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Predicting the Prices of Cryptocurrencies using Deep Learning

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ABSTRACT

Cryptocurrency is an excellent investment opportunity. Predicting the prices of cryptocurrencies is a problem that has been around since the origin of cryptocurrencies. Many machine learning approaches are proposed to solve the problem but none of them couldn't solve the problem with expected accuracy. Recent developments in deep learning have proven that using deep learning is one of the best approaches for predicting the prices of cryptocurrencies. In this paper, how LSTM networks are an upgrade over the previous solutions (regression, traditional neural networks, simple recurrent neural networks) and how they can be implemented for predicting the price of any cryptocurrency have been demonstarted.

1. INTRODUCTION

Cryptocurrency is a new type of currency that is emerging in this world. Cryptocurrencies are very different from fiat currencies since they are not governed by a centralized authority.

Cryptocurrencies are verified with the help of digital signatures, and with the emergence of blockchain technology, they have become even more robust.

A new era has begun with the introduction of Bitcoin in the market. Since it is a currency, its value will be changing every day. But, sometimes, its value changes abruptly and every industry that depends on it either directly or indirectly will be affected accordingly. There are a lot of reasons for this hype some of them being political influences and social opinions.

Investors are investing in the markets using stock markets. Two factors make these cryptocurrencies attractive and unpredictable. The way they enter into the market [1], [2], the difficulty one has to undergo to obtain it.

2. MOTIVATION

Although investors have their practices to predict the trends in the stock market, they still need better practices for long term benefits [3-5]. A machine learning based approach is used to solve this problem efficiently.

Machine Learning was introduced to "teach" computers to do things that couldn't be done with conventional practices. Machine learning algorithms use data feeding and mathematical and statistical algorithms to find hidden relationships and patterns [6].

Deep learning is a subfield in machine learning, which has algorithms that are essentially upgraded versions of earlier algorithms. They are inspired by the human brain. Deep learning models evolved in a

different direction for analyzing and solving computer science problems.

Applying deep learning to find the patterns that make markets seem almost random and dynamic [7], [8]. Although deep learning can't model the exact way a market reacts to changes in different variables, it can model those trends to a level that is better than any other algorithm.

3. LITERATURE SURVEY

Many computer science researchers have started working on cryptocurrencies to observe more profits. The research in machine learning started with regression to address various issues.

In regression, a linear equation between the independent and dependent variables is obtained with training data. This is one of the best algorithms used to find the linear dependency among the variables. A function has to be defined to assess the performance of the model. This function is known as the cost function. It helps the user understand how well the model fits the given data. The data scientist's goal is to find a method that minimizes the value produced by the cost function. The most popular method that is used in this approach is the least-squares. It has been found, after using the approach, that the relationship among the variables involved in predicting the price of a cryptocurrency is non-linear [9].

Artificial Neural Network (ANN) is another efficient approach researchers have used to analyze non-linear dependency [10]. In traditional ANNs, the patterns are learned using different layers of neurons. The input layer is the one that brings the variables into the network. The output layer is the layer that predicts the desired output value. ANN is shown in figure 1.

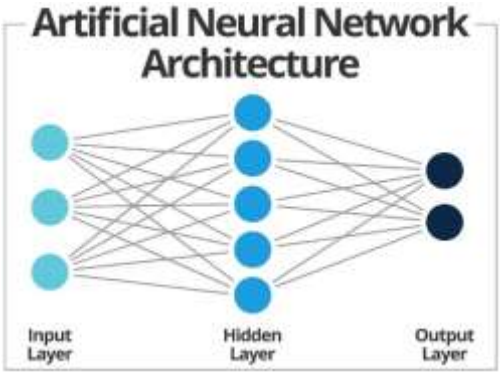

Figure 1. Artificial Neural Network

The relationship between these two layers is captured with the help of some layers known as the hidden layers. The more the number of hidden layers, the better the model can learn patterns from the data that are present in higher dimensions. But there is a limitation in this approach. Adding more hidden layers increases the degrees of freedom, it also has a high chance of overfitting. So, one needs to find a clear gap between overfitting and an accurate model. This is done, usually, by trial and error. Recently, few methods have been proposed to approximately guess the number of hidden layers needed for the model. Few researchers have tried to find a better solution to this problem using an advanced approach. This new approach includes a modification of the traditional multi-layer perceptron (MLP), and it is called a Recurrent Neural Network (RNN) [11].

RNNs are essentially built for solving problems that include time as an essential variable. RNNs are loops that takes the output of the network as input to the same network in the next iteration. This is an improved deep learning model that has tried to solve the problems involving time as an important factor [12]. This is a significant improvement over using the ANNs.

4. EXISTING SYSTEM

One of the systems that are currently used for predicting the price of a cryptocurrency is the Holt-Winters Exponential Smoothing

technique [13]. This technique has four aspects that make it more efficient.

The first aspect deals with assigning weights to each of the values of the dependent variables in each iteration. The second aspect deals with assigning weights in an order such that the weight given to the most recent one is exponentially better than the weight given to the one before it. This trend goes on until the weights become negligible.

This aspect must be only used when there is no seasonal variation in the given problem. The third and fourth aspects of the system deal with solving the issues with trends as well as seasonal variation. An existing system is an improved approach over the RNNs but its accuracy when it comes to predicting the trend in the cryptocurrency market is not as good when it is compared with other models like advanced neural networks. RNN is shown in figure 2.

5. PROPOSED SYSTEM

The proposed system uses RNN to deal with a high number of layers. Here, the problem arises due to activation functions, like the sigmoid function or tanh function, which convert the value of the previous layer into values that are more suitable for computation as deep learning requires a lot of hardware resources as shown in figure 3.

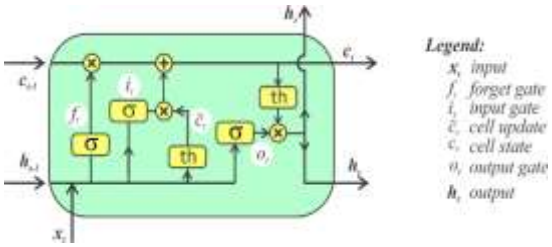

Figure 2. Recurrent Neural network

As more and more layers are included in the neural network, the activation functions of these layers cause the values to become smaller and smaller rendering the weight updates with the help of backpropagation.

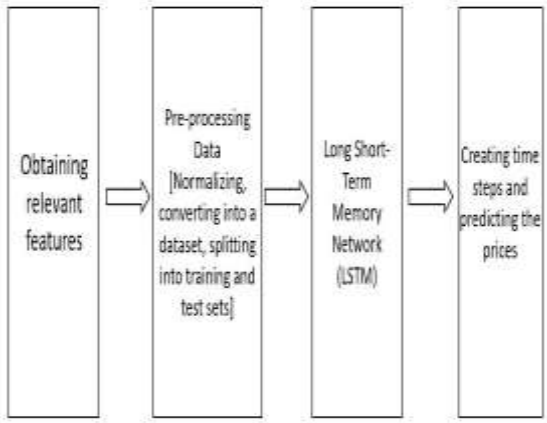

Figure 3. The architecture of the proposed model

This problem is referred to as the 'Vanishing Gradient Problem' [14]. A computer scientist named Hochreiter has found out a solution to this problem by making sure that information from the past iterations won't be lost when computing the values of the present iteration which are heavily dependent on the past values [15].

This new network is called the Long Short-Term Memory neural network. This network has a few more weight matrices whose weights need to be computed along with the default weight matrices for the values that are given as input to this layer.

There are different types of gates in this network each with a different purpose. The gate stores the information to remember the current information to be useful in the future. Another gate conveys the amount of information at present that will be relevant in future computation. In this way, each gate has its purpose and its corresponding weight matrices are trained based on the given input.

These new weight matrices are used to address the problem of assigning importance that carries from the previous iterations of time steps. In this way, an LSTM serves the purpose better when it comes to efficient problem solving[16,17].

LSTM networks are also used in a lot of other fields in computer science. Some of them include recognizing speech, composing music, recognizing handwritten digits, detecting anomalies, etc.

6. RESULTS & EXPLANATION

The proposed LSTM model has a significant increase in accuracy when predicting the trends of the market. It has been compared with the models discussed earlier like the regression model, ANN model, RNN model with Holt-Winters technique.

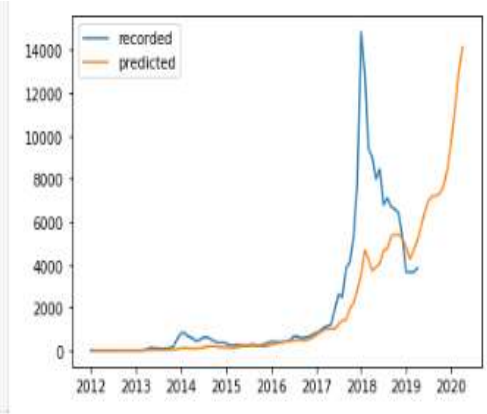

Figure 4. LSTM recorded vs predicted

LSTM has achieved the best RMSE among all the existing techniques.

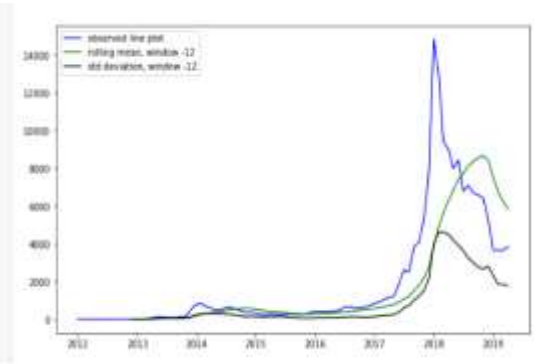

Figure 5. LSTM line plots

RMSE is the root mean square error which is one of the standard ways of testing the reliability of an AI model because it calculates the average of the squared deviation of each value from the mean.

It is mainly used for numeric data because the evaluation metrics like accuracy, recall, precision, etc. can't be measured for quantitative data.

Table 1. Bitcoin price comparison (Regression, ANN and LSTM)

	Bitcoin Price (USD)	Regression	ANN	LSTM
0	7357.445677	7259.233622	7380.473681	7498.407875
1	7424.734238	8129.976262	6756.682551	7577.588336
2	7411.200525	7725.467085	8306.748560	7204.011402
3	7730.247480	7176.272429	8902.950930	8273.679692
4	8325.801534	8684.547633	6901.116009	7860.321301
5	8271.597920	9473.063568	8651.155584	8268.175140
6	7925.247396	7497.471013	6534.683207	8358.494470
7	8254.277348	7701.099188	9097.572443	7983.141260
8	8184.695535	7868.889082	7024.990425	8058.799020
9	8201.890090	6361.440201	8501.164065	8248.330719
10	8166.388360	8047.327407	8722.206813	7536.610010
11	7700.834129	6579.362108	8260.941357	7440.325946
12	7588.586180	9261.131247	7044.308976	7866.459584
13	7547.314951	9037.915752	6240.656216	6955.685873
14	7423.074378	9143.441528	8094.245881	7546.406196
15	7396.041122	6110.009947	6732.002519	7798.042662
16	7411.515299	9203.455896	6746.059264	6897.545334
17	7402.336634	6012.251330	6438.247521	7360.003510
18	6748.441484	4921.063146	8072.599762	6082.030623
19	6460.153155	8091.359682	6327.758618	5917.603703

The efficiency of two of the models are compared with the proposed model and the results are tabulated. It can be seen that the LSTM network outperforms both the regression model and the ANN model in predicting the prices of the cryptocurrency Bitcoin. This is due to consideration of important information from the past that couldn't be captured by other models like regression models, traditional artificial neural networks and recurrent neural networks.

7. CONCLUSION

Cryptocurrency has proven to be a worthy investment opportunity despite the challenges it has faced in the beginning. This has made it attractive to investors. Prediction of the values for digital currency is based on block-chain based technology. Automating the prediction task is a challenging job. Hard-coded algorithms aren't helpful as there is an element

of randomness involved in this job. ML models are, unsurprisingly, a better alternative as they have been solving lots of problems that can't be solved using traditional programming. The proposed model outperformed with improved efficiency when compared with the existing novel approaches.

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