold, which is typically set at zero, and typically -1 if the sum is less than the threshold. Machine learning properties may also be present in single layer perceptrons.

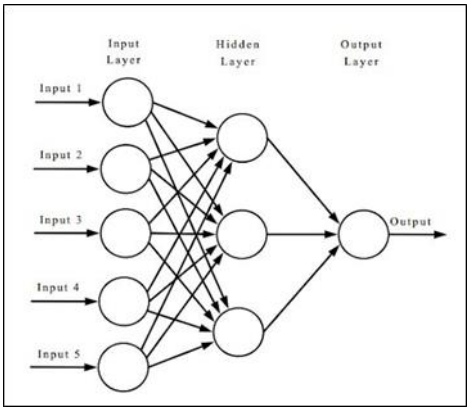

Fig 2

5. MATHEMATICAL MODEL

For any basic neural network, there is a particular weight '**w**' assigned to every input '**x**.' To transfer the data from input layer to hidden layer to output layer the summation of the product of all the inputs and their weights is taken into consideration. It is denoted as:

$\sum = (x_1 \times w_1) + (x_2 \times w_2) + \ldots (x_n \times w_n)$

Hebb Rule:

Increase the strength of the relationship between A and B when they are positively connected. Reduce the intensity of the relationship between A and B when their correlation is negative. In actuality, we establish the weights using the formula below:

$$W = \sum_{p=1}^{p} S^T(p)S(p)$$

where S(p): p-distinct n-dimensional prototype patterns and W = weighted matrix.

We must take the following actions to determine whether the model knows or doesn't know the input:

Take the weights produced by Hebb's rule during the training phase. Perform the following steps for each input vector: Set input vectors as the input activation in the input units. For j=1,2,3, set activation in output units for n:

$$y - in_j = \sum_i x_i w_{ij}$$

For j=1, 2, 3..., n, apply the activation function:

$$y_j = f(y - in_j) = \begin{Bmatrix} 1 \; if \; y - in_j > 0 \\ -1 \; if \; y - in_j \leq 0 \end{Bmatrix}$$

6. APPLICATIONS OF ARTIFICIAL NEURAL NETWORK

- Artificial neural networks are frequently employed in **social media**. Take Facebook's 'People you may know' tool, for instance, which suggests users you may know so you can friend them. The individuals you could know are determined by employing Artificial Neural Networks, which examine your profile, interests, existing friends, their friends, and several other characteristics to determine who you might know. Facial recognition is a typical use of machine learning in social media. Convolutional neural networks are used to locate approximately 100 reference points on the subject's face and then compare them to points already present in the database.
- **Marketing and Sales**: When you visit e-commerce websites like Amazon and Flipkart, they will make product recommendations based on your previous browsing activity. Similar to how Zomato, Swiggy, etc. will present restaurant suggestions based on your preferences and previous order history if you love pasta. It is done by implementing personalized marketing, which is true across all new-age marketing segments, including book sites, movie services, hospitality sites, etc. The marketing efforts are then customized in accordance with the customer's preferences, dislikes, previous purchases, etc. using artificial neural networks.
- **Personal assistants**: Based on the phones you all own, I'm sure you've all heard of Siri, Alexa, Cortana, and other personal assistants. These are personal assistants that employ speech recognition and Natural Language Processing to converse with their users and create responses in line with their needs. Artificial neural networks are used in natural language processing to manage many of these personal assistants' functions, including managing language syntax, semantics, accurate pronunciation, ongoing conversations, etc.
- **Healthcare**: Artificial neural networks are utilized in oncology to train algorithms that can accurately and quickly identify tiny malignant tissue. Using facial analysis on the images of the patients, certain rare diseases that can appear physically can be detected in their early stages. Therefore, the widespread adoption of artificial neural networks in the healthcare sector can only improve the diagnostic skills of healthcare professionals and, in the long run, raise the standard of healthcare globally.

7. CONCLUSION

The aforementioned data leads us to the conclusion that ANN has a huge future potential. We discovered that ANN is the primary component of every AI device. There are different kinds of ANN, including recurrent, convolutional, feedforward, and auto associative. Artificial neural networks are developed to simulate the human brain digitally. These networks can be used to create the next generation of computers, and they are already being utilized for complicated analysis in a variety of disciplines, from engineering to medicine [2]. The gaming sector already heavily relies on artificial neural networks. What further uses do artificial neural networks have? They help us identify handwriting, which is helpful in fields like banking. In the area of medicine, artificial neural networks are also capable of many crucial things. They could be utilized to create human body models that would aid physicians in correctly diagnosing diseases in their patients. Furthermore, complex medical images like CT scans can now be analyzed more quickly and precisely thanks to artificial neural networks. Neural network-based machines will be able to figure out many abstract issues on their own. From their errors, they will grow. Maybe one day, a device known as a brain-computer interface will allow us to connect people to machines! This would translate mental cues from people into signals that robots could respond to. Maybe in the future, all of our interactions with the environment will be mental.

8. REFERENCES

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