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Review Article

Overview of Neural Networks

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ABSTRACT

Since it was confirmed and verified that the human nervous system consists of individual cells, which were later called neurons, and it was discovered that these cells connect with each other to form an extensive communication network, a large number of possibilities have been opened for application in multiple disciplines in areas of knowledge. Neural Networks are created to perform tasks such as pattern recognition, classification, regression, and many other functions that serve humans and are an essential component in the field of machine learning and artificial intelligence. In computer science, progress has been made, and computers are supposed to learn how to solve problems like that of the human brain. Through pre-established examples, the computer must be able to provide solutions to issues that are like those presented during training. This article overviews neural networks and their application in developing computer systems.

1. INTRODUCTION

Artificial Neural Networks (ANN) is inspired by the human brain and it's can be used for machine learning and artificial intelligence [1-4]. With these networks, various problems can be solved computer-based. The artificial neural network (ANN) is to some extent modelled on the structure of the biological brain [5-7]. It consists of an abstracted model of interconnected neurons, whose special arrangement and linking can be used to solve computer-based application problems in various fields such as statistics, technology or economics. The neural network is a research subject of Neuro informatics and part of the artificial intelligence. Neural networks must be trained before they can solve problems.

Today, artificial neural networks have become one of the most noteworthy models that include many tasks in performance [8-10]. Even before the first computer was built in 1946, researchers and programmers were interested in studying neural networks and possibly applying this model industrially for various applications and practices. As far back as 1936 with Alan Turing, the possibility of working with neural networks artificially began when connections were found between the human brain and the computing concept. There are currently many articles covering works and developments in the field of artificial neural networks, and companies are working on applications of these models for hardware and software. In this paper, a brief description of the working principles of neural networks will be provided to benefit from them in automating human tasks.

Neural networks can be broadly categorised into different types based on their architecture and functionality, such as feedforward neural networks [11], recurrent neural networks (RNNs)[12], convolutional neural networks (CNNs)[13][14], and more.

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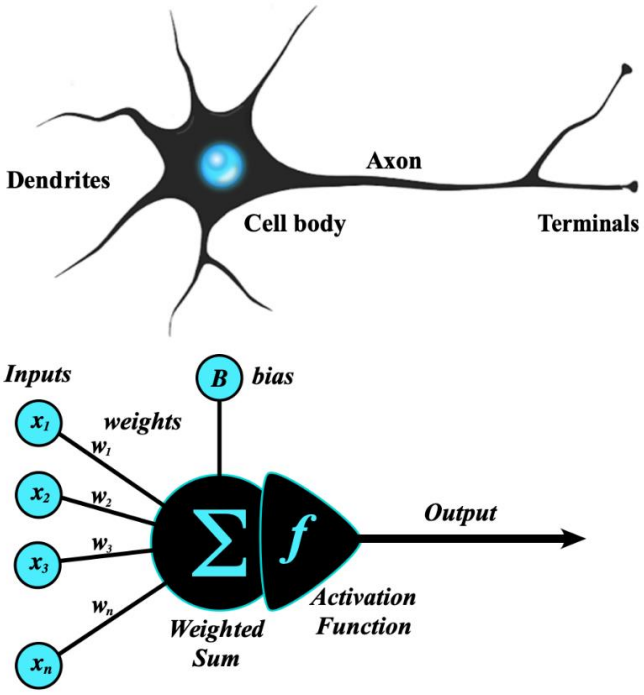

Fig. 1. Similarity between biological and artificial neural networks [15].

2. CONSTRUCTION OF A NEURAL NETWORKS

To simplify matters, the structure and operation of a neural network can be described as follows: First, the abstract model of a neural network consists of neurons, also called units or nodes. They can pick up information from outside or from other neurons and pass it on to other neurons or output it as a final result. Basically, a distinction can be made between input neurons, hidden neurons and output neurons. The input neurons receive information in the form of patterns or signals from the outside world. The hidden neurons are located between the input and output neurons, and map internal information patterns. The output neurons relay information and signals to the outside world as a result. The different neurons are connected to each other via the so-called edges. Thus, the output of one neuron can become the input of the next neuron. Depending on the strength and meaning of the connection, the edge has a certain weighting. The stronger the weighting, the greater the influence a neuron can exert on the connection to another neuron.

3. POSITIVE AND NEGATIVE WEIGHTS

There are positive and negative weights that are an exciting or inhibiting influence. If the weight is zero, one neuron exerts no influence over the connection on the other neuron. The knowledge and thus the artificial intelligence of a neural network are ultimately stored in the connections and their weightings. The number of neurons and neuronal layers as well as the connectivity of the neurons of different layers determines the complexity (the depth) of the neural network and its ability to solve problems. During the training of the neural network, i.e. the learning, the weightings of the connections change, depending on the applied learning rules and obtained results. The number of neurons in an artificial neural network is theoretically unlimited. However, with the number of neurons and the existing layers and connections, the required computing power for training and operation increases.

4. TYPICAL STRUCTURES OF NEURAL NETWORKS

Neural networks can have a variety of different structures whose description would go beyond the scope of this definition. In principle, a distinction is possible in feed forward networks and recurrent networks. In feed forward networks, the information flow takes place only forward-directed from the input neurons via the hidden neurons to the output neurons. In recurrent networks, there are connections in which information can traverse backwards and forward through certain network neuron connections. These networks are also referred to as feedback networks or feedback neural networks.

5. TYPICAL APPLICATIONS OF NEURAL NETWORKS

Neural networks are used in many areas. They are predestined for applications in which there is little systematic solution knowledge and a large amount of sometimes imprecise input information must be processed to a concrete result. Areas of application are, for example, speech recognition or image recognition. Neural networks can also create simulations and predictions for complex systems and relationships, such as in weather forecasting, medical diagnostics or business processes. Typical applications of artificial intelligence and neural networks are:

- Image recognition
- Voice recognition
- Pattern recognition
- Speech synthesis
- Handwriting recognition
- Control of complex processes
- Forecasts for complex systems
- Early warning systems
- Time series analysis
- Machine-based translation
- Simulations of complex systems
- Biometric systems
- Economic models and more

6. NEURAL NETWORK TRAINING

Before a neural network can be used for the intended problem or task, it must first be trained. Based on given learning material and learning rules, the neural network weights the connections of the neurons until it has developed certain "intelligence". The learning rules dictate how the learning material alters the neural network. In principle, a distinction can be made between supervised learning and unsupervised learning. In supervised learning, a concrete result of the different input options is given. On the basis of the constant comparison between the target and actual results, the network learns to connect the neurons appropriately.

Unsupervised learning gives no result. The learning process is based solely on the information of the many different patterns entered. The neural network only makes the changes based on the input patterns. There are various learning rules for this purpose, such as adaptive resonance theory or Hebb's learning rule.

7. CONCLUSIONS

There are different applications and practices of artificial neural networks today, where the great potential of using them to automate tasks or procedures can be seen through training processes depending on the type of learning they want without human intervention. Neural networks have evolved significantly as they have been used to enhance computer science and apply them to mimic the workings of the human brain artificially. Humans have come close to making a computer learn, think, solve, and reason in a way similar to what the human brain does. In future work, we will analyse whether it is possible to integrate artificial intelligence, neural networks and virtual reality into the process of automating human-performed processes, tasks and structural tests.

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Conflicts Of Interest

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