A
Synopsis
on

optimizing asset diversification using genetic algorithm

submitted in partial fulfillment of the requirements
for completion of AI LAB
of

TY COMP
in
Computer Engineering
by

Sandesh Sahane - 112103118
Ritika Kher - 112103116
Samarth Kanwate - 112103122

Under the guidance of

Suraj Sawant
Professor
Department of Computer Engineering

Department of Computer Engineering,
COEP Technological University (COEP Tech)
(A Unitary Public University of Govt. of Maharashtra)
Shivajinagar, Pune-411005,Maharashtra, INDIA

December, 2023

1 Introduction

In today's dynamic financial landscape, optimizing investment portfolios is of paramount importance for both seasoned investors and novices seeking to capitalize on opportunities while managing risks. This project aims to address this critical need by developing an AI-based Portfolio Optimization System using a Genetic Algorithm approach.

Focusing on stock selection within user-specified sectors, the system empowers investors to make informed decisions based on fundamental metrics, thus aligning their investments with their individual goals and preferences. By harnessing the power of artificial intelligence, this project seeks to offer a user-centric and data-driven solution to enhance portfolio performance while providing valuable insights into the stock market's complex dynamics. Through this, we aim to contribute to the field of financial technology and provide a practical tool for investors looking to navigate the ever-evolving world of stock market investments.

As mentioned in [2], The most prominent traditional method is the modern portfolio theory (MPT) which was published by Harry Markowitz in 1952 and for which he has received the Nobel Prize for economics in 1990. The goal of MPT is to create a diversified portfolio consisting of a variety of assets to be prepared for future uncertainties. The risk/return ratio of a broadly diversified portfolio is superior to any investment in just one single asset – no matter how well chosen. The MPT is a one-step method that simply maximizes the portfolio return subject to a given risk constraint. Portfolios compiled with the modern portfolio theory have some limitations. The major one is the high sensitivity to the given input data and the lack of not being able to handle multiple input factors. A major issue of MPT is the estimation of the input parameters' "expected returns" and "variances" which are required for the calculation of optimal portfolios. The assumption of the future values of these parameters is based on data from the past, which are used for predictions of future developments. Consequently, in the MPT, effective values deviate from the estimated values, which leads to misallocation and thus to only optimal portfolios in theory, but not in reality.

To tackle this issue, [2] uses various factors such as customer economic outlook, confidence factor, covariance matrix by assigning each category a specific weight based on the

importance they have on the output.

Research paper [8] presents a highly complex way experimenting with various algorithms such as vector evaluated genetic algorithm(VEGA), Fuzzy VEGA, multiojective optimised genetic algorithm and non dominated sorted genetic algorithm.

Research paper [1] focuses on those assets/stocks which distribute high dividends each year consistently.

one interesting approach for solving this problem is presented in [10], where fundamental parameters of the stocks are also considered. Priority index is used in stock selection based on some parameters: price/earnings (P/E), earnings/share (EPS), wealth creation, undervaluation, and price per earnings/growth (PEG). Stock selection in each sector is determined by choosing the stocks which have a priority index score at least equal to the minimum priority index score of the selected stocks. The minimum priority index score of the selected stock is determined by using a certain scale parameter. The percentage of investment in each selected stock is then determined by using a genetic algorithm. The results showed that increasing the value of scale parameters does not always increase the average return. Moreover, the stock selection with a wealth creation parameter has a higher average return than without a wealth creation parameter. Stock selection using daily data has a higher average return than annual data. The results also showed that the method has an optimum period of up to five months to make an investment decision.

Research paper [4] presents a more complex way. First the expected rate of returns are found using support vector regression algorithm and then using multi period prospect theory and conditional value at risk (CVar) algorithms, the genetic algorithm is applied to find optimal portfolio. The paper does not aim to maximise the profit, but helps investors to limit the loss by introducing Cvar constraint. Despite the complexities of the real world, it is not possible to conduct a comprehensive study of the real situation. So the models are somewhat abstract. In other words, modeling is based on assumptions that simplify the situation compared to the real world. One of the advantages of this work is achieving important and significant relationships and results, and one of the disadvantages is distancing from reality.

2 Motivation

The field of portfolio optimization has garnered significant attention in both academic and practical finance. In today's complex and dynamic financial markets, investors are faced with an overwhelming array of investment options, each offering a unique set of risks and returns. Therefore, there is a growing need for intelligent and adaptable tools that can help individuals and institutions make informed investment decisions tailored to their specific objectives and risk tolerance. Traditional methods of portfolio optimization, such as the Mean-Variance model, have proven to be effective but often fall short in addressing the nuanced preferences and constraints of investors. To address these limitations and provide a more personalized approach to portfolio management, the implementation of advanced techniques like Genetic Algorithms is crucial.

3 Literature Review

https://docs.google.com/spreadsheets/d/1DbfW8WcSTgzdvax4ZbYIg˙JxQJf-LLM4jZeJNnEB˙5Q/editgid

4 Research Gaps

Despite the extensive work on portfolio optimization, several notable research gaps persist. First, traditional portfolio optimization methods, like the Mean-Variance framework, often assume that investment returns are normally distributed, which may not hold true in real-world scenarios. The research papers [3] , [1] consider the Sharpe ratio as the only parameter that may hinder the performance as it only considers the past stock movements, while combining fundamental metrics along with risk-return based on past performance can give significant results. Applying new age algorithms like SVM and LSTM can be applied but they don't give good results when the expected return is to be calculated for long term

5 Problem Statement and Objectives

develop a portfolio optimization solution using Genetic Algorithms, tailored to each investor's unique requirements and based on various performance metrics. objectives:

- Development of a Genetic Algorithm Framework
- User-friendly Interface
- Optimized Portfolio Generation

6 Methodology

Methodology:

1. Data Collection and Preprocessing: Gather historical price data, financial reports, and other relevant financial information for a range of stocks. This data will be sourced from reliable financial databases and APIs. Clean and preprocess the data to handle missing values, outliers, and inconsistencies, ensuring that it is ready for analysis.

2. Fundamental Score and Genetic Algorithm Implementation: Find the fundamental analysis score of the stocks and then develop a Genetic Algorithm framework that consists of key components such as selection, crossover, mutation, and fitness evaluation. Define a fitness function taking into account factors variability , expected returns , diversification and risk which are represented with sharpe ratio and another factor which is the stock fundamental analysis score. Define the genetic representation of the portfolios and the rules governing the evolution of portfolios within the algorithm.

3. Risk Assessment: This will involve using historical data to estimate risk parameters for individual stocks and sectors.

4. Sector-specific Optimization: Develop mechanisms to consider sector-specific preferences and constraints, allowing the algorithm to optimize portfolios with sector exposure limitations.

5. User Interface Design: Create a user-friendly interface. Design the interface to display suggested portfolios and allow users to fine-tune their selections.

7 Hardware and Software Requirements

Software requirements:

- Python3
- Google collab or Jupyter notebook IDE

- Numpy
- Pandas
- Matplotlib
- streamlit

8 Conclusions

In the field of portfolio optimization using genetic algorithms, efficiency is a crucial metric that helps us evaluate the performance of the algorithm in constructing a diversified investment portfolio. One common approach to measure efficiency is by comparing the sharpe ration which is the risk adjusted returns of the obtained portfolio with a portfolio in which all assets have equal weights. This comparison serves as a valuable benchmark for assessing the effectiveness of the optimization process.

9 Timeline Chart

- Research Phase literature review, data collection, and initial concept development.
- Data Collection: necessary financial data and sources.
- Algorithm Development: develop the genetic algorithm for portfolio optimization.coding, testing, and refining the algorithm.
- Result Analysis: results obtained from the optimization runs. Comparing the result returns with the benchmark portfolio which has equal allocation for each stock.

References

[1] Genetic Algorithm Approach in Forming the Optimal Portfolio of Issuer Companies with Dividend Distribution Criteria

[2] Personalized Portfolio Optimization Using Genetic (AI) Algorithms

[3] Selecting Valuable Stock Using Genetic Algorithm

[4] Behavioral approach in multi-period portfolio optimization using genetic algorithm

[5] A double stages genetic optimization algorithm for portfolio selection

[6] Using Genetic Algorithm to support Clustering-based Portfolio Optimization by Investor Information

[7] Investment portfolio optimization by applying a Genetic algorithm-based approach

[8] Portfolio Optimisation using multi-objective Genetic Algorithms

[9] Portfolio Selection Using Genetic Algorithm

[10] Stock portfolio optimization using priority index and genetic algorithm