



Comparison of banking stock price movements using KNN and Linier Regresi methods

Wresti Andriani¹, Gunawan², Sawavyya Anandianskha³

^{1,2,3}STMIK YMI Tegal, Teknik Informatika, Teknik Informatika, Kota Tegal, Indonesia

ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received Oct 25, 2023 Revised Oct 28, 2023 Accepted Nov 07, 2023</p> <hr/> <p><i>Keywords:</i> <i>k-NN:</i> <i>Linier Regresi:</i> <i>MAE:</i> <i>MSE:</i> <i>RMSE</i></p>	<p>Stock price movements are a reflection of various situations and factors such as economics, politics and markets. Influencing factors such as economic news both foreign and domestic such as monetary policy, changes in interest rates and political events such as general elections. Indonesian politics is currently holding a general election process, the Presidential election can influence stock movements. Causing investors to be more careful about investing in this case in banks in Indonesia that have state-owned status, such as BTN, BRI, BNI and Bank Mandiri. This research predicts stock price movements using the Linear Regression method compared to the k-NN method, to find the best evaluation results from the two methods in selecting banks that are more profitable and do not influence political process factors. The results obtained were that Bank Mandiri was safer and promised profits using the Linear Regression method which was better than k-NN with RMSE 281,012, MAE 97,909 and MSE 80348,873. Bank Mandiri is safer and promises profits.</p> <p><i>This is an open access article under the CC BY-NC license.</i></p> 

Corresponding Author:

Wresti Andriani,
Teknik Informatika Program,
STMIK YMI Tegal,
Address Jl. Pendidikan No. 1, Kota Tegal, Jawa Tengah, 52142, Indonesia.
Email: wresty.andriani@gmail.com

1. INTRODUCTION

Stock price movements are a reflection of various situations and factors such as economics, politics and markets (Al-Thaqeb et al., 2022). Influencing factors such as economic news both foreign and domestic such as monetary policy, changes in interest rates and political events such as general elections, company performance (Su et al., 2023), where if the company experiences profits, its share price tends to increase or vice versa, industrial developments and other factors, such as market sentiment (Syofyan et al., 2020). These factors cause stock market movements to be very volatile and therefore difficult to predict (Li & Pan, 2022). This is what encourages investors to often carry out careful research and diversify their portfolios so that the risk of loss can be avoided (Saputra et al., 2021). Likewise, share price movements in the banking world (Hasan et al., 2021). Stock prices for banks are influenced a lot, including the existence of banking regulations with government regulations and supervisory bodies (Nazaritehrani & Mashali, 2020), such as the central bank, which have a significant impact because they influence the way banks operate and

the level of compliance that must be followed, in addition to several other factors (Engineering et al., 1810).

Indonesia has four banks that have the status of state-owned enterprises (BUMN), namely Bank Mandiri, Bank Rakyat Indonesia (BRI), Bank Negara Indonesia (BNI) and Bank Tabungan Negara (BTN) (Almahdali et al., 2021). (Almahdali et al., 2021). The political upheaval that occurred in Indonesia ahead of the Indonesian presidential election has more or less influenced stock movements in Indonesia, requiring investors to be more careful in examining stock movements (Tomsa, 2018).

Several methods that are often used to predict stock price movements include (Prasetyo et al., 2023). Using the LSTM method to predict stock movements which produces a MAPE evaluation value of 95.78%, although it has the advantage of being able to combine current information with past information so that it is considered efficient, this method has the weakness is that it tends to be overfitting and requires large training data, difficult for limited data. Research conducted (Nuzula Agustin, 2019), using the ARIMA method to predict the LQ45 share price produces an RMSE of 93%. This method has the advantage that the approach used is simple, but this method also has the weakness, namely that it is not always successful in predicting stock prices, especially if the situation and the presence of external factors that are difficult to predict, using the Artificial Neural Network method to predict the S&P 500 stock price which produces a fairly high evaluation value, namely MAPE of 97% (Fitriyaningsih et al., 2019). The Neural Network method has the advantage of being able to handle complex and non-linear data well, but this method also has the weakness of often overfitting and requiring large amounts of data (Puzyrev, 2019).

Previous research has carried out stock price predictions by comparing three methods, namely Linear Regression, LSTM and GRU algorithms on KEJU shares, the results are GRU (Gate Recurrent Unit) is better (Khalis Sofi et al., 2021). In car price prediction research using a comparison of the Support Vector Machine and Linear Regression methods, the results of SVM are better than Linear Regression (Yennimar et al., 2022). As well as research on the comparison between SVM, Regression and ANN to predict water surface results, SVM is better than Regression and ANN (Soebroto et al., 2022).

Based on the background above, this research will conduct research using the Linear Regression method and K-Nearest Neighbor in predicting stock prices from share price movements of four banks which are included in state-owned banks, namely BRI, BNI, Bank Mandiri and Bank BTN. The Linear Regression method was chosen because this method is very simple and easy to understand (Ray, 2019), while the KNN method was chosen because apart from being simple, K-Nearest Neighbor is also flexible in handling several types of data (Li et al., 2019) .

The expected implication of this research is theoretically to assess the health of banks to determine investment potential and to find out the factors that influence the share prices of the four state-owned banks, in this case the political policies that occur in Indonesia. In practice, the results of this research are to help investors to assess the health of banks from share price movements, thereby helping investors to make investment decisions so as to avoid the risk of loss.

2. RESEARCH METHOD

The procedures for this research can be seen in Figure 1.

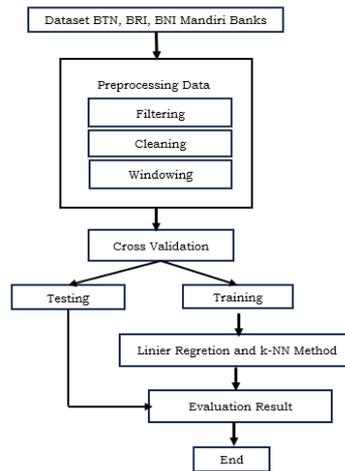


Figure 1. Prediction Process Flow Diagram

In Figure 1 it can be seen that the flow of this research started from data collection carried out online from the Yahoo Finance.com data page on Historical data, from 2021 to 2023, 487 data were obtained. Links are <https://finance.yahoo.com/quote/BBRI.JK?p=BBRI.JK&.tsrc=fin-srch> for BRI stock Price, <https://finance.yahoo.com/quote/BMRI.JK?p=BMRI.JK&.tsrc=fin-srch> for Mandiri Stock Price, <https://finance.yahoo.com/quote/BBNI.JK?p=BBNI.JK&.tsrc=fin-srch> for BNI stock Price, and <https://finance.yahoo.com/quote/BBTN.JK/history?p=BBTN.JK> for BTN. The four state-owned banks studied the results can be seen in Table 12,3,4

Table 1. BRI Stock Price

Date	Open	High	Low	Close	Adj Close	Volume
10/25/2021	4330	4370	4300	4300	3891.932617	128240100
10/26/2021	4280	4370	4270	4350	3937.1875	108782400
10/27/2021	4330	4340	4260	4290	3882.881592	258038300
10/28/2021	4210	4300	4200	4240	3837.626465	159645200
10/29/2021	4300	4300	4220	4250	3846.677734	155011100
11/1/2021	4330	4330	4220	4230	3828.575439	102079300
11/2/2021	4270	4270	4210	4210	3810.473389	124799700
11/3/2021	4250	4300	4210	4290	3882.881592	100486300
11/4/2021	4330	4340	4250	4250	3846.677734	119591100
11/5/2021	4270	4270	4210	4240	3837.626465	74347000
...
...
10/20/2023	4980	5100	4960	5050	5050	173353600

Table 1 above is data on share price movements from Bank Rakyat Indonesia, which was obtained online, for the period 25 October 2021 to 20 October 2023. The data obtained was 487, consisting of 7 variables, namely date, opening data, highest data, lowest data, closing data, adjusted close data and volume data from BRI bank share price movements.

Table 2. Bank Mandiri Stock Price

Date	Open	High	Low	Close	Adj Close	Volume
10/25/2021	3587.5	3625	3562.5	3562.5	3235.251953	76296200
10/26/2021	3550	3600	3550	3587.5	3257.955322	55872800
10/27/2021	3600	3612.5	3562.5	3575	3246.603516	82925200
10/28/2021	3562.5	3575	3500	3512.5	3189.844727	99023600
10/29/2021	3587.5	3650	3575	3587.5	3257.955322	160952400
11/1/2021	3625	3625	3575	3587.5	3257.955322	65621400
11/2/2021	3587.5	3600	3500	3512.5	3189.844727	51923400
11/3/2021	3487.5	3625	3462.5	3562.5	3235.251953	107556600
11/4/2021	3625	3650	3587.5	3587.5	3257.955322	103726400

11/5/2021	3625	3625	3500	3550	3223.899902	48035600
...
10/20/2023	5675	5800	5650	5750	5750	82132000

Likewise, in table 2 above is data on share price movements from Bank Mandiri, which was obtained online, for the period 25 October 2021 to 20 October 2023. The data obtained was 487, consisting of 7 variables, namely date, opening data, highest data, data lowest, closing data, adjusted close data and volume data from bank Mandiri share price movements

Table 3 BNI Stock Price

Date	Open	High	Low	Close	Adj Close	Volume
10/25/2021	3737.5	3787.5	3675	3675	3248.96167	97000800
10/26/2021	3675	3700	3600	3637.5	3215.809082	52453800
10/27/2021	3612.5	3625	3525	3537.5	3127.4021	95347600
10/28/2021	3512.5	3537.5	3462.5	3525	3116.351074	78045400
10/29/2021	3587.5	3587.5	3425	3500	3094.249268	118294800
11/1/2021	3512.5	3512.5	3412.5	3425	3027.943848	69669000
11/2/2021	3425	3475	3362.5	3400	3005.842041	60944600
11/3/2021	3400	3525	3362.5	3512.5	3105.300049	93339800
11/4/2021	3537.5	3562.5	3500	3500	3094.249268	54733000
...
10/20/2023	4940	5025	4910	4970	4970	48517500

For table 3 above, it is the same as for BRI and Mandiri banks, the variables consist of 7, namely date, opening data, Highest data, Lowest data, closing data, Adjusted Close data and volume data from share price movements from BNI bank. Data obtained online, for the period 25 October 2021 to 20 October 2023. Data obtained was 487.

Table 4. BTN Stock Price

Date	Open	High	Low	Close	Adj Close	Volume
10/25/2021	1820	1835	1795	1805	1722.637085	45537000
10/26/2021	1810	1815	1780	1780	1698.777832	23458400
10/27/2021	1780	1790	1730	1740	1660.603027	41038100
10/28/2021	1740	1750	1675	1745	1665.375	56192300
10/29/2021	1760	1785	1735	1780	1698.777832	56675000
11/1/2021	1795	1810	1780	1790	1708.321533	39097000
11/2/2021	1790	1790	1715	1720	1641.515625	29147500
11/3/2021	1740	1775	1720	1765	1684.46228	26946400
11/4/2021	1775	1790	1750	1765	1684.46228	36368600
11/5/2021	1765	1775	1700	1760	1679.69043	34354100
...
10/20/2023	1200	1220	1200	1210	1210	11902500

In table 4, data from BTN bank, there are also 7 variables, namely date, opening data, Highest data, Lowest data, closing data, Adjusted Close data and Volume data. Data obtained online, for the period 25 October 2021 to 20 October 2023. Data obtained was 487.

Stock price movements have a data variable that explains the date of the transaction event, an opening variable that shows the initial stock price on that day which is the first price in the initial stock trading session, the highest variable is the highest price achieved during the trading session before closing, the lowest variable is the price the lowest reached by the stock before the closing session, the closing variable is the last price of the stock traded on that day. This data is often used as a reference for stock performance in daily reports, and an important element as a starting point for stock analysis and this fact is what drives this research to use the close variable as a reference. While adjusted close is a

term used in the context of stock prices as a reference for closing prices after experiencing adjustments from an event as well as volume data which is the total number of shares bought and sold during a given trading period and measured in share units (Huang et al., 2023).

After obtaining data from the four state-owned banks, data preprocessing was then carried out, including filtering, noisy and windowing. Filtering is by changing time series data from the oldest to the newest to vice versa, namely from the newest year 2023 to the old year, namely 2021. Meanwhile, Noisy is to fill in impossible data and empty data, while windowing is by changing univariate data into multivariate data. This research will use the Close variable as the target, and use a sliding window to obtain input variable data for the previous three days which will be used as the input variable. After that, this data is ready to be used as research data. Then this data is used to predict stock prices using Linear Regression and K-Nearest Neighbor methods by comparing the three methods to find the best evaluation results from the RMSE, MSE and MAE values.

The linear regression method (linear regression) is a statistical technique used to model linear relationships between one or more independent variables (predictors) and dependent variables (variables to be predicted). The main goal of linear regression is to find the regression line (straight line) that best characterizes the data. This regression line is used to make predictions or evaluate the relationship between variables. The simple linear regression equation is seen in equation 1 (Shen, 2009).

$$Y = a + bX \quad (1)$$

Where, Y is the dependent variable. X is the independent variable. a is the intercept (Y value when X = 0), and b is the regression coefficient that measures the slope of the regression line.

The k-NN method is used to predict the continuous value of an object based on its nearest neighbors in feature space. calculate the distance between that object and all objects in the training data. Select k-Nearest Neighbors based on this distance. The predicted value of the object to be predicted is the average or middle value of the dependent variable values from the k-Nearest Neighbors. The equation is seen in equation 2 (Lubis & Lubis, 2020).

$$k\text{-NN} = \frac{1}{k} \sum_{i=1}^k Y_i \quad (2)$$

Where is the value of the dependent variable of the neighbor to i.

The evaluation results used in this research are the RMSE, MAE and MSE values (Lyu et al., 2022). Root Mean Square Error (RMSE) is a metric used to measure the extent of the difference between predicted and actual values in regression analysis (Hamzah et al., 2021). RMSE is the square root of the average of the squares of the differences between the predicted value (\hat{y}) and the true value (y) of the data. The smaller the RMSE, the better the regression model is at making predictions, and the closer it is to the true value. RMSE is one of the metrics commonly used to evaluate the performance of a regression model. The equation is seen in equation 3 (Wang & Lu, 2018).

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_1 - \hat{y}_1)^2} \quad (3)$$

Where, n is the number of samples or observations in the dataset, y_1 is the true value of the observation to i, \hat{y}_1 is the predicted value of the observation to i.

Mean Squared Error (MSE) is a metric used to measure the extent of the difference between predicted and actual values in regression analysis. MSE is the average of the

squared differences between the predicted value (\hat{y}) and the true value (y) of the data. The equation is seen in equation 4 (Prayudani et al., 2019).

$$MSE = \frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2 \quad (4)$$

Where, n is the number of samples or observations in the dataset, y_i is the true value of the observation to i , and \hat{y}_i is the predicted value of the observation to i . The smaller the MSE, the better the regression model is at making predictions, and the closer it is to the true value (Rustam et al., 2020). However, MSE has the property of giving high weight to large differences, so the regression model tends to be sensitive to outliers (*WIRES Computational Stats - 2020*).

Mean Absolute Error (MAE) is a metric used to measure the extent of the difference between predicted and actual values in regression analysis. MAE is the average of the absolute value of the difference between the predicted value (\hat{y}) and the actual value (y) of the data. The equation is seen in equation 5 (Kane et al., 2020).

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}_i| \quad (5)$$

Where, n is the number of samples or observations in the dataset, y_i is the true value of the observation to i , and \hat{y}_i is the predicted value of the observation to i . MAE provides information about the extent to which regression predictions differ from the actual value in the same units as the dependent variable (Mayer & Butler, 1993). MAE does not give greater weight to large differences, so it is not sensitive to outliers such as Mean Squared Error (MSE) or Root Mean Squared Error (RMSE) (Sewdien et al., 2020). Therefore, MAE is often used in situations where outliers can have a large impact on the evaluation of model.

3. RESULTS AND DISCUSSIONS

The data obtained from The Yahoo Finance.com page for each bank was carried out by a windowing process, because the target was the Close variable, so the close variable was processed using a sliding window, being 3 days earlier with the last day close variable being the target. As in tables 5,6,7.

Table 5. Bank BRI

C-3	C-2	C-1	Close
5150	5150	5000	5050
5250	5150	5150	5000
5275	5250	5150	5150
5300	5275	5250	5150
5250	5300	5275	5250
5175	5250	5300	5275
5125	5175	5250	5300
5175	5125	5175	5250
5175	5175	5125	5175
5250	5175	5175	5125
...
...
4300	4350	4290	4240

Table 6. Bank Mandiri

C-3	C-2	C-1	Close
3512.5	3575	3587.5	3562.5
3587.5	3512.5	3575	3587.5
3587.5	3587.5	3512.5	3575
3512.5	3587.5	3587.5	3512.5
3562.5	3512.5	3587.5	3587.5
3587.5	3562.5	3512.5	3587.5
3550	3587.5	3562.5	3512.5
3500	3550	3587.5	3562.5
3437.5	3500	3550	3587.5
3575	3437.5	3500	3550
...
...
5750	5725	5850	6000

Table 7. Bank BNI

C-3	C-2	C-1	Close
3525	3537.5	3637.5	3675
3500	3525	3537.5	3637.5
3425	3500	3525	3537.5

Table 8. Bank BTN

C-3	C-2	C-1	Close
1745	1740	1780	1805
1780	1745	1740	1780
1790	1780	1745	1740

3400	3425	3500	3525
3512.5	3400	3425	3500
3500	3512.5	3400	3425
3475	3500	3512.5	3400
3525	3475	3500	3512.5
3525	3525	3475	3500
3537.5	3525	3525	3475
...
...
4970	4940	5125	5200

1720	1790	1780	1745
1765	1720	1790	1780
1765	1765	1720	1790
1760	1765	1765	1720
1795	1760	1765	1765
1770	1795	1760	1765
1775	1770	1795	1760
...
...
1210	1210	1225	1235

Then each data that has gone through the windowing process is processed using a comparison of Linear Regression and K-NN methods to obtain the most accurate evaluation values in the form of RMSE, MAE and MSE. Using Rapidminer. The share price movements of each bank can be seen in the scatter graph in figure 1.

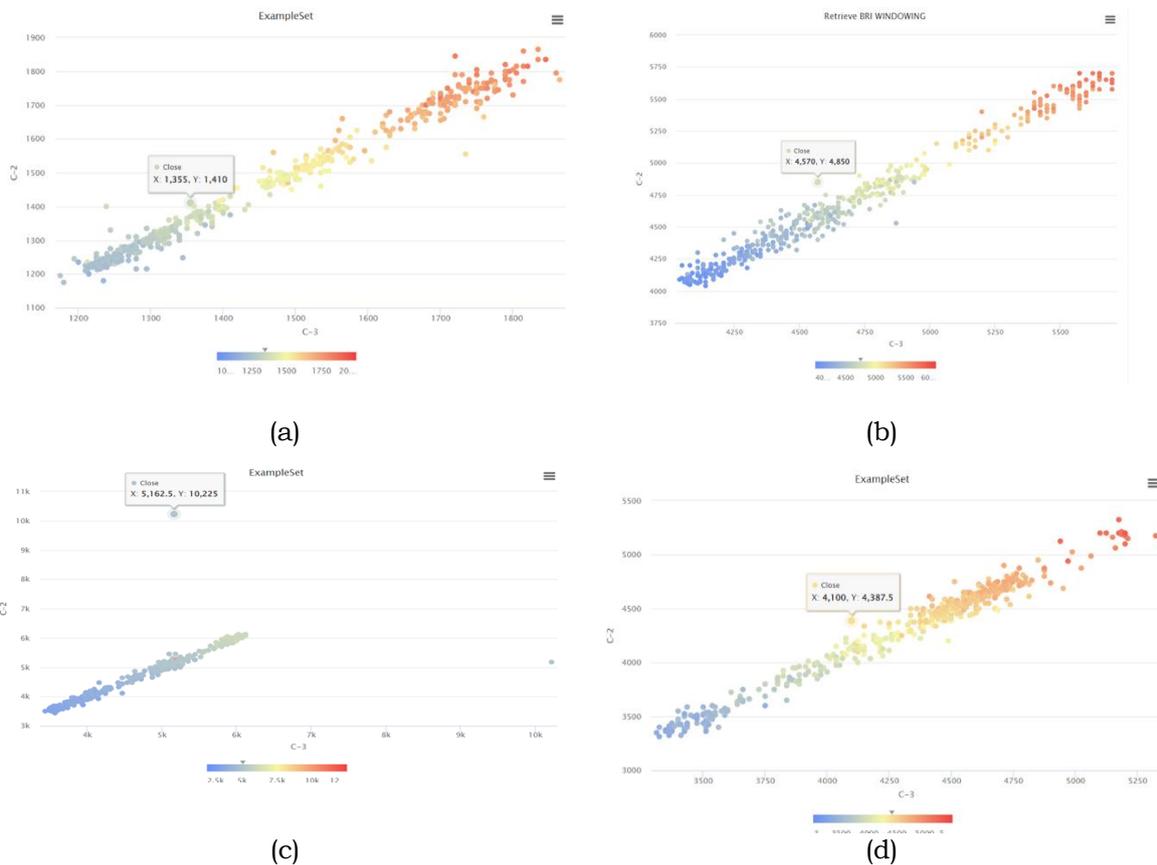


Figure 1. Stock Price (a) Mandiri, (b) BNI, (c) BTN and (d) BRI Bank

The method used to predict stock price movements is the Linear Regression method. Automatic division of training data and testing data using Cross Validation. Then the results of the evaluation values are generated with RMSE, MAE and MSE values. These results were compared using the K-NN method in the same way. A comparison of the results of the RMSE, MAE and MSE values can be seen in Table 9.

Table 9. Comparison of KNN and LR

Bank Method	BRI		BTN		BNI		Mandiri	
	KNN	LR	KNN	LR	KNN	LR	KNN	LR
RMSE	75.269	78.860	30.934	36.988	77.610	97.895	214.215	281.012
MAE	58.217	60.106	21.413	25.677	58.161	73.782	89.138	97.909
MSE	5789.958	6557.20	995.451	163680	6208.967	10098.943	80348.873	10098.943

From table 9 it can be seen that from the results of the research conducted, using the Linear Regression method and the k-Nearest Neighbor method shows that for banks with BUMN status above, the best evaluation results are for Bank Mandiri, both with the LR method, which is better than k-Nearest Neighbor, with an RMSE value of 281.012, MAE of 97.909, and MSE is 10098.943. Meanwhile, for the k-NN method, the RMSE value is 214,215, MAE is 89,138 and MSE is 80348,873, at k=5. This shows investors to invest in Bank Mandiri, because share price movements are safer, followed by BNI bank, then BRI, and then BTN. It is hoped that you will get higher profits and avoid losses, not affected by the events of the presidential nomination.

4. CONCLUSION

From the results of the research that has been carried out, it can be concluded that to predict share price movements in banks with the above BUMN status, namely BNI, BTN, BRI and Mandiri, the Linear Regression method is better than the k-NN method, with the best evaluation results of share price movements, namely at Mandiri Bank. Evaluation results with RMSE of 281,021, MAE of 97,909, MSE of 10098,943. This is expected to help investors choose to invest in Bank Mandiri and get maximum profits and minimize losses. Share price movements at Bank Mandiri are least affected by ongoing political activities in Indonesia. However, because the linear regression method also has weaknesses, including being very susceptible to the influence of outliers which do not always have a linear pattern, it is recommended for further research to try using various time series methods such as ARIMA or GARCH which can model changes in stock prices over time (time series) and improve data and variable data to produce more accurate evaluation values.

REFERENCES

- Al-Thaqeb, S. A., Algharabali, B. G., & Alabdulghafour, K. T. (2022). The pandemic and economic policy uncertainty. *International Journal of Finance and Economics*, 27(3), 2784–2794. <https://doi.org/10.1002/ijfe.2298>
- Almahdali, F., Natsir, S., Hasanuddin, B., & Husnah. (2021). The Effect of Servant Leadership, Emotional Intelligence, and Self-Efficacy on Organizational Citizenship Behavior. *International Journal of Multicultural and Multireligious Understanding*, 8(5), 682–694.
- Engineering, G., Crossing, M., Engineering, G., & Crossing, M. (1810). The Assessing Impact of Cebtral Bank Digital. *Spatio-Temporal Analysis of Seismic Anisotropy Associated with the Cook Strait and Kaikōura Earthquake Sequences in New Zealand Kenny*, 1–10.
- Fitriyaningsih, I., Tampubolon, A. R., Lumbanraja, H. L., Pasaribu, G. E., & Sitorus, P. S. A. (2019). Implementation of Artificial Neural Network to Predict S&P 500 Stock Closing Price. *Journal of Physics: Conference Series*, 1175(1). <https://doi.org/10.1088/1742-6596/1175/1/012107>
- Hamzah, F. B., Hamzah, F. M., Razali, S. F. M., & Samad, H. (2021). A comparison of multiple imputation methods for recovering missing data in hydrological studies. *Civil Engineering Journal (Iran)*, 7(9), 1608–1619. <https://doi.org/10.28991/cej-2021-03091747>
- Hasan, M. B., Mahi, M., Sarker, T., & Amin, M. R. (2021). Spillovers of the COVID-19 Pandemic: Impact on Global Economic Activity, the Stock Market, and the Energy Sector. *Journal of Risk and Financial Management*, 14(5). <https://doi.org/10.3390/jrfm14050200>
- Huang, W., Gao, T., Hao, Y., & Wang, X. (2023). Transformer-based forecasting for intraday trading in the Shanghai crude oil market: Analyzing open-high-low-close prices. *Energy Economics*, 127, 107106. <https://doi.org/https://doi.org/10.1016/j.eneco.2023.107106>
- Kane, J. X., Connell, B., Yip, H., McAlister, J. C., Beckingsale, P., Snibson, G. R., & Chan, E. (2020).

- Accuracy of Intraocular Lens Power Formulas Modified for Patients with Keratoconus. *Ophthalmology*, 127(8), 1037–1042. <https://doi.org/10.1016/j.ophtha.2020.02.008>
- Khalis Sofi, Aswan Supriyadi Sunge, Sasmitoh Rahmad Riady, & Antika Zahrotul Kamalia. (2021). Stock Price Prediction using Time Series Model Comparing Linier Regression, LSTM and GRU Algoritm. *Seminastika*, 3(1), 39–46. <https://doi.org/10.47002/seminastika.v3i1.275>
- Li, Y., & Pan, Y. (2022). A novel ensemble deep learning model for stock prediction based on stock prices and news. *International Journal of Data Science and Analytics*, 13(2), 139–149. <https://doi.org/10.1007/s41060-021-00279-9>
- Li, Y., Yang, Y., Che, J., & Zhang, L. (2019). Predicting the number of nearest neighbor for kNN classifier. *IAENG International Journal of Computer Science*, 46(4), 1–8.
- Lubis, A. R., & Lubis, M. (2020). Optimization of distance formula in K-Nearest Neighbor method. *Bulletin of Electrical Engineering and Informatics*, 9(1), 326–338.
- Lyu, Z., Yu, Y., Samali, B., Rashidi, M., Mohammadi, M., Nguyen, T. N., & Nguyen, A. (2022). Back-Propagation Neural Network Optimized by K-Fold Cross-Validation for Prediction of Torsional Strength of Reinforced Concrete Beam. *Materials*, 15(4). <https://doi.org/10.3390/ma15041477>
- Mayer, D. G., & Butler, D. G. (1993). Statistical validation. *Ecological Modelling*, 68(1–2), 21–32. [https://doi.org/10.1016/0304-3800\(93\)90105-2](https://doi.org/10.1016/0304-3800(93)90105-2)
- Nazaritehrani, A., & Mashali, B. (2020). Development of E-banking channels and market share in developing countries. *Financial Innovation*, 6(1). <https://doi.org/10.1186/s40854-020-0171-z>
- Nuzula Agustin, I. (2019). the Approach of Box Jenkins Time Series Analysis for Predicting Stock Price on Lq45 Stock Index. *Profit*, 13(01), 18–25. <https://doi.org/10.21776/ub.profit.2019.013.01.2>
- Prasetyo, F. A., Nugroho, S., & Setiawan, A. (2023). Prediction of stock closing price PT. Telkom Indonesia with LSTM method. *AIP Conference Proceedings*, 2706(1).
- Prayudani, S., Hizriadi, A., Lase, Y. Y., Fatmi, Y., & Al-Khowarizmi. (2019). Analysis Accuracy of Forecasting Measurement Technique on Random K-Nearest Neighbor (RKNN) Using MAPE and MSE. *Journal of Physics: Conference Series*, 1361(1). <https://doi.org/10.1088/1742-6596/1361/1/012089>
- Puzirev, V. (2019). Deep learning electromagnetic inversion with convolutional neural networks. *Geophysical Journal International*, 218(2), 817–832. <https://doi.org/10.1093/gji/ggz204>
- Ray, S. (2019). A quick review of machine learning algorithms. *2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon)*, 35–39.
- Rustam, F., Reshi, A. A., Mehmood, A., Ullah, S., On, B. W., Aslam, W., & Choi, G. S. (2020). COVID-19 Future Forecasting Using Supervised Machine Learning Models. *IEEE Access*, 8, 101489–101499. <https://doi.org/10.1109/ACCESS.2020.2997311>
- Saputra, J., Astuti, D., & Pertiwi, D. (2021). Effect of Financial Literacy, Risk Attitude and Saving Motives To Disposition Bias on Mutual Funds Investors. *International Journal of Financial and Investment Studies (IJFIS)*, 2(1), 27–33. <https://doi.org/10.9744/ijfis.2.1.27-33>
- Sewdien, V. N., Preece, R., Torres, J. L. R., Rakhshani, E., & van der Meijden, M. (2020). Assessment of critical parameters for artificial neural networks based short-term wind generation forecasting. *Renewable Energy*, 161, 878–892. <https://doi.org/10.1016/j.renene.2020.07.117>
- Shen, J. (2009). Linear Regression. *Encyclopedia of Database Systems*, 1622–1622. https://doi.org/10.1007/978-0-387-39940-9_542
- Soebroto, A., Cholissodin, I., Pratiwi, D., & Putra, G. (2022). Comparative Study of SVR, Regression and ANN Water Surface Forecasting for Smart Agriculture. *Habitat*, 33(1), 86–92. <https://doi.org/10.21776/ub.habitat.2022.033.1.9>
- Su, C. W., Yuan, X., Umar, M., & Chang, T. (2023). Is presidential popularity a threat or encouragement for investors? *Economic Research-Ekonomiska Istrazivanja*, 36(2). <https://doi.org/10.1080/1331677X.2022.2129409>
- Syofyan, R., Putra, D. G., & Aprayuda, R. (2020). Influence of Company Value Information, Dividend Policy, and Capital Structure on Stock Price. *SAR (Soedirman Accounting Review): Journal of Accounting and Business*, 5(2), 152. <https://doi.org/10.20884/1.sar.2020.5.2.3554>
- Tomsa, D. (2018). Regime resilience and presidential politics in Indonesia. *Contemporary Politics*, 24(3), 266–285. <https://doi.org/10.1080/13569775.2017.1413502>
- Wang, W., & Lu, Y. (2018). Analysis of the Mean Absolute Error (MAE) and the Root Mean Square Error (RMSE) in Assessing Rounding Model. *IOP Conference Series: Materials Science and Engineering*, 324(1). <https://doi.org/10.1088/1757-899X/324/1/012049>
- WIREs Computational Stats - 2020 - Filzmoser - Robust linear regression for high-dimensional data An overview.pdf.* (n.d.).
- Yennimar, Kelvin, Suwandi, & Amir. (2022). Comparison Analysis of SVM Algorithm with Linear.