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Information Technologies

**PRICE PREDICTION OF DIFFERENT
CRYPTOCURRENCIES USING TECHNICAL
TRADE INDICATORS AND MACHINE
LEARNING**

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by

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The thesis titled “**PRICE PREDICTION OF DIFFERENT CRYPTOCURRENCIES USING TECHNICAL TRADE INDICATORS AND MACHINE LEARNING**” prepared and presented by **Mohammed Khalid SALMAN** was accepted as a Master of Science Thesis in Information Technologies.

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.



Mohammed Khalid SALMAN

Approval Date of Institute of Graduate Studies:

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DEDICATION

First, I would like to thank Allah Almighty for the power of mind, health, strength, guidance, knowledge and skills to complete this study.

This thesis is wholeheartedly dedicated to my parents. There are no words to describe what you mean to me, there is nothing that I can repay for what you have done to me. I will continue to do my best to achieve your expectations.

And lastly, I dedicated this to the family, relatives and friends who have been encouraging me during this study.

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ABSTRACT

PRICE PREDICTION OF DIFFERENT CRYPTOCURRENCIES USING TECHNICAL TRADE INDICATORS AND MACHINE LEARNING

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From the past two years with increasing geopolitical and economic issues, global currency values have been falling and stock markets have been having a poor run & investors losing wealth. This has led to a renewal of interest in digital currencies. Cryptocurrency one of the most prominent digital currency has found itself in spotlight with investors wanting a piece of it and business establishments accepting it as a source of payment due to its stable performance in the last few years. This research has been done on predicting cryptocurrency prices using machine learning based neural network which has a lowest the model loss over 100 epochs during training and Technical Trade Indicators (TTI) graphs depicts a real BTC value 5 to 10 times in 300-days of current fiscal year has further supported this increasing trader confidence and a shift in global cryptocurrency graph by predicted BTC values. On the same lines, we are analyzing bitcoin prices using Machine Learning and Sentiment Analysis. We also study stock market trends in order to better predict bitcoin prices quantitatively. In this work we analyze the impact of global currencies like US Dollar, foreign exchanges on Bitcoin prices and whether Bitcoin has the stability to dethrone global currencies and become the single medium of transaction. This work is adequate enough to aid in predicting price and with results obtained from predicting Bitcoin prices using machine learning based neural network achieving an accuracy of 94.89% under all

circumstances of technical trade indication thereby bringing down its price prediction by over 13.7% in April 2020 itself during evaluation.

Keywords: Cryptocurrency, Technical Trade, Machine Learning, Neural Network, Prediction, Bitcoin, Economics.



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LIST OF ABBREVIATIONS

| | |
|-----|-------------------------------------|
| AI | : Artificial Intelligence |
| BIS | : Bank of International Settlement |
| CPP | : Cryptocurrency Price Prediction |
| DLT | : Distributed Ledger Technology |
| FTR | : Funds Transfer Regulation |
| FIR | : Fixed Investment Rate |
| LCL | : Legal Cryptocurrency Law |
| ML | : Machine Learning |
| OTF | : Organized Trading Facility |
| PoS | : Proof of Stake |
| PoW | : Proof of Work |
| TCI | : Technical Trade Indicator |
| IRS | : Internal Revenue Service |
| ICO | : Initial coin offering |
| IMF | : International Monetary Fund |
| API | : Application Programming Interface |
| BTC | : Bitcoin |

1. INTRODUCTION

The aim of this research is to examine whether the price of Bitcoin can be predicted similar to other stock market tickers. This will have a basis on whether we can further use it as a medium of payment. In order to arrive at this, we will look at factors such as if cryptocurrency can be used as an investment as described in [1]. This will help in providing support to our objectives. We will also analyze how sentiments affects bitcoin and whether it is similar to the manner in which stock markets are influenced by sentiments as mentioned in [2]. This will lead to drawing similarities and differences between how bitcoin and stocks perform. In-order to ensure that cryptocurrency is not spent recklessly or to further keep security and practicality of cryptocurrency, a central ledger was planned and built that would keep track of all transactions taking place as mentioned in [3]. The unique aspect of this ledger is that it is controlled by all the users who own bitcoins and not by a centralized entity such as banks or financial firms. This ledger was named 'Blockchain'. Blockchain keeps track of all Bitcoin transactions occurring anywhere in the world. It is a cryptographic implementation that provides the highest security towards ensuring that misuse or leak of Bitcoin data does not occur as described in [4]. It is implemented as a chain of blocks where each block contains the hash of the previous block. A network of nodes keeps the network up & running as well as maintains the cryptocurrency.

A key feature of implementing cryptocurrency for keeping a check on Bitcoin transactions was for avoiding double-spending as described in [5]. Double-spending can be explained as a drawback of digital cash systems where a digital coin or token can be spent more than once if the details of the digital coin or token are duplicated. This majorly affects currency values since devaluations of such currency takes place. Transactions in cryptocurrency are confirmed using Proof of Work concept as described in [6]. Proof of work makes use of hash functions, mathematical computations and solving a puzzle in order to ensure the legitimacy of bitcoin transactions. Proof of work makes use of Merkle Trees, which store the hash of each data block. This technique allows efficient and secure verification of each data block inside the blockchain

as mentioned in [7]. The computations however in proof of work require time and resources in terms of graphical processing units and continuous power supply.

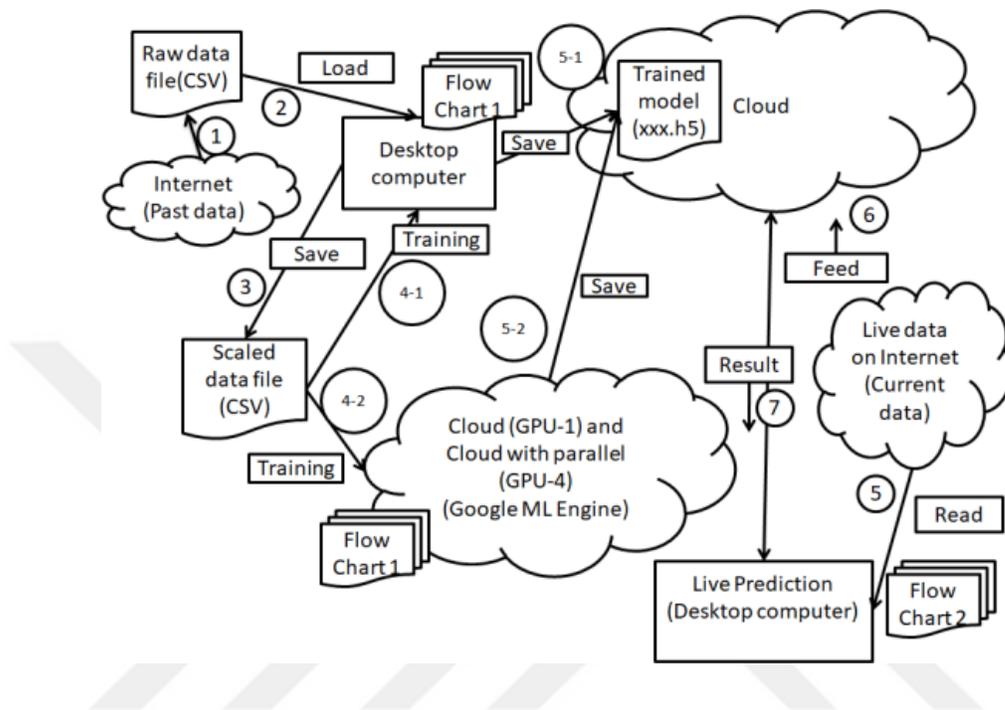


Figure 1.1: A cloud-based lice price prediction mechanism on desktop computer [7].

The advantage of using a proof of work algorithm is to ensure that the network is safe from Denial of Service attacks which have become rampant nowadays as mentioned in [8]. This is because such an attack would require a huge amount of time and computation cost in order to be successful and even though bitcoin exchanges and wallets have been hacked due to poor security protocols, bitcoins stolen haven't been able to be cracked and used because of this important feature as given in [9]. As we talk about cryptocurrency and proof of work for ensuring security of Bitcoins, it is a matter of interest to further talk about how bitcoins are generated as mentioned in [10]. The process of obtaining bitcoins is called as Mining. In simple term, bitcoins are awarded when miners are able to solve some puzzles which require heavy computations that take days or months even. Once they have solved the puzzle, a new block is formed and the transactions are confirmed. On successful confirmation, the miners are awarded bitcoins based

on their work as described in [11]. Cryptocurrency mining has been rampant in countries like Russia and America where old warehouses and industry units have been converted into mining farms as mentioned in [12]. These farms have been setup with hundreds of CPU's and GPU's that work consume huge amounts of electricity and work 24 hours a day 7 days a week in order to mine cryptocurrencies as mentioned in [13]. This clearly shows the huge amount of investment that needs to be made for a return which could be a petty amount or turn the investor a millionaire by stroke of luck as described in [14].

1.1 PROBLEM STATEMENT

Unlike traditional paper currency which can be printed as per market needs, Cryptocurrency has a limited supply. This is in order to ensure that printer inflation does not occur and the currency does not get devalued. However, due to the limited supply of cryptocurrency and with 80% cryptocurrencies already mined by mid-July 2018, it is anticipated that the remaining of the 21 million worth of cryptocurrencies will take a large amount of time to mine and in order to perform such large computations, relative infrastructure will also be required with the possibility of a low return in the future. The price controlling is quite challenging task in the domain of cryptocurrency. With a general acceptance and price prediction of cryptocurrency since the last few years, other cryptocurrencies or digital currencies as we call them have also come to reality and become mainstream for price prediction. We will use Machine Learning and Technical Trend Indicator for the controlling the price hike in the cryptocurrency. Bitcoin and Ethereum are two of the most commonly known cryptocurrencies which have been used for developing different applications and further researched by banking firms for implementation. We will overcome the above-mentioned problems with more advance design of price prediction of different currencies using machine learning techniques.

1.2 CONTRIBUTION

The core idea behind this research is to design and integrate the price prediction of different cryptocurrencies using technical trade indicators and machine learning which is an automated mechanism of controlling the price of currency.

- Is it possible to have Bitcoin as a publicly traded commodity with price prediction? The results for the objective can be then applied to findings of the following objectives:
- Can cryptocurrency be used as any other traditional currency like US Dollar for controlling the price.
- Does cryptocurrency like Bitcoins have the ability to become a primary method of transaction, replacing US Dollar and other traditional currencies with weekly price prediction.
- Developing an automated application for predicting a price hike in cryptocurrency with respect to different time series using machine learning and technical trend indicator.

1.3 STANDARDIZATION OF MACHINE LEARNING

The machine learning based tasks could be standardized and that can be classified into three major categories:

- **Supervised Learning:** Here, the datasets contain examples from which the computer can learn and produce results accordingly. The learning algorithm generalizes the results based on the training data provided to it.
- **Unsupervised Learning:** Here, the datasets are provided with no examples or patterns. It is expected of the algorithm to find patterns in the data and apply the results to the testing data which is provided to it subsequently.
- **Reinforcement Learning:** Here, datasets contain feedbacks which are fed to the training network in order to identify the patterns by itself and apply those results to testing data.

The tasks can be used for classifying data such as images or numbers in order to find a pattern or trends as mentioned in [15]. For example, machine learning algorithms can be used to classify between objects on a street such as pedestrians, vehicles and street signs & other non-static objects. Similarly, machine learning algorithms can also be used for forecasting or predicting future data such as future stock prediction, predicting how a new product would be perceived in the market to name a few examples as given in [16].

These days' machine learning is being used in game development and on equipment's sent in probes to outer space. This tremendous progress in applications of machine learning are due to the fact that it improves the analytics and decision-making capabilities of applications as mentioned in [17]. We have plethora of machine learning frameworks available to use for depending on the type of application that needs to be created. A few of them are as follows:

- TensorFlow
- Keras
- Microsoft Cognitive Toolkit / CNTK
- Deep Learning

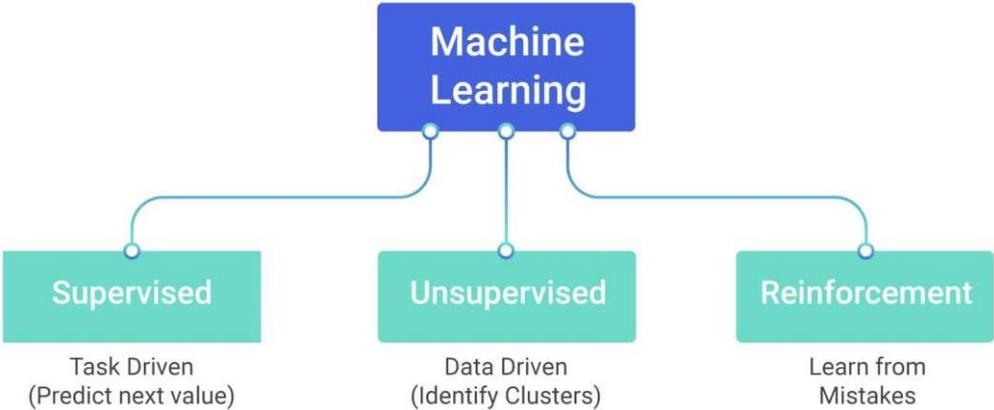


Figure 1.2: Standardization and different types of machine learning for making certain prediction.

1.4 TECHNICAL TRADE PREDICTORS

Technical trade predictor classifies this reaction as either positive, negative or neutral. It is based on analyzing the words that are present in a sentence to find the overall polarity of the sentence as mentioned in [18]. We can develop techniques for analyzing sentiments using machine learning, natural language processing on large amounts of data including webpages, news articles, discussions, web blogs to name a few sources. As said above, technical trade predictor can also be performed on images and videos nowadays as mentioned in [19].

There are several different techniques to perform technical trade predictor. We can use several supervised learning techniques to train our data and then test the results on new data. Naïve Bayes is one of the most widely used supervised learning techniques for analyzing and finding the sentiment of a sentence as mentioned in [20]. The neural network technical trade predictor library Text-Blob is based on Naïve Bayes as well as mentioned in [21]. With new algorithms and technologies being developed with every passing day, there have been new methods devised to find the sentiments as mentioned in [22]. One such exciting technique is using TensorFlow which is a machine learning framework. TensorFlow uses a dictionary approach or a bag of words model to firstly develop a prediction result from the training data as mentioned in [23]. After this, based on the test input that is provided, it accordingly predicts the sentiment of the test input.

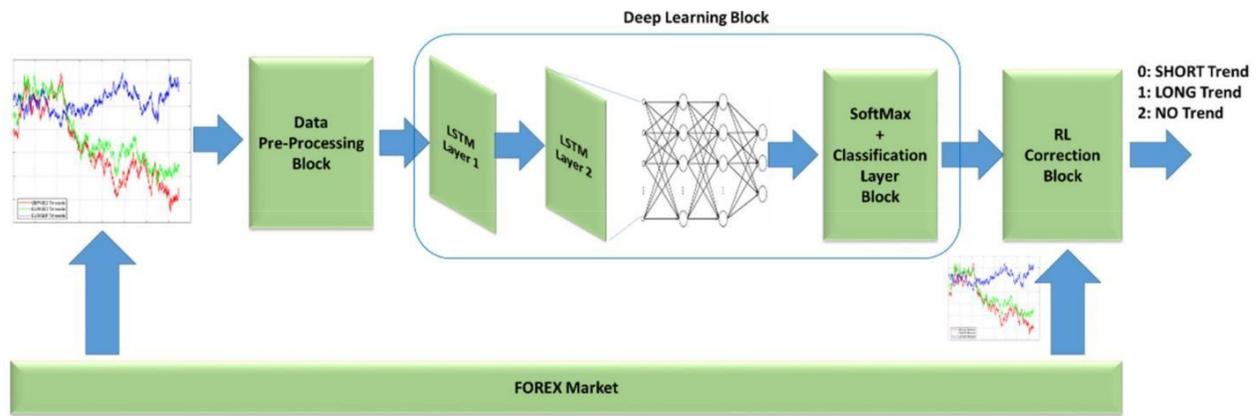


Figure 1.3: Standardization of technical trade predictor with LSTM for price prediction [24].

Our application of technical trade predictor is majorly directed towards understanding the reactions of investors and traders towards Bitcoin’s volatile prices. We can further analyze sentiments towards US Dollar and the global economic scenario which has not been doing so well since the last few months. All this helps in trying to find ways to support our prediction

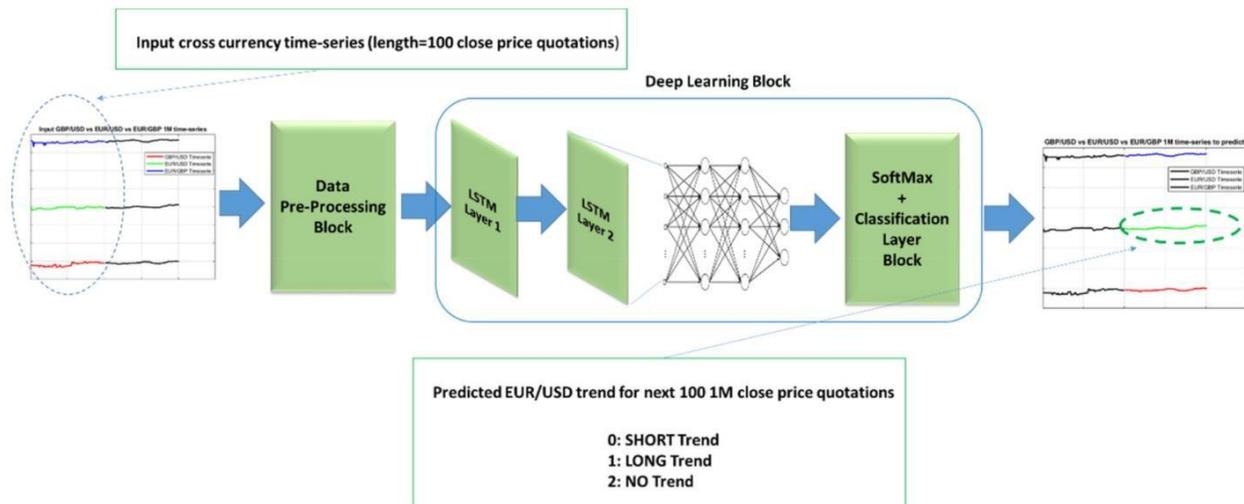


Figure 1.4: Standardization of technical trade predictor with LSTM and price quotation [24].

1.5 STRUCTURE OF THESIS

The research structure presented in this thesis is organized as follows:

Chapter 1: This chapter explains introduce the research community to this domain and provides problem statement for the research and draws the significance of research that contributes to the advancement of price prediction in cryptocurrency technology. The aims of study and the technical approaches used are also presented in this chapter.

Chapter 2: This chapter provides an overview of cryptocurrency operation and a comprehensive literature review on relevant aspects of cryptocurrency access in current cryptocurrency technology and its deployment scenarios. This chapter focuses on the challenges and solution branches of the access mechanisms. The required branches of a machine learning and advance

network, such as the network architecture, cryptocurrency modeling, sensing, and access methods, are thoroughly reviewed along with the current challenges and future trends.

Chapter 3: This is most important chapter that shows the methodological approach for cryptocurrency impacts of price prediction on the design of the cryptocurrency operation through a capacity measurement of the price prediction opportunity. The underlying obstacles of the prediction-throughput trade-off, issue is synthesized with the analysis of the receiver operating characteristic and access probability. To achieve the highest possible price prediction of cryptocurrency, a novel machine learning based mechanism is proposed by differentiating the target cryptocurrency prices. And also provides the design aspects of the machine learning mechanism in order to achieve the highest possible price prediction throughput. The achievable throughput by machine learning is formulated based on the proposed mechanism. To obtain maximum throughput under the constraint of cryptocurrency price prediction, an optimization is conducted between the prediction period and the detection probability of the machine learning mechanism in this chapter. This optimization shows the significance of the price prediction using machine learning for designing an efficient access cryptocurrency.

Chapter 4: This chapter provides the simulation-based results for price prediction of bitcoin cryptocurrency using machine learning mechanism for price prediction. The price prediction machine learning framework of the predicting the price of cryptocurrency is described, with consideration of practical price prediction scenario. The derivation of the cryptocurrency detection sensitivity configuration according to the contention parameters is provided in this chapter. The achievable throughput is formulated with the cryptocurrency based on machine learning mechanism.

Chapter 5: This chapter presents a complete discussion of performed experiments for a cryptocurrency with machine learning based mechanism. The cryptocurrency framework exhibited in chapter 4 is exploited with the contribution of embedding the cryptocurrency and doing comparison of accuracy with existing literature.

Chapter 6: This chapters presents the conclusions of this thesis along with the essentials of the tasks accomplished and the technical contributions made. In addition, recommendations are made for the further improvement of the access strategies in cryptocurrency technology for price prediction.



2. RELATED WORK

This chapter provides the background information needed to understand the chapters that follow. It delivers a basic overview of a block-chain and cryptocurrency detailing the infrastructures, nodes, the literature of machine learning mechanism in communication as well as briefly discuss the standards, sensing methods and security implemented. Secondly, this chapter investigates cryptocurrency as a method of price prediction with previous papers. Finally, it briefly discusses the components of machine learning techniques and standardization of cryptocurrency.

2.1 LITERATURE REVIEW

A company's financial evaluation is done on the basis of certain fundamentals which are qualitative and quantitative data. These factors are examined by Analysts and Traders in order to estimate whether an asset, company are performing well and whether investment can be made in it as described in [25]. Apart from these technical indicators, traders also rely on market sentiments or investor sentiments. These are sentiments that influence technical indicators as well since they can be used to make a profit by predicting short term price movements as mentioned in [26]. Although these predictions are irrational investment decisions but since they yield a result, we can say that the decision was driven by sentiment rather than by facts.

This paper [27] guides home the point that the basis of an outcome of an important democratic activity like elections can have a huge bearing on the performance of stock markets. We have all seen several instances of this such as the stock markets rallying in green when a market friendly government is elected. Author in [28] has provided a report speculating the impact of recently held Midterm Elections in November 2018 on U.S stock markets. The report covers excerpts from different banking directors and a thorough analysis of historical performances of stocks during election times which were directly impacted by the outcomes of the elections. However, a speculation is also drawn which tries to dispel these assumptions in light of the fact that stocks tend to sway more not due to the results of the winners which might have a little say but also due to the implications that arise from different policy decisions that are waiting to be implemented

and might not be now due to a change in government rhetoric after election outcomes as mentioned in [29].

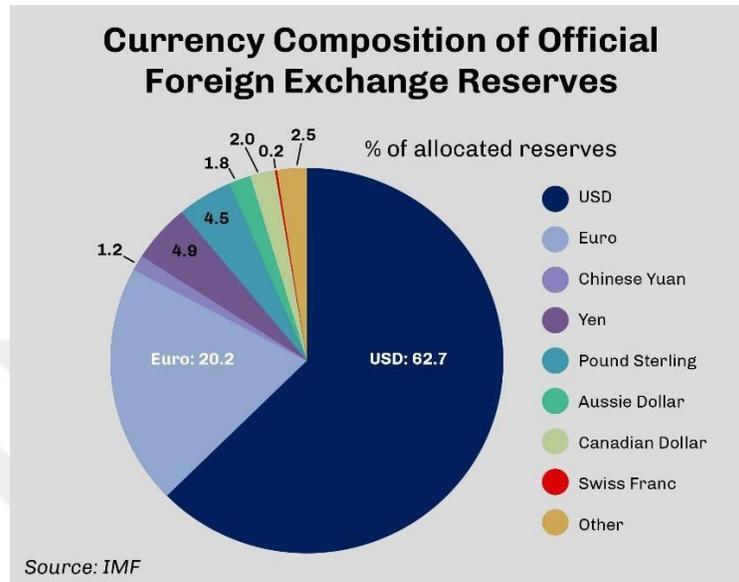


Figure 2.1: The up to date global foreign exchange reserves by normal currency transaction [30].

This has had a spiraling effect on economies of countries like Turkey, Argentina who have been seeing their currency devalued with every passing day. Other countries such as China have been struggling hard to ensure that Chinese yuan is still comparable to global currencies due to the ongoing trade wars. In order to do this, they have been devaluing their currency, but it has had a serious impact on countries that borrow from China as described in [31].

The figure 2.1 above depicts the percentage distribution of different currencies globally. We can clearly see that US Dollar leads with 62.7% presence in the markets followed by 20.2% presence of Euro and other global currencies as described in [32]. It wouldn't be right to say that dollar has a monopoly over world trade and any changes that affect the dollar have a cascading effect on other commodities too. However, this has been the way things were set up by the erstwhile governments. It's solely the author's view that there needs to be a new global currency which is immune from the impacts that a single currency causes globally as mentioned in [33]. This global currency has its advantages in terms of not affecting developing countries' economy such

as Argentina's pesos and Turkey's lira which are running in the upgrade flow due to dollar becoming stronger of late as described in [34]. The volatility in the price of Cryptocurrency generated a lot of attention in the latter half of 2017 when the price of cryptocurrency was steadily rising and at one point one can say it was a steep rise as well. This rise not only attracted the attention of the general public which saw it as a way to increase their fortunes but also brought the focus of many hedge funds, banking corporations and even Wall Street and other world stock exchanges to it as mentioned in [35]. Chicago Exchange Board did an in-depth study and introduced Cryptocurrency Futures trading with an eye to the future and to attract investors. The media also has carried stories of different individuals becoming overnight millionaires due to the rapid increase in cryptocurrency value. Banking corporation CEO's have been speculating a lot on whether to open cryptocurrency trading desks and support operations or not as mentioned in [36]. Businesses have sprung up which solely use cryptocurrency for transactions such Ethereum, a California based Real Estate agency that uses Cryptocurrency and other cryptocurrency for real estate transactions and is quite active on Neural network as described in [37].

With all the attention on cryptocurrency, it seems quite an innovative idea to invest in Cryptocurrency and earn a fortune on your investment. However, before taking a step towards deciding and investing, let us first analyze the feasibility of investing in Cryptocurrency compared to investing in other stable stocks as from the above sections we do note that Cryptocurrency prices are volatile as mentioned in [38]. This volatility is due to many factors. The primary of all these factors is the attention it is getting from individuals. We call this as the sentiment people have towards cryptocurrency.

about three-fourths of the total world supply in gold. Now countries could set up their exchange rates for local currency versus US dollar as mentioned in [41].

With time the value of dollar started increasing and thereby its demand too. The International Monetary Fund and World Bank were set up as a result so that member countries could contribute their share as well borrow in order to maintain stability in local currencies and for economic development projects as mentioned in [42]. But on account of massive inflation in the US during the 1970's and with the supply of dollar being very high related to the demand, people started redeeming their dollars for gold. This led to depletion of gold reserves at Fort Knox, the US government de-linked US dollar from gold which has led to the floating exchange rates that we see today as mentioned in [43].

After the events of 2009, the Feds had to step in to rescue businesses and banks. They printed a lot of dollars and supplied it to the markets in order to ease the situation. However, this excess supply of dollar found its way to emerging markets as well which meant a greater than supply of US dollars worldwide. This caused a drop-in dollar's value against Euro, Yen and other currencies. This measure taken by Feds called as quantitative easing program ended in 2014 as mentioned in [44]. Since then there had been speculation of economy coming back to a normal phase and this would lead to increase in interest rates which have been very low since 2009.

This speculation although increased the value of dollar had a negative effect on other currencies since investors and traders were willing to trade in dollars instead of other currencies. As the demand for dollars' increase, it has a spiraling impact on the local currency since the exchange value or the amount of local currency to be spent for buying one-dollar increases. This spells a doom for the local country economy.

USD Share of Global Reserve Currencies % of allocated reserves



Figure 2.3: The global USD shares that are reserved as per source from IMF [44].

As we observe Figure 2.3, we can clearly see that with the increase in interest rates it's a signal that the US economy is improving. Lowering cost of prices, lowering unemployment ratios are some of the factors that are again improving investor confidence in US dollar bonds. However, as discussed above this also shifts the interests of investors from other global currencies to US dollar for security.

This has had a spiraling effect on economies of countries like Turkey, Argentina who have been seeing their currency devalued with every passing day. Other countries such as China have been struggling hard to ensure that Chinese yuan is still comparable to global currencies due to the ongoing trade wars. In order to do this, they have been devaluing their currency, but it has had a serious impact on countries that borrow from China as mentioned in [45].

The figure 2 below depicts the percentage distribution of different currencies globally. We can clearly see that US Dollar leads with 90% presence in the markets followed by 31% presence of Euro and other global currencies.



Figure 2.4: Global Foreign Exchange distribution.

It wouldn't be right to say that dollar has a monopoly over world trade and any changes that affect the dollar have a cascading effect on other commodities too. However, this has been the way things were set up by the erstwhile governments. Its solely the author's view that there needs to be a new global currency which is immune from the impacts that a single currency causes globally. This global currency has its advantages in terms of not affecting developing countries economy such as Argentina's pesos and Turkey's lira which are running in the red due to dollar becoming stronger of late.

2.3 CRYPTOCURRENCY AS AN INVESTMENT

The volatility in the price of cryptocurrency generated a lot of attention in the latter half of 2017 when the price of cryptocurrency was steadily rising and at one point one can say it was a steep

rise as well. This rise not only attracted the attention of the general public which saw it as a way to increase their fortunes but also brought the focus of many hedge funds, banking corporations and even Wall Street and other world stock exchanges to it as mentioned in [46]. Exchange Board did an in-depth study and introduced Cryptocurrency Futures trading with an eye to the future and to attract investors.

The media also has carried stories of different individuals becoming overnight millionaires due to the rapid increase in cryptocurrency value. Banking corporation CEO’s have been speculating a lot on whether to open cryptocurrency trading desks and support operations or not. Businesses have sprung up which solely use cryptocurrency for transactions such Propy, a California based Real Estate agency that uses Cryptocurrency and other cryptocurrency for real estate transactions and is quite active on machine learning as mentioned in [47].

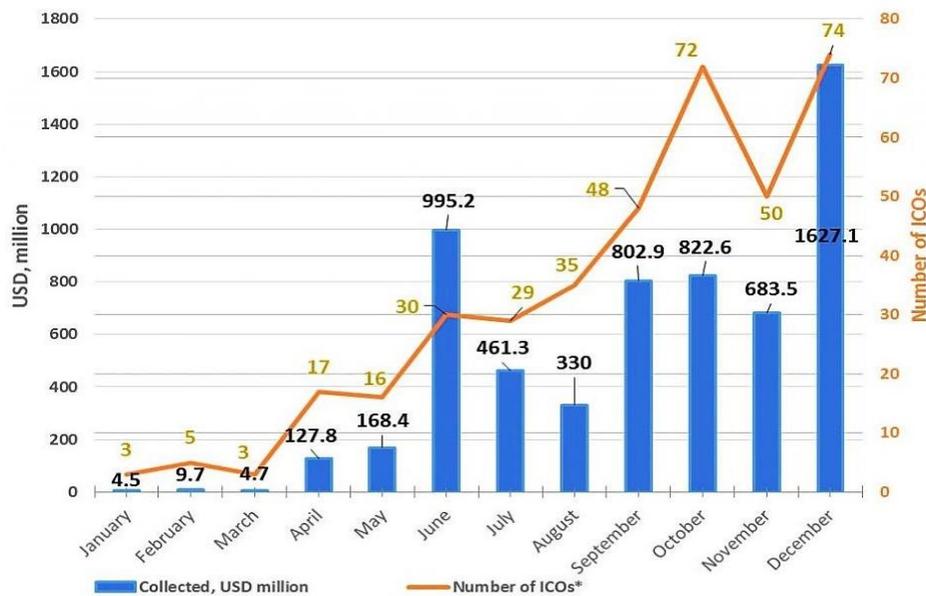


Figure 2.5: The cryptocurrency growth, trend and investment by a year [47].

With all the attention on cryptocurrency, it seems quite an innovative idea to invest in Cryptocurrency and earn a fortune on your investment. However, before taking a step towards deciding and investing, let us first analyze the feasibility of investing in Cryptocurrency

compared to investing in other stable stocks as from the above sections we do note that Cryptocurrency prices are volatile as mentioned in [48]. This volatility is due to many factors. The primary of all these factors is the attention it is getting from individuals. We call this as the sentiment people have towards Cryptocurrency.

Cryptocurrency has been directly and indirectly influenced by sentiments that people have towards it, government policy decisions after gauging people's perception. This has caused a huge volatility in the prices. Such volatility only introduces a sentiment of apprehension in people about whether to invest or not. Cryptocurrency has been treated more like a property that can be purchased and kept with a hope of having an increase in its value rather than spending it. This affects the price of cryptocurrency as well since it was deemed to be a digital currency and not an investment property.

2.4 DIFFERENT CRYPTOCURRENCIES

An interesting fact to note is that Bitcoin, Ripple and Ethereum have created an industry of itself. One of the mentions above was that of Ripple. Apart from it, there are several other firms that's do business in bitcoin and other cryptocurrency, notably ethereum. There have been several bitcoin exchanges coming up in every country, out of which major ones are located in United States, Japan and South Korea. These bitcoin exchanges serve as fronts for investors and clients who are interested in investing in bitcoin. They also serve as points of contact with governments and local income tax departments as mentioned in [49].

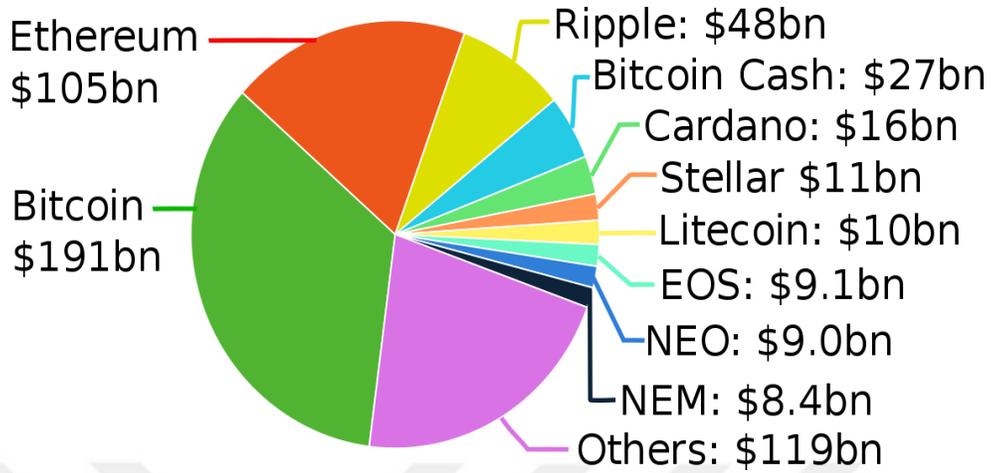


Figure 2.6: Different types of cryptocurrencies as per Wikipedia [49].

Bitcoin is based on cryptocurrency technology, a secure platform which is being adopted in developing products by major banks worldwide as well as by companies in medical domain in order to provide clients with greater security for their data. In this manner, investment can be made in cryptocurrency so as to not get tangled with Bitcoin and its associated volatility. Organizations such as IBM, Apple, Microsoft have been adopting cryptocurrency technologies to fit in with their client demands as mentioned in [50].



Figure 2.7: The introduction of different cryptocurrencies by the year [50].

Another manner of indirectly investing in Bitcoin is by mining Bitcoins. Companies like Apple develop processors that can perform complex computations as required by algorithms designed to produce bitcoins. It should be noted here though that mining bitcoins is a complex task in itself since it consumes a lot of electricity, time and resources in order to mine a single bitcoin. Greater analyses would be required before partaking this option which will include the amount of money that can be invested in setting such an equipment, understanding about the volatility of the returns and the legal aspect of declaring to the federal government of bitcoin ownership.

2.5 SUMMERY

The method followed for research has been outlined in the above sections. The philosophy being highlighted through this study is that of positivity in the light of Bitcoin prices fluctuating by huge margins and investor confidence eroding with every passing day. The experiments use a machine learning approach to create results on which analysis can be performed and a near to accurate prediction can be obtained. The approach used to capture the data and datasets used in the process has been highlighted. Also, the review illustrates the necessity of cryptocurrency design for developing a price prediction system for cryptocurrency. According to the prediction cycle, cryptocurrency is one of the key enablers of the price prediction operation that should be considered explicitly in the design of a complete price prediction. Therefore, the impact of cryptocurrency on the design of the price prediction system is thoroughly reviewed in the next chapter, with their applications and technical challenges and methodology.

3. METHODOLOGY

Bitcoin price data (BTC-USD) was initially collected from Kaggle [51]. The data collected was cross-checked with that from cryptocurrency in order to avoid any unwanted discrepancies. Data collection in the beginning stage was manual since Kaggle deprecated their API Library which was earlier used on Python Programming on Anaconda Navigator IDE to seamlessly fetch data and save it directly by making an API call to the website. However, in due course it was realized that the existing data had values which even though were compensated for, still affected the prediction and thereby produced wrong results. Hence, a shift was made to using REST API's which proved to be significant since the results now obtained were more accurate and meaningful. The flow diagram has been shown in Figure 3.1.

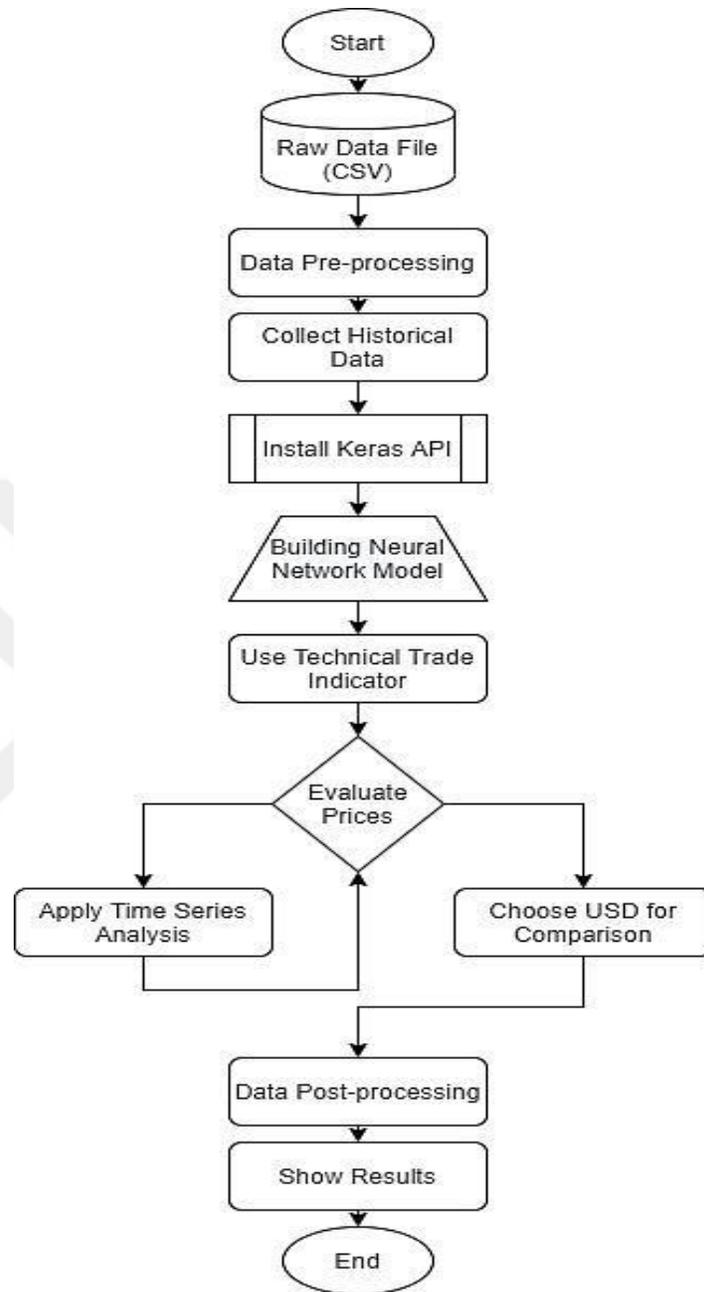


Figure 3.1: Flow diagram of approach being followed.

We used an API's to fetch this Kaggle Bitcoin Historical dataset. The obtained dataset was then averaged into one dataset for consistency and in order to fill in the gaps created by missing data in dataset. This obtained data was provided to Keras for prediction purposes.

3.1 BUILDING NEURAL NETWORK MODEL

Machine Learning is the most suitable technique which can be used here to predict Bitcoin cryptocurrency prices prediction. The model to be built had to achieve several goals in order to produce a near to accurate prediction. This included selecting the framework which could produce a good prediction accuracy, take in consideration of other parameters in its prediction algorithm and be trainable. Keeping these goals in mind, several different frameworks were tested and the author finally landed on using Keras, which is a neural networks API running on top of Tensorflow. Keras was compared against Support Vector Machine. In comparison to SVM, Keras is less expensive in performance and computation. When we discuss about machine learning frameworks, depending on how we would want the learning to be, we can decide over the frameworks that can be used.

Next, there was the need to decide which layers had to be included and how many of them will be required along with deciding the epoch rates. The dataset used for training was standardized and transformed since this is more suitable for many activation functions.

To collect data for sentiment analysis from Neural network, trades from different neural network handles were collected by using Neural network API's for python. Neural network API's use Keras, a library written in Python that enables the user to search for cryptocurrency based on specific keywords and fetches all the trades related to the keyword. This by far is one of the most efficient unpaid services for gathering trades from Neural network. For older data and better-quality trades, there were also paid services whose API's easily fetched quality data.

Quality of trades is essential for performing sentiment analysis since the results obtained affect other parameters taken into consideration. The keywords, for example "cryptocurrency" also included trades on un-related topics as well. Hence, there was a need to filter the trades being fetched and select appropriate ones. In absence of filter mechanisms provided by neural network, new ones were created which used regular expressions library of python to remove unwanted letters and duplicated.

Apart from using neural network trades, as the work progressed web scraping news articles was also performed in order to have a greater accurate pool of data which could be helpful in analyzing and arriving to conclusions.

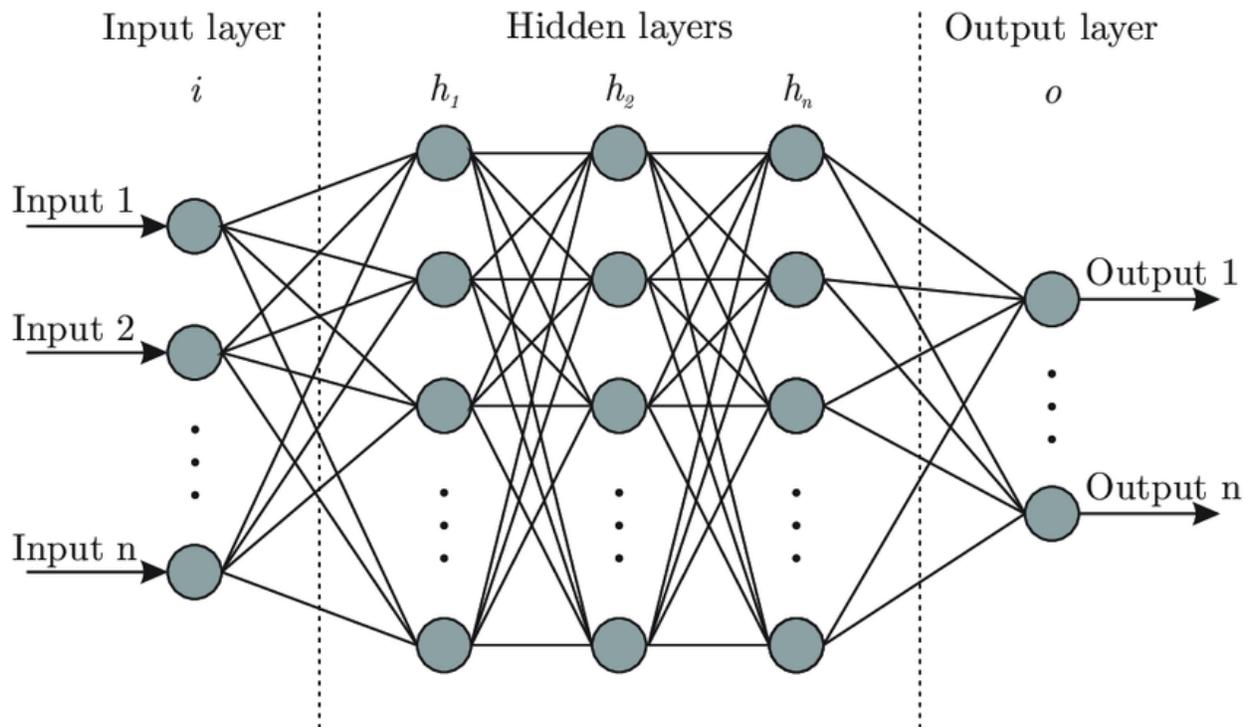


Figure 3.2: The architectural diagram of neural network with input, hidden and output layers.

NN, which stands for Neural Network is a class of neural work that becomes hot in recent years because of the huge success in lots of task across from object classification, image segmentation, object tracking etc. NN was inspired by the connectivity pattern of the neurons in the brain. As the name indicates, the main portion in NN is neural operation. The process described as here is just by convention in deep learning. Mathematically, it is a cross-correlation. In machine learning application, neural is always done between kernel (filter) and the data. The main purpose of these operations is extracting the features. The pre-processing required in NN is much fewer than other traditional methods. With enough training, NN can learn those filters that were hand-engineered in traditional methods. This main advantage of NN is that there is no need to extract the matrix

and design the formula to extract the features manually. The learnable weights and bias in NN are a more powerful alternative than human effort and knowledge in feature design.

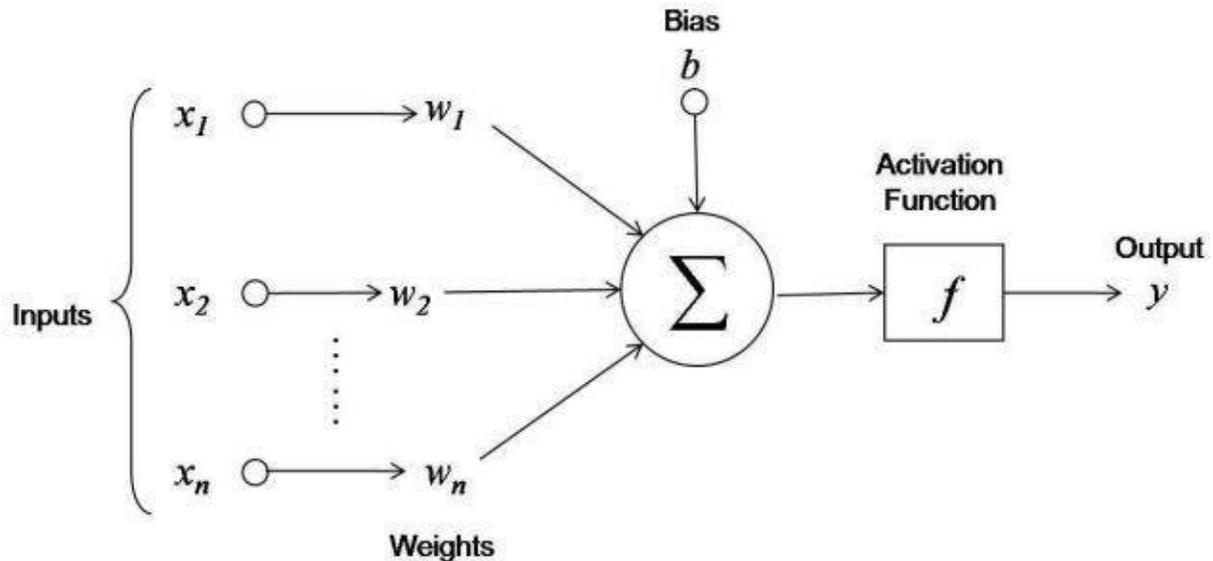


Figure 3.3: The basic operations of neural network [55].

In addition to neural layer, there are two main kinds of operations also important in NN which are input layer, hidden layer and output layers. Input may compute max or average depending on the application. The purpose of the input layer is reducing the dimension of the data and might be equivalent to increase the receptive field of neurons in the later layer of the network. Fully connected layers (FC) connect every neuron in previous layer to every neuron in the later layer. It is the same as traditional Multi-Layer Perceptron (MLP). The FC in the NN is serving as a classifier to classify the features got in the previous convolutional layers (this is just a rough explanation, in recent works, lots of other methods have been proposed which can replace FC and also achieve a great result). Since NN is just a tool for the thesis, detail will also not be explained here. This work will only briefly go through the network architecture that used in this thesis and mention some main improvement technique.

3.2 CRYPTOCURRENCY PRICE PREDICTION PROCESS

The prediction process for cryptocurrency involves using Machine Learning techniques for running a neural networks-based prediction model for predicting the next day price. The test data and training datasets were obtained from the Kaggle keeping in mind the importance to produce an accurate or near-to-accurate prediction for price.

3.2.1 Training and Testing

A good training dataset and testing dataset can help to achieve an objective with greater accuracy compared to a poorly created dataset. With this in mind, multiple datasets were extensively obtained dataset from the kaggle and tested multiple times in order to land up to the dataset which could be free from any discrepancies. As discussed earlier, we started predicting prices using datasets obtained from Kaggle. However, with volatile changes in cryptocurrency prices and Kaggle is keeping up with the updated values in their dataset, we decided to switch to this sourced dataset. Selecting a dataset is of utmost importance as said above and this decision aided in generating the results that we had been aiming.

The training dataset ranges from the 1st of May 2014 until the 1st of May 2020. These values were selected because prior to 2014, the cryptocurrency price was very low to influence the prediction. From the late 2013 onwards, the price started increasing and by mid-May of 2014, it had been showing a trend in a stable price bracket. The testing dataset had a range from 1st of April, 2020 to 1st of May 2020. This is the period feels where the prices have been the most instable and volatile of all the years starting from 2014.

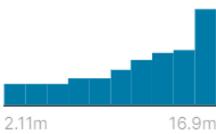
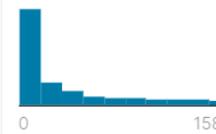
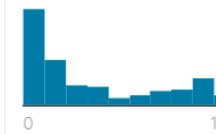
| # btc_total_bitcoins | # btc_market_cap | # btc_trade_volume | # btc_blocks_size | # btc_avg_block_si... |
|---|---|---|--|---|
|  |  |  |  |  |
| 2.11m 16.9m | 0 327b | 0 5.35b | 0 158k | 0 1.11 |
| 2110700.0 | 0.0 | 0.0 | 0.0 | 0.000216334661355 |
| 2120200.0 | 0.0 | 0.0 | 0.0 | 0.000281721052632 |
| 2127600.0 | 0.0 | 0.0 | 0.0 | 0.000226905405405 |
| 2136100.0 | 0.0 | 0.0 | 0.0 | 0.000318676470588 |
| 2144750.0 | 0.0 | 0.0 | 0.0 | 0.000223416184971 |
| 2152850.0 | 0.0 | 0.0 | 0.0 | 0.000291450617284 |
| 2162150.0 | 0.0 | 0.0 | 0.0 | 0.000228225806452 |
| 2171950.0 | 0.0 | 0.0 | 0.0 | 0.000248005102041 |
| 2179350.0 | 0.0 | 0.0 | 0.0 | 0.000220128378378 |

Figure 3.4: The sample parameter of dataset can be seen as its under consideration [51].

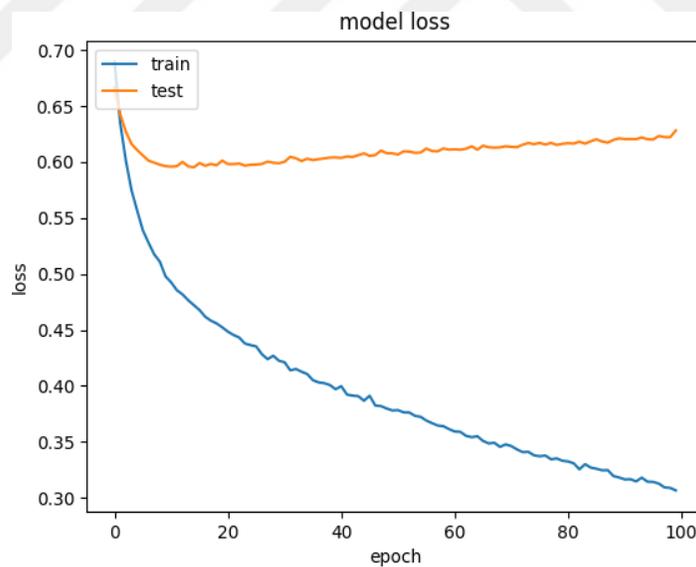


Figure 3.5: The model lost recorded during the training process at 100 epochs.

3.2.2 Reducing Noise from Dataset

The cryptocurrency content automatically obtained from online available datasets and API's has a lot of irrelevant data which is undesirable for analysis. This is because of the fact that such data can affect the results and produce a wrong outcome which could make the prediction inaccurate. In order to remove the impact of irrelevant data, python libraries were used to filter out such data.

The data was analyzed using regular expressions (Library in Python: 're') which removed all non-alphabetic symbols and symbols (removing "RT", "@" & "#") that affected the analysis in terms of prediction negatively. The data was next checked for duplicity and any duplicate trades found were removed. The data was also checked for trades from bots which made irrelevant announcements or offered bitcoins and had been fetched with the remaining trades. Manual analysis of the trades was also performed in order to further weed out any trades which had escaped the above filters. This phase was typically the cleaning phase since the data was cleaned and filtered.

The cleaning phase was also applied to data scrapped from different websites, news articles. However, it was noted by the author that web scrapped data was free of any hidden or unhidden bot messages and much easier to deal with. This was majorly because of certain libraries in python which only fetched data within targeted HTML tags.

Another way to consider a price prediction of cryptocurrency by using the formula below, which can be applied to a time series under consideration, where 'p' represent the current price, 'c' represent the cryptocurrency price, 'x' represents the daily changes in the prices and their integration by the following formula.

$$C_x = \int_1^x x(t) \frac{1}{\sqrt{p}} \left(\frac{x_2 - x_1}{p} \right) xtotal_p \quad (3.1)$$

The following equation adjoins the different prices of cryptocurrencies are given by the equation (3.2) below:

$$C(x) = \begin{cases} C(n) \\ C(n) - P(n) \end{cases} \quad (3.2)$$

3.2.3 Understanding the Trade Issue

The next stage after thoroughly cleaning the data involved analyzing the data and deducing the training issue associated with it. For this, python programming provided a useful library in Python known as TextBlob. TextBlob was based on Neural Network Algorithm and easily predicted the cryptocurrency trade issues and scores of the data that was provided to it. The trade score was then compared with the cutoff values for classifying the cryptocurrency as positive, negative or neutral. Neutral trades according to TextBlob were those which had equal positive & negative scores or could not be classified. The dataset was then updated with the sentiment score of each trade after analysis.

However, it was found that TextBlob was unable to deduce the sentiment scores for trades which could have been easily classified as positive or negative manually. This was also correlated with observation of more than 50% of trade data being classified as neutral by TextBlob and only a small percentage of data was classified as positive or negative. This impacted the prediction scores as well. Observing the shortcomings of TextBlob library in predicting sentiments, a need was realized to have a better and more effective method for classifying trades.

3.2.4 Foreign Exchange and US Dollars

We followed the neural network based foreign exchange in USD from cryptocurrency scraping data was helpful in understanding people's perceptions apart from those obtained using cryptocurrency. News articles carried more opinions and clearly spoke of their apprehensions or incline towards bitcoin and other cryptocurrencies in focus.

It was exciting to come across news articles which spoke about topics that had a direct but hidden impact on cryptocurrency prices. Primarily among these were the ones which discussed about recent policy changes implemented by the US government such as tax cuts and increase in

federal interest rates. This news had a positive impact on investors and trader’s world over. However, with a strong US dollar other global currency have taken a hit and tumbled down

Foreign Currency Reserves



Figure 3.6: The foreign exchange reserves of different paper based currencies for exchange.

3.3 TECHNICAL TRADE INDICATOR

Sentiment in the technical trade indication is commonly defined as a reaction to an event or thing. Every living organism expresses sentiments in one way or another. Human beings display reactions or sentiments in multiple ways such as facial expressions, change in tone, physical actions. This expression of sentiment is being used since a long time on different domains most common among them being products analysis and demand. Producers can tap into sentiments of the people to find out more about how their products are perceived and changes that could be made to make them more successful.

In a similar way, technical trade indicator can be gauged as to how people react when there are tax cuts, changes in prices, stock prices changing. This sentiment can be analyzed to forecast or predict stock prices since if there is good news about a company performing well, people will be interested in buying stocks of that company or be a part of it so as to achieve success in the future. Similarly, in the event of a failure, people dis-associate themselves from poor performing

companies. The decision to use sentiment analysis was majorly to follow in the footsteps of existing works that had used sentiment analysis on cryptocurrency data with the help of different machine learning frameworks to analyze the sentiment of the data and build conclusions on it. We will be covering multiple phases of using sentiment analysis apart from obtaining tweets from cryptocurrency and web scrapping data. We would be looking at how people perceive changes in government policies, economic changes, geopolitical factors to name a few.

3.4 CRYPTOCURRENCY PRICE MINING API

Python Web Scraping or data scraping from web or price mining is a technique used for extracting data from websites using either web crawlers built personally or by web crawling service providers or by means of API's provided by websites. Some notable services providing web-scraping tools are Amazon, Google, Webhose.io etc.

Apart from fetching and classifying tweets obtained from Cryptocurrency API, the author realized a need to obtain data from sources other than cryptocurrency in order to improve the prediction algorithm and delve deeper into finding the reasons for bitcoin's volatile price. For this purpose, it was decided to web scrape data from news articles which would serve as additional support apart from cryptocurrency obtained data. This web scraping of data was performed by writing code in Python and automating the feature of reading price from websites and running prediction algorithms on them.

3.5 PRICE SENTIMENT DATA

Price sentiment is commonly defined as a reaction to an event or thing. Every living organism expresses sentiments in one way or another. Human beings display reactions or sentiments in multiple ways such as facial expressions, change in tone, physical actions. This expression of sentiment is being used since a long time on different domains most common among them being products analysis and demand. Producers can tap into sentiments of the people to find out more about how their products are perceived and changes that could be made to make them more successful. In a similar way, sentiment can be gauged as to how people react when there are tax

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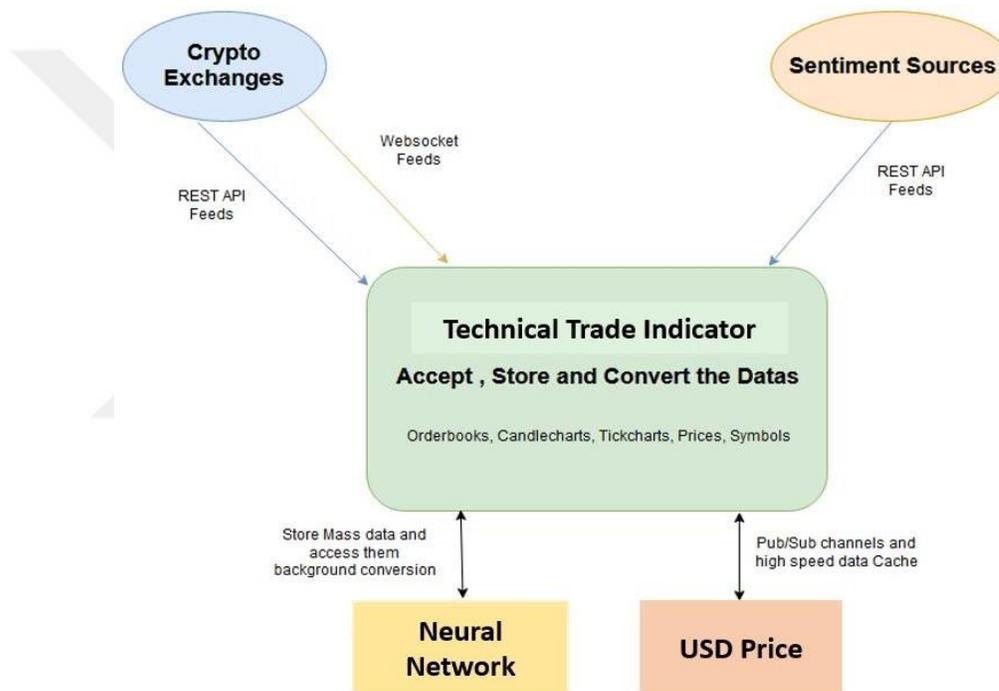


Figure 3.7: The block diagram of technical trade indicator based on predictions from neural network through USD price for cryptocurrency exchange.

In order to have a much better quality of analysis data, news articles from different news outlets and countries were scraped legally using both personally built web crawlers as well as third party web scrapping tools. Some of the few websites from which news articles were obtained included Forbes & Reuters. These news articles written with opinions for and against were helpful in

understanding sentiments of investors towards daily events such as volatile price changes of Bitcoin. Scraping helped in obtaining news articles which spoke about how business institutions were reacting to bitcoin and planning their moves in order to bring in more profits and clients interested in buying and dealing with bitcoins. Policy decisions made by governments worldwide to respond to growing popularity of cryptocurrency was also discussing extensively in multiple news articles.



4. RESULTS

We have achieved a near to accurate price prediction using our neural network algorithms which can be helpful in deciding whether to buy cryptocurrencies or not. From the graph, we can observe the volatility of Bitcoin prices in the last 1 month of April itself since the sample testing space for this research. As discussed above, this volatility in cryptocurrency prices has been due to several factors. We can attribute this fall of Bitcoin price due to the technical trade indicators which have been positive towards cryptocurrency due to governments readily accepting it. This coupled with stronger global currency indices may have been a reason in its fall. There are no specific reasons or events that point to the cause in the fall of cryptocurrency unlike for stock markets, where a reason for the meltdown in a company's stock can be pinpointed to some frantic event. One reason attributed here is price correction of cryptocurrency and other digital currencies which have brought down the exchange price by 5 to 10 time as predicted by the technical trade indication graphs below.

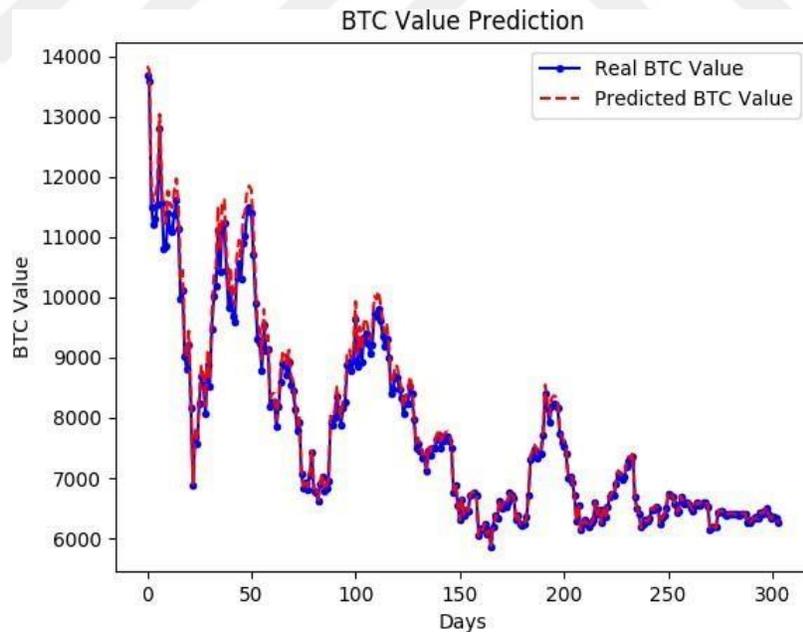


Figure 4.1: The technical trade indicator graph of real BTC value 5 times in 300-days of current fiscal year has further supported this increasing trader confidence and a shift in global cryptocurrency graph by predicted BTC values.

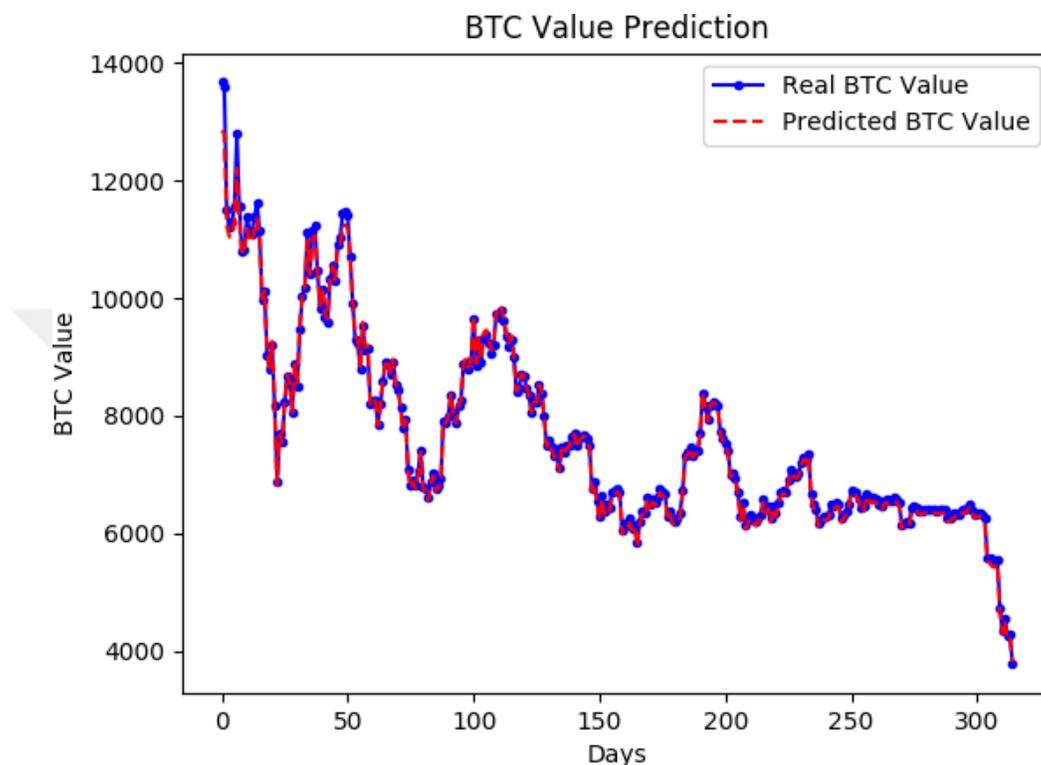


Figure 4.2: The technical trade indicator graph of real BTC value 10 times in 300-days of current fiscal year has further supported this increasing trader confidence and a shift in global cryptocurrency graph by predicted BTC values

There were discrepancies in the prediction of public sentiment due to the fact that given the volatility of Cryptocurrency Prices, public reaction was not quick and adequate enough to aid in predicting price and correlating the results with results obtained from predicting bitcoin prices using machine learning based neural network achieving an accuracy of 94.89% under all circumstances of trade indication.

There has been a widespread crackdown on Bitcoin in the recent months following the magnanimous rise in the price of Bitcoin during the month of December 2019. This widespread

crackdown although started since late last year, did not have a bearing on the prices up until January 2018 when the leading world ordered IRS to look into possible cases of tax evasions by early bitcoin investors in the years between 2014-2020 when the price of Bitcoin had risen tremendously. This news sent major ripples through the world which was already looking at news of successful/unsuccessful hacking attempts on different Bitcoin exchanges and silent crackdown on cryptocurrency mining centers since late 2019. Below we analyze different reasons that have led or may have led to the fall of Bitcoin to its current value of \$6000 compared to \$20,000 in December 19.

Bitcoin along with Ethereum and other cryptocurrencies had been rising during the year of 2020. In the past, futures trading has been introduced for other stock items as well such as Gold, Silver, Platinum to name a few. However, it had been noticed that when the either of above three mentioned futures were introduced in the market, their prices fell down by several points before regaining to their original value after a certain time period which varied from 4 weeks to 7 weeks easily. It is being speculated that even for Bitcoin, there must have been traders who might have bet on the fall of bitcoin after its introduction in the futures market. Negative speculation is a common feature observed in stock markets. It was also speculated that during the economic collapse in 2008, many traders had benefited from the fall since they had bet against the trend. This goes on to show that the stock market functions in unpredictable ways sometimes.

Cryptocurrency has been displaying signs of high volatility since the last few months. Its steady increase and subsequent huge fall lead one to speculate that maybe there may have been external forces trying to control the investor market by fluctuating bitcoin prices, thereby creating a demand supply situation. When the prices nearly touched 20,000 USD, these forces must have been the beneficiaries and sold their bitcoins at huge profits but at the cost of starting a huge turmoil in the market. Countries like Russia, China, South Korea have been seriously cracking down on cryptocurrency mining centers and bitcoin exchanges banning the mining of cryptocurrency and any transactions involving them. South Korean Government has gone an extra mile by raiding financial institutions and exchanges dealing with cryptocurrencies. This has

set a massive negative and fearful sentiment among investors which can be attributed to the cause of cryptocurrencies selling, thereby bringing down its price by over 13.7% in March and April itself.

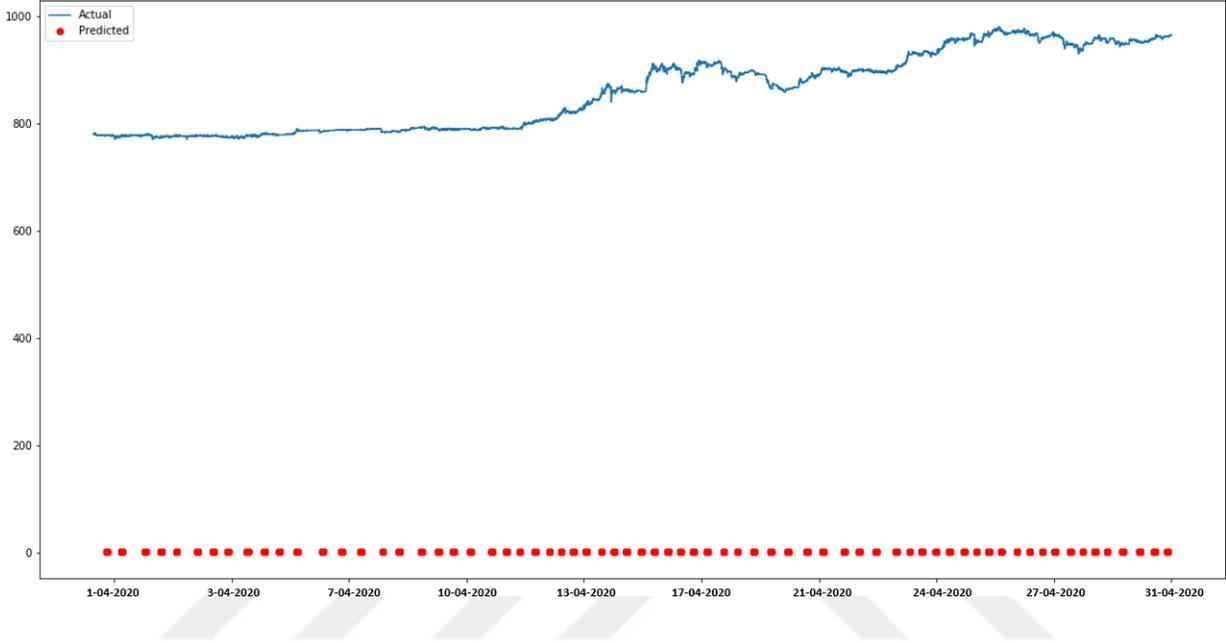


Figure 4.3: The prediction of actual bitcoin-based cryptocurrency price in comparison with the predicted price by the neural network model and trade indicator before initialization.

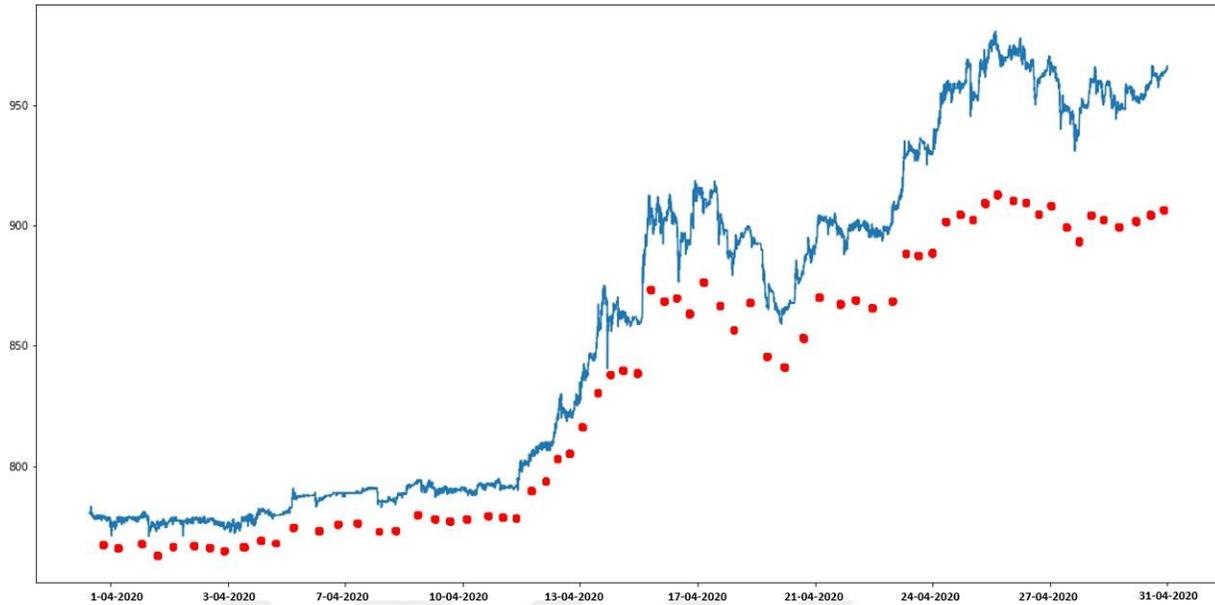


Figure 4.4: The prediction of actual bitcoin-based cryptocurrency price in comparison with the predicted price by the neural network model and trade indicator after initialization.

The figure above depicts results obtained from a sample set of python-based web scrapped data for technical trade indicator graphs. This python-based web scrapped data consisted of news data available on cryptocurrencies from famous and widely read sources. It is being speculated that even for cryptocurrency, there must have been traders who might have bet on the fall of bitcoin after its introduction in the futures market. Negative speculation is a common feature observed in stock markets.

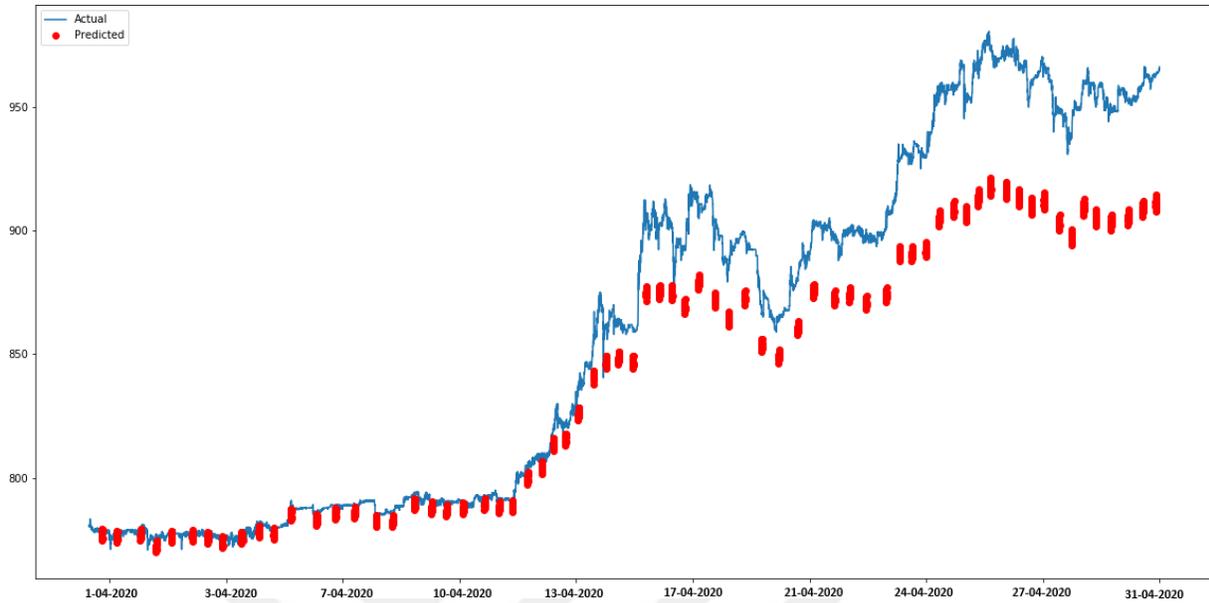


Figure 4.5: The prediction of actual bitcoin-based cryptocurrency price in comparison with the predicted price by the neural network model and trade indicator predicting all the price hikes in a month.

A different technique to obtain data from blogs and news articles was also attempted. This technique involved taking a screenshot of webpages that were difficult to access due to the failure of BeautifulSoup to return required text data. Such web sites had multiple advertisements on their page that loaded once the page was opened due to which BeautifulSoup was unable to fetch data. Keras, a library used in Python and with support extended to all major web browsers was used to take processing of data. The web browser used here was Google Chrome and hence you will see a Google Chrome web-driver being used here.

5. DISCUSSION

5.1 DISCUSSION

In the discussion section, we have analyzed that the cryptocurrencies price could be predicted using the machine learning based neural network for any new cryptocurrency to become global, it needs to be accepted by people and business firms alike for price prediction. When we look at traditional methods of transactions such as US Dollar or Euro or any paper currency for that matter on which the global world depends, we observe that it has been accepted and implemented at the root level. Access to paper currency is the easiest and only requires barter of physical objects in order to earn it or give it away. Everything from oil prices, trading to commodities are purchased and sold using paper currency that is controlled by institutions and supported globally.

When we talk of Bitcoin which is a digital currency to start with, we realize that it not only requires people to have access to a digital device such as a smartphone but also requires them to be connected to wireless internet in order to support validation and authentication of bitcoin transactions. For countries where people have access to such technology there is a high possibility that bitcoin transactions can be adopted over traditional currency. However, in countries still developing and where people do not access to technology, this would prove to be a disaster. Hence, although we are optimistic about Bitcoin becoming a medium of transaction in the present, it cannot be made as a primary method of transaction.

5.2 ANALYSIS AND LIMITATIONS

We have observed that cryptocurrency mining centers and cryptocurrency exchanges banning the mining of bitcoins and any transactions involving prediction of price. Turkish Government has gone an extra mile by raiding financial institutions and exchanges dealing with cryptocurrency. This has set a massive positive and fearful sentiment among investors which can be attributed to the cause of cryptocurrency selling, thereby bringing down its price by over 13.7% in April

itself. Governments have been leading the upgradation on cryptocurrency mining, exchanges, declaring them not legal in order to reserve their state currencies from getting affected. For instance, China's major bank People's Bank of China (PBOC) has been saying that bitcoin cannot be trusted since it's difficult to control a risky financial speculation, but maybe protecting yuan plays an important role. The increase in federal interest rates (2%) by the Federal Reserve Board not only affects US Markets, but worldwide markets as well. For example, when the Federal reserve board increased the federal interest rates, it sent ripples through all major stock markets affecting the values of Nikkei, Sensex, Euro, GBP. Traders in these markets namely Japan Stock Exchange, Turkish Stock Exchange, London Stock Exchange started buying dollars which also affected the exchange rates. Now, when this happens naturally the leading banks of the respective countries have to step in to control any fall in their country's currency exchange value.

This change in federal interest rates can be seen impacting the prices of cryptocurrency. This is because investors purchase by exchanging one form of currency for 1 Bitcoin and there is a certain exchange rate setup. Now, when interest rates are increasing, people will naturally invest and buy USD since it's showing signs of stability and yield and not buy cryptocurrency which has been severely volatile for the last several weeks.

Table 5.1: A comparison between several techniques for price prediction of cryptocurrency in terms of automated solution for price prediction.

| TECHNIQUES | ACCURACY/ THROUGHPUT | CITATION |
|---------------------------|----------------------|---------------|
| Neural Network | 94.89% | Proposed Work |
| Artificial Neural Network | 92.15% | [52] |
| Logistic Regression | 47% | [53] |
| Support Vector Machine | 89.6% | [54] |

A major limitation that was encountered while studying Bitcoin was the huge volatility and fluctuation in its prices over a period of this research. Bitcoin prices steadily rose to 20,000 US Dollar from the course of September to December 2019. However, with news of IRS looking

into cryptocurrencies and South Korean & Japanese governments cracking down on Bitcoin exchanges, hacking of bitcoin exchanges in the US brought down the price by a huge percentage in the month of January 2018 itself. Since then the prices have been declining or we can say slowly becoming stable again.

While using sentiment analysis on Cryptocurrency data, it was observed that 40% of tweets obtained from Cryptocurrency were either garbage or duplicate tweets. Tweets by automated bots, tweets which have a keyword in them but no relation with the context are treated as garbage tweets. Hence, even though Cryptocurrency was a huge treasure trove of data for sentiment analysis and previously used for similar research by other researchers, it was realized that a more dependable and accurate source of information would be required for obtaining results from sentiment analysis. However, there is still optimism that Cryptocurrency improves their API's for fetching tweets and adds filters which would make it easier to collect the data automatically.

6. CONCLUSION

6.1 CONCLUSION

In this proposed research thesis, we have designed a price prediction system of different cryptocurrencies using technical trade indicators and machine learning achieving an accuracy of 94.89% under all circumstances of technical trade indication thereby bringing down its price prediction by over 13.7% in April 2020 itself during evaluation. For any new product to become global, it needs to be accepted by people and business firms alike. When we look at advance methods of machine learning for the transactions of paper-based currencies (such as US Dollar currency) to cryptocurrency for that matter on which the global world depends, we observe that it has been accepted and implemented at the root level. We used a python language based fully automated machine learning and technical trade indicator for the prediction of price. For countries where people have access to such technology there is a high possibility that bitcoin transactions can be adopted over traditional currency. However, in countries still developing and where people do not access to technology, this would prove to be a disaster. The prediction of actual bitcoin-based cryptocurrency price in comparison with the predicted price by the neural network model and trade indicator before initialization, after initialization and gave the prediction in price hike for whole month.

6.2 FUTURE RECOMMENDATION

Cryptocurrency price prediction has a huge potential of answering questions that have been lingering on in the capital markets about the advent of a new currency medium of transaction. There has been ongoing research on this and many papers have started appearing which are trying to find correlation between cryptocurrency and its use in markets. This seems to be an exciting time for Bitcoin and other cryptocurrencies even though they have been inconsistent performers.

From sentiment analysis point of view, there are improvements to be made. Although this research made use of twitter data as well as news articles and web blogs, there is still possibility of mining more data from social media websites like Facebook and LinkedIn which could provide more clarity in results.

We also plan to apply more machine learning based techniques and deep learning techniques especially convolutional neural network and deep convolutional neural network because these are the most advanced networks for making effective and more efficient prediction.



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