# Long Short Term Memory (LSTM) Algorithm for Artificial Intelligence-Based Bitcoin Price Index Prediction

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Abstract     : *This study aims to update prediction results and the efficiency level of bitcoin prices using Long Short Term Memory (LSTM). The data to be predicted can be viewed with the accuracy outcomes by gathering data for the LSTM construction. The data used in this study were obtained from the Yahoo Finance website, and in Figure 4.1, a comparison between the initial closing price and the expected closing price shows an increase of USD 3,000. The initial closing price is around USD 17,000, while the predicted result is worth USD 20,000. Even if the price drops in 2022, the writer can still accurately anticipate the price for the next 30 days. A prediction system is required for the prediction of the movement of the bitcoin exchange rate for the prediction of the dangers associated with investing in bitcoin. Like other unique commodities, bitcoin also exhibits constant daily price fluctuations. One of the cryptocurrencies that are currently in demand as a profitable investment is bitcoin. But there are still major risks associated with investing in bitcoin.*

## 1   INTRODUCTION

It's clear how the world has changed in the 4.0 era. This is because technology has developed rapidly and changed almost every aspect of human life, including commercial activities. One of the economic shifts we are seeing is that people who used to only do business with traditional currencies are now turning to fintech/digitalization. The financial sector, governments, interest groups, and private investors are all interested in blockchain technology related to the use of cryptocurrencies. Bitcoin's popularity is growing, especially in Indonesia, due to the recent price spike. Popular cryptocurrencies like Bitcoin have received a lot of attention in recent years. Globally recognized cryptocurrencies and virtual currencies Fauzi dkk., (2020).

Cryptocurrency is a digital currency that is widely used and built on blockchain. The role of digital currencies is very similar to traditional currencies. There are only blocks of data bound by hashes as validation, not actual money such as currency.

*Artificial Intelligence* (AI) is the ability of machines to imitate intelligence like humans. Machine Learning is part of AI. Machine Learning gives computers the ability to learn by programming indirectly. Life now has a wide variety of sides and points of view. Many aspects of life, including insurance, business, economy, education, society, and even medicine and health, have adopted artificial intelligence. Artificial intelligence is predicted to impact every element of human life.

One of the drawbacks of Machine Learning is that it cannot cope with inputs and outputs. AI is a technology that requires data to be used as knowledge/learning, just like humans. AI requires experience and learning from data so that its intelligence can improve. An important point in the AI process is learning, reasoning and self-correction. The process of learning AI is not always told by humans, AI can learn by itself based on its experience when used by humans. Examples of applications are Self Driving Cars and Sign and Voice Recognizer

(SVR). In figure 1.1, the branches of Artificial Intelligence are Machine Learning, Natural Language Processing (NLP), Speech, Expert Systems, Planning, Scheduling, and Optimization, Robotics, and Vision. This research uses Deep Learning which is a branch of Machine Learning.
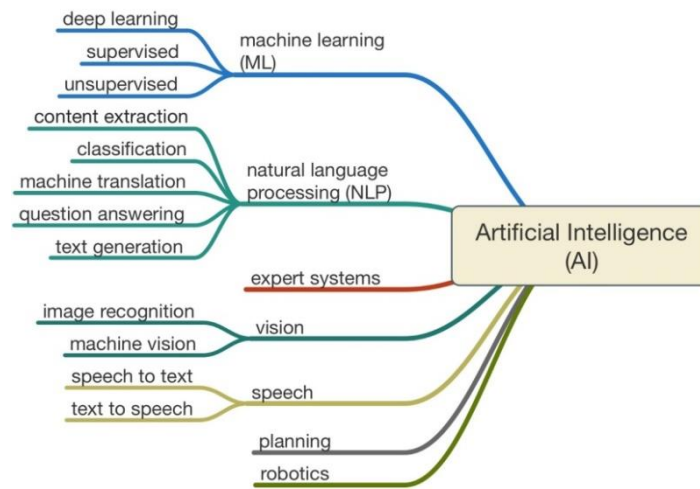


**Figure 1. Branch Artifical Intelligence**

This study combines recurrent neural networks with short-term memory known as long short time memory (LSTM), to estimate the price of bitcoin using the RNN (Recurrent Neural Network) approach. LSTM is a type of Recurrent Neural Network (RNN) where modifications are made to the RNN by adding memory cells that can store information for a long period of time. LSTM is proposed as a solution to overcome the occurrence of vanishing gradients in RNNs when processing long sequential data. One of the deep learning algorithms that has proven successful in being used to predict time series data is the Long Short Term Memory (LSTM) algorithm which is a derivative of the Recurrent Neural Network.

Research using the LSTM Method was also conducted by Wiranda & Sadikin (2019) The results of research on PT. Metiska Farma product sales prediction shows the LSTM value for forecasting sales is 13,762,154.00 for RMSE in rupiah and MAPE is 12%, It is determined by analyzing the performance of the training data model on data testing. Furthermore, research conducted Wijaya *et al.,* (2021) which estimates EUR/USD uses a single input to generate a single-layer ten-node LSTM model that has the lowest Mean Squared Error value of 0.0535. When using the LSTM 10 layer model node 1 and the Nadam optimizer, the MSE value for model 3 input gain with the lowest MSE is 0.0529. The lowest MSE value on a three-input model with one LSTM layer has 10 nodes, and the Nadam optimizer produces an MSE of 0.0543. Research conducted Mulyana & Marjuki, (2022) The advantage of high adaptation can be an added value for pond farmers as a cultivation option. However, the high interest in vaname shrimp farming is not balanced with the equitable distribution of feed distribution channels and shrimp marketing which can affect the price of the shrimp. Research is needed on the prediction of the price of vaname shrimp so that it can be used as an ideal or not ideal determinant of vaname shrimp prices. This study obtained RMSE value results of 1932587 each and MAE results of -0.01. Riyantoko & dkk, (2020) found that RMSE values and data models created using epoch value variations imply that the LSTM algorithm has an accurate prediction rate. The research is analyzed by Qiu *et al.,* (2020) The determination coefficient of the LSTM model is higher than 0.94, and the mean squared error of both models is less than 0.05, according to the results of experiments conducted on the DJIA and S&P 500 datasets. Same with the results of the analysis performed Wildan *et al.,* (2018) using the Long Short Term Memory Neural Networks architecture The analysis findings show that the system's ability to forecast Bitcoin prices is strong, with an average accuracy rate of 93.5% when compared to test data.

Based on the explanation above and good test results, the author is interested in discussing more about "**Long Short Term Memory (LSTM) Algorithm for Artificial Intelligence-Based Bitcoin Price Index Prediction**". This research is expected to be used as a consideration for the general public, or crypto traders in predicting the price of bitcoin and can provide input in carrying out their business activities, so that it can be used as information material in an effort to avoid the risks of investing in stocks and cryptocurrencies and increasing profits from stock and cryptocurrency investments.

# 2 LITERATURE REVIEW

## Artifical Intelligence

Artificial intelligence, commonly called AI, is intelligence introduced into systems that can be organized in a scientific environment. It is described as the intelligence of scientific entities Molnar & Szuts (2018); Monett *et al.,* (2020). According to Andreas Kaplan and Michael Haenlein defines artificial intelligence as "the ability of systems to interpret external data correctly, to learn from that data, and to use that learning to achieve specific goals and tasks through flexible adaptation". These devices are usually referred to as computers. Computers are given artificial intelligence so that they can perform tasks just like humans. Expert systems, computer games, fuzzy logic, artificial neural networks, and robotics are some examples of some types of fields that apply artificial intelligence. The interesting thing about AI is that it is able to self-correction or correct itself. If you've ever heard the AI phrase "If I never win, then at least I shouldn't lose". AI is indeed programmed to keep learning and fixing itself from the mistakes it has made Chen *et al.,* (2020).

## Cryptocurrency

Using advanced cryptography, cryptocurrencies create virtual "coins" and ensure secure ownership and transactions. This issue is intended to be simple to examine but challenging to resolve from a processing standpoint. Which functions are used by various cryptocurrencies for this purpose; The most popular is the target hash, where the hash is calculated so that it is less than a certain value. The target hash (for example, "difficulty problem") is changed each time depending on the less constant total processing power. Transactions are made unique and reliable by using proof-of-work intensive processing. Transactors may charge transaction fees for the first user to successfully verify himself or herself to promote participation Bouri *et al.,* (2020); SP *et al.,* (2022); Xiaofan Li & Andrew B. Whinston, (2019).
Cryptocurrencies are digital or virtual currencies secured by cryptography, which makes them almost impossible to counterfeit or double spend. According to Huda & Hambali, (2020) Cryptocurrency is the name given to a system that uses cryptography. The word "cryptocurrency" comes from the combination of two words, "cryptography" which means secret code and "currency" which means money. Cryptocurrency is a digital asset that is understood as a digital currency. This currency is very different from the usual version, where cryptocurrencies are used for virtual transactions on the Internet. Bitcoin was one of the first recognized cryptocurrencies in the largest capital market to date.

## Bitcoin

Bitcoin is an electronic money created in 2009 by Satoshi Nakamoto. The name is also associated with the open-source software he designed, and also uses a peer-to-peer network without centralized storage or a single administrator where the United States Department of the Treasury calls bitcoin a decentralized currency. Unlike most currencies, bitcoin does not depend on trusting major issuers. Bitcoin uses a database that is distributed and deployed to nodes from a P2P network to a transaction journal, and uses cryptography to provide basic security functions, such as ensuring that bitcoins can only be spent by people owning them, and should never be done more than once according to Arli *et al.,* (2021); Ayu & Wati, (2022); Hasan *et al.,* (2020); Rafi Bakri & Muhammad Hakim (2022).

## Long Short Term Memory *(LSTM)*

Long short term memory network (LSTM) is a data storage system that can process, predict, and classify information that has been stored for a long time. LSTM comes as a modified form of recurrent neural network or RNN and is included as one of the popular Yong Yu, Xiaosheng Si, Changhua Hu, (2019);Wijaya *et al.,* 2021.

# 3 METHODOLOGIES

**Data Analysis Techniques**
Some of the stages of this study are presented as follows:

**1. Data Acquisition**
Data collection methods required to develop AI projects. This is the starting point or material that is then noticed, observed, and studied according to the problem to get the best solution. In this first stage, it prepares bitcoin price data which consists of 6 features, namely date, open, high, low, close, and volume. The data used is daily bitcoin price data for the period January 14, 2018 to December 14, 2022 obtained through the Yahoo Finance website.

**2. Prepocessing**
In the preprocessing stage, it is preparing data before entering the stage of designing a prediction model. At this stage, data normalization is carried out to eliminate null values using min-max scaling techniques on the prepared dataset to minimize errors when performing prediction model tests.
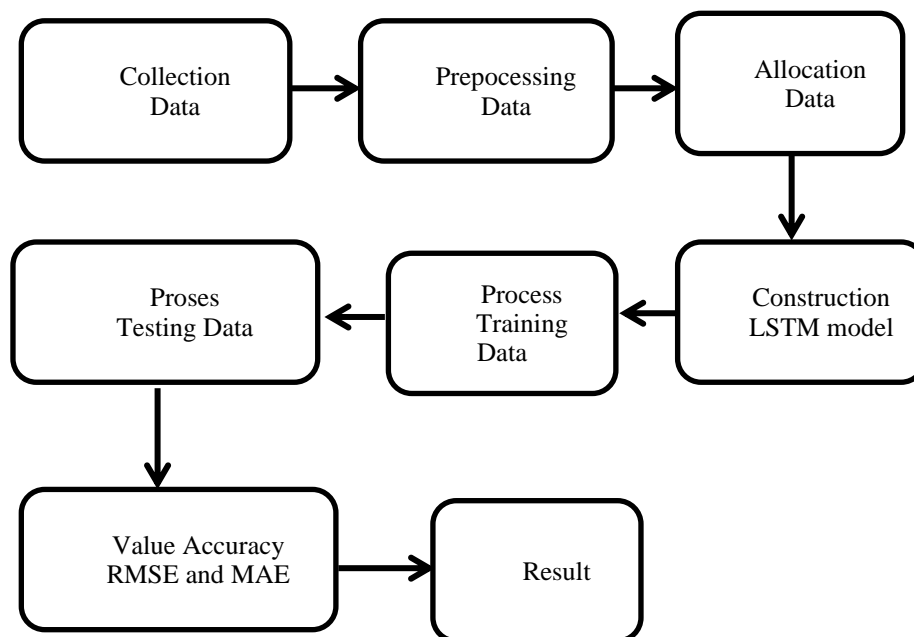


**Figure 2. Data Analysis Techniques**.

# 4 RESULT AND DISCUSSION

**Data Collection**

The form of data used in this study is in the form of a time series which is secondary data, where the author accesses bitcoin price data online through Yahoo Finance (CCC - *CoinMarketCap. Currency in USD, n.d.)*. The data taken in this study is daily bitcoin price data in the period from the beginning of January 2018 to the end of December 2022 as many as 1,795 data, as attached. due to the market for the rapid expansion of bitcoin. The cost of creating volatility is rather expensive in the cryptocurrency market. As a result, the market's potential now includes possible profits as well as market hazards, which often move with high volatility. The daily bitcoin price movement over the 5 years can be seen in figure 4.1. Where the figure is in the form of a line chart that includes Stock Open Price, Stock Close Price, Stock High Price, Stock Low Price.

**Figure 3. Graph Stock analysis chart 2018-2022**

Source : processed data (2023)

Figure 3. shows that the price of bitcoin fell drastically from the beginning of 2018 to the end of 2019 and reached a low of 3,746 USD, after which it rose by 20,000 USD until the end of 2020. But the price of bitcoin increased significantly at the beginning of 2021. The price of bitcoin usually decreases after that. It was noted that since the beginning of mid-2021, the price of bitcoin has plummeted drastically. From the initial price of about 63,000 USD to 30,000 USD and then to 50,000 USD by the end of 2021, the price of bitcoin is recorded. However, it dropped to 30,000 USD at the beginning of 2022. After that, the price of bitcoin dropped drastically until the end of 2022, when its value was around 17,000 USD.

### *Prepocessing Data*

Before proceeding to the stage of designing a prediction model, at this stage, data normalization is carried out. Aims to delete unused data when going to the prediction process. To remove null values, use the min-max scaling technique in the prepared data set to minimize errors when performing prediction model tests. The results of normalization can be seen in table 1.

**Table 1. Normalization Data**

| No. | Date | Open | High | Low | Close |
|-----|------|------|------|-----|-------|
| 0 | 14/1/2018 | 14370.7998 | 14511.7998 | 13268 | 13772 |
| 1 | 15/1/2018 | 13767.2998 | 14445.5 | 13641.7002 | 13819.79981 |
| 2 | 16/1/2018 | 13836.0996 | 13843.0996 | 10194.9004 | 11490.5 |
| 3 | 17/1/2018 | 11431.0996 | 11678 | 9402.29004 | 11188.59961 |
| 4 | 18/1/2018 | 11198.7998 | 12107.2998 | 10942.5 | 11474.90039 |
| ... | ... | ... | ... | ... | ... |
| 1791 | 10/12/2022 | 17134.2207 | 17216.8262 | 17120.6836 | 17128.72461 |
| 1792 | 11/12/2022 | 17129.7109 | 17245.6348 | 17091.8203 | 17104.19336 |
| 1793 | 12/12/2022 | 17102.5 | 17212.5645 | 16899.3945 | 17206.4375 |
| 1794 | 13/12/2022 | 17206.4414 | 17930.0859 | 17111.7637 | 17781.31836 |
| 1795 | 14/12/2022 | 17782.0664 | 18318.5313 | 17739.5137 | 17815.65039 |

*Source : Google Colaboraty processing data (2023)*

1.  Normalization is a technique often applied as part of data preparation for machine learning. The purpose of normalization is to change the values of numeric columns in the data set to use a common scale, without distorting the difference in the range of values or losing information.
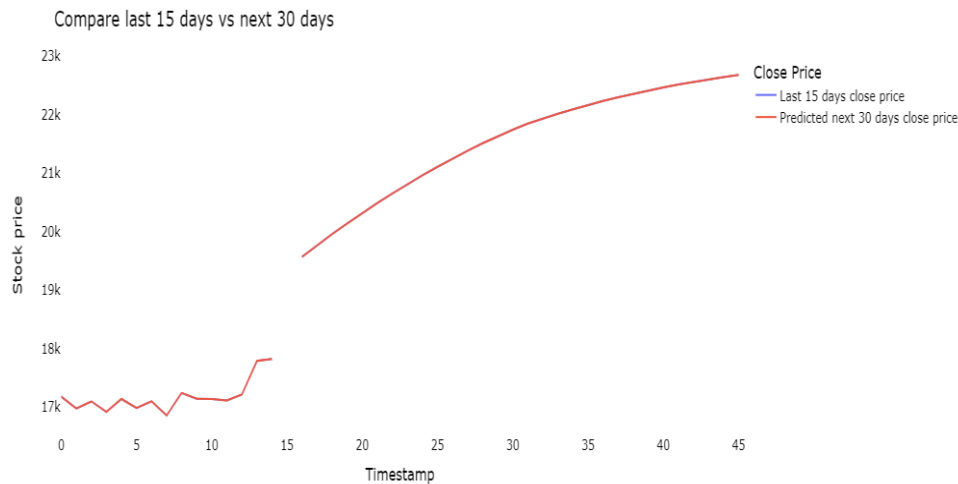
**Data Prediction**

After getting the model in the training process, the model will be tested using the testing data that has been obtained in the formation of training data and testing data. To see whether or not the results of the formed model are good can be seen from the actual data plot and prediction data. The plot can be seen in Figure 4:



**Figure 4. Comparison between the original closing price vs the closing price prediction**
Source: Data Processing Colaboraty (2023)

In Figure 4. it can be seen that the model formed can produce the appropriate output. This can be seen from the predictive pattern of the data which follows the pattern formed by the actual data. Actual data is presented in blue and predicted data is presented in blue.

**Figure 5. Compare last 15 days vs next 30 days**

Source: processed data (2023)

Figure 5 shows the results of price comparisons for the last 15 days by predicting the next 30 days. From the picture it is very clear that the red line shows the prediction of the daily price of Bitcoin for the next 30 days, which will be better than Figure 4.1. the results show predictions for the next 30 days there will be an increase in the price of bitcoin and it is true that in January 2023 the daily price of bitcoin will return to stability.

# 5. CONCLUSIONS

Based on this discussion, it can be concluded that some of the results obtained in this study, including::

1. Prediction results for a comparison between the original closing price vs the predicted closing price in Figure 4.1 where with the original closing price of around 17,000 USD and the predicted result of 20,000 USD, it means that there has been an increase of 3,000 USD. Even though in 2022 there was a price reduction, we managed to get good prediction results.

2. The formation of the LSTM model and its application to time series data from its accuracy to predict the daily price of bitcoin produces good results which can be seen in Figure 4.3 after seeing the results of the prediction data which states that daily bitcoin decreases in 2022.

3. This research in academia is expected to be able to add to and expand reference materials and literacy in the field of business economics, especially international business economics, as well as provide input for researchers and other academics who also conduct similar research in an effort to develop and provide benefits for other research, namely as media to train critical thinking and scientific writing.

And for practitioners (government & international business economists) it is hoped that the results of this research can be used as material for consideration for the general public, or crypto traders in predicting bitcoin prices with even better benchmarks.

# REFERENCES

Arli, D., van Esch, P., Bakpayev, M., & Laurence, A. (2021). Do consumers really trust cryptocurrencies? *Marketing Intelligence and Planning*, *39*(1), 74–90. https://doi.org/10.1108/MIP-01-2020-0036

Ayu, S., & Wati, L. N. (2022). *CRYPTOCURRENCY , TAX IMPOSITION AND SHARIA FINANCE IN INDONESIA : A SYSTEMATIC*. *3*(13), 2278–2290.

Bouri, E., Lucey, B., & Roubaud, D. (2020). Cryptocurrencies and the downside risk in equity investments. *Finance Research*

*Letters*, *33*(September 2018). https://doi.org/10.1016/j.frl.2019.06.009

CCC - CoinMarketCap. Currency in USD. (n.d.). *Bitcoin USD (BTC-USD) Price History & Historical Data - Yahoo Finance*. Retrieved January 31, 2023, from https://finance.yahoo.com/quote/BTC-USD/history?period1=1515888000&period2=1670976000&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, *8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Fauzi, M. A., Paiman, N., & Othman, Z. (2020). Bitcoin and cryptocurrency: Challenges, opportunities and future works. *Journal of Asian Finance, Economics and Business*, *7*(8), 695–704. https://doi.org/10.13106/JAFEB.2020.VOL7.NO8.695

Hasan, R., Hassan, M. K., & Aliyu, S. (2020). Fintech and Islamic Finance: Literature Review and Research Agenda. *International Journal of Islamic Economics and Finance (IJIEF)*, *3*(1), 75–94. https://doi.org/10.18196/IJIEF.2122

Huda, N., & Hambali, R. (2020). *Risiko dan Tingkat Keuntungan Investasi Cryptocurrency PENDAHULUAN Latar Belakang Di Era Revolusi 4 . 0 Perkembangan Dunia teknologi semakin pesat dan telah membawa dunia menuju ke arah yang baru pada hampir keseluruh aspek kehidupan manusia termasuk dala*. *17*(1), 72–84.

Molnar, G., & Szuts, Z. (2018). The Role of Chatbots in Formal Education. *SISY 2018 - IEEE 16th International Symposium on Intelligent Systems and Informatics, Proceedings*, 197–201. https://doi.org/10.1109/SISY.2018.8524609

Monett, D., Lewis, C. W. P., Thórisson, K. R., Bach, J., Baldassarre, G., Granato, G., Berkeley, I. S. N., Chollet, F., Crosby, M., Shevlin, H., Fox, J., Laird, J. E., Legg, S., Lindes, P., Mikolov, T., Rapaport, W. J., Rojas, R., Rosa, M., Stone, P., … Winfield, A. (2020). Special Issue "On Defining Artificial Intelligence"—Commentaries and Author's Response. *Journal of Artificial General Intelligence*, *11*(2), 1–100. https://doi.org/10.2478/jagi-2020-0003

Mulyana, D. I., & Marjuki. (2022). Optimasi Prediksi Harga Udang Vaname Dengan Metode Rmse Dan Mae Dalam Algoritma Regresi Linier. *Jurnal Ilmiah Betrik*, *13*(1), 50–58. https://doi.org/10.36050/betrik.v13i1.439

Qiu, J., Wang, B., & Zhou, C. (2020). Forecasting stock prices with long-short term memory neural network based on attention mechanism. *PLoS ONE*, *15*(1), 1–15. https://doi.org/10.1371/journal.pone.0227222

Rafi Bakri, M., & Muhammad Hakim, A. (2022). PPh ATAU PPN: MENAKAR KEBIJAKAN PERPAJAKAN TERHADAP CRYPTOCURRENCY DI INDONESIA Oleh. *Jurnal Ekonomi Dan Bisnis*, *9*(1).

Riyantoko, P. A., & dkk. (2020). Analisis Prediksi Harga Saham Sektor Perbankan Menggunakan Algoritma Long-Short Terms Memory (Lstm). *Seminar Nasional …*, *2020*(Semnasif), 427–435. http://www.jurnal.upnyk.ac.id/index.php/semnasif/article/view/4135

SP, M. E., Riady, D. K., Majid, M. S. A., Marliyah, M., & Handayani, R. (2022). STUDY OF LITERATURE FINANCIAL TECHNOLOGY, BLOCKCHAIN AND ISLAMIC FINANCE. *International Journal of Educational Review, Law And Social Sciences (IJERLAS)*, *2*(1), 21–32. https://doi.org/10.54443/IJERLAS.V2I1.129

Wijaya, A. J., Swastika, W., & Kelana, O. H. (2021). Prediksi Harga Foreign Exchange Mata Uang Eur/Usd Dan Gbp/Usd Menggunakan Long Short-Term Memory. *Sainsbertek Jurnal Ilmiah Sains & Teknologi*, *2*(1), 16–31. https://doi.org/10.33479/sb.v2i1.121

Wildan, M., Aldi, P., & Aditsania, A. (2018). *Analisis dan Implementasi Long Short Term Memory Neural Network untuk Prediksi Harga Bitcoin*. *5*(2), 3548–3555.

Wiranda, L., & Sadikin, M. (2019). Penerapan Long Short Term Memory Pada Data Time Series Untuk Memprediksi Penjualan Produk Pt. Metiska Farma. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *8*(3), 184–196.

Xiaofan Li & Andrew B. Whinston. (2019). Analyzing Cryptocurrencies. *SpringerLink*. https://link.springer.com/article/10.1007/s10796-019-09966-2

Yong Yu, Xiaosheng Si, Changhua Hu, J. Z. (2019). A Review of Recurrent Neural Networks: LSTM Cells and Network Architectures. *MIT Press Direct*. https://doi.org/10.1162/neco_a_01199

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