

Review of Neural Networks and Deep Learning.

José Martín Véliz Zambrano.
Tecnológico de Monterrey, Querétaro, México.

Abstract

Neural networks, as an integral part of artificial intelligence, emulate the human brain's functionality to produce complex machine-learning models. This review seeks to provide an integrated understanding of neural networks, their structure, and applications, hence suggesting potential research avenues.

Introduction

Neural networks have transformed our ability to process vast amounts of data, breaking down information in much the same way as the human brain. In this review we will be taking into account the following research, mainly "An Introduction To Neural Networks," "Introduction to Artificial Neural Network," "Neural Networks and Their Applications," and "Deep Learning in Neural Networks: An Overview," these papers have laid the foundations for this analysis, focusing primarily on artificial neural networks (ANN) and their architecture, learning rules, and application.

Artificial Neural Networks (ANN) and their Structure

Artificial Neural Networks (ANN) are an information-processing paradigm inspired by the biological nervous system. As highlighted by two papers (An Introduction To Neural Networks and Introduction to Artificial Neural Network)[1][2], the neurons form the basic building block of the ANN with a key function of collecting inputs and generating output.

These neurons are interconnected assemblies of simple processing elements, whose function

relies on the combined interaction of inputs. The transmission of signals between neurons through action potentials and synaptic connections plays a pivotal role in information processing. This comparison to biological systems provides the foundation of artificial neural networks and their utility in predictive modelling.

Neurons structure and threshold logic units (TLUs) are the primary topics of the first paper, which explains their role in processing inputs to generate binary (two-dimensional) output. *Gurney, K.*[1] also introduced the concept of pattern space and the linear separability of input patterns through a geometric context utilising vectors.

Types of Learning and their Importance

The learning process and training are intrinsic to the adaptability and effectiveness of neural networks. Within the realm of artificial neural networks, there are three types of learning: supervised, unsupervised, and reinforced learning (Introduction to Artificial Neural Network). These learning methods are varied and cater to the requirements of the task in question.

For example, supervised learning is ideal when the target data is known, unsupervised learning caters to scenarios where the target data is unknown and the neural network is left to identify patterns in the data itself, while reinforced learning works best in conditions where learning depends on the outcome of actions taken.

Deep Learning and Neural Networks

The application of neural networks extends to more advanced machine learning algorithms, is commonly referred to as deep learning. The two fields differ primarily in their structure,

with deep learning algorithms designed to mimic the human brain's own learning patterns. This is achieved through multiple artificial neural network layers that each perform a different transformation of their input, subsequently enabling the algorithm to train on a wider range of data and produce more complex models.

As identified in Neural Networks and Their Applications[3], three types of Neural Networks are frequently used in deep learning: Restricted Boltzmann Machine (RBM) and Deep Belief Nets, Convolutional Neural Networks, and Recurrent Neural Networks. These types are leveraged according to the specific requirements of the task, each with its unique capabilities.

Deep Learning in neural networks: An overview[4] pushes the understanding of deep learning further, signifying the differences between shallow and deep learners based on the depth of their Credit Assignment Paths (CAPs). The paper also introduces the concept of Dynamic Programming (DP), which aids credit assignment under specific conditions.

Applications of Artificial Neural Networks and Deep Learning

The application of artificial neural networks ranges from system analysis to pattern recognition, prediction, system identification and control, and more, including the hydrodynamic journal bearing and stability analysis. With the development of deep learning algorithms and more computational technology availability, these applications have expanded into data science. The versatility and adaptability exemplified in these computational models are only projected to grow further with advancements in computational power and big data handling capabilities.

Conclusion

Artificial Neural Networks, paired with their more advanced counterpart, deep learning, present numerous opportunities for advancements within the realm of predictive modelling and data science. As computational resources and mathematical formulations continue to improve, their evolution and growth will persist, resulting in better-tailored solutions for data-driven tasks. The study on Artificial Neural Networks and the derived technology must be sustained and enhanced, emphasizing the investigation of knowledge gaps and future research directions.

6. References

- [1]Gurney, K. (1997). *An Introduction to Neural Networks*. University of Sheffield.
- [2]Dongare, A. D., Kharde, R. R., & Kachare, A. D. (2012). *Introduction to Artificial Neural Network*. *International Journal of Engineering and Innovative Technology (IJEIT)*, 2(1), 189-194.
- [3]Coban, E. B. (2016) "Neural Networks and Their Applications." *Istanbul Sehir University*.
- [4]Schmidhuber, J. (2015). *Deep learning in neural networks: An overview*. *Neural Networks*, 61, 85-117.