Capstone Project Proposal: Momentum-Based Portfolio Optimization

The Problem Area

One persistent challenge in this field is how to effectively combine alpha signal generation with robust portfolio construction. While momentum strategies have long been used to generate excess returns, many implementations fail to properly optimize portfolio weights to manage risk and volatility. This project seeks to bridge that gap by integrating price momentum signals with portfolio optimization techniques to improve return consistency and risk-adjusted performance.

The User

The primary users of this project are retail and institutional investors, quant researchers, and portfolio managers who rely on data-driven methodologies. These users are often faced with the difficulty of selecting and rebalancing portfolios in a way that both exploits alpha and manages downside risk. A tool that dynamically selects long and short positions and adjusts weightings using quantitative metrics like the Sharpe ratio or volatility could help them make more informed and consistent investment decisions.

The Big Idea

This project proposes a two-step machine learning-inspired approach: (1) signal generation using factor-based momentum scores, and (2) portfolio optimization using Monte Carlo simulation. Each month, stocks from the S&P 500 universe are ranked by their momentum z-scores. From this, a long-short portfolio is created. Then, two optimization methods—Sharpe ratio maximization and volatility minimization—are applied using Monte Carlo simulations to identify the most efficient portfolio weights. This approach builds on modern portfolio theory and is informed by similar strategies seen in quantitative hedge funds and research literature (e.g., Black-Litterman, factor investing frameworks).

The Impact

This project can deliver real business value by enhancing decision-making around portfolio construction. If implemented, the strategy could improve investment outcomes by boosting returns or reducing portfolio risk. On a practical level, even a modest increase in risk-adjusted returns (e.g., Sharpe ratio improvement from 0.6 to 0.9) could translate into significant dollar gains in institutional portfolios. The approach could also save time and

reduce human error for portfolio managers by automating both asset selection and weight optimization.

The Data

The primary dataset is historical daily and monthly stock price and volume data for S&P 500 constituents, sourced from Yahoo Finance. This data is used to compute momentum factors, returns, and volatility metrics. The portfolio is evaluated against SPY, a benchmark ETF. Supplementary data for sector, beta, and macroeconomic indicators could be integrated in future iterations to enhance factor models. Tools used include `yfinance`, `pandas`, `NumPy`, and `matplotlib`.

The Alternative

An alternative project idea is to build a real-time Twitter sentiment analysis tool for predicting short-term stock movements. This project would involve natural language processing (NLP), social media APIs, and classification models to gauge market sentiment and link it to stock price changes. It could benefit day traders or fintech platforms that want to incorporate sentiment signals into trading algorithms.