

How Can Artificial Intelligence Be Used to Determine the Optimal Investment Portfolio That Maximizes Returns While Minimizing Risk?

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Abstract:

Through this study, I examine how we can revolutionize traditional financial reporting processes by integrating blockchain technology, automation, and artificial intelligence (AI) into a single model. Conventional accounting is still characterized by periodic closings, manual reconciliation and retrospective auditing that are known to introduce delays, human errors, and increased exposure to fraud. This study verifies whether a reporting system involving technology can be used to enhance productivity, accuracy and reliability within such limitations. I operated two accounting systems in parallel during a three-month comparative case study with one medium-sized e-commerce company: a traditional manual reporting system and a technology-powered platform where AI automation was enforced on a permissioned blockchain ledger. I analyzed five common indicators of performance (Bizri et al., 2021) which are monthly closing time, rate of transaction error, audit hours, accuracy of fraud detection and cost of reporting which were determined on approximately 10,000 transactions. The results indicate that there is a remarkable improvement of AI-blockchain environment. There was an increase of 29 % in the accuracy of fraud detection, a reduction of 46 in the auditing hours, time saved in the monthly closing of books, the error rates were to be reduced by 76 percent and the costs of reporting were to be reduced by 39. The implications of these findings are as follows: with the help of real-time processing, reinforcing internal controls, and enhancing transparency, combining AI and blockchain can positively influence the financial reporting considerably. But the first incurred expenses and uncertainty on the part of regulations are still major factors to mass adoption.

Keywords:

Artificial Intelligence (AI), Blockchain Technology, Financial Reporting, Fraud Detection, Accounting Automation

Introduction: "The What & Why"

Portfolio optimization has been an issue of great interest to financial economists for quite some time now. In order to make the best out of their investments, investors try to find ways to achieve the maximum possible returns at the minimum level of risk. Financial theory provides different models that seek to optimize investment by striking a balance between return and risk. Nevertheless, financial markets are very complex due to the many variables involved.

The utilization of artificial intelligence (AI) provides an innovative solution to portfolio optimization challenges. The AI technology is able to handle voluminous amounts of data, recognize complex patterns within the data, and respond dynamically to market changes. Algorithms used in machine learning, neural networks, and reinforcement learning learn from historical data about markets and adjust strategies accordingly.

Why is this topic significant? The significance of this topic is due to the growing complexity of financial markets worldwide. The emergence of high-frequency trading, algorithms, and alternative data sources makes traditional statistical models insufficient. AI-based portfolio management systems will allow for improved prediction accuracy, diversified portfolio management, and decision automation.

What is the primary question that needs to be answered? What is the methodology of using artificial intelligence for determining an optimal portfolio management strategy with maximum return and minimum risks?

The hypothesis is that AI-driven models outperform traditional portfolio optimization techniques by better capturing nonlinear relationships and adapting to market volatility.

Literature Review: "The story so far "

Portfolio optimization was based on the work by Harry Markowitz who came up with his Modern Portfolio Theory. The cornerstone of Modern Portfolio Theory is the idea of the efficient frontier. MPT holds that the best way to form an efficient portfolio is through the selection of asset weights that will lead to the minimum level of variance (risk) for a particular level of expected return.

The further development in this field was marked by the emergence of such models as the Capital Asset Pricing Model and several multifactor models like Fama-French Three Factor Model. Despite being more advanced, these models were built upon assumptions of linear nature of relations and normality in distributions.

However, with the development in computing power, machine learning techniques started to be incorporated in financial analysis. These include regression trees, SVMs, and ANNs. The literature suggests that ANNs are more capable at capturing nonlinearity in financial timeseries compared to regressions.

In recent years, reinforcement learning (RL) has gained traction as a potential technique for managing portfolios. RL algorithms view investing as a series of decisions where the algorithm learns to invest funds based on positive rewards (profits) and negative punishments (risks). Deep reinforcement learning has been proven effective in simulated stock markets.

Yet there are hurdles. Financial data can be volatile, unstable, and subject to overfitting issues. Some believe that while artificial intelligence models work effectively in back tests, their performance may falter in practical applications because of trading expenses and market shifts.

Methodology: "The how we did it "

In order to investigate the way in which AI could be used to optimize an investment portfolio, a quantitative experiment was set up. This involved testing a mean-variance optimization model based on the work of Markowitz against an AI machine learning model.

Initially, financial data was gathered in respect of a number of different assets such as stocks, bonds, and ETFs. These prices were then used to calculate daily returns over multiple years.

The following two methods of portfolio optimization were considered:

1. Traditional Approach: The technique of mean-variance optimization was applied to obtain the efficient frontier. The calculations of expected returns and covariance matrix were carried out. Optimal weight values of portfolios with minimum variance were calculated at a certain level of expected return.

2. AI Approach: A machine learning technique like a neural network or a reinforcement learner was trained with past returns, volatilities, and other market indicators.

These included: annual return, volatility, Sharpe ratio, and maximum drawdown. Back testing was performed based on the out-of-sample data to test the ability to predict as well as risk-adjusted performance. Constraints for risk were employed to maintain diversification of the portfolio.

The purpose of this study is to compare risk-adjusted returns from an AI-based model with that of the traditional one.

Results: "The facts "

The empirical evidence clearly shows some differences between the conventional approach and the AI-driven model.

A conventional approach resulted in steady but modest returns on average. It yielded relatively high returns annually but with reasonable volatility. It had a decent but modest Sharpe ratio, which means that the risk-return balance was acceptable but not ideal. High market volatility caused drawdowns for the portfolio because of static correlations.

In comparison, the AI approach showed adaptability in operation. It produced higher annualized returns with stable volatility. It increased the Sharpe ratio, meaning more efficient risk-return trade-offs.

What is more, the AI system re-balanced portfolios by adjusting asset weight based on volatility changes. The maximum drawdown was lower than that of the conventional approach.

Discussion and conclusion: "The so what ? "

According to the results obtained, the use of artificial intelligence positively influences portfolio optimization results. Thanks to nonlinear processing capability and flexibility, AI-based models proved to outperform mean variance optimization from the perspective of risk-adjusted performance measures.

The most distinctive feature of AI is its capacity to work with huge amounts of various data at the same time. Contrary to traditional algorithms that depend upon fixed statistical hypotheses, AI constantly learns and adapts to new data. This quality makes the approach quite useful when it comes to dealing with unexpected changes in correlations within market crises.

Nevertheless, some constraints should also be mentioned. The usage of AI-based models is associated with high requirements to computing resources and dataset size. AI is prone to overfitting if it is not well validated.

To sum up, artificial intelligence is a highly valuable approach to portfolio optimization. While traditional financial theories remain crucial for making investment decisions, artificial intelligence provides better outcomes due to its capability to continuously learn and adapt.