

CHAPTER 1

INTRODUCTION

1.1 Rationale

The foreign exchange (forex) market is a financial market where currency trading occurs. In April 2022, daily forex trading was reported to have reached \$7.5 trillion [1], making it the largest financial market. Participants in this market are ranging from large commercial banks to small retail traders who require a broker to access the trading platform. As a result, the forex market has become popular among retail speculators or day traders. Despite its large trading volume and numerous participants, the forex market has a high failure rate, with 95% of investors reportedly failing[2]. Hayley and Marsh [3] also reported a high rate of Forex traders lost money. This failure rate is largely due to various market characteristics[4], such as the influence of economics, politics, society, and traders' psychology.

These factors often cause traders to act impulsively, leading to noise in price data and distorted genuine market trends. The noise can also come from broker manipulation of market prices and volatility, which makes it difficult to determine when to open or close a position. These actions can significantly impact a trader's losses and profits in forex trading. To minimize losses, several studies have been conducted to overcome these characteristics and forecast price trends in the forex market.

There are two approaches to forecast the forex market's price trend: fundamental and technical. The fundamental approach takes into consideration the economy, politics, and social conditions of a country and the world, while the technical approach relies solely on historical market data, such as open price, high price, low price, close price, and volume. The technical approach is based on the idea that price reflects market psychology and market participants' changing attitudes towards economic, monetary, political, and psychological forces[5]. Surveys [6],[7],[8] show that the technical approach has been widely used in research and has produced good results.

The forex market has various time frame markets, such as 5-minute, 1-hour, daily, and weekly price movements, each with its own level of volatility. The higher time frame market provides a larger picture of the price movement, while the lower time frame market provides detailed information. The correlations between each time frame market can be useful. Shavandi et al. [9] proposed a multi-agent deep reinforcement learning framework to trade in the forex market by utilizing multiple time frame markets, resulting in a 22.7% higher average cumulative return than a single time frame method. The research uses a fixed time window to open and close positions, aiming for consistent profits as reflected in the Sharpe ratio evaluation of 0.63. However, this fixed time window may miss potential profits if the position is closed before the desired profit is achieved. Furthermore, the position could not close the position flexibly resulting in avoidable losses that may not occur if the position close before the loss.

1.2 Theoretical Framework

The techniques used in technical analysis to predict forex market price trends vary from human analysis to computer analysis. Technical indicators [10] are often used to simplify market data and reduce noise. This is done through manual analysis by humans, who study charts to identify trends and patterns. A widely used technical indicator among forex traders is the Moving Average. When the spot rate or a shorter moving average crosses the moving average, it can indicate a potential change in trend. Another popular indicator is the Relative Strength Indicator, which assesses the relative strength of upward movements versus downward movements[11]. The more traders expect a certain indicator to influence trading patterns, the more likely it will occur[12].

Another approach is machine learning (ML), which uses algorithms to learn from data and discover relationships and patterns. Deep learning, a subset of ML that uses a multi-layer neural network, is widely used in forex market forecasting[6],[7],[8]. Long Short-term Memory (LSTM) is a popular deep learning method due to its ability to remember relevant and discard irrelevant information from previous steps, making it ideal for time series data. Reinforcement learning, which has been gaining popularity, is another method commonly used in the gaming industry but can be used in the forex market as well[13],[14],[15],[9]. This approach can simulate forex trading by treating the market as an environment with specific trading rules. Buying or selling decisions in forex trading can be considered as actions that lead to rewards in the form of profits or losses.

1.3 Conceptual Framework/Paradigm

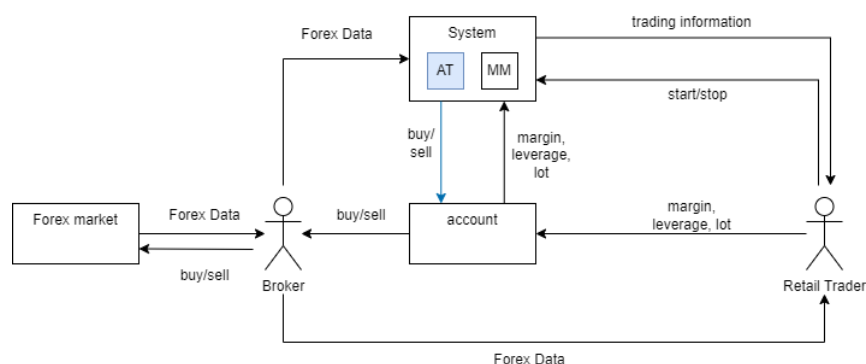


Figure 1: Forex trading framework

In the framework for forex trading, as shown in Figure 1, a retail trader obtains access to forex market data through a broker. The trader then sets the margin, leverage, and lot size, which determines the size of their trading position. A margin is proof of fund by the trader to shield the broker from the trader's losses. It is tied to leverage, a ratio that allows a smaller position size to be treated as a larger one. For instance, a \$100,000 EUR/USD position with a leverage of 1:20 would require a margin of \$5,000. The lot size refers to the size of the position. Once

these values are set, the trader can choose to buy or sell, opening or closing a position in the forex market through the broker. Additionally, an automated trading system can be utilized. The system obtains forex data from the broker, and the trader can give instructions to start or stop the system.

The system then provides the agent with trading information, which is obtained by determining the margin, leverage, and lot size from the trader's account and choosing to buy or sell to open or close a position in the forex market through the broker. The system consists of two sub-systems, one for money management such as margin, leverage, and lot and one for automated trading that determines which action to choose. This research focuses on the automated trading sub-system, specifically the selection of buy or sell action given forex data from the broker, without considering margin, leverage, or lot size, therefore, the money management sub-system is not considered.

1.4 Statement of the Problem

Removing the fixed time window can be a challenging task as it could result in inconsistent profits with potentially high loss values. However, the fixed time window may also lead to missed profits and unnecessary losses that could have been avoided.

The question arises: Will removing the time window lead to increased profits and decreased loss because the time window does not restrict it?

1.5 Objective and Hypotheses

This research aims to create a framework that facilitates the flexible opening and closing of positions in the forex market to achieve more profitable results. The framework employs reinforcement learning with LSTM to predict buying, selling, or holding actions based on price trends as the default instead of random action. The use of Reinforcement Learning in the framework seeks to regulate losses and achieve profitable results and the most optimal closing price by re-designing the state and Q-function.

The hypothesis for the research question is removing the fixed time window might lead to increased profit and decreased loss because there is no set time limit to open and close the position. Therefore, the independent variable is the time window of holding position and not opening a position in the forex market, while the dependent variables are profit and drawdown.

1.6 Assumption

The data for this research are collected from a broker platform [16] and covers 15 years' worth of historical EUR/USD exchange rates from 2008 to 2022. The data obtained are also considered clean, so no missing value is filled. The initial balance for the proposed trading system is set at \$1,000, and the system would stop if its loss or the balance reaches \$0 and if the simulation reaches one year. There is no cost or benefit besides the result of trading profit; therefore, the commission fee is considered zero. There is no forex market

spread, so the selected action would be executed immediately at the exact price the agent received.

1.7 Scope and Delimitation

This research focuses solely on utilizing technical analysis with historical data of EUR/USD to train and test the proposed system. The decision to buy or sell and open or close a position in the forex market is the primary function of the system. Furthermore, the system only allows for one open position at a time and does not support multiple positions simultaneously.

This research does not consider any fundamental factors such as economic, political, or social news and events. The proposed system does not include any considerations for determining margin, leverage, lot size, or other money management strategies, and therefore trades using all available balances.

1.8 Significance of the Study

This research aims to help retail traders make flexible buy and sell decisions in the foreign exchange market while avoiding excessive losses in the pursuit of profit. This is achieved by utilizing a combination of reinforcement learning and LSTM, where LSTM optimizes the reinforcement learning process by providing a good starting prediction rather than relying on random numbers. The finite state space in reinforcement learning is designed by considering not only price trends, but also other parameters to address the research question and enable flexible opening and closing of positions in the foreign exchange market. Additionally, the Q-function in reinforcement learning has been re-designed to specifically suit foreign exchange trading.