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M.I. Tretyak

NEURAL NETWORKS

Vinnytsia National Technical University

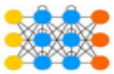
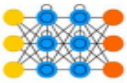
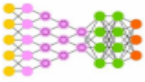
Abstract

This study investigated the use neural networks in all fields. This study reviewed modern researches about Machine Learning and Deep Learning. Result found that the utilization of Machine Learning and Deep Learning is anticipated to rise substantially as the potential of neural networks to solve problems, make predictions and improve decision-making are unparalleled.

Keywords: neural networks, Machine Learning, Deep Learning, specific tasks.

Introduction

Over the past several years, many neural networks with different architectures and specifications have emerged. Feedforward Neural Networks (FNNs) are the simplest form of ANNs. For specific tasks, more complex ANNs have been invented, including the Convolutional Neural Networks (CNNs), which aim to mimic the human visual system, as well as the Recurrent Neural Networks (RNNs), which are used to interpret sequential data such as text and video.

Neural Network	Description	Applications	Network Image
FNNs	Each perceptron (simplest and oldest form of neurons) in one layer is connected to every perceptron from the next layer. Information is fed forward from one layer to the next in the forward direction only. There are no feedback loops. Thus, the data is processed, and the results are calculated on every input sequence. This network may or may not have hidden layers.	Primarily used for animal recognition, digit recognition, cheque recognition, medical diagnosis, etc.	
RNNs	Use sequential information such as time-stamped data from a sensor device or a spoken sentence, composed of a sequence of terms. Unlike FNNs, inputs to RNNs are not independent of each other, and the output for each element depends on the computations of the preceding elements.	Primarily used in forecasting and time series applications, sentiment analysis and other text applications.	
Long Short-Term Memory (LSTM)	A type of RNN that is explicitly designed to hold information for long periods of time and process the incoming data, along with the previously calculated results. LSTMs contain their information in a memory and can read, write and delete information from its memory.	Primarily used for text classification, machine translation, dialog systems, speech recognition, translating videos and images to natural languages, etc.	
CNNs	Typically contain five types of layers: input, convolution, pooling, fully connected and output (more recent versions tend to be deep with more than seven or nine layers). Each layer has a specific purpose, like summarizing, connecting or activating.	Primarily used for image classification and object detection. Other applications include language processing, computer vision and video analytics.	

These major types of ANNs are described in Figure 4.

Supervised Learning versus Unsupervised Learning

Since the advent of Machine Learning, different algorithms or methods have been developed to process both structured and unstructured data. However, all Machine Learning methods can be broadly classified into either supervised learning or unsupervised learning (Figure 5), though supervised learning is the most commonly used form of Machine Learning [1; 2].

With supervised learning, each input fed to the system is labeled with a desired output value. A supervised learning algorithm analyzes the data and compares its actual output with desired output to find errors and modify the model accordingly. Supervised learning is commonly used in applications where future events are predicted based on historical data, e.g. determining fraudulent credit card transactions and predicting insurance customers likely to file claims. In unsupervised learning, the training set submitted as input to the system is not labeled with the historical data or a desired outcome. In simple words, unsupervised learning is used against data that has no historical labels. Therefore, the system itself develops and structures the data,

identifies common characteristics, and modifies it based on knowledge gained during the process.

This form of Machine Learning is commonly used to segment customers with similar attributes who can then be treated similarly in marketing campaigns. It can also identify the main attributes that separate customer segments from each other. Other applications include segmentation of text topics, image recognition, pattern recognition in financial markets data, identification of data outliers, sound analysis, e.g. to detect anomalies and potential problems in jet engines etc.

Parameter	Supervised Learning	Unsupervised Learning
Type of Input Data	Labeled	Unlabeled
Degree of Computational Complexity	High	Low
Accuracy of Results	High	Low to moderate
Timeliness of Analysis	Off-line	Real time
Commonly Used Algorithms	Random Forests, Linear Regression, Decision Trees, Naïve Bayes, Support Vector Machines, Neural Networks	Clustering (K-means, SVD, PCA, etc.), Association Analysis (Apriori, FP-Growth), Hidden Markov Model
Key Use Cases	Prediction and classification	Grouping and data interpretation

F IGURE 5: S UPERVISED LEARNING VS. U NSUPERVISED LEARNING

Convolutional Neural Networks are widely used today

CNNs are among the most widely used ANNs today given that they can learn unsupervised and require relatively little pre-processing. CNNs are used in a range of areas, including statistics, natural language processing as well as in signal and image processing, e.g. for medical image analysis [1; 2].

However, CNNs are rather impractical for visual imagery classification given the large data sets that need to be processed, which consumes enormous amounts of energy while CNNs are relatively slow. With the advent of autonomous vehicles and the stringent requirements on image recognition capabilities by Advanced Driver Assistance Systems (ADAS) in cars, today's CNNs may not be the best solution.

Pros and Cons of Machine Learning and Deep Learning

In summary, Machine Learning and Deep Learning have many applications, and organizations use these applications to drive automation for specific tasks and processes, e.g. to save cost, bring products to market faster, improve operational efficiencies, prevent fraud, gain new insights into data and enable new technologies to be deployed faster. Home Land Security (HLS) and law enforcement are other application areas for AI. While Machine Learning supplements data mining, assists decision making and enables development of autonomous computers and software programs, Deep Learning, on the other hand, performs complex computations and is widely used for difficult problems that require realtime analysis, such as speech and object recognition, language translation and fraud detection [1; 2].

However, these AI technologies do have their own limitations. Both Machine Learning and Deep Learning are susceptible to errors and whenever they make errors, diagnosing and correcting them can be difficult. In addition, it is impossible to make immediate accurate predictions with these technologies as they require substantial computational power and can be difficult to deploy, especially in real time.

Furthermore, the outcomes generated by these technologies are prone to hidden and unintentional biases, including racial biases, depending on the data provided to train them. Also, these technologies cannot always provide rational reasons for a prediction or decision. Nevertheless, the utilization of Machine Learning and Deep Learning is anticipated to rise substantially as the potential of neural networks to solve problems, make predictions and improve decision-making are unparalleled.

REFERENCES

1. https://static1.squarespace.com/static/5af533a312b13fb602fe7d7b/t/5cdbc6c824a694a8e46b5713/1557907167761/BrainChip+initiating+coverage+15+05+19.pdf
2. https://www.biometricupdate.com/202001/brainchip-announces-year-end-achievements-and-product-updates

Tretyak Miroslava I. − Student, Department of Information Technology and computer engineering, Vinnytsia National Technical University, Vinnytsya.