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Review Article

Artificial Neural Networks Advantages and Disadvantages

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A B S T R A C T

Artificial neural networks (ANNs) are the modelling of the human brain with the simplest definition, and the building blocks are neurons. There are about 100 billion neurons in the human brain. Each neuron has a connection point between 1,000 and 100,000. In the human brain, information is stored in such a way as to be distributed, and we can extract more than one piece of this information from our memory in parallel when necessary. We are not mistaken when we say that a human brain is made up of thousands of very, very powerful parallel processors. In multi-layer artificial neural networks, there are also neurons placed in a similar manner to the human brain. Each neuron is connected to other neurons with specific coefficients. During training, information is distributed to these connection points so that the network is learned

1. INTRODUCTION

Artificial Neural Networks (ANNs)[1] represent a fascinating and dynamic area of research within the realm of artificial intelligence and machine learning. At their core, ANNs are inspired by the biological neural networks that constitute animal brains, an approach that distinguishes them from more traditional computational models[2]. This introduction aims to elucidate the fundamental concepts, historical development, key architectures, and diverse applications of ANNs.

The inception of ANNs[3] can be traced back to the mid-20th century, with foundational work by pioneers such as Warren McCulloch and Walter Pitts, who first proposed a computational model for neural networks. Over the decades, the field has evolved dramatically, influenced by advancements in computing power, theoretical understanding, and algorithmic innovations. ANNs are structured in layers of nodes, or "neurons," each of which performs simple computations. These neurons are interconnected, allowing them to transmit signals to one another, akin to the synaptic connections in biological brains. The strength of these connections, known as weights, is adjusted during the learning process, enabling the network to learn from input data and improve its performance over time.

There are several key architectures within ANNs, [4]each suited to different types of tasks. For instance, feedforward neural networks, where connections between the nodes do not form cycles, are widely used for simple prediction tasks. Conversely, recurrent neural networks (RNNs), which feature loops in their architecture, are better suited to sequential data like language or time series. Convolutional neural networks (CNNs) have revolutionized fields such as image and video recognition due to their ability to process spatial hierarchical patterns. ANNs have a vast range of applications, spanning from image and speech recognition to natural language processing, and from medical diagnosis to financial forecasting. Their adaptability and capability to handle complex, non-linear data make them a powerful tool in the arsenal of modern computational techniques.

In conclusion, the study of Artificial Neural Networks is not only a pursuit of technical and theoretical depth but also a journey into a domain that mirrors the complexities and intricacies of the human brain. As this field continues to grow and evolve, it promises to unlock new potentials and applications, reshaping the landscape of artificial intelligence and its impact on various sectors.

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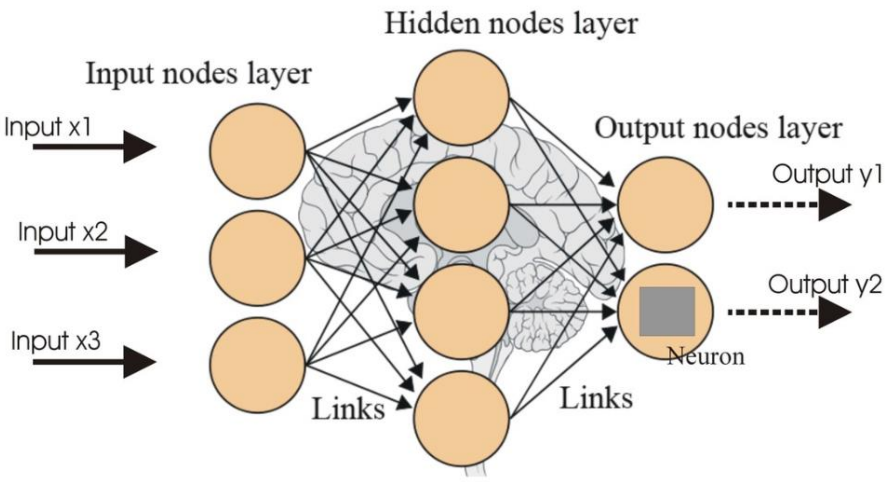

Fig. 1. Layers of the Artificial Neural Network [5]

As shown in Figure 1, a neural network consists of three layers: an input, hidden, and output. The yellow circles above represent the neurons, and the arrows represent the connection points. The dataset prepared for training at the input layer is shown to the network. The network assigns the weights of the events it learns to the connection points in the intermediate layer. Not every point has to be a value; some points can be zero. A threshold value is added between the layers so the zero values at the connection points do not become zero.

ADVANTAGES OF ANNs

- **Storing information on the entire network**: Information such as in traditional programming is stored on the entire network, not on a database. The disappearance of a few pieces of information in one place does not prevent the network from functioning.
- **Ability to work with incomplete knowledge**: After ANN training, the data may produce output even with incomplete information. The loss of performance here depends on the importance of the missing information.
- **Having fault tolerance**: Corruption of one or more cells of ANN does not prevent it from generating output. This feature makes the networks fault tolerant.
- **Having a distributed memory**: In order for ANN to be able to learn, it is necessary to determine the examples and to teach the network according to the desired output by showing these examples to the network. The network's success is directly proportional to the selected instances, and if the event cannot be shown to the network in all its aspects, the network can produce false output.
- **Gradual corruption:** A network slows over time and undergoes relative degradation. The network problem does not immediately corrode immediately.
- **Ability to make machine learning**: Artificial neural networks learn events and make decisions by commenting on similar events.
- **Parallel processing capability**: Artificial neural networks have numerical strength that can perform more than one job at the same time.

DISADVANTAGES OF ANNs

- **Hardware dependence**: Artificial neural networks require processors with parallel processing power, in accordance with their structure. For this reason, the realization of the equipment is dependent.
- **Unexplained behavior of the network**: This is the most important problem of ANN. When ANN produces a probing solution, it does not give a clue as to why and how. This reduces trust in the network.
- **Determination of proper network structure**: There is no specific rule for determining the structure of artificial neural networks. Appropriate network structure is achieved through experience and trial and error.

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- **Difficulty of showing the problem to the network**: ANNs can work with numerical information. Problems have to be translated into numerical values before being introduced to ANN. The display mechanism to be determined here will directly influence the performance of the network. This depends on the user's ability.
- **The duration of the network is unknown**: The network is reduced to a certain value of the error on the sample means that the training has been completed. This value does not give us optimum results.

Science artificial neural networks that have stepped into the world in the mid-20th century are rapidly developing. In the present day, we have examined the advantages of artificial neural networks and the problems encountered during their use. It should not be forgotten that the disadvantages of ANN networks, a developing science branch, are eliminated individually, and their advantages are increasing daily. This means that artificial neural networks will become an indispensable part of our lives and are increasingly important.

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