Selected papers on portfolio optimization

By – Akshit Wadhwa

Paper 1

"Deep learning portfolio optimization"

Authors—Zihao Zhan , Stefan Zohren

Portfolio Optimization meaning defined

- The optimization aims to select the best asset distribution within a portfolio to maximize returns at a given risk level,
- This is also widely known as the modern portfolio theory.
- Another meaning it defined was that despite such diversification and language models, it is not easy and straightforward to select the right asset allocations in a portfolio as the dynamics of the financial markets change significantly.

What data it has taking to observe

- The paper shows that the available asset for constructing a portfolio is enormous. So there are 5000 stocks available to choose from in the US stock market.
- Instead of using predicting expected returns often using econometric models , we bypass this forecasting step and directly compute optimal asset weights.
- The optimal asset weights are those portfolio asset allocation percentage that achieve the best trade-off between risk and return
- **Machine Learning / Deep Learning Approaches:**
- Directly learn a mapping from input features (price, volume, macro indicators) to asset weights by optimising a performance metric like the Sharpe ratio.

Explaining the model
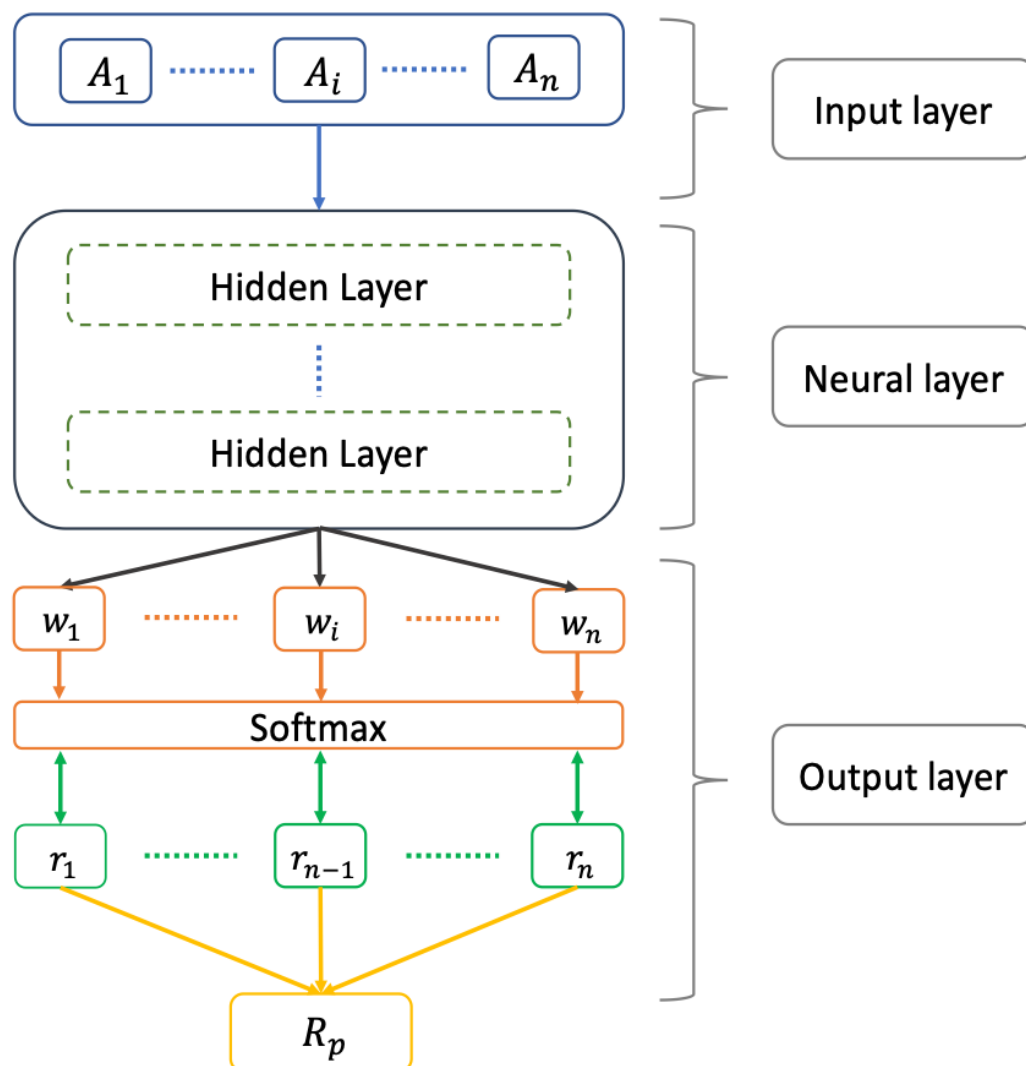
Our model is made up of three layers which has the input layer , neural(hidden) layer and the output layer. The goal is to use a neural network to automatically learn useful patterns (features) from multiple assets, and output **optimal portfolio weights** that maximise the **Sharpe ratio** (i.e., return per unit of risk).

- **Input layer—**

  - Here we have taken many variables such as past prices and returns over a given fixed window and examined the pattern.

- The combined pattern is then passed into the neural network and the model to extract patterns across time and assets

- **Neural Layer**— It is also called as the brain of the model

  - Fully Connected Networks(FCN) is used which takes each model and feature individually. It tries to learn everything individually. It learns things from scratch but this can also lead to overfitting.
  - Convolutional Connected Networks(FCN)- What this does is that it finds small repeating patterns which is better for short term trading as this holds the ability to analyse the pattern changes happening in milliseconds.

- **Output layer**

  The network outputs a vector of **portfolio weights**, one for each asset. It selects the stocks based on the best return per unit of the risk.

Why select this paper-

I selected this paper as it not only has the advantage being of short term stocks but also of the long term stocks as it had distributed those stocks based on the three levels and then implemented Deep Learning

Conclusion –

This method reads stock data like a seasoned trader:

• It tracks **price trends**, **correlations**, and **market patterns**.

• It chooses the **best features** to focus on.

• And it helps decide **how to split your money** across stocks in the smartest way.

Artificial Counsellor System for Stock Investment

Authors **-- Hadi NekoeiQachkanloo∗ , Benyamin Ghojogh**

Methodology and proposed idea

- It highlights the condition of investor who has a certain amount of money and he or she has to invest that money in stocks. The problem is to find the optimum weights and invest the money to **"Minimize the risks and raise the outputs"**
- What this paper does is it first tries to predict the future prices of stocks based on their previous behaviour which can be modelled by time series. The primary goal of this project is to find the best weights according to the predicted prices and fluctuations of every stock as well as the risk tolerance of the investor.
- This paper presents a **complete trading system** that does two main things:

    1. **Predicts future stock prices**, and

    2. **Recommends how to split your investment budget** across different stocks (optimal asset weights).

Theorems used and output—

- After it has predicted the future price of the stock , what it does is that it finds the ways to allocate the stocks based on the investors risk tolerance.
- It sees the price based upon two analysis which is technical analysis as well as fundamental analysis.
- In the fundamental analysis it looks at the financial health of all the companies of a specific weight like debt , weight and size.
- The dataset which this model is using is the stocks market NYSE dataset which is the new York stock exchange data.
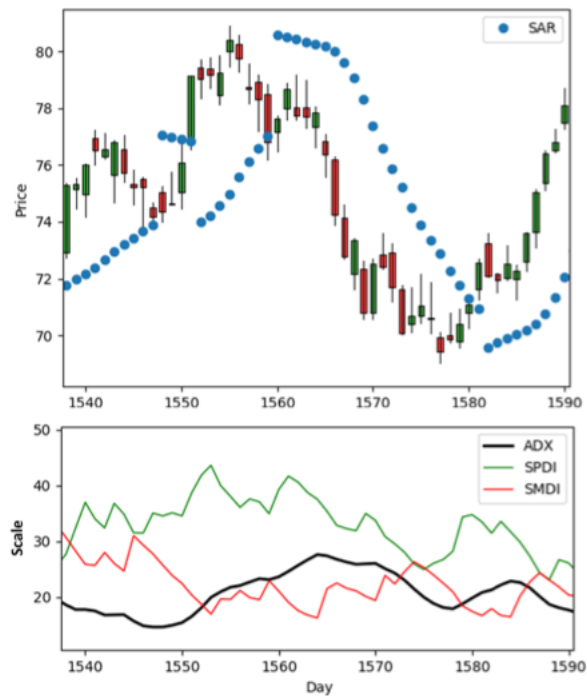
Figure 2: The candle plot of a stock and its indices.

This is the example which shows the future data prediction of the stock.

1. Fuzzy Logic-Based Investment Advisor— this is another theory which is uses which tells the user to modulate the risk when It feels that the price of one of the stocks can dip or lead to a lose
2. It is important as it models Mimics human reasoning; flexible to include various data types.

A brief review of portfolio optimization techniques

What does this paper depict –

1. It understands the problem of dynamic models such as mpt and fits them with the traditional market
2. Combining **technical, fundamental, and sentiment data** is still underexplored, especially in learning-based systems.
3. It defines optimization as – Portfolio management is the decision making process of continuously reallocating an amount of fund into a number of different financial investment products, aiming to maximize the return while restraining the risk
4. This paper shows us to work given in a short period of time

The trading strategy runs in **fixed time intervals**, for example every 30 minutes.

5. At the **start of each 30-minute window**, the algorithm decides **how to split your money** across different assets.
6. During each 30-minute period, prices move up and down, but the model tracks four key price points:

 Opening price: The price at the start of the period

 High: The highest price reached in that period

 Low: The lowest price in that period

 Closing price: The price at the end of the period

7. This also keeps the commission fee cut in mind as in the present world there is commission in the buying and selling of stocks.

8. Think of it like this: Every 30 minutes, your robot takes a look at the market and says: "Okay, based on what's happening, I'll move 20% of the money to stock A, 30% to stock B, and so on." It uses the **opening price** of that 30-minute window to do this buying/selling.
9. One of the advantage of this method is that it avoids extreme weights that often arise in traditional mean-variance optimization.

Techniques include:

Factor investing: Focus on factors like size, value, momentum, volatility, quality, etc.

Regression analysis: Predicts returns based on the historical data.

RESEARCH GAP IN ALL THE THREE PAPERS

- Assumes constant returns and covariances, which is rarely true in real markets.- **No dynamic adaptation**: Doesn't adapt to changing market conditions or trends.- **Requires user-defined stock set**: Doesn't help in selecting which stocks to include.
- In the first and second paper the time limit given to us is on the period of more than a month but the third one works on the small time
- Only deep learning-based methods adapt—but at the cost of complexity. This means that all of them rely on deep learning models but sometimes in present markets certain unnoticeable fluctuations are there which lead to black boxes.
- Simple and interpretable, but assumes **static correlations** and normally distributed returns. All the three models are simple and interpretable but some depend on future returns while some depend on past trends. This shows that problem of both underfitting and overfitting can be caused as normally not models are equally distributed