003 Deep Learning

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Introduction

The purpose of this project is to find a trading strategy using 3 different kinds of technical indicators, and when 2 out of these 3 indicators gave us a sign to buy or sell (long or short positions) make a movement in our portfolio buying or short selling assets. First, we decided which 3 technical indicators we would use (RSI, BOLLINGER and MACD), then we would go with our first trial with the data set we already had and with the parameters that we thought would fit best in our model. Then, using the Optuna optimization framework, we conducted 50 trials, each testing a different combination of parameters to identify the optimal configuration for our model. Finally, we evaluated the model's performance by calculating key metrics that allowed us to assess its overall effectiveness.

3 technical indicators

As said in the introduction, we decided to use 3 different technical indicators on our model, which were:

- **RSI:** The Relative Strength Index (RSI) is a momentum oscillator that measures the speed and magnitude of recent price changes to evaluate overbought or oversold conditions in a financial asset, which ranges from 0 to 100. Values above 70 are generally interpreted as indicating an overbought market, while values below 30 suggest oversold conditions. The RSI is computed using the average gains and losses over the specified period and transformed into an index through the formula: RSI = 100 - [100 / (1 + RS)], where RS is the ratio of average gain to average loss. This indicator helps traders identify potential reversal points and confirm price trends when used alongside other tools.
- **Bollinger:** Bollinger Bands are a volatility-based technical indicator that consists of three lines: a simple moving average (SMA) in the center, and two standard deviation bands (upper and lower) plotted above and below the SMA. Bands help identify relative price extremes. When the price touches the upper band, it may indicate an overbought condition, whereas contact with the lower band may signal an oversold condition. It is commonly used to spot potential reversals, breakouts, or periods of consolidation.
- **MACD:** The Moving Average Convergence Divergence (MACD) is a trend-following momentum indicator that illustrates the relationship between two exponential moving averages (EMAs) of a price. It is calculated by subtracting the 26-period EMA from the 12-period EMA, producing the MACD line. A signal line, which is a 9-period EMA of the MACD line, is then plotted to generate buy or sell signals through crossovers. When the MACD line crosses above the signal line, it may indicate bullish momentum; a crossover below may signal bearish momentum.

In the graph below, we can observe how the technical indicators interact with the market data. Each indicator is split into two signals: BUY and SELL, indicating whether to take a long or short position, respectively, based on its internal model and calculation. A signal of True suggests that the indicator recommends opening a position, while False means no position should be taken. In our strategy, a position is opened only when at least two indicators simultaneously generate the same signal.

pen	High	Low	Close	Volume	RSI	BB	macd_signal	MACD	RSI_BUY	RSI_SELL	BB_BUY	BB_SELL	MACD_BUY	MACD_SELL
905	129.365905	129.130004	129.279998	1280572.0	43.872388	129.512161	0.009407	0.059188	False	False	False	False	False	False
998	129.440002	129.259994	129.419998	1220198.0	44.697231	129.466961	0.015230	0.073458	False	False	False	False	False	False
003	129.740005	129.369995	129.440093	2893069.0	44.815400	129.434295	0.021526	0.084486	False	False	False	False	False	False
996	129.649993	129.119995	129.410003	4282748.0	44.670309	129.398962	0.027688	0.089311	False	False	False	False	False	False
999	130.589996	128.429992	130.490005	6746812.0	50.508487	129.375495	0.040505	0.168674	False	False	False	True	False	False

Results using our Parameters

With the first parameters we thought would fit the best we got the following results:

As we can see, the orange line represents the data of the stocks, while the blue line represents our portfolio. In this first trial we lost money, and we got a final value of the portfolio of $948795.46.
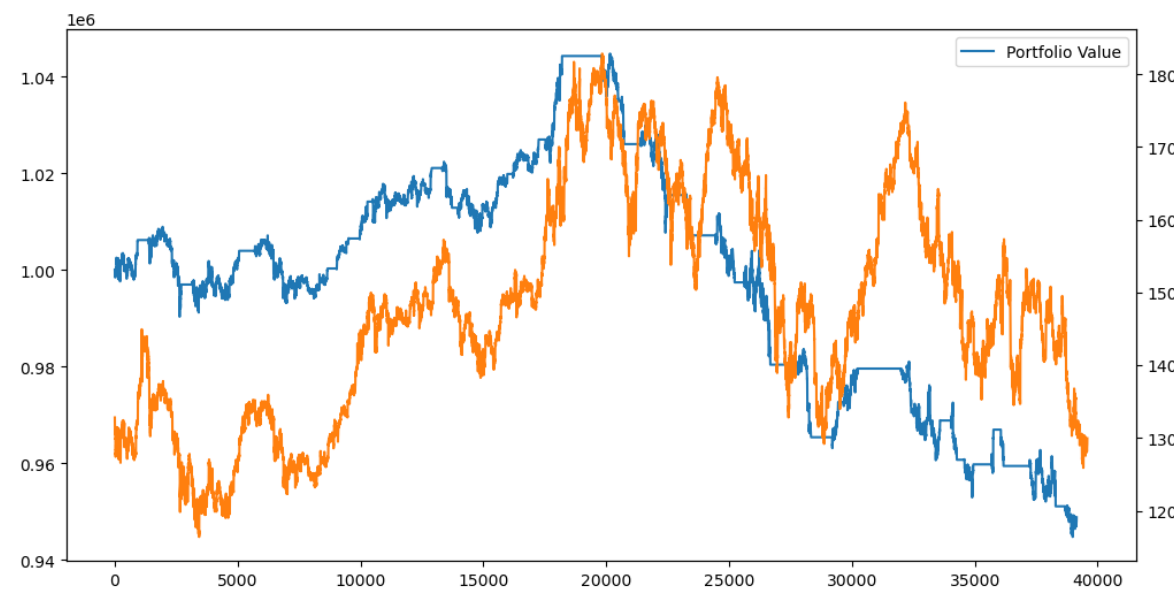
Results optimizing with Optuna

After looking at the results with our own Parameters, we decided to run 100 trials with different combinations of the parameters, and with the help of Optuna we could get to know which combination would fit the best in our model and strategy. The results we got were:

As shown in the results, the optimized parameters significantly outperformed the initial configuration. Using Optuna, the best-performing trial was number 91, which achieved a final portfolio value of $2,114,411.93.
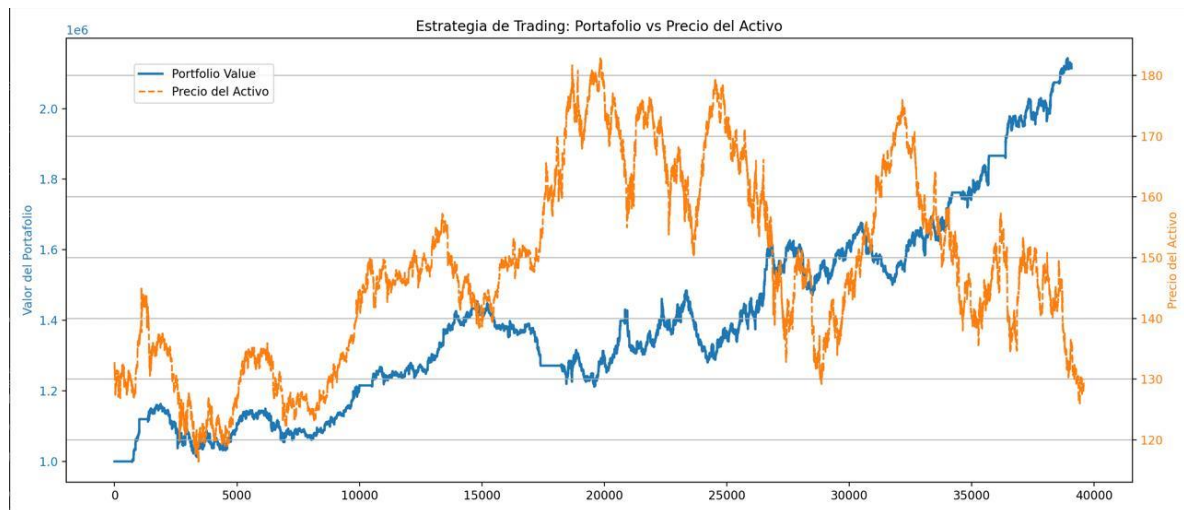
In the graphic below we can see the parameters that Optuna suggests to us to have the performance of the graphic above. These parameters are the following:

```
{'rsi_window': 26,
 'rsi_lower': 21,
 'rsi_upper': 81,
 'bb_window': 78,
 'bb_window_dev': 2,
 'window_slow': 17,
 'window_fast': 3,
 'window_sign': 39,
 'stop_loss': 0.18043257686551875,
 'take_profit': 0.09505358378932884,
 'n_shares': 7000}
```

Calculating the metrics of the trading strategy

To evaluate our performance with the optimized parameters

- **Sharpe:** The Sharpe Ratio is used to measure the risk-adjusted return of an investment strategy. It compares the excess return to the standard deviation of returns, which represents total risk. A higher Sharpe Ratio indicates that the strategy delivers more return per unit of risk taken.
    - **Sharpe Ratio:** 1.4647 - This indicates a solid risk-adjusted return.

- **Sortino**: The Sortino Ratio is a variation of the Sharpe Ratio that focuses only on downside risk. Instead of using the standard deviation of all returns, it only considers the standard deviation of negative returns.
    - **Sortino:** 1.9275 - The strategy performed even better when focusing only on downside risk

- **Calmar Ratios:** The Calmar Ratio compares the average annual return of a strategy to its maximum drawdown (i.e., the largest observed loss from a peak to a trough). It is especially useful in evaluating strategies that may have high returns but also high potential losses
    - **Calmar Ratio:** 6.6964 - This high value shows that the strategy delivered strong returns

- **Win/Loss percentage:** The Win/Loss Percentage measures the proportion of profitable trades relative to losing trades. It helps evaluate the consistency of the strategy.
    - **Win Percentage:** 0.9167 – It has over 91% of the trades being profitable.

Conclusion

In conclusion, the development and back testing of our trading strategy demonstrated the importance of using technical indicators in combination. By incorporating RSI, Bollinger Bands, and MACD into our decision-making process, and optimizing the key parameters using Optuna, we were able to significantly improve the performance of our model. The optimized strategy delivered a much higher final portfolio value compared to our initial configuration, confirming the value of the parameters. While the results are exceptional, is necessary to test this model in the real world, to see how it would develop realistically.