Title:

Evaluating the Efficacy of Artificial Intelligence for novices in the Foreign Exchange Market

ABSTRACT

The foreign exchange market is a dynamic market environment worldwide and also the largest market where currencies are exchanged in large values. Foreign exchange markets are influenced by macro-economic and micro-economic factors where financial institutions such as banks play a role in exchanging currencies and the exchange rate for currencies is influenced by political scenarios, economic conditions, market trends, etc. The role of technology in foreign exchange has been significant over the last decade. Emerging technologies such as AI that use advanced algorithms are widely used in forex to identify risks, predict currency exchange values and monitor performance. With the availability of electronic trading platforms, the role of AI in foreign exchange markets is getting popular and increasing. AI due to its ability in predictions, processing of large volumes of data and support for decision-making based on objective logic plays a major role in forex markets.

Given these aspects, the project presents an AI model developed to support novice traders in forex to understand risks and the market and make the right decisions in trading. The AI-based system is developed using an Artificial Neural Network (ANN) algorithm that makes use of Yahoo Finance's historical dataset over a time period to decide whether a currency pair in foreign exchange is performing high or low. The developed system will help novice traders select a currency pair and a date, for the given date the recommendations are made for traders in decisions such as buying or selling the currency and avoiding loss. The results show the developed system is efficient, accurate and easy to use for novice traders. The system requires more vigorous testing in real-time market scenarios prior to implementation in forex markets.

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1 Chapter One: Introduction

1.1 Introduction

In the financial sector, the foreign exchange (FX or forex) market is considered the largest in the world and operates in a complex market environment. Importantly FX market influences the financial market globally with an average market turnover of billions of dollars every day. FX market operates 24 hours across all time zones to represent each trading centre across the world during daylight trading sessions for each day (Dakalbab, Talib and Nasir, 2023). Forex markets impact the wider economy of nations and major currencies in FX trading include the US dollar (USD), EUR, Japanese Yen (JPY), and British pound (GB) along with currencies of other developing economies. The main entities involved in FX markets are banks and large financial institutions. Usually, the FX rates are volatile and are determined by comparing the strengths or weaknesses of currency pairs such as USD/JPY, EUR/USD and GBP/USD. Therefore, FX markets refer to marketplaces where currencies are exchanged at rates that are pre-determined. The currencies are valued in foreign exchange as one against the other as a pair (Wen and Wang, 2020).

Looking into the trends in FX markets, it was noted that, according to BIS Quarterly Review, global foreign exchange markets trade more than 50 currencies globally with FX trading being dominated by the US dollar (USD). The turnover in FX markets reached a high of USD 7.5 trillion in April 2022, and the FX market seems poised for growth in the coming years (Drehmann and Sushko, 2022). Markets indicate FX has shown growth recently with a Compounded annual growth rate (CAGR) of 5.7% in 2024 with USD 795.91 billion compared to USD 752.66 billion in 2023. The market is projected to grow at a CAGR of 6.5% in 2028 to reach USD 1023.89 billion. FX markets are influenced by geo-political events, commodity prices, exports, and other market scenarios (TBRC, 2024). Further, the growth of FX is attributed to the increase in international transactions by businesses worldwide.

Recent advances in technology implementation financial markets and trade have provided the pathways for modern electronic trading systems that are available online for FX market trading (Guo

and Zhou, 2023). These online FX market trading systems are affordable for investors and these developments have resulted in significant growth of electronic trading networks and software applications that support investors in trading decisions driven by smart algorithms-based predictive models. These predictive models are easy to use, cheaper and can encompass diversified financial, economic and social media data that are processed to make predictions in FX rates. Interestingly, the potential growth of FX markets along with technology developments have supported investors and traders in decision-making in FX markets (Horn, Oehler and Wendt, 2020).

More recently the use of artificial intelligence (AI) technology plays a significant role in understanding the accuracy of trading decisions. FX markets are highly complex, noisy and volatile and hence there is a need for more adaptive and quicker trading algorithms in real-time trading scenarios. Due to the potential of AI technology in FX markets, novice or first-time traders can benefit from understanding the efficacy of trading decisions and avoiding loss. Also, FX markets change rapidly and hence new trades need support and assistance in understanding the performance of exchange rates in volatile environments.

The project is developed to support novice traders in FX markets with the use of an AI-assisted model. The project is intended to help beginners with their difficulties and evaluate AI strengths and limitations in the context. This is because novice traders are often overwhelmed due to high risks, and rapid changes and need support in interpreting market signals by navigating trading platforms. A software based on AI is developed and presented in the project to support novice traders in guiding decision-making and potential financial loss during trading. The project will also assess the strengths and limitations of AI in the developed system and help determine if AI can be an alternate approach in helping new traders get started with FX trading.

1.2 Project Aim & Objectives

This project aims to make foreign exchange trading more accessible to new investors using AI technology to develop a new system towards increased trader success rates. The developed system is evaluated for its performance in resolving issues faced by novice traders in foreign exchange.

Objectives

- To identify how human-guided trading operates in FX markets and how trading decisions are made based on real-time data
- To understand the challenges faced by new-comers in the foreign exchange trade market
- To develop an AI-based system using algorithms for accessing FX market data
- To implement the AI-based system to support novice traders in decision-making and ease of access to trading markets
- To evaluate the implemented AI system for its strengths and weaknesses in trading decisions for novice traders
- To assess the performance of AI systems and analyse using a SWOT matrix to understand AI-assisted FX trading versus human guidance training

1.3 Project Significance

The project will make use of AI technology in applying within markets to resolve challenges faced by users, especially people new to FX trading. The developed AI-based model will help overcome the complexities in forex trading for newcomers. Newcomers to FX trading face challenges related to an overload of information, difficulty in grasping market trends, and problems in decision-making due to fear of financial loss. The project is intended to make foreign exchange trading more easy to understand and accessible with increased success for new traders. The use of AI is also evaluated for its strength and limitations in foreign exchange trading environments in trading decisions. The ease of availability of emerging technologies is another important motivating aspect in developing the system to support newcomers.

1.4 Structure of Report

Chapter 1 provides an overall introduction to the topic and highlights the aims and objectives, and the significance of this project.

Chapter 2 provides a review of literature related to the topic, identified from secondary sources. The methodology followed in the project is presented in Chapter 3, and the section on project work presents the design and development of the project.

Chapter 4 presents the implementation and results in the form of screenshots with explanations and provides the results of testing, and evaluation along with general discussions on the use of AI in financial markets.

Conclusions are provided along with recommendations for usage and future work in Chapter 5.

2 Chapter Two: Literature Review

The era of technology in the financial services sector began way back in the 1990s with Citigroup initiating the setup of the 'Financial Services Technology Consortium' to facilitate the use of technology in financial services. Initially, the use of technology in finance was termed Fintech (Financial Technology) and over the years the integration of finance and technology has strengthened. The Fintechs of today are viewed as the main driver of innovation as new business models and applications are developed and used.

Technology developments also provided pathways for new products and services, especially in markets facilitated by new emerging technologies such as big data, blockchain, artificial intelligence (AI), cloud computing, and others. Technology significantly impacts financial markets by providing a variety of services. Forex, as mentioned earlier is one of the biggest financial markets where technologies and Fintech innovations provide opportunities for investors to capitalise on foreign exchange investment opportunities. Interestingly, technology provides opportunities for new investors to understand markets and make decisions without incurring losses.

Looking into the current trends in finance sector innovation three main technology areas are blockchain, big data and AI. Here, AI complements the other two technologies and vice versa supporting new innovative solutions.

In the field of forex AI along with big data is a breakthrough, as AI is based on DL where intelligent analysis and finally decision making is possible for investors. DL technology is used in AI to implement AI scientifically and rationally in foreign exchange. In forex, large volumes of data are involved as there are cross-border payments and written guarantees along with domestic and international financial situations (Kaur, Kumar and Kaur, 2024). AI systems with DL can analyse large volumes of data to decide on the direction of foreign capital flows and predict possible risks in cross-border funds transfers. In this manner, new beginner investors or first-time investors can monitor and understand foreign exchange measures and note risks at early stages before actually investing in forex. In addition to avoiding risks, AI will guide investors effectively to different options

in future foreign exchange markets. For instance, the future of foreign exchange can be predicted using historical foreign exchange data, international payments and balances, inflation and interest rates, and exchange rate policies. This is possible using DL algorithms that are used in AI-based applications to support first-time investors in making the right decisions for investments. Examples of AI in the area of foreign exchange are Robo-adviser, Regulatory Sandbox and others. Since forex involves rapidly changing exchange rates AI-based applications will help novice investors to understand unknown financial risks involved in foreign exchange management. Given these aspects, the efficacy of AI in forex is emphasised.

The use of AI, machine learning and related algorithms in the finance sector and FX trading were widely found in the literature. Nguyen, Sermpinis and Stasinakis (2022) explain that AI has been a major technology since 2010 and recently has become a dominant technology in a variety of industries and services. Importantly, AI plays a major role in the financial services industry in automation, detecting fraud in transactions, and in various other areas. For example, financial technology (FinTech) applications make use of AI to transform financial services, especially bank services in curbing errors in transactions. Some studies highlight the use of AI in the capture and analysis of finance variables. Ahmed et al. (2022) state, AI applications are used to solve complexities in FX trading and stock exchange markets through the use of deep learning (DL) techniques. DL is another subset of AI technology. Given the above aspects, the role of AI in FX trading is explored and summarised from literature using existing research sources.

Exploring the use of AI in financial markets it was observed that the forex market operates on currency exchange globally. AI has a lot of scope in forex trading as it helps to create models and systems to access market data, help in informed decisions for traders and eventually gain profits. The study by Goodell et al., (2021) explains that digitised information available in financial systems complemented by technology growth in terms of computations and storage is significantly impacting the finance industry. The study highlights the importance of AI and ML in the areas of portfolio

analysis, investor behaviour, valuation, financial fraud and risks, forecasting, sentiment analysis and planning.

According to (Cohen, 2022) algorithms in ML, DL or ANN are used in trading as these algorithms have the ability to analyse diverse datasets from multiple sources. Trading systems built using emerging systems have the capacity to transact high-frequency trading (HFT) algorithms that can process data efficiently. For this reason, stock markets or forex trading institutions make use of the HFT algorithm for its advantage and usefulness in performing financial transactions and to perform arbitrage trading to understand the existence of different prices of the same commodity (Khandelwal and Jain, 2022).

According to Noonan (2022), forex is dependent on economic and political events in addition to the psychological state of investors and traders. These factors have unstable interactions in a dynamic and volatile market environment. Hence, there is a need for improved prediction of rate changes in international finance exchanges and ensure maximum profits. Investors have the need for trading at the right time with correct decisions to capitalise on profits but a wrong move can incur significant loss. Stone et al., (2020) explain that AI systems have the capacity to generate rules and decision strategies based on input data and the ability to define and decide targets set by human users. AI systems are developed using market analysis combined with other economic and political factors to overcome limitations in low-performance rates, inefficiency and delays in communication in the area of foreign exchange.

A large number of studies highlight the use of ML to forecast forex rates using time series data. For example, in addition to foreign exchange rate predictions, time series data is also used to predict future stock prices. In one study the use of support vector regression (SVR) with back-propagation is used to forecast daily prices in the stock market to cite an example (Dash et al., 2021). Studies highlight the use of SVR in combination with other algorithms in predicting stock prices. Such studies demonstrate the use of large datasets available in the finance sector to predict future prices based on prior knowledge. These are some of the advantages of ML and DL algorithms. Jung and Choi (2021)

provided a method of predicting foreign exchange rates during volatility using DL auto encoding and long-term short memory (LSTM) techniques.

Aslam et al., (2020) provided a method named multi-fractal detrended fluctuation analysis (MF-DFA) during the pandemic times to investigate the efficiency of the forex market. The study makes use of high-frequency data involving six major currencies in forex markets for the period October 2019 to March 2020. The trends and inner dynamics of currencies were examined prior to applying the MF-DFA. The results of this study indicate that forex markets during the COVID-19 pandemic outbreak provided heterogeneous effects on exchange rates and an overall decline in the forex market in general. In terms of multi-fractality, the Australian dollar showed high efficiency along with the Canadian dollar and Swiss Franc. The study suggests the need for comprehensive improvements in forex market efficiency during challenging times such as the pandemic outbreak.

Jamali et al (2023) examined external factors as these factors influence profitable results in forex forecasting. The authors made use of DNN and particle swarm optimisation (PSO) techniques using the relationship value between gold and silver to predict EUR/USD predictions using S&P data. The study by Hu, Zhao and Khushi (2021) explains the importance of close price to determine the effects of forex price prediction. The close price is an important element in forecasting prices in the forex market accurately. In another study, Agrawal et al., (2022) present a DNN model to predict whether the close price will yield profit for investors thus improving the accuracy of predictions.

Jamali et al., (2023) explain that making decisions in financial markets is a risky proposition because the markets are not always reliable. Hence, in forex markets, three important elements are usually involved namely money management, fundamental and technical analysis. Money management refers to the determination of investment risks in advance and improvements to protect investments and the ability to make earnings by avoiding risks outside of investment strategies. Fundamental analysis depends on external factors that directly influence exchange rates and currencies to anticipate and predict forex rates in a fair manner. The factors are economic growth, geo-political situations, import and export, monetary policies and interest rates. Lastly, technical analysis aims to forecast foreign

exchange prices by predicting forex movements using historical market data, and volumes traded and by identifying trends. The above three elements are important as they are interpreted to identify opportunities in buying or selling.

Saka and Moyanga (2023) state that two approaches were used to make forex currency exchange rate predictions in the forex market. To have good speculation, the qualitative method is used in situations where data is not available immediately for forecasting. The second approach was done using quantitative methods that exploit historical data in digital form while taking into account past achievements of forex rates, economic factors and close prices.

Michaela Denise Gonzales and Hargreaves (2022) explain that recommender systems based on algorithms will help investors overcome information overload in trading markets. Further, the prices in trading are based on investor preferences. To consider these aspects, a hierarchical clustering method is presented to improve computational efficiency to assess the expected rate of return and value at risk in markets. The study presents the use of K-Nearest Neighbour (kNN), Singular Value Decomposition (SVD) and Association Rule Mining (ARM) algorithms for recommending prices in the market. The results indicate minimum financial loss and recommendations were advantageous for users. However, the proposed recommender system was tested with experimental data, the presented system was intended to support users with stock trading expertise. However, the recommender system support for first-time or novice traders is not available.

Dautel et al., (2020) presented a study to evaluate the potential of DL algorithms in exchange rate forecasting. The study compares the long short-term memory network (LSTM) and Gated Recurrent units (GRU) in RNN architectures to obtain accuracy of directional forecasting and to obtain the profitability of the trading model for its predictions. The results of this study highlight the suitability of DL for forex forecasting in general. The study also highlights the difficulties in implementing RNN architectures. In addition, the study recommends the use of simple neural networks to perform better than complex DNNs. The article provides scope for future research on this topic.

Bashir, Ali and Rashid (2020) presented a tool named the probabilistic uncertain linguistic (PUL) consensus method for supporting the consensus level of a group. The tool will address two specific consensus approaches namely the consensus-based PUL-gain and lost dominance score method. The next was named the consensus-based PUL-aggregation method. Both these methods make use of different semantics in decision-making. These methods were applied in forex trading as a case study to illustrate the practical implementation of the PUL methods. The study also provides a comparative analysis to highlight the method that is advantageous for forex trading.

Forex trading has gained popularity over the years. Notably, forex trading helps businesses manage their international transactions and supports investors in diversifying their portfolios while helping traders make a profit from currency fluctuations (Anastasovska, 2022). The use of technology in finance initially began with basic applications to automate transaction processing and create reports. With the emergence of AI, the finance industry adapted the technology to analyse data, make predictions using ML/DL algorithms and understand human language (Olubusola et al., 2024). In this manner AI soon became a game changer in making predictions and in decision making for traders.

In summary, international asset allocation in financial markets drives foreign exchange trading. While this is the case investor's requirements are in high demand in terms of trading systems, services and products. Investors also have personalised demands in foreign exchange trading in terms of the efficacy of investment decisions. The use of different algorithms and AI in forex trading has motivated me to conceptualise the use of AI to understand the efficacy of trading decisions for users new to forex trading. From studies, it was also noted that innovations driven by AI and emerging technologies provide the potential to solve multiple problems in the foreign exchange market and meet the needs for decision-making by investors in markets.

3 Chapter Three: Methodology and Project Work

3.1 Methodology

The development of AI algorithms for the forex market is a multidisciplinary study as it involves different technologies, tools and data validation at different levels. Due to the diverse nature of the topic, the research methods involved in this project are a combination of quantitative, qualitative and system development methods. Thus, a mix of research methods is used to achieve the objectives. The quantitative approach involves the development of an AI algorithm and processing of the forex dataset to obtain results for further verification. The qualitative approach involves the exploration and review of literature from existing sources to understand the various approaches used by researchers on this topic. The dataset used is obtained from Yahoo Finance data, which is available to the public for research or analysis and for experimental purposes.

In addition, the inductive and deductive methods are also used in the project. The inductive method allows the observations to be made in the forex market and understand data to finally derive conclusions or decisions. Inductive reasoning will make use of foreign exchange data from Yahoo Finance to understand its features, market trends, patterns and other insights that can be used in training the developed AI model. In addition, the deductive method allows the to first define a hypothesis statement and the developed artefact is tested whether the hypothesis is true or not. Therefore, deductive methods will support in development of the algorithm using programming languages. The developed algorithm will be implemented on the dataset to obtain forex results to understand whether there is an exchange price rise or not for a set of currencies.

3.2 Data source

The data source used is Yahoo Finance, publicly available as it provides a range of APIs, libraries and methods to gather historical or real-time data from different financial markets including the foreign exchange market. The dataset from Yahoo Finance is chosen because it is freely available and is easy to set up the data according to processing requirements. Also, Yahoo Finance API is easy to set up

with the existing developed system, installing libraries and calling the API using a specific URL will provide the data as required.

3.3 Development and Algorithm

The development algorithm is created using Python programming language. Python provides easy-to-use commands, libraries and functions to process large amounts of data efficiently. The algorithm used is an Artificial Neural Network (ANN) for training the dataset and further testing to arrive at appropriate results.

3.4 Data Analysis

The developed algorithm in Python is applied to Yahoo Finance data to first perform pre-processing. Subsequently, the features are extracted to remove unwanted information from the dataset. The ANN model will process the data to make future recommendations. The features defined are 'Open', 'High', 'Low', 'Close. The extracted feature will further result in developing the data frame. The data frame is used in the algorithm to train the developed AI model. The dataset is split into training and testing datasets. When the AI model is adequately trained, the AI model provides test data as input to provide information and support correct decisions.

Further, results are verified and the strengths and drawbacks of AI in the forex exchange market are analysed and discussed.

3.5 Project Work

The project is conducted through different tasks as mentioned in the Gantt chart and project timeline. This is the first step in the project to achieve the project objectives. The project outcomes are intended to help beginner traders to overcome challenges in the forex market. As mentioned earlier the algorithm is developed using code the Activities in the Gantt chart. The AI system development involves the tasks of algorithm design and development, implementation and testing for verification of results. The second step involves testing the developed system, results and evaluation with discussions. Lastly, the conclusions are provided.

3.6 AI system design and development

Algorithm design: The algorithm is designed using Python programming. The algorithm will fetch input data from Yahoo Finance Data API.

The design involves the following steps:

1. Loading libraries in Python
2. Creating the function to fetch historical data from Yahoo Finance API. The data fetched will include the information related to currency symbol, start date and end date. The currency symbol is usually in pairs such as EUR/USD, GPB/USD, and so on.
3. The data from Yahoo Finance API is downloaded using with fields symbol, start_date, and end_date.
4. In this step, the dataset is pre-processed and features are generated. The features are open, high, low, and close. The max() and min() functions in Python are used to obtain the highest and lowest values for a given currency pair. The training and test datasets are defined from the data frame.
5. In this step, the function to train the ANN model is defined. The data from the data frame that has the feature values are represented by X and the target variable is denoted as Y. The training dataset and test dataset are represented as X_train, X_test, Y_train and y_test using the train_test_split function.
6. The features are standardised using the StandadScaler() function for both the X_train and X_test datasets. The ANN model is built using the Sequential() function in Python with activation relu function on input data to change negative values to 0 and maintain the positive values in the input. The sigmoid function is further used in the ANN, as this function will allow the network to learn relationships in data that are non-linear.
7. The model is trained by running 50 iterations (epochs=50) that have a batch_size of 32. The model is trained in this manner. Further, the AI model is implemented.

3.7 Implementing the AI model

The test dataset created using train_test_split() function is used as input for the developed model. The system has the ability to make future recommendations. The future recommendation for a currency will be based on the last data point feature value (open, high, low and close). The StandardScaler() function will standardize the features to check the last data point feature value. The last data point feature value is important for the prediction of whether there is a rise or fall in price. Subsequently, the recommendations based on prediction are provided for the user. The prediction is verified using the model.predict() function and if the value is > 0.5, the recommendation is 'Buy' for the user as it implies a price rise. If the prediction is < 0.5, implies a price fall and the user is recommended with 'Sell' option.

Given the above functions and procedures, the AI model is implemented for the user. This forms the main function of the system. The system provides the initial interface when launched, as shown in Figure 1.

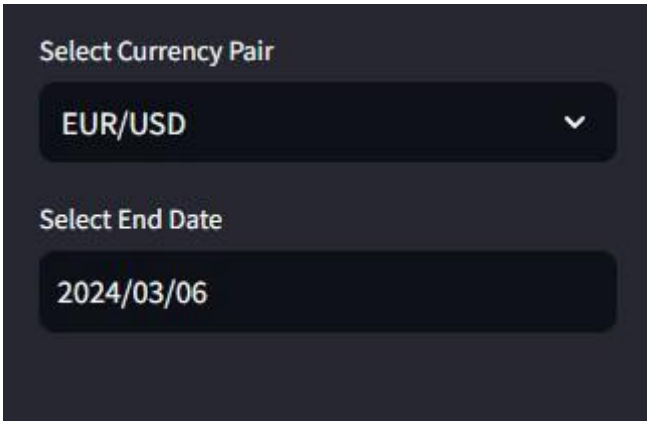


Figure 1: Currency pair selection for a date

The user can select the currency pair along with the date. The model uses the date input to aggregate data for 150 days in long-term breakout calculation for the selected currency. The number of fetch_data() function will get all data that matches the currency symbol, the start_date and end_date for the currency value. The obtained dataset for 150 days is pre-processed and the ASNN model is trained using the pre-processed data.

The user is presented with the option to make future recommendations, as shown in Figure 2.

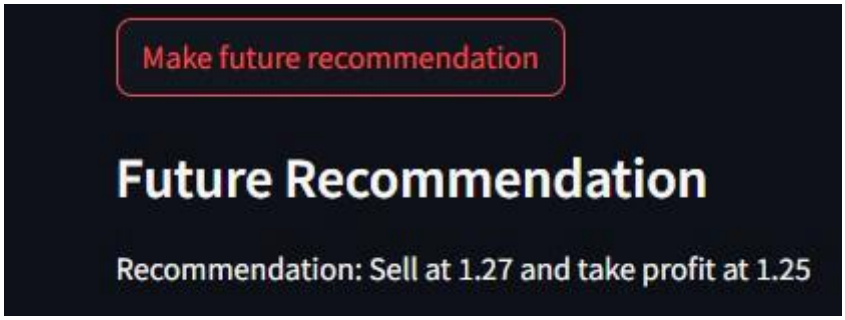
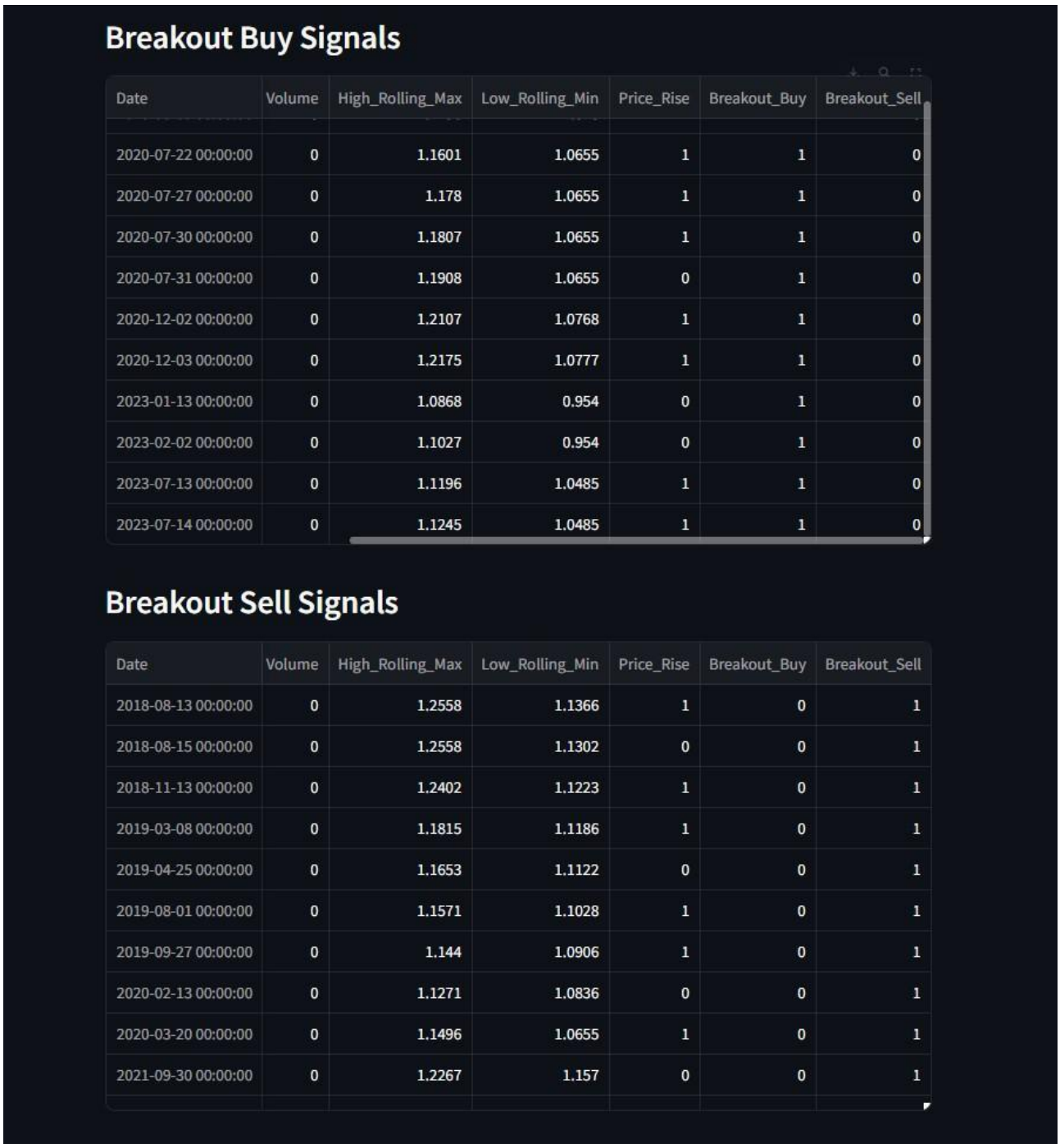


Figure 2: User option for future recommendation

The future recommendation feature will recommend the user either Buy or Sell the selected currency in the earlier screen. The future recommendation is based on the trained model and input data in Figure 1. For instance, the recommendation for the chosen currency and date is to Sell at 1.27 which can yield a profit of 1.25.

The user is also presented with a break-out signal chart as provided in Figure 3. The chart is created using the candlestick trace to represent the Open, High, Low and Close features in the graph shown as different colours. The data values for breakout Buy and Sell signals are shown in Figure 3.



Breakout Buy Signals

Date	Volume	High_Rolling_Max	Low_Rolling_Min	Price_Rise	Breakout_Buy	Breakout_Sell
2020-07-22 00:00:00	0	1.1601	1.0655	1	1	0
2020-07-27 00:00:00	0	1.178	1.0655	1	1	0
2020-07-30 00:00:00	0	1.1807	1.0655	1	1	0
2020-07-31 00:00:00	0	1.1908	1.0655	0	1	0
2020-12-02 00:00:00	0	1.2107	1.0768	1	1	0
2020-12-03 00:00:00	0	1.2175	1.0777	1	1	0
2023-01-13 00:00:00	0	1.0868	0.954	0	1	0
2023-02-02 00:00:00	0	1.1027	0.954	0	1	0
2023-07-13 00:00:00	0	1.1196	1.0485	1	1	0
2023-07-14 00:00:00	0	1.1245	1.0485	1	1	0

Breakout Sell Signals

Date	Volume	High_Rolling_Max	Low_Rolling_Min	Price_Rise	Breakout_Buy	Breakout_Sell
2018-08-13 00:00:00	0	1.2558	1.1366	1	0	1
2018-08-15 00:00:00	0	1.2558	1.1302	0	0	1
2018-11-13 00:00:00	0	1.2402	1.1223	1	0	1
2019-03-08 00:00:00	0	1.1815	1.1186	1	0	1
2019-04-25 00:00:00	0	1.1653	1.1122	0	0	1
2019-08-01 00:00:00	0	1.1571	1.1028	1	0	1
2019-09-27 00:00:00	0	1.144	1.0906	1	0	1
2020-02-13 00:00:00	0	1.1271	1.0836	0	0	1
2020-03-20 00:00:00	0	1.1496	1.0655	1	0	1
2021-09-30 00:00:00	0	1.2267	1.157	0	0	1

Figure 3: Breakout Buy and Sell data values

The breakout signals chart is created using the data in Figure 4. For instance, High is provided as green colour and Low as red marks. The breakout signal chart is created to display buy and sell recommendations for a given time period.

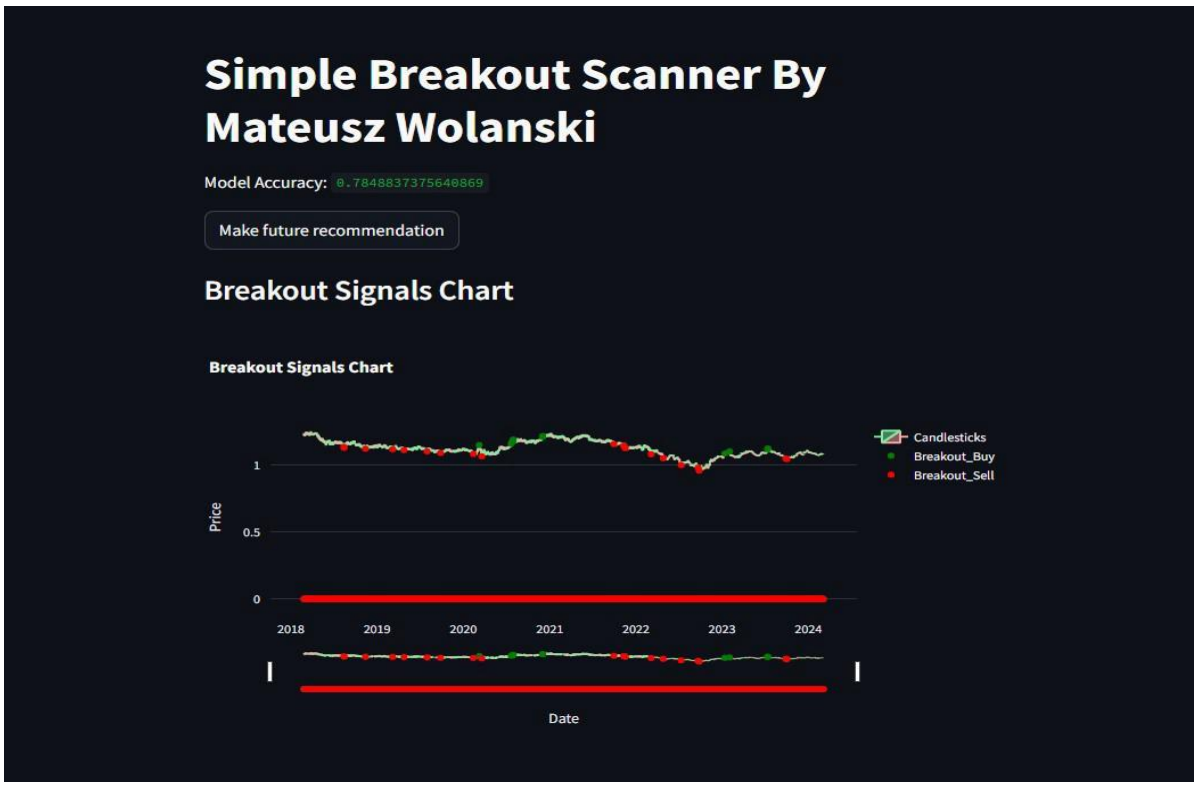


Figure 4: The breakout signal chart recommending buy and sell options using

The recommendation markers are generated using the go.Scatter() function for the features High and Low. The go.scatter() function is a visualisation function in Python to understand the recommendation easily. The recommendation markers are added using the go.Scatter function to show the Buy or Sell recommendation. The graph is shown in Figure 5.

Figure 5: Breakout signal chart with recommendation markers

Lastly, the system is programmed to display breakout buy signals and sell signals table, thus supporting the user with recommendations. Using the system, novice investors can benefit because, for a given date and currency, the performance of the chosen currency is provided along with recommendations. Based on the recommendations the user is supported with decision making without any market complexities.

4 Chapter Four: Results and Discussion

4.1 Testing

The developed system is tested using standard test methods and test cases are created using random data obtained from test data frames obtained from Yahoo Finance. The testing will further validate and justify application usage in foreign exchange markets by novice investors. Also, since AI is emerging in multiple fields in the finance industry, the AI model algorithm presented in the project can have problems, and challenges due to their special needs related to the efficacy of forex investing decisions. However, the testing approach follows the standard scientific approaches as in software implementation. The following tests were performed on the model,

- Integration test: AI algorithms are developed to work in tandem with other systems and implemented to resolve specific challenges from complex datasets. The integration testing is done with the Forex platform that supports users in investing using Yahoo Finance datasets.
- Real-time test: This test approach is considered as the system must be able to provide accurate guidance on decision-making for novice investors on a currency whether to Buy or Sell based on the market. The test datasets were created from the data frame developed with features in Yahoo Finance data. The test datasets will ensure the efficacy of the trained model. The data for testing were logically constructed to test different currency scenarios and different dates. This is important to refine the AI model to improve its learning and thus its accuracy in decision making.
- The test evaluated the use of test datasets for the time period, the evaluation results are presented as screenshots below.

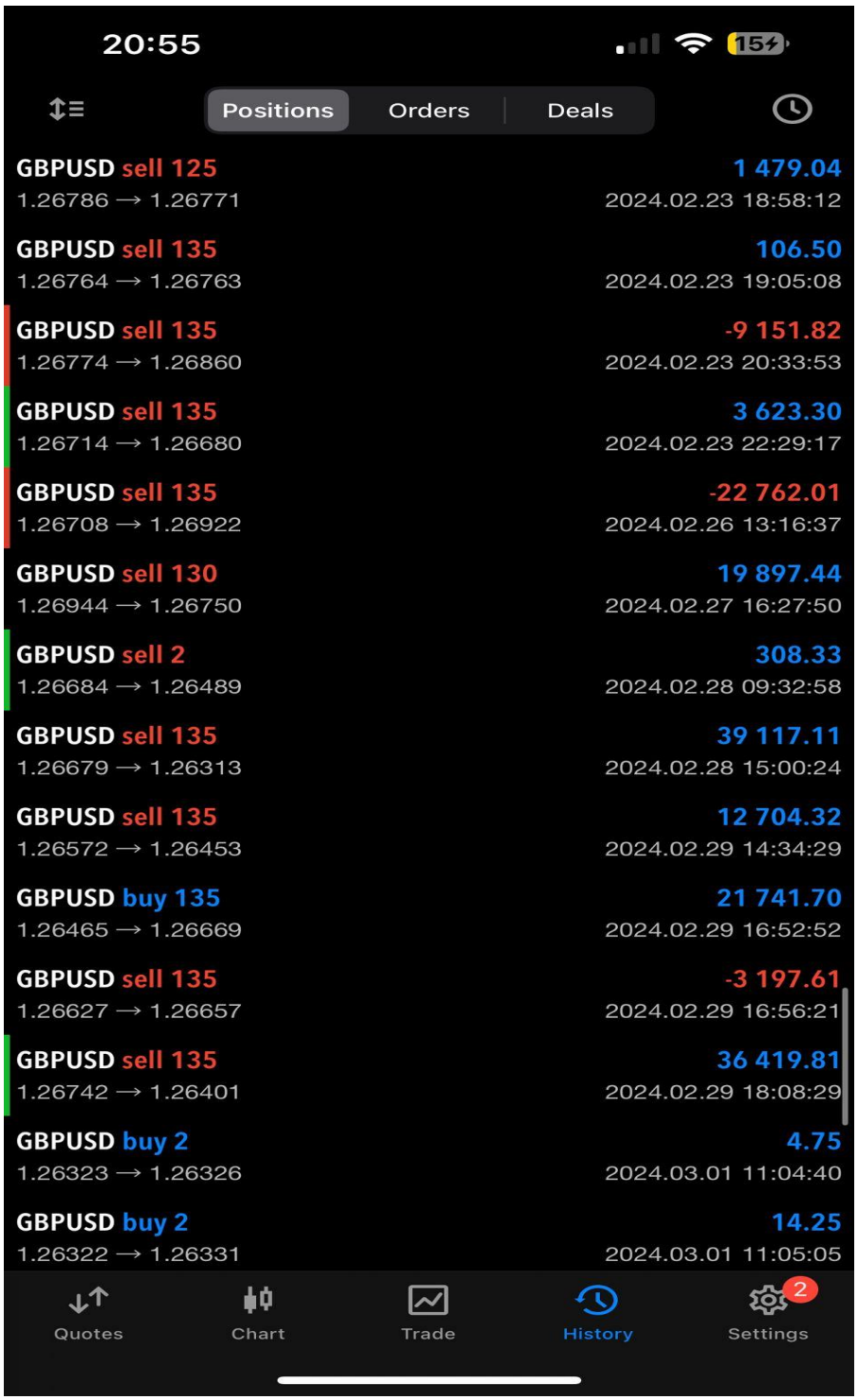


Figure 6*:* Test output 1

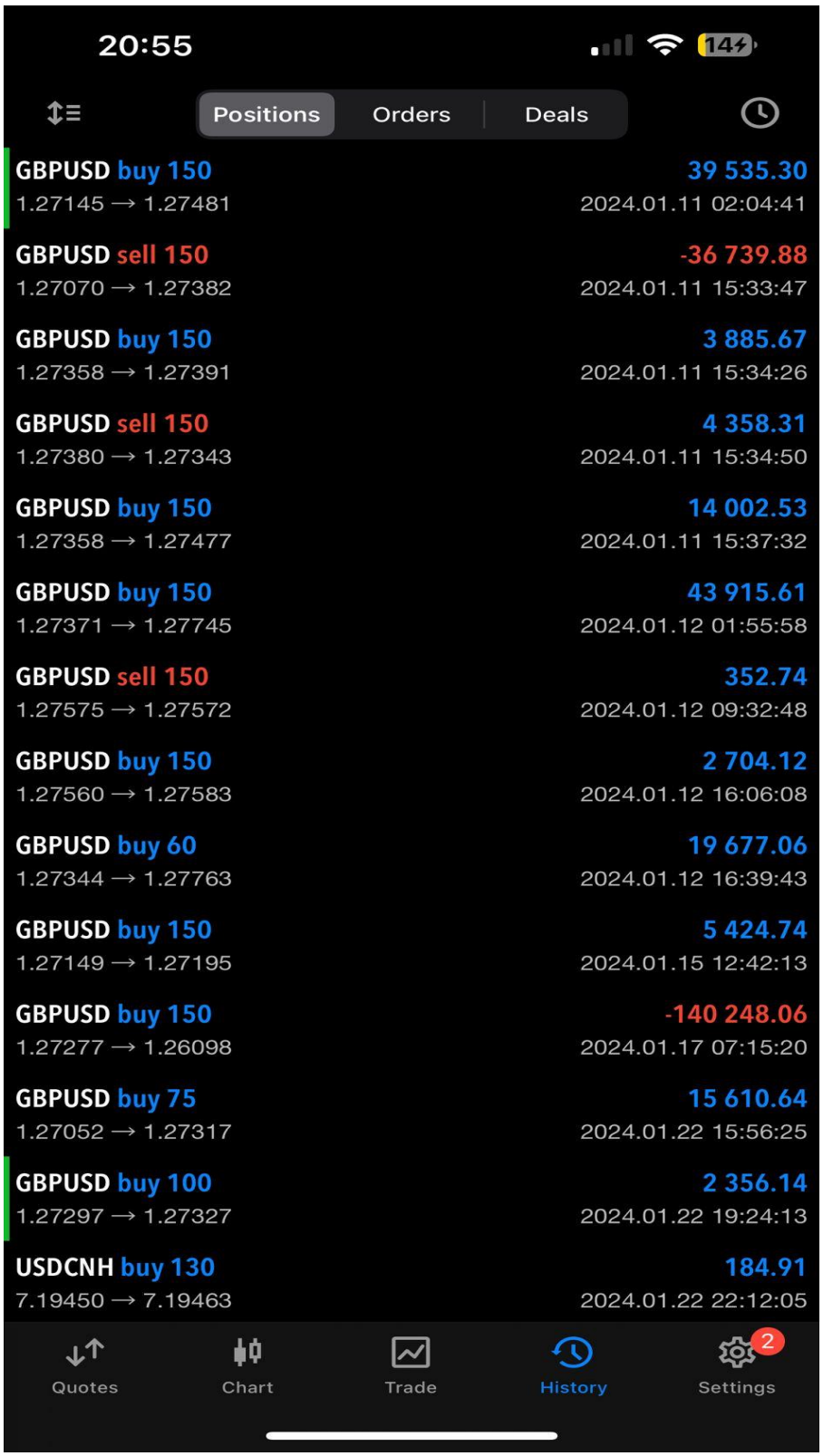


Figure 7: Test output 2

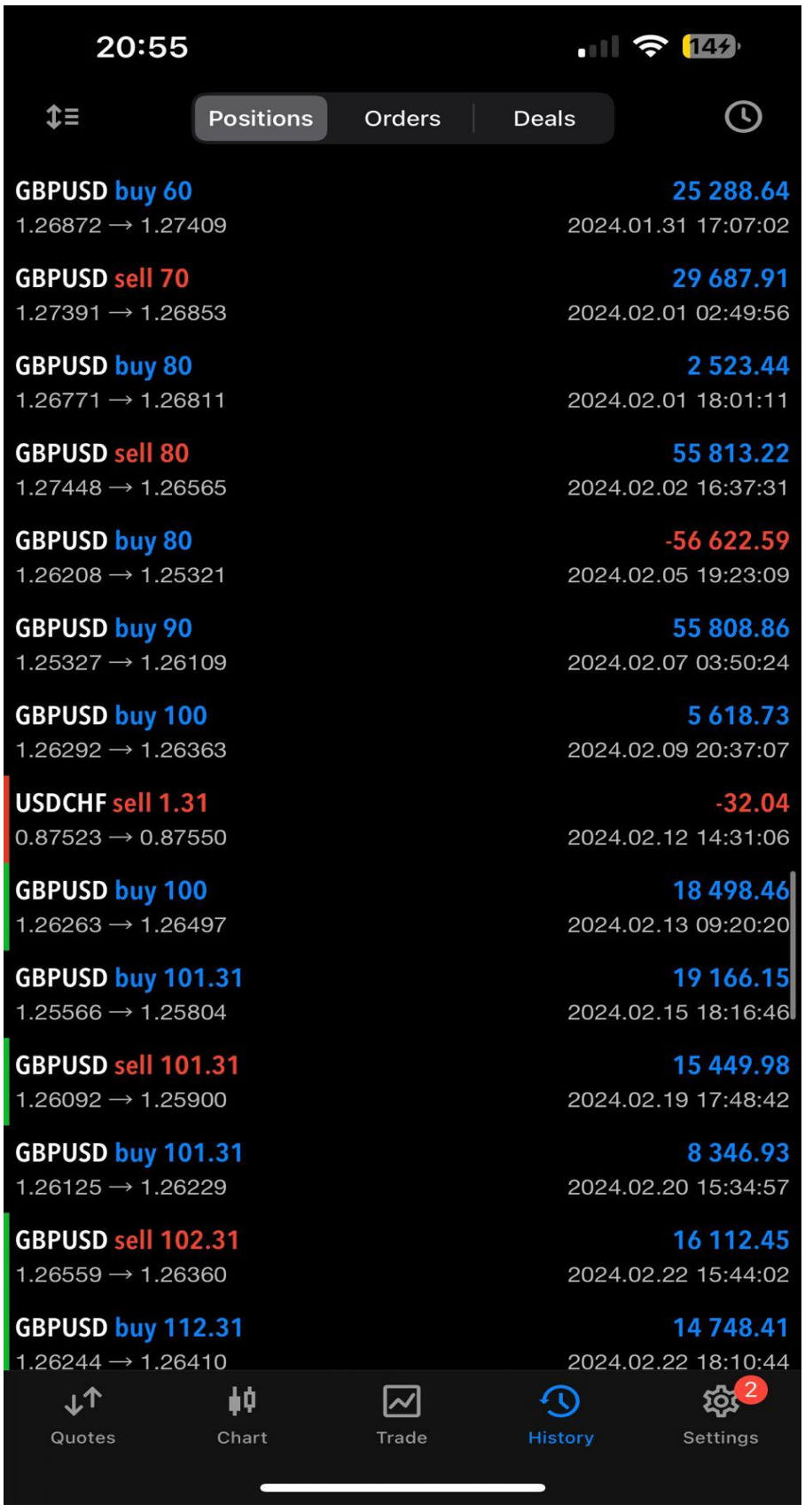


Figure 8: Test output 3

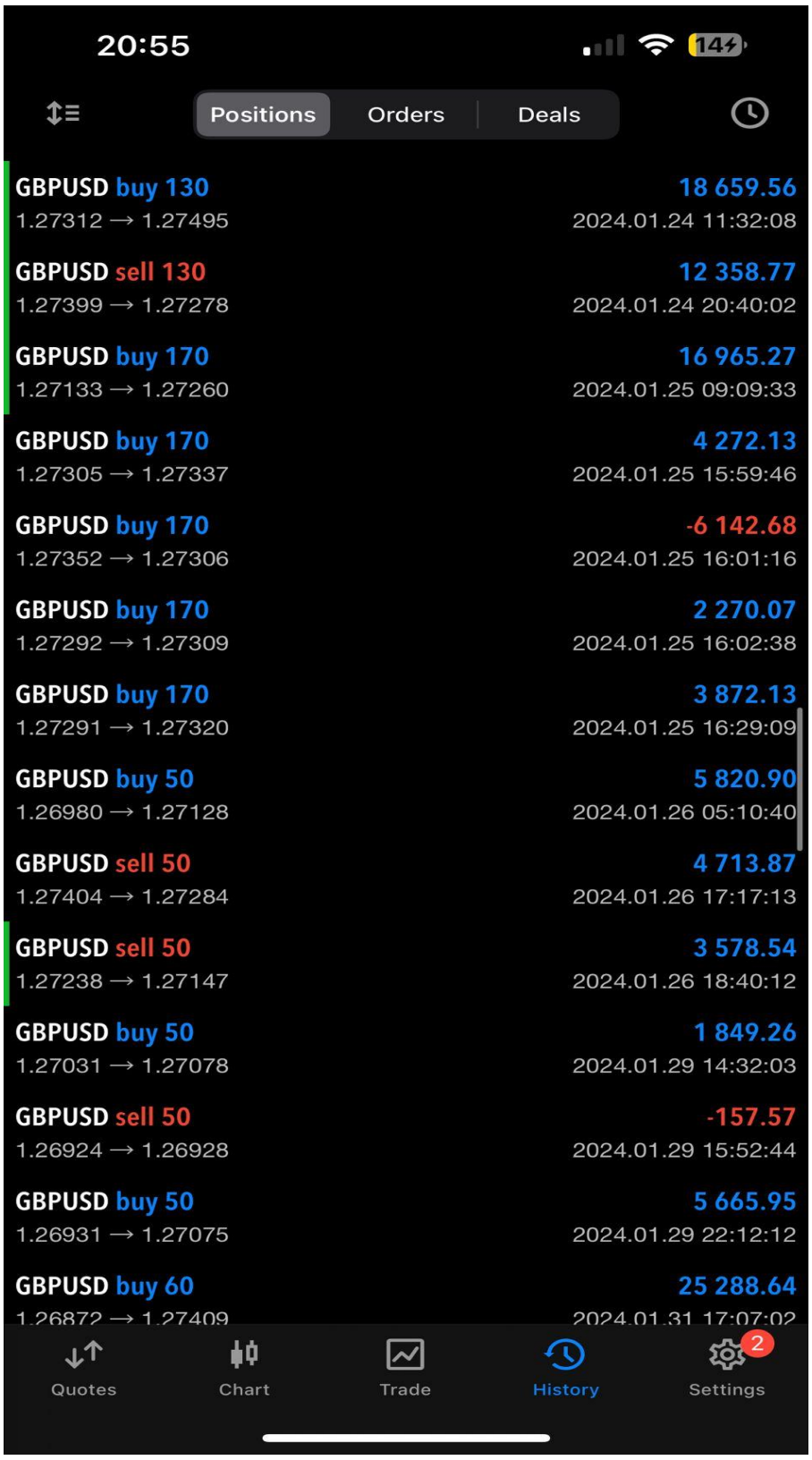


Figure 9: Test output 4

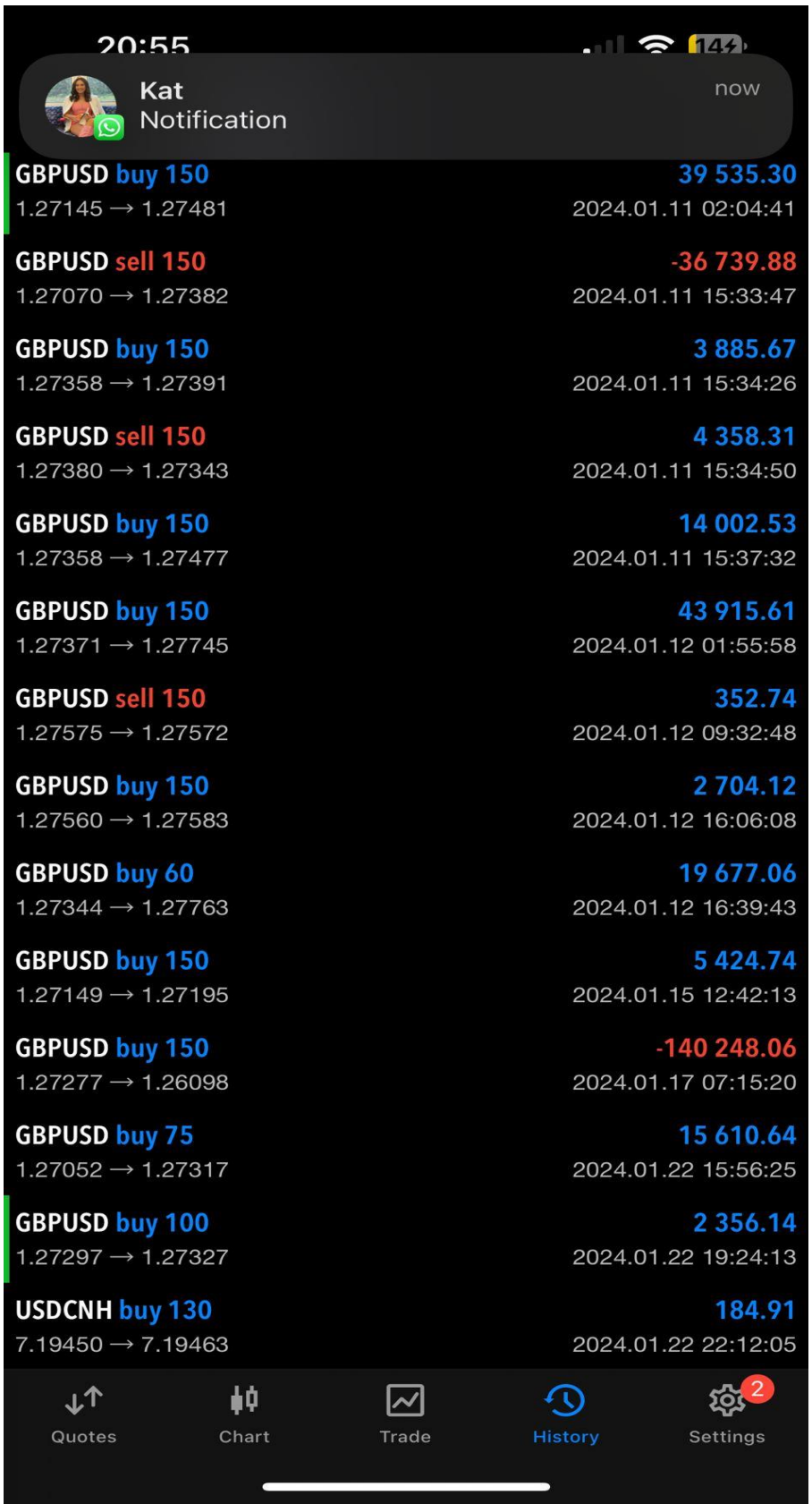


Figure 10: Test output 5

Figure 11: Test output 6

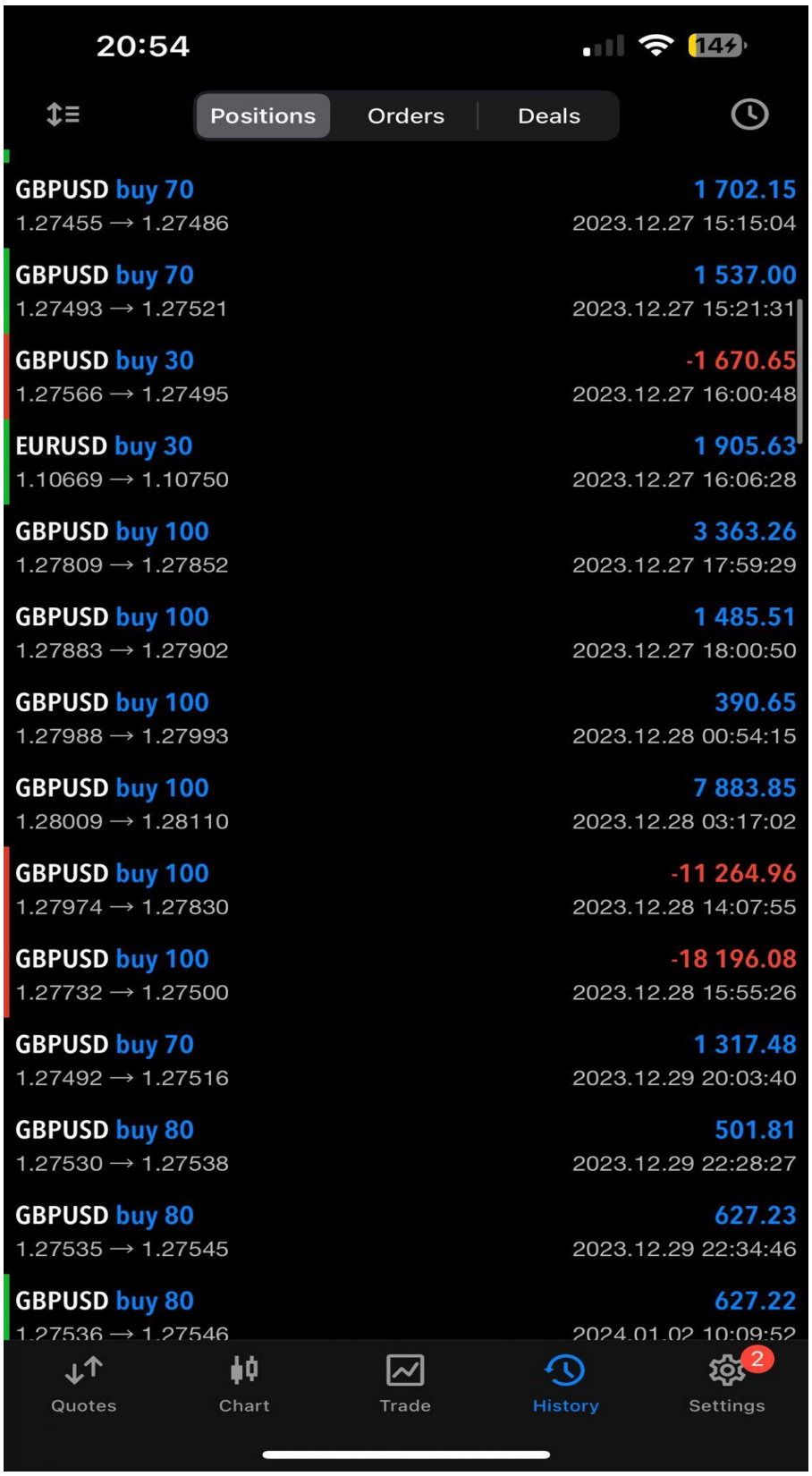


Figure 12: Test output 7

Figure 13: Test output 8

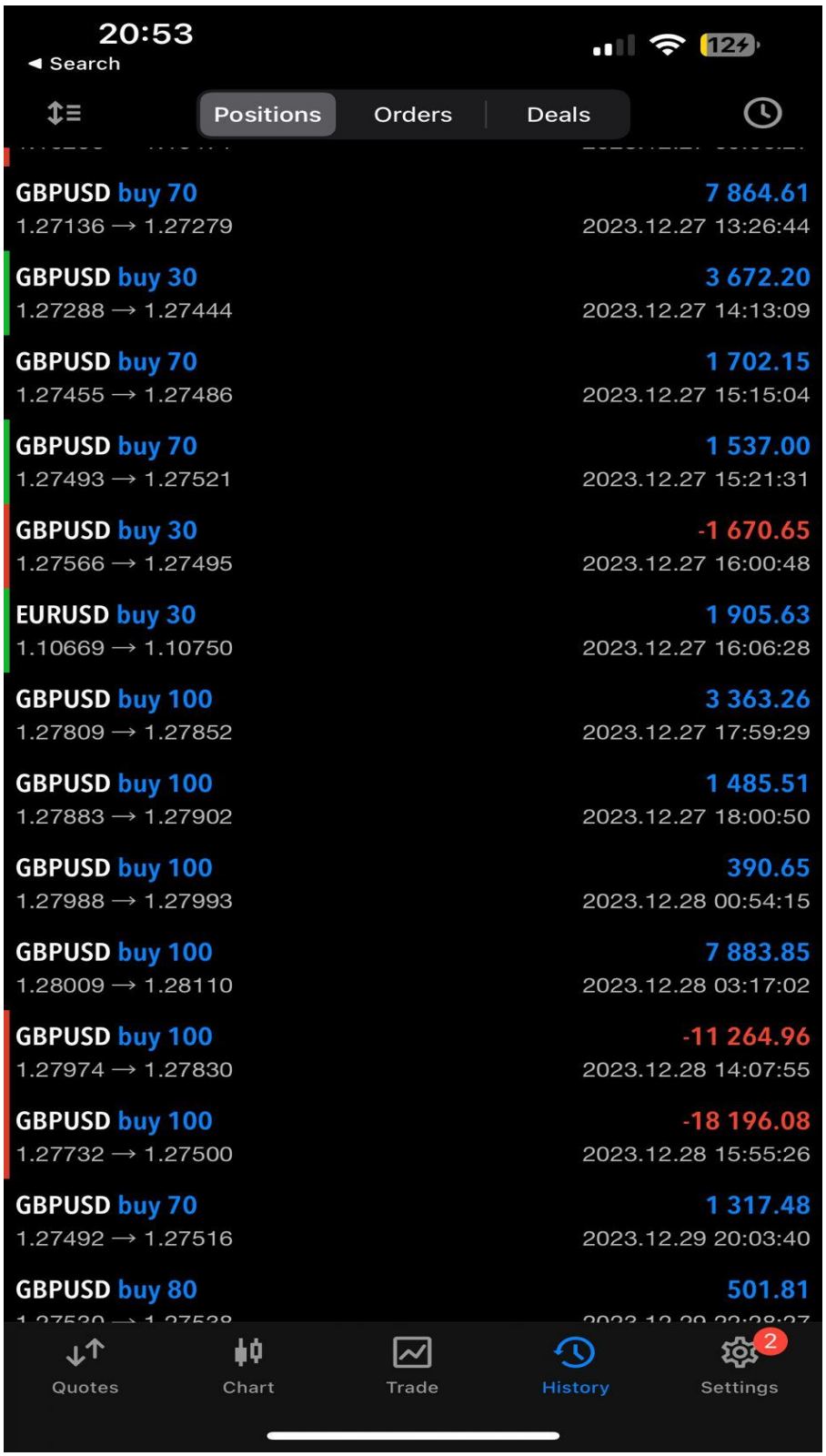


Figure 14: Test output 9

In all the test outputs (Figure 6 to Figure 14), it is noted that the currency chosen is GBPUSD, along with the date (as in Figure 1). The outputs provided in blue colour indicate the performance of this currency combination for a particular date. The future recommendations

on whether the user can buy or sell the currency are also provided along with expected gain or loss. The decline in performance is shown in red colour for the particular date. Based on these indicators the investor can decide on whether to Buy or Sell the currency.

- The testing of the AI model considers non-functional requirements such as security and performance. The system is run for different currencies at different dates and outputs obtained that match with the market projected output for foreign exchange. The tests were extensively done to ensure the performance of the AI model is robust with good levels of accuracy in all test iterations. In addition, the regulatory compliance aspects were also considered in the test runs.

The tests done consider different currency and date scenarios. The system is found to predict future recommendations on test data accurately as found from the outcomes during tests. The algorithm is thus verified as discussed above and found to yield expected outcomes. The evaluation of the AI model is done by analysing the strengths, weaknesses, opportunities and threats (SWOT) method to understand its usability in the real-time forex market.

The resources were analysed with a focus on helping novice traders confidently invest in the intricate forex market. The AI model with distinct approach to recommending trading decisions using historical data. The ANN-based algorithm will help in decision support for novice traders with multiple advantages as discussed earlier. The system has the ability to process large volumes of data to enable real-time analysis. The algorithmically based decision-making will certainly eliminate subjective information such as emotional biases and hence AI-based algorithms are used in forex markets. In addition, the learning ability of the algorithm will ensure the model is adaptable in dynamically changing markets.

While working and testing the developed model for its accuracy, multiple challenges were faced. It is noted that the accuracy of the AI predictions is dependent on historical data and its quality. One important aspect to consider in AI systems output reliability is the quality of data as in complex markets there are requirements for adaptability and continuous learning. As discussed above there are

various quantitative and qualitative factors that play a role in forex market trading. Hence, the developed AI model has the ability to include both human expertise and AI algorithms to overcome limitations in trading decisions. The developed system is based on the combined effect of both human efforts to complement the algorithmic analysis to have a comprehensive grasp on the foreign exchange market without compliance or ethical implications. Importantly, in the case of human intervention there is scope for subjectivity and potential errors. To overcome subjectivity or bias the algorithm is developed based on quality input data and tested using historical foreign exchange data from reliable sources.

While conducting this project, it was identified that AI is effective in supporting novice users on market trends, support in identifying risks, and decision-making. Further AI is adaptable due to its learning abilities and hence novice users can easily access and navigate forex trading markets. At the same time, user requirements can be different. In such scenarios, the AI model can adapt itself according to user needs and provide the expected outputs.

4.2 Evaluation

4.3

Evaluating the AI model is emphasised because the development of algorithms is scientific and the development does not always follow the well-defined software engineering process and methodology. There are other constraints that were considered while evaluating the developed AI model. Further, the AI model uses ML models and techniques that are trained with limited input datasets in ad hoc conditions. The learning features provided are based on static datasets, however live dataset tests have to be used to perform tests. Another constraint with AI system testing is that the outputs, or decision-making responses can be uncertain since the ANN algorithm used depends on statistical technique. The testing methods followed in the project consider the above criteria and tests are performed for decision making by the user. Given the above aspects, a SWOT analysis of the developed system is done to understand any drawbacks found in the system.

4.4 SWOT Analysis

Strengths	**Weaknesses**

• Uses advanced algorithms and technology to generate correct trading • The model is developed with features Open, Buy, Sell, and Close. Based on the performance of the currency on a given date, one of these features is recommended for new investors, thus easing market complexity. • The model will provide results to make informed trading decisions. • The interface is user-friendly and outputs are easy to understand and interpret, even for new forex users. • The system provides future recommendations for decision-making for investors • New investors can understand risks as the outputs provide a colour to indicate risk or gains. • The model will integrate easily with existing applications/ platforms.	• Personal experience and expertise are lacking and hence there is over-dependence on technology. • The system can provide wrong results when input data is noisy. • The system can be vulnerable in rapidly changing markets as the model is dependent on historical data. • An accurate prediction in the real-time forex market must be verified for different scenarios. • The system does not provide options for customised trading based on individual preferences.
Opportunities • With a growing number of investors new to the forex market, the model can support trading decisions. • Recent advances in Fintech provide the opportunity to further develop more sophisticated algorithms to obtain accuracy in forex trading. • The model can be used on any computing device including smartphones.	**Threats** • Competition is high in the forex market and hence the system must have built-in mechanisms for protecting user information. • Forex trading is governed by regulations and hence ensuring compliance is important, especially in anti-money laundering (AML) requirements. • Technical issues are possible, issues include application crashes,

• Users can use the model in large datasets to understand risks. • The presented model will motivate new users interested in foreign exchange markets.	vulnerability to attacks, and threats on the internet. • Investors can face financial loss when results or recommendations are inaccurate due to changes in the forex market.

Table 1: SWOT Analysis

From the SWOT matrix, it is evident the developed model has many advantages and provides multiple opportunities for novice traders. The application is developed to access the foreign exchange market efficiently. The SWOT analysis will also provide first-time users with the strengths, weaknesses, opportunities and threats in forex trading as this is important even for users already involved in forex trading. The developed application provides unique strengths and opportunities for more refinements. However, there are potential threats and weaknesses in the model that must be resolved and addressed correctly for success in the real-time market. Importantly, the access to different currency pairs for a given date to obtain future recommendations further improves the strength of the presented AI model.

4.5 Discussion

As mentioned in the literature review, the role of AI in financial markets is significant due to its ability to make predictions, support decision making and create economic benefits. Especially in foreign exchange the role of AI is to provide the ability to predict risks and future performance of currency based on historical data. Predicting risks and performance in the forex market provides the opportunity for novice investors to understand the real-time waning and direction of the forex market for a given date. The importance of technology in the foreign exchange market cannot be ignored because with online trading, modern technology and financial applications have significantly facilitated investors and market participants with effective interactions and transactions.

Earlier, customers depended on banks for foreign exchange market activities. However, with technology advancements, this scenario has dramatically changed and customers are able to freely access online trading platforms 24/7. In terms of market accessibility and efficiency, technology has

increased the accessibility to foreign exchange markets by motivating new traders despite the fierce competition in forex markets. Due to prediction and risk evaluation mechanisms in technology, individual traders have the benefit of not losing gains while investing. AI technology also supports decision-making based on market information that helps traders understand the performance of a given currency pair. Importantly, since foreign exchange markets are de-centralised, the problems related to observing markets globally have become easier with technology. For example, a novice trader on the internet using AI to understand future recommendations can immediately notice currency pairs in different markets to decide and make a profit. In addition, technology facilitates simultaneous purchase and sale activities. For instance, a trader can purchase currency at a lower price from one market and sell the purchased currency for a higher price in another market. In this manner, there are multiple opportunities and possibilities.

AI in financial markets also supports decision making especially in foreign exchange markets filled with complexities. The complexities are due to a variety of factors that influence exchange rate movements. The reasons for exchange rate movements are based on both, quantitative and qualitative factors. AI model with the ability to support investors both quantitatively and qualitatively will consider both macro-economic and micro-economic variations and make them measurable on numeric terms to support trading decisions. For instance, interest rates, changes in trade conditions, and the performance of a particular currency over a period are considered quantitative measures. Alternatively, political situations, economic events, speculation in exchange rates, etc. are qualitative measures. Hence, decisions in the forex market are dependent on both factors. Further, to arrive at a tangible solution in forex trading decisions, AI systems with the ability to handle both quantitative and qualitative parameters are ideally suited to handle market data.

The ANN algorithm is used in the developed model for its ability to analyse the primary relationship between various parameters. For instance, for the selected currency pair and date the recommendations for decision are given based on quantitative historical data, and using the performance of the currency over a time period that involves other qualitative factors. AI model built

using ANN has multiple layers of interconnected nodes, similar to the human brain. The neural network in currency trading is popular for decision-making because of its ability to interpret exchange rate patterns, along with strengths related to conformity and non-linearity. Further neural network-based AI algorithms are popular in trading markets as they help to reduce costs involved in consulting services in forex markets. However, the AI system requires high-quality input information to train the model to ensure the model has understood complex relationships and interactions between the parameters. Due to the above advantages the ANN-based AI model is developed as it can work continuously handling tedious tasks and input data. Importantly, the AI model cannot provide creative responses each time with input data, but the algorithm will provide output information based on the input dataset provided to the system. This is another important aspect to avoid speculation in decisions. The AI model recommendations for decision-making will be based on actual input information, which is a major advantage for both novice and experienced investors.

Another advantage of the developed system is that in a given forex market based on international trade, often the exchange rates can be erratic in the absence of a governing body. Hence market analysts obtain data from multiple trading sources with international currencies. In this scenario, the data obtained and incorporated into the system may not provide the right results because the AI model depends on objective data without many errors. This is another important aspect to consider with input data in the presented model. Reliability is important for decision-making in forex markets, considering the fact forex markets depend on AI systems for predicting prices and investing decisions.

5 Chapter Five: Conclusion

5.1 Conclusion

The project presents an AI model for use in forex trading to support novice investors. The growing influence of AI in forex is significant as it helps in handling complicated processes in rapidly changing markets. Due to this reason, AI has found its place in financial markets. Foreign exchange is the most active market where trading is quick with changing trends and interactions. In such complex markets, AI comes to the fore to support traders in trading decisions. There are many applications available in forex platforms, however, the project is unique as this will make use of historical data to provide future recommendations for novice traders taking into account the risks in currency pairs. It is noted that there are many advantages of AI in forex trading. Given these aspects, the project presents an AI model that will provide accessibility to novice traders to understand the market and inherent risks in trading.

A literature review is done to understand the use of AI in financial markets and on how AI can support forex markets, especially for traders interested in foreign exchange investing. The reviews cover existing studies available from journals, conference proceedings and market reports. The studies highlight the use of technology significantly in foreign exchange, especially in the areas of fraud detection, data analysis and making predictions on price based on closing price value. However, not many studies were found that underline the efficacy of AI in forex trading. However, AI along with other emerging technologies play a significant role with the potential to solve complex market problems and make predictions to support investing decisions for traders. The summaries of the studies reviewed are presented in the literature review.

Methodology sections provided a brief on research methods followed, the project uses a mix of qualitative and quantitative methods to achieve the project objectives. The data source used in the analysis for the AI model is explained, and the dataset is obtained from Yahoo Finance API. The development of the algorithm is explained, the algorithm is developed using Python programming

and makes use of ANN for decision-making. The methodology section also explains the analysis techniques and the expected outcomes using the Yahoo finance dataset.

The section on project work explains the steps followed in AI system design and development. The design steps are provided in sequence to help the reader for easy understanding. The section on implementation explains the Python functions used and the purpose of the developed AI model. The implementation also provides the screenshots obtained while executing the algorithm. The screenshots for outputs are also presented along with explanations that highlight future recommendations for investors whether to buy or sell the currency. The breakout signals table obtained from multiple iterations of the algorithm is presented and the breakout chart is for easy identification with colour coding to support buy or sell decisions.

The developed AI model is tested and the tests done on the system are explained. Tests are important to understand the usefulness and reliability of the developed system. The evaluation of tests is presented as screenshots, importantly the developed A algorithm can be used even on smartphone apps for foreign exchange trading. The screenshots indicate the value of the currency pair and the performance of the currency for a given date. If the performance is poor, red colour is used and if performance is good, blue colour text is provided for easy identification and decision making.

The resource analysis section provides the use of resources to emphasise the need for this AI algorithm in forex markets. The section on evaluation provides the strengths, weaknesses, opportunities and threats (SWOT) analysis to understand the usefulness and the advantage of the developed model along with the disadvantages and threats it can pose to novice investors. From the SWOT analysis, it is noted that the strengths and opportunities outweigh the weaknesses and threats, however, the drawbacks identified in SWOT have to be addressed in further research on this topic.

General discussions are provided on the use of AI in forex markets with emphasis on the developed AI algorithm. The developed system must be further evaluated with real-time market data to understand its effectiveness.

5.2 Recommendations

The following recommendations may be considered based on the advantages of the developed model,

- The developed model is easy to use and can support both novice and experienced investors in understanding the performance of currency pairs on a given date.
- The system can provide future recommendations to help the investor in either buy or sell decisions.
- The developed AI system is designed to identify risks and highlight the performance using different colours to highlight good or poor performance. However, the system will require high-quality input data to obtain accurate results.
- The developed system is user-friendly with easy-to-understand screens to help freshers interested in forex trading.
- The system is considered compliant with regulations in forex markets.

Based on the above recommendations the system can be considered for implementation as it will support novice traders.

5.3 Future Work

Further work on the topic area is to make use of dynamic real-time datasets and implement the algorithm in the forex market to understand the efficacy of the developed system. The weaknesses identified in the existing system will be addressed to make the algorithm more robust in changing market conditions.

6 Reference list

Agrawal, M., Kumar Shukla, P., Nair, R., Nayyar, A. and Masud, M. (2022). Stock Prediction Based on Technical Indicators Using Deep Learning Model. *Computers, Materials & Continua*, 70(1), pp.287–304. doi:https://doi.org/10.32604/cmc.2022.014637.

Ahmed, S., Alshater, M.M., Ammari, A.E. and Hammami, H. (2022). Artificial intelligence and machine learning in finance: A bibliometric review. *Research in International Business and Finance*, 61(101646), p.101646. doi:https://doi.org/10.1016/j.ribaf.2022.101646.

Anastasovska, M. (2022). Currency Diversification Of Investments: Is It Worth It? *Economy & Business Journal*, 16(1). doi:https://doi.org/366-374.

Aslam, F., Aziz, S., Nguyen, D.K., Mughal, K.S. and Khan, M. (2020). On the efficiency of foreign exchange markets in times of the COVID-19 pandemic. *Technological Forecasting and Social Change*, 161(1), p.120261. doi:https://doi.org/10.1016/j.techfore.2020.120261.

Bashir, Z., Ali, J. and Rashid, T. (2020). Consensus-based robust decision making methods under a novel study of probabilistic uncertain linguistic information and their application in Forex investment. *Artificial Intelligence Review*, 54(3), pp.2091–2132. doi:https://doi.org/10.1007/s10462-020-09900-y.

Cohen, G. (2022). Algorithmic Trading and Financial Forecasting Using Advanced Artificial Intelligence Methodologies. *Mathematics*, 10(18). doi:https://doi.org/10.3390/math10183302.

Dash, R.K., Nguyen, T.N., Cengiz, K. and Sharma, A. (2021). Fine-tuned support vector regression model for stock predictions. *Neural Computing and Applications*, 35. doi:https://doi.org/10.1007/s00521-021-05842-w.

Dautel, A.J., Härdle, W.K., Lessmann, S. and Seow, H.-V. (2020). Forex exchange rate forecasting using deep recurrent neural networks. *Digital Finance*, 2. doi:https://doi.org/10.1007/s42521-020-00019-x.

Drehmann, M. and Sushko, S. (2022). *The global foreign exchange market in a higher volatality environment. BIS Quarterly*. [online] BIS. Available at: https://www.bis.org/publ/qtrpdf/r_qt2212f.htm#box-A [Accessed 11 Mar. 2024].

Fatima Mohamad Dakalbab, Manar Abu Talib and Nasir, Q. (2023). Machine Learning-Based Trading Robot for Foreign Exchange (FOREX). *Lecture notes in networks and systems*, 721, pp.196–210. doi:https://doi.org/10.1007/978-3-031-35308-6_17.

Goodell, J.W., Kumar, S., Lim, W.M. and Pattnaik, D. (2021). Artificial intelligence and machine learning in finance: Identifying foundations, themes, and research clusters from bibliometric analysis. *Journal of Behavioral and Experimental Finance*, 32(1), p.100577. doi:https://doi.org/10.1016/j.jbef.2021.100577.

Guo, D. and Zhou, P. (2023). *The evolution of financial market infrastructure: From digitalization to tokenization*. Cardiff: Cardiff Economics Working Papers No. E2023/05. Cardiff University, Cardiff Business School.

Horn, M., Oehler, A. and Wendt, S. (2020). FinTech for Consumers and Retail Investors: Opportunities and Risks of Digital Payment and Investment Services. In: *Palgrave Studies in Sustainable Business In Association with Future Earth*. Palgrave Macmillan, pp.309–327. doi:https://doi.org/10.1007/978-3-030-38858-4_14.

Hu, Z., Zhao, Y. and Khushi, M. (2021). A Survey of Forex and Stock Price Prediction Using Deep Learning. *Applied System Innovation*, 4(1), p.9. doi:https://doi.org/10.3390/asi4010009.

Jamali, H., Younes Chihab, Iván García-Magariño and Bencharef, O. (2023). Hybrid Forex prediction model using multiple regression, simulated annealing, reinforcement learning and technical analysis. *IAES International Journal of Artificial Intelligence (IJ-AI)*, 12(2), pp.892–892. doi:https://doi.org/10.11591/ijai.v12.i2.pp892-911.

Jung, G. and Choi, S.-Y. (2021). Forecasting Foreign Exchange Volatility Using Deep Learning Autoencoder-LSTM Techniques. *Complexity*, 2021, pp.1–16. doi:https://doi.org/10.1155/2021/6647534.

Kaur , K., Kumar , Y. and Kaur, S. (2024). Artificial Intelligence and Machine Learning in Financial Services to Improve the Business System. In: *Computational Intelligence for Modern Business Systems. Disruptive Technologies and Digital Transformations for Society 5.0*. Singapore : Springer .

Khadelwal, N. and Jain, A. (2022). Effect of Technology Innovations toward High-Frequency Trading (HFT) in Equity. *International Journal of Advances in Engineering and Management (IJAEM)*, 4(4), pp.600–617.

Michaela Denise Gonzales, R. and Hargreaves, C.A. (2022). How can we use artificial intelligence for stock recommendation and risk management? A proposed decision support system. *International Journal of Information Management Data Insights*, 2(2). doi:https://doi.org/10.1016/j.jjimei.2022.100130.

Nguyen, D.K., Sermpinis, G. and Stasinakis, C. (2022). Big data, artificial intelligence and machine learning: A transformative symbiosis in favour of financial technology. *European Financial Management*, 2(2). doi:https://doi.org/10.1111/eufm.12365.

Noonan, T. (2022). *Forex Trading QuickStart Guide:" The Simplified Beginner's Guide to Successfully Swing and Day Trading the Global Foreign Exchange Market Using Proven Currency Trading Techniques"*. ClydeBank Media LLC.

Olubusola , O., Mhlongo , N.Z., Daraojimba, D.O. and Olusola, A. (2024). Machine learning in financial forecasting: A US review: Exploring the advancements, challenges, and implications of AI-driven predictions in financial markets. *World Journal of Advanced Research and Reviews*, 21(2), pp.1969–1984.

Saka , N. and Moyanga, D.T. (2023). Evaluating the influence of foreign exchange policy regime on the construction sector in Nigeria. *International journal of real estate studies*, 17(1), pp.1–12.

Stone, M., Aravopoulou, E., Ekinci, Y., Evans, G., Hobbs, M., Labib, A., Laughlin, P., Machtynger, J. and Machtynger, L. (2020). Artificial intelligence (AI) in strategic marketing decision-making: a research agenda. *The Bottom Line*, 33(2), pp.183–200.

TBRC (2024). *Foreign Exchange Global Market Report 2024*. [online] The Business Research Company. Available at: https://www.thebusinessresearchcompany.com/report/foreign-exchange-global-market-report [Accessed 11 Mar. 2024].

Wen, T. and Wang, G.-J. (2020). Volatility connectedness in global foreign exchange markets. *Journal of Multinational Financial Management*, 54(1), p.100617. doi:https://doi.org/10.1016/j.mulfin.2020.100617.