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i ABSTRACT It is not an easy task to predict any shares value, even more so using machine learning. There are a lot of variables involved in the same. In this project report I have tried to accomplish different methods to find out how a stock will behave. Portraying a stock price is done usually using time series data, where neural networks look for existing data movement to find out the inclination of what the next prices could be. Using BMCE BANK previous data of its prices, we analyse the results of a basic single LSTM model. A hybrid model that combines sentiment analysis and stacking auto-encoders has also been looked at. INTRODUCTION Anybody who is only starting out in the world of stock market can employ these techniques and benefit largely in making better decisions. To help someone who is new, the neural networks that have been built before can be employed for transfer learning. After then, whatever projections our data represent, we will overlap it with what the actual stock prices behaved like. We can thus make safer investment knowing our money isn't at risk. Because of the quality of bending easily without breaking and disburse pre-built models and open-source modules, python happens to be the best choice . Also, the best-fitting model is the LSTM (Long Short Term Memory) model. The memory component can be very beneficial to further improve the quality of LSTM model which will further help for the time series forecasting. This model even has the potential to perform even better than the earlier ones to conjecture the possible outcomes.

[2] CHAPTER 1 THEORITICAL BACKGROUND

[3] Deep Learning The way humans' brain perform, deep learning has been an approach that uses artificial intelligence, and lately been used to give lessons to robot. Many applications have come forward for this like self-driving cars to understand traffic signs, recognise pedestrians, and even evaluate whether or not a driver is attentive in order to park the vehicle safely. A Deep Learning allows a computer model to learn to categorise images, text, or voice. Deep learning models have the potential to attain cutting-edge accuracy, sometimes surpassing that of humans. (Image Source: https://thedatascientist.com/what-deep-learning-is-and-isnt/)

[4] Transfer Learning This uses earlier data points to find out newer ones. What this does is hugely improve the process of accomplishing an action. The approach we'll try to look into is - Model Development Approach: To begin, we pick all the stocks prices of a stock ever since it was created only to increase the data points. Different target points are taken to eventually calculate the upcoming targets. Performance with Transfer Learning & without (Image Source: https://www.researchgate.net/figure/Performance-graph-with-and-without-Transfer-Learning_fig2_345904103)

[5] Time Series Analysis A time time series is a set of data points or values that have been organized, catalogued, or visualised. Time- series analysis' major aims are to understand what is really going on and anticipate what will occur subsequently. Among these objectives are the finding and systematic elucidation of empirical results in time series. Procedures for gathering feedback from a variety of data points over duration are referred to as time series analysis. A series of statistical mining approaches may be used, each with varying degrees of efficacy. Following that, we'll look at some very intriguing methods for estimating time series data, and therefore how LSTM neural networks have swept over the domain. Long Short Term Memory model (LSTM) A time series assessing neural network is described as an LSTM. This is due to their ability to store trends deliberately throughout period. LSTMs replace the conventional feed-forward neural networks and recurrent neural networks in a lot of formats. LSTMs may arbitrarily recall or discard details. They really do not divide between 'critical' and 'less valuable' data.

[6] LSTM Cell Architecture (Image Source: https://www.analyticsvidhya.com/blog/2017/12/fundamentals-of-deep-learning- introduction-to-lstm/) The cells which are like blocks of different memory are what comprise a LSTM. Mainly hidden and cell state get carried over to the cell which is next in line. Memory blocks are in charge of knowing information, and they are altered by three basic procedures known as gates which we discuss in the upcoming pages.

[7] Forget Gate: (Image Source: https://www.analyticsvidhya.com/blog/2017/12/fundamentals-of-deep-learning-introduction-to-lstm/) Forget gate suffers from amnesia and any unnecessary data, as the name suggests itself, is forgotten.

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For the forward passing of an LSTM cell with a forget gate,

the succinct formulations of the calculations are: (Source: https://en.wikipedia.org/wiki/Long_short-term_memory) Variables :

[8] Input Gate: (Image Source: https://www.analyticsvidhya.com/blog/2017/12/fundamentals-of-deep-learning-introduction-to-lstm/) The data has to be offered towards the cell state, for which input gate is made in charge of and to patch the cell state, the input gate conducts the three processes - • The subsequent sigmoid function receives the existing operational X(t) and the formerly concealed data h(t-1). The data is adjusted from 0 (critical) to 1 (less vital). • The tanh function will be used to provide the identical information from the concealed state and contemporary state.

attribute outcomes within -1 and 1 to monitor the infrastructure. • The activation functions provide model parameters that are suitable for stage multiplication. We ensure that only pertinent information is submitted to the repository after these three requirements have been met.

[9] Output Gate: (Image Source: https://www.analyticsvidhya.com/blog/2017/12/fundamentals-of-deep-learning-introduction-to-lstm/) The output gate is in function of extracting and presenting critical data from an existing cell state. An output gate's action may be composed of three main components once more: 1. Using the tanh function on the cell state and adjusting the numbers to -1 to +1 to create a vector. 2. Implementing a strainer utilizing parameters of h t-1 and x t to govern the results from either the vector produced before. Yet another, a sigmoid function can be used in any strainer. 3. Spreading the outcome of this prudential strainer through the vector created in and passing it as an outlet also to the subsequent cell's hidden state.

[10] Stacked Auto-Encoders An input layer, a convolution layer, and a rebuilding layer make up a unique layer autoencoder, and that is a three-layer neural net. These autoencoders are used to produce convolution layers features that are greater depth or more conceptual. During the development of these autoencoders, we try to minimise the discrepancy between the intake and rebuilding layers. For financial time series, the piled autoencoder is a variety of deep learning model. It has four autoencoders and five layers in this context, and its goal is to provide enhanced qualities. A multilayered auto encoder's initial layer learns first-order information (such as picture edges), while the lower part learns second-order data (i.e., contours or corners).

[11] CHAPTER 2 LSTM MODELS AND RESULTS

[12] Single LSTM Model example Our algorithm is formed by two tiered Hidden layer and a fully - connected layers, featuring linear regression executed at the final layer level. MSE (mean squared error) has been used for loss evaluations, while RMSProp is seen as an evolutionary algorithm. The implications of this paradigm are presented in the graphic here: Figure: Results of Single LSTM It's a relatively straightforward concept to include an LSTM deep neural network to foresee value of equities. The plot here displays that the model's recommendations aren't as comprehensive as we'd like. It's probably the easiest way, as it is built for educating and exploring with time series data.

[13] Hybrid LSTM Model Flowchart

[14] It really is a deep learning method that incorporates layered autoencoders to blend news scraping for sentiment analysis. For scalability and improvement, this program utilizes the Keras toolbox to make multiple closely packed tiers with 20 as the incoming variable, a tanh activation unit, and an interaction rejigger to severely punish component disturbance. It leverages SGD (Stochastic gradient descent) for effectiveness and reliability, which are noteworthy aspects for a pretrained model throughout 2000 iterations. Figure: Results of Hybrid LSTM

[15] CHAPTER 3 STOCK PREDICTION FOR BMCE BANK

[16] The statistics below comes from a three-year-old Moroccan information gathering for BMCE shares. The following was the initial set of results generated from the Casablanca-bourse official site: Original BMCE BANK Dataset

[17] The information was processed, scraped, and transformed to.csv format. Our conditions now looks such as this: To make projections, market participants often employ two indices: 1. OHLC (average of Open, High, Low and Closing Prices) 2. HLC (average of High, Low and Closing Prices

[18] • The time series is normalized using the OHLC method. There is now only solitary field of information in the data source. • The time series was therefore broken into 2 categories for analysis.. 1. The stock price at period interval is reflected in the first column. 2. The financial position during time t+1 is presented in the second column. . • After that, all levels are related within 1 and 0.

[19] Divided into training and testing data with appropriate proportions of 75% and 25%: This system contains two consecutive LSTM stages put out using the Keras deep learning toolbox. For the last tier, linear regression is applied considering the nature of the problem. I opted to be using the Adam optimizer after altering the script, especially for the data pre-processing module, and playing with other metaheuristics.

[20] Training for 10 Epochs Here, one can see how much he might be losing out by looking at the root mean squared error.

[21] CHAPTER 4 CONCLUSION AND FUTURE WORKS

[22] After doing so, it's clear that the integration of LSTM networks, stacked autoencoders, and sentiment analysis yields reliable findings for realtime investing. New efforts on this venture will necessitate this in investigation commitment to tailor the combined approach, particularly yields the desired outcomes, to the BMCE market. In this case, the enormous volume of information data, which is unsuitable for an effective and marketable classifier, is perhaps a considerable impediment. It may be taken into account by applying data augmentation techniques to existing data sets in order to enhance their capacity and render them relevant for profound project - based learning..

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