Deep Learning Algorithms to Improve Financial Decisions

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Abstract -- **Finance is the most computationally intensive field. Today, neural networks are used for solving many business problems such as sales forecasting, customer research, data validation, and risk management. They are revolutionizing virtually every aspect of financial and investment decision making. Financial firms worldwide are employing neural networks to tackle difficult tasks involving intuitive judgment or requiring the detection of data patterns which elude conventional analytic techniques.**

Keywords: Neural network, Deep learning, Machine learning, Artificial intelligence, Pattern simulations

I. INTRODUCTION

ABIDING interest is evinced to determine applications of emerging technologies like Neural Networks and Artificial Intelligence to the crucial problems of the real world, namely improved financial decision making.

There has been a substantial effort in combining learning and evolution with artificial neural networks. Artificial intelligence and artificial neural networks are two exciting and intertwined fields in computer science. The key difference is that neural networks are a stepping stone in the search for artificial intelligence.

Unlike other types of artificial intelligence, neural networks mimic to some extent the processing characteristics of human brain. As a result, neural networks can draw conclusions from incomplete data, recognize patterns as they unfold in real time and forecast the future. They can even learn from past mistakes.

II. ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) may have come on in leaps and bounds in the last few years, but we're still some way from truly intelligent machines – machines that can reason and make decisions like humans. Artificial neural networks (ANNs) may provide the answer to this.

Basics: Human brains are made up of connected networks of neurons. ANNs seek to simulate these networks and get computers to act like interconnected brain cells, so that they can learn and make decisions in a more human like manner. Different parts of the human brain are responsible for processing different pieces of information, and these parts of the brain are arranged hierarchically, or in layers. In this way, as information comes into the brain, each level of neurons processes the information, provides insight, and passes the information to the next, more senior layer. For example, your brain may process the delicious smell of pizza wafting from a street café in multiple stages: 'I smell pizza,' (that's your data input) … 'I love pizza!' (thought) … 'I'm going to get me some of that pizza' (decision making) … 'Oh, but I promised to cut out junk food' (memory) … 'Surely one slice won't hurt?' (reasoning) 'I'm doing it!' (action).

It's this layered approach to processing information and making decisions that ANNs are trying to simulate. In its simplest form, an ANN can have only three layers of neurons: the *input layer* (where the data enters the system), the *hidden layer* (where the information is processed) and the *output layer* (where the system decides what to do based on the data). But ANNs can get much more complex than that, and feature multiple hidden layers. Whether it's three layers or more, information flows from one layer to another, just like in the human brain.

It is a computational system inspired by the Structure Processing Method Learning Ability of a biological brain.

Characteristics

- A large number of very simple processing neuron-like processing elements.
- large number of weighted connections between the elements
- Distributed representation of knowledge over the connections
- Knowledge is acquired by network through a learning process

Learning: Learn the connection weights from a set of training examples - Different network architectures required different learning algorithms.
Supervised Learning: The network is provided with a correct answer (output) for every input pattern Weights are determined to allow the network to produce answers as close as possible to

the known correct answers. The back-propagation algorithm belongs to this category: supervised learning takes place under the supervision of a teacher. This learning process is 'dependent'. During the training of ANN under supervised learning, the input vector is presented to the network, which will produce an output vector. This output vector is compared with the desired/target output vector. An error signal is generated if there is a difference between the actual output and the desired/target output vector. On the basis of this error signal, the weights would be adjusted until the actual output is matched with the desired output.

Unsupervised Learning: Unsupervised Learning does not require a correct answer associated with each input pattern in the training set: Explores underlying structure in the data, or correlations between patterns in the data, and organizes patterns into categories from these correlations. The Kohonen algorithm belongs to this category. These kinds of networks are based on the competitive learning rule and will use the strategy where it chooses the neuron with the greatest total inputs as a winner. The connections between the output neurons show the competition between them and one of them would be 'ON' which means it would be the winner and others would be 'OFF'.

Following are some of the networks based on this simple concept using unsupervised learning.

Hybrid Learning: Hybrid Learning combines supervised and unsupervised learning: part of the weights are determined through supervised learning and the others are obtained through unsupervised learning.

The novelty of neural networks lies in their ability to discover non-linear relationship in the input data set without *a priori* assumption of the knowledge of relation between the input and output.

Finance is the most computationally intensive field. In fact, the financial domain is hugely complex and non-linear with a plethora of factors influencing each other. Many consider neural networks as some lofty scientific idea that is out of their reach, or think of it as a slick marketing gimmick that has nothing to offer. For a serious, thinking trader, neural networks are a next-generation tool with great potential that can detect subtle non-linear interdependencies and patterns that other methods of technical analysis are unable to uncover.

III. MACHINE LEARNING

Neural networks do not make any forecasts. Instead, they analyze price data and uncover opportunities. *It is believed neural networks will eventually outperform even the best traders and investors.* Neural networks are already being used to trade the securities markets, to forecast the economy and to analyze credit risk. Indeed, apart from the U.S. Department of Defense, the financial services industry has invested more money in neural network research than any other industry or government body.

In stock market successful investors can earn lots of profit taking on-time suitable decisions. Investors use two statistical techniques to make financial decisions: technical and financial analysis. Machine learning models which are part of artificial intelligence, have been applied to assist investors for investment.

A number of machine learning models have been investigated for stock prediction such as Genetic Algorithms (GAs), Support Vector Machines (SVMs) and Neural Network (NN). In [2], several multiclass classification techniques using neural networks are investigated. The multi-binary classification experiments using One-Against-One (OAO) and One-Against-All (OAA) techniques are tested and they are compared with the traditional neural network. Furthermore, an alternative data preparation and a data selection process are proposed. The experimental results show that the multi-binary classification using OAA technique outperforms other techniques. It can provide the return on investment greater than the traditional analysis techniques.

IV. DEEP LEARNING

Deep learning is another advanced concept of neural networks in which multiple layers are used. It performs very well on large data set. The output of one layer is input to the next layer.

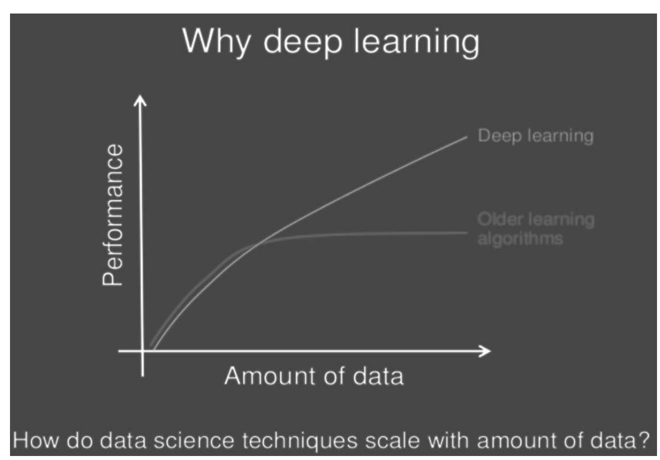

image [1]

According to Andrew Deep learning is large neural network as we can see in the image [1] given above. The amount of data increases the performance of deep learning network.

Deep learning represents the very cutting edge of AI. Instead of teaching computers to process and learn from data (which is how machine learning works), with deep learning, the computer trains itself to process and learn from data [3].

The term deep learning, is basically a large deep neural net. Deep refers to the number of layers typically and so this is kind of the popular term that has been adopted in the press.

Scalability is one of the main features of Deep Learning. Another important feature is automatic feature extraction from raw data. Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower level features. Automatically learning features at multiple levels of abstraction allow a system to learn complex functions mapping the input to the output directly from data, without depending completely on human-crafted features.

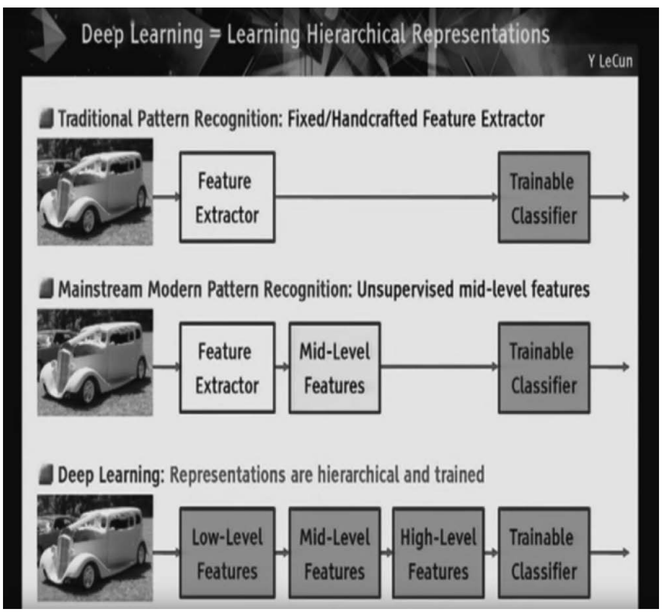

Image [2]

The image [2] shows how deep learning features are at par in feature extraction. So Deep learning is basically large neural network which works on large amount of data sets. The most popular neural networks used in Deep Learning are:

- Multilayer Perceptron Networks.
- Convolutional Neural Networks.
- Long Short-Term Memory Recurrent Neural Networks.

This is all possible thanks to layers of ANNs: an ANN in its simplest form has only three layers *i.e.* an input layer, an output layer and multiple hidden layers – is called a 'deep neural network', and this is what underpins deep learning. A deep learning system is self-teaching, learning as it goes by filtering information through multiple hidden layers, in a similar way to humans.

It can be seen, the two are closely connected in that one relies on the other to function. Without neural networks, there would be no deep learning.

Deep Learning use in financial predictions is being explored for last few years. Financial prediction problems – such as those presented in designing and pricing securities, constructing portfolios, and risk management often involve large data sets with complex data interactions that currently are difficult or impossible to specify in a full economic model [8].

Applying deep learning methods to these problems can produce more useful results than standard methods in finance. In particular, deep learning can detect and exploit interactions in the data that are, at least currently, invisible to any existing financial economic theory [10] [11].

Use of Deep Learning in financial problems has been discussed in one of the research papers [7]. It has presented general Deep learning frame work for predictions in financial decisions. In this paper Deep learning hierarchical decision models have been presented for financial prediction and classification. For example, smart indexing presents one way to implement deep learning models in finance [12,13].

The application of deep learning approaches to finance has received a great deal of attention from both investors and researchers [5].

One of the studies [1] presents a novel deep learning framework where wavelet transforms, stacked auto encoders (SAEs) and long-short term memory are combined for stock price forecasting. The SAEs for hierarchically extracted deep features were introduced into stock price forecasting for the first time. The deep learning framework comprises three stages. First, the stock price time series is decomposed by WT to eliminate noise. Second, SAEs is applied to generate deep high-level features for predicting the stock price. Third, high-level features are fed into LSTM to forecast the next day's closing price. Six market indices and their corresponding index futures are chosen to examine the performance of the proposed model. Results show that the proposed model outperforms other similar models in both predictive accuracy and profitability performance.

V. CONCLUSION

Deep learning presents a general framework for using large data sets to optimize predictive performance.

As such, deep learning frameworks are well-suited to many problems (both practical and theoretical) in finance. Many applications remain for development.

Author's research-aim is to strive to discover fruitful applications of the emerging concepts to come up with efficient, effective strategies for synergizing latest knowledge to generate profits via sound financial decisions.

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