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ANALYSIS OF ACCURACY LEVEL OF MOVING AVERAGE, PARABOLIC SAR AND CONVOLUTIONAL INDICATORS NEURAL NETWORK ON BUY AND SELL DECISIONS (Case study of shares of PT Bank Negara Indonesia, Tbk)

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ABSTRACT

The development of the global COVID-19 pandemic in the fourth quarter of 2021 was marked by the increase in global daily cases after the reopening in various countries and the emergence of Omicron as a new variant of concern. The banking sector is one of the main sectors supporting the Indonesian economy. As we enter the era of the industrial revolution 4.0, people see the capital market as a reliable source of income to increase their income. This is evidenced by the large number of foreign and local investors who invest their capital in the world capital market. The movement of stock prices on the Indonesian stock exchange is very volatile. This is a risk that must be borne by every investor, especially short-term investors. Many methods are used in predicting the stock price, one of which is by using technical analysis indicators such as the Moving Average and Parabolic SAR. In addition to using technical analysis in making investment decisions, investors can also use machine learning algorithmic indicators such as the Convolutional Neural Network. By using the tradingview website application and the AXMAL 1.0 mobile application in collecting data and also analyzing data on stock price movements of PT. Bank Negara Indonesia Tbk., it is obtained that the results of the Convolutional Neural Network indicator accuracy are greater than the Moving Average and Parabolic SAR indicators, which are 56.1% and also produce a higher return of 27.14% during the 2021 period, while the Parabolic SAR indicator produces an accuracy level which is the same as the Moving Average indicator, which is 33.3% but produces a positive return of 12.51% while the Moving Average indicator produces a negative return of-4.46%.

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1. INTRODUCTION

The development of the global Covid-19 pandemic in the fourth quarter of 2021 was marked by the increase in global daily cases after the reopening in various countries and the emergence of Omicron as a new variant of concern (VOC). On the other hand, domestic Covid-19 cases are on a downward trend. However, the Indonesian government continues implementing anticipatory measures to control the pandemic[1]. The banking sector is one of the leading sectors supporting the Indonesian economy[2]. As an intermediate institution between people who have excess funds and people who need funds, the banking sector has a strategic role in developing various sectors[3]. In their business, banking companies collect funds and distribute funds to the public through credit[4].

In this era of the industrial revolution 4.0, people see the capital market as a reliable source of income to increase their income. This is evidenced by a large number of foreign investors and local investors who invest their capital in the world capital market[5]. With the capital market, economic activity is expected to increase because it is alternative funding for companies so that companies can operate on a larger scale and increase company income and the prosperity of the wider community[6]. Therefore, the capital market is considered necessary in the world of the economy because the capital market can encourage the economy of a country to become more developed and developed[7].

Law Number 8 of 1995 concerning Capital Market defines the capital market: as "Activities related to Public Offering and trading of Securities, Public Companies relating to the issued Securities, as well as institutions and professions related to Securities." The movement of stock prices on the Indonesian stock exchange is very volatile[8].

This is a risk that every investor, especially short-term investors, must bear. Each investor has their strategy and analysis for anticipating any stock price changes. Technical analysis is the most appropriate analysis to anticipate movements in the stock price in the short term[9]. In buying or selling shares, investors must be able to predict a stock price so that losses from a purchased stock can be minimized and profits can be maximized. In predicting the stock price, many methods are used, one of which is technical analysis.

According to Edianto Ong, technical analysis is a method of evaluating stocks, commodities, or other securities by analyzing past market activity statistics to predict future price movements[10]. In conducting technical analysis, analysts usually use indicators as a tool. According to Desmon Wira, technical analysis indicators are mathematical formulas to help make trading decisions. These indicators are beneficial for providing information about trends, volumes, and so on, including providing buy and sell signals[11].

In general, in capital markets, two analyses can be studied, namely fundamental analysis and technical analysis[12]. However, it is often heard about trading robots among traders and investors in recent years. The trading robot itself is just software or a program created using artificial intelligence programming algorithms and machine learning to issue buy or sell signals and help execute orders, be it cut loss or take profit. One example of an algorithm that can be used to create a trading robot is the Convolutional Neural Network algorithm.

Many indicators can be studied in the capital market. An example is studying indicators in reading charts that arise due to stock price movements. Some examples of these indicators are the Average Directional Index, Bollinger Bands, Ichimoku Kimko Hyo, MACD, Parabolic SAR, Relative Strength Index, Stochastic, and Candlestick. With these various indicators, investors can predict which stocks are likely to go up and which stocks are likely to go down. So that investors get an overview of the results of calculations using these indicators.

Moving Average (MA) is the most widely used indicator by technicals because it is elementary to use or analyze. Historical data on stock price movements are used in a formula, and the results are displayed as a day on the charts

According to Edianto Ong, Parabolic SAR is another indicator that is quite powerful when the market is in a strong trend but is not suitable for a sideways market, so this indicator is also said to be part of the trend-following indicators. J. Welles Wilder proposed this technique in 1980 in his work entitled New Concept in Technical Trading System. The word "SAR" on this indicator that compares price and time variables comes from "Stop And Reverse." While the word "Parabolic" is used to describe the Parabolic SAR line in the form of a curve like a parabola [10].

In addition to the technical analysis indicators above, in machine learning, especially artificial neural networks, many deep learning models have been developed for modeling and predicting time series data [13]. Among them is the Convolutional Neural Network or CNN, which is one of the deep learning models that has been used in several previous studies to predict time series data[13], where it was found that although, in general, CNN is widely used for classification process, it can also provide good time series prediction results. In addition, research published by R. Qiao et.al also confirms the performance of other deep learning models that are more commonly used for time series data prediction, namely Long Short-Term Memory or LSTM in stock price forecasting[14].

In this study, the author conducts technical analysis of the trading view website application using two technical indicators, namely Moving Average and Parabolic SAR, as well as Machine Learning algorithms in the form of a Convolutional Neural Network as a third indicator which will later be entered into the AXMAL 1.0 mobile application system to get buy and sell signals and compare the level of accuracy of the three indicators.

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2. METHOD

Research Object

The object used in this study is the stock price of PT. Bank Negara Indonesia (Persero) Tbk., formed from January – December 2021. The data collection method used in this study used a purposive sampling method, a type of non-random selection of samples or objects whose criteria information is obtained using specific considerations or criteria. The selection of objects used as data in this study are as follows:

a) PT. Bank Negara Indonesia (Persero) Tbk is a well-known company among the public and investors
b) PT. Bank Negara Indonesia (Persero) Tbk is a banking company that is included in the BUKU 4 category in Indonesia
c) PT. Bank Negara Indonesia (Persero) Tbk is one of the companies with large capitalization shares and is the leading stock (blue chip) on the Indonesia Stock Exchange
d) PT. Bank Negara Indonesia (Persero) Tbk is a company included in the LQ-45 index, which contains forty-five stocks with the best liquidity on the Indonesia Stock Exchange

Based on what was explained earlier in the introduction, the method of predicting stock price movements used in this research is the Moving Average and Parabolic SAR indicators, both indicators use the tradingview website application in their analysis, and the Convolutional Neural Network indicator uses the AXMAL 1.0 Mobile application in their analysis.

Moving Average Indicator

According to Edianto Ong, Moving Averages (MA) is the most widely used indicator by technicals because it is straightforward to use or analyze[10]. The historical stock price movement data is used in a formula, and the results are displayed as a line on the charts. This line is used to Detect the stock price movement trend, which signals a new trend or confirmation that the current trend will be a reversal. Moving averages can also be used instead of conventional trend lines to determine support and resistance. Another function of moving averages that is no less important is to reduce fluctuations that are too "wild" in stock prices and other indicators.

a. Simple Moving Average

As the name implies, the Simple Moving Average reflects the average price of the value of the movement of a stock within a specific time range simply. The most commonly used average price is the closing price. However, this parameter can be changed by using the opening price, high price, etc. The time range in question can also vary according to the settings determined by the trader. However, the most commonly used are between 10,20,25,30,50,100, and 200 days.

Figure 1. Simple Moving Average

The shorter the period used, the more sensitive the signal will be. This short period is generally more noticed by short-term traders. On the downside, there will be more whipsaws. Meanwhile, the longer the period used, the opposite will result in a slower, more effective signal to reduce whipsaws.

b. Weighted Moving Average

This method is intended to overcome the shortcomings of the previous SMA, which uses the exact weighting daily. The calculation in the WMA formula uses a linearly weighted moving average formula which gives "more weight" on the last day, so it is considered more representative in predicting future prices.

c. Exponential Moving Average

The EMA further develops the previous moving average variants (SMA and WMA). This indicator already includes the entire history of stock price movements, and the weight of the calculation is getting heavier for the last day so that later the EMA line will look "smooth."

Parabolic SAR Indikator Indicator

According to Edianto Ong, Parabolic SAR is another indicator that is quite powerful when the market is in a strong trend but is not suitable for a sideways market, so this indicator is also said to be part of the trend-following indicators. J. Welles Wilder proposed this technique in 1980 in his work entitled New Concept in Technical Trading System. The word "SAR" on the indicator that compares the price and time variables comes from the word "Stop and Reverse." While the word "parabolic" is used to describe the parabolic SAR line in the form of a curve like a parabola[10].

The parabolic SAR line consists of dots that overshadow a chart's price movements. These dots indicate when it is time to take action, "sell then buy," or vice versa. Hence the name "Stop And Reverse." When the indicator line crosses the stock price from bottom to top, it is a sell signal. On the other hand, if it crosses from top to bottom, it is a buy signal.

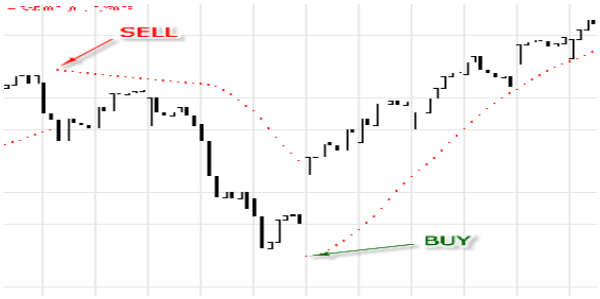

Figure 2. Parabolic SAR

Convolutional Neural Network

Convolutional Neural Network, started by Yann LeCun and his friends, classified zip code images using a particular case from the Feed Forward Neural Network In 1989. Starting in 2012, when the Graphical Processing Unit (GPU) hardware was developed, DNN was also developed, and even a CNN can perform imagery with excellent accuracy and rival humans on specific datasets[15].

Convolutional Neural Network (CNN) is one of the developments of an artificial neural network inspired by human neural networks. It is commonly used in image data to detect and recognize an object in an image. Convolutional Neural Network (CNN) is the development of Multilayer Perception (MLP) designed to process two-dimensional data. In CNN, each neuron is represented in two-dimensional form, unlike MLP, where each neuron is only one-dimensional. CNN is included in the Deep Neural network because of its high network depth and is widely applied to image data[16]. CNN is almost the same as a neural network, which has neurons with weights and biases. CNN has 1 training stage (Supervised Backpropagation)

Technically, CNN is an architecture that can be trained and consists of several stages. Each stage's input (input) and output (output) are composed of several arrays commonly called feature maps. Each stage consists of three layers: convolution, activation function, and pooling.

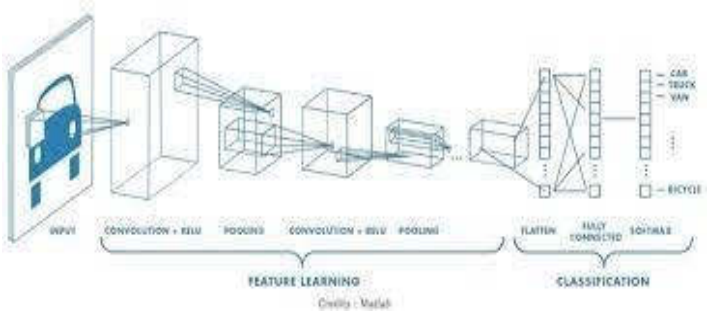

Figure 3. Convolutional Neural Network Architecture

Population and Sample

The target population used by the author in compiling this research is a limited population, namely a population that can provide information to the author so that it can provide an overview of the conclusions in this study. The population of this research is the data of stock price movements of PT. Bank Negara Indonesia, Tbk which is listed on the Indonesia Stock Exchange since its IPO on November 25, 1996 until December 31, 2021. The sample used is the stock price of PT. Bank Negara Indonesia, Tbk which was formed during January – December 2021 used in this study.

Data Collection Technique

The type of data used in this study is secondary data on stock price movements, including the opening price, closing price, highest price, and lowest price of PT. Bank Negara Indonesia, Tbk, during the January period – December 2021, secondary data originating from the Indonesia Stock Exchange and then processed using technical methods through the tradingview site and candlestick chart image data of PT. Bank Negara Indonesia, Tbk processed using the AXMAL 1.0 application.

Data Analysis Techniques

The data analysis techniques used to examine more deeply in research on the level of accuracy in buy and sell decisions are divided into two, first by using a technical method, namely using the Moving Average and Parabolic SAR indicators on the Tradingview application. The second is using the AXMAL 1.0 android application in which a Convolutional Neural Network machine learning algorithm exists. To be more specific, the data analysis technique in this study is divided into 7 steps, namely:

1) Determine the criteria for companies that are included in the research requirements
2) Open a chart of stock price movements for the period January – December 2021 on the Tradingview application
3) Perform technical analysis using the Moving Average and Parabolic SAR indicators for the period January – December 2021 on the Tradignview application
4) Collecting image data of candlestick chart patterns
5) Create an AXMAL 1.0 android application in which there is a Convolutional Neural Network model based on image data of candlestick chart patterns
6) Collecting company Candlestick Chart image data for the period January – December 2021
7) Perform technical analysis using the AXMAL 1.0 application, which includes the Convolutional Neural Network algorithm model on the company's candlestick chart pattern image data for January – December 2021.

3. RESULT AND DISCUSSION

The use of the Moving Average indicator on PT. Bank Negara Indonesia Tbk. During January – December 2021, 6 buy and sell signals were produced. Of the 6 transactions produced, 2 resulted in capital gains, and 6 other transactions experienced capital losses. The following are the results of transactions using moving average indicators on PT. Bank Negara Indonesia Tbk.

Moving Average Indicator Accuracy Level

The use of the Moving Average indicator on PT. Bank Negara Indonesia Tbk. During January – December 2021, 6 buy and sell signals were produced. Of the 6 transactions produced, 2 resulted in capital gains, and 6 other transactions experienced capital losses. The following are the results of transactions using moving average indicators on PT. Bank Negara Indonesia Tbk.

Table 1. Moving Average Calculation

Transaction	Signal buy Date	Moving Average Buy Price	Signal Sell Date	Moving Average Sell Price	Capital Gain/ Loss	Percentage
1	09-Feb	6.225	23-Feb	5.950	-275	-4,42%
2	15-Mar	6.325	25-Mar	5.900	-425	-6,72%
3	07-Jun	5.525	18-Jun	4.950	-575	-10,41%
4	21-Jul	4.900	20-Sep	5.150	250	5,10%
5	04-Oct	5.700	15-Nov	6.800	1100	19,30%
6	25-Nov	7.175	01-Dec	6.650	-525	-7,32%
Total Capital Loss					-450	-4,46%

In table 1, 2 transactions generate profits, namely transaction 4 of 5.10% and transaction 5 of 19.30%. While the other 4 transactions resulted in losses, namely transaction 1 of -4.42%, transaction 2 of -6.72%, transaction 3 of -10.41%, and transaction 6 of -7.32%. All transactions that occurred resulted in a Total Capital Loss of -4.46%. This shows the percentage level of accuracy of the Moving Average indicator in predicting the movement of PT. Bank Negara Indonesia Tbk period January – December 2022 amounted to 33.3%.

Parabolic SAR Indicator Accuracy Level

The use of the Parabolic SAR indicator on PT. Bank Negara Indonesia Tbk. January – December 2022 has produced 9 buy and sell signals. Where from all transactions that occur, 3 transactions generate capital gains and 6 other transactions result in capital losses. The following are the results of transactions using the Moving Average indicator on PT. Bank Negara Indonesia Tbk.

Table 2. Parabolic SAR Calculation

Transaction	Signal buy Date	Parabolic SAR Buy Price	Signal Sell Date	Parabolic SAR Sell Price	Capital Gain/ Loss	Percentage
1	11-Jan	6.525	25-Jan	6.225	-300	-4,60%
2	03-Feb	6.300	30-Mar	5.800	-500	-7,94%
3	25-May	5.325	16-Jun	5.375	50	0,94%
4	08-Jul	4.750	14-Jul	4.575	-175	-3,68%
5	16-Jul	4.800	30-Jul	4.775	-25	-0,52%
6	05-Augs	5.200	02-Sep	5.250	50	0,96%
7	03-Sep	5.450	16-Sep	5.275	-175	-3,21%
8	30-Sep	5.375	27-Oct	7.075	1.700	31,63%
9	11-Nov	7.025	29-Nov	6.950	-75	-1,07%
Total Capital Gain					550	12,51%

Table 1 where 2 transactions generate profits, namely transaction 4 of 5.10% and transaction 5 of 19.30%. In contrast, the other 4 transactions resulted in losses: transaction 1 of -4.42%, transaction 2 of -6.72%, transaction 3 of -10.41%, and transaction 6 of -7.32%. All the transactions that occurred resulted in a Total Capital Loss of -4.46%. This shows the percentage level of accuracy of the Moving Average indicator

in predicting the movement of PT. Bank Negara Indonesia Tbk from January – December 2022 amounted to 33.3%.

Convolutional Neural Network Indicator Accuracy Level

The use of the Convolutional Neural Network indicator on PT. Bank Negara Indonesia Tbk. During the period January – December has produced 42 buy and sell signals. Of all transactions, 23 resulted in capital gains, 18 resulted in capital losses, and 1 did not generate profits or losses. The following are the results of transactions using the Moving Average indicator on PT. Bank Negara Indonesia Tbk.

Table 3. Convolutional Neural Network Calculation

Transaction	Signal buy Date	Convolutional Neural Network Buy Price	Signal Sell Date	Convolutional Neural Network Sell Price	Capital Gain /Loss	Percentage
1	04-Jan	6.375	07-Jan	6.425	50	0,78%
2	18-Jan	6.300	22-Jan	6.275	-25	-0,40%
3	26-Jan	6.075	27-Jan	5.975	-100	-1,65%
4	28-Jan	5.775	04-Feb	6.275	500	8,66%
5	11-Feb	6.200	16-Feb	6.350	150	2,42%
6	22-Feb	5.925	25-Feb	6.075	150	2,53%
7	02-Mar	6.150	03-Mar	6.025	-125	-2,03%
8	05-Mar	6.000	10-Mar	6.050	50	0,83%
9	12-Mar	6.150	16-Mar	6.225	75	1,22%
10	22-Mar	6.100	30-Mar	5.800	-300	-4,92%
11	31-Mar	5.725	08-Apr	5.800	75	1,31%
12	15-Apr	5.975	16-Apr	5.950	-25	-0,42%
13	21-Apr	5.775	27-Apr	5.900	125	2,16%
14	05-May	5.675	10-May	5.575	-100	-1,76%
15	11-May	5.525	17-May	5.500	-25	-0,45%
16	18-May	5.450	27-May	5.150	-300	-5,50%
17	28-May	5.200	03-Jun	5.750	550	10,58%
18	09-Jun	5.625	10-Jun	5.675	50	0,89%
19	11-Jun	5.675	15-Jun	5.525	-150	-2,64%
20	18-Jun	4.950	05-Jul	4.725	-225	-4,55%
21	09-Jul	4.650	13-Jul	4.675	25	0,54%
22	14-Jul	4.575	15-Jul	4.725	150	3,28%
23	16-Jul	4.800	21-Jul	4.900	100	2,08%
24	29-Jul	4.925	02-Aug	4.825	-100	-2,03%
25	03-Aug	4.950	04-Aug	5.050	100	2,02%
26	12-Aug	5.075	18-Aug	5.425	350	6,90%
26	12-Aug	5.075	18-Aug	5.425	350	6,90%
27	25-Aug	5.250	01-Sep	5.325	75	1,43%
28	10-Sep	5.450	13-Sep	5.400	-50	-0,92%
29	16-Sep	5.275	17-Sep	5.300	25	0,47%
30	21-Sep	5.125	22-Sep	5.150	25	0,49%

Transaction	Signal buy Date	Convolutional Neural Network Buy Price	Signal Sell Date	Convolutional Neural Network Sell Price	Capital Gain /Loss	Percentage
31	24-Sep	5.100	27-Sep	5.075	-25	-0,49%
32	29-Sep	5.225	30-Sep	5.375	150	2,87%
33	05-Oct	5.700	06-Oct	6.000	300	5,26%
34	28- Oct	7.050	08-Nov	7.050	0	0,00%
35	10-Nov	7.075	11-Nov	7.025	-50	-0,71%
36	12-Nov	6.900	16-Nov	6.875	-25	-0,36%
37	17-Nov	7.000	19-Nov	7.025	25	0,36%
38	26-Nov	6.875	29-Nov	6.950	75	1,09%
39	02-Dec	6.825	08-Dec	6.850	25	0,37%
40	13-Dec	6.850	16-Dec	6.750	-100	-1,46%
41	21-Dec	6.700	23-Dec	6.650	-50	-0,75%
42	24-Dec	6.725	28-Dec	6.700	-25	-0,37%
		Total Capital Gain			**1.400**	**27,14%**

It can be seen in table 3 where 23 transactions generate profits, namely transaction 1 of 0.78%, transaction 4 of 8.66%, transaction 5 of 2.42%, transaction 6 of 2.53%, transaction 8 of 0.83%, transaction 9 was 1.22%, transaction 11 was 1.31%, transaction 13 was 2.16%, transaction 17 was 10.58%, transaction 18 was 0.89%, transaction 21 was 0.54%, transaction 22 by 3.28%, transaction 23 by 2.08%, transaction 25 by 2.02%, transaction 26 by 6.90%, transaction 27 by 1.43%, transaction 29 by 0.47%, transaction 30 by 0 .49%, transaction 32 by 2.87%, transaction 33 by 5.26%, transaction 37 by 0.36%, transaction 38 by 1.09%, transaction 39 by 0.37%. While 18 transactions suffered losses, namely transaction 2 by -0.40%, transaction 3 by -1.65%, transaction 7 by -2.03%, transaction 10 by -4.92%, transaction 12 by -0.42% , transaction 14 was -1.76%, transaction 15 was - 0.45%, transaction 16 was -5.50%, transaction 19 was -2.64%, transaction 20 was -4.55%, transaction 24 was - 2.03%, transaction 28 of -0.92%, transaction 31 of -0.49%, transaction 35 of -0.71%, transaction 36 of -0.36%, transaction 40 of -1.46%, transaction 41 is -0.75%, transaction 42 is - 0.37%. And the last is transactions that do not generate profits or losses, namely transactions 34 of 0.00%.

Comparison of Results between Moving Average, Parabolic SAR, Convolutional Neural Network indicators

Table 4. Comparison of Results

Indicator	Capital Gain/Loss	Return	Transaction Successful	Transaction failed	Total Transactions	Level of accuracy
Moving Average	-450	-4,46%	2	4	6	33,3%
Parabolic SAR	550	12,51%	3	6	9	33,3%
Convolutional Neural Network	1.400	27,14%	23	18	41	56,1%

Based on the comparison of several indicators, the Convolutional Neural Network indicator is more effective than the Moving Average and Parabolic SAR indicators because, from the analysis in this study, the Convolutional Neural Network indicator produces more significant Capital Gain and a higher level of accuracy than the Moving Average and Parabolic SAR indicators. It can be concluded that the Convolutional Neural Network indicator is more effective in making investment decisions with a Capital Gain of 27.14% in PT. Bank Negara Indonesia Tbk during the period January – December 2021

4. CONCLUSION

Based on the comparison of several indicators, the Convolutional Neural Network indicator is more effective than the Moving Average and Parabolic SAR indicators because, from the analysis in this study, the Convolutional Neural Network indicator produces a more considerable Capital Gain and a higher level of effectiveness than the Moving Average and Parabolic SAR indicators. It can be concluded that the Convolutional Neural Network indicator is more effective in making investment decisions with a Capital Gain of 27.14% in PT. Bank Negara Indonesia Tbk during the period January – December 2021.

For investors who want to invest in shares of PT. Bank Negara Indonesia Tbk can use the Convolutional Neural Network indicator as the basis for buying and selling because this indicator has a better level of accuracy when compared to the Moving Average and Parabolic SAR indicators.

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