

Time Series Forecasting for Portfolio Management Optimization

1. Project Overview:

This project aims to leverage time series forecasting techniques to optimize investment portfolio management. The focus is on extracting historical financial data, analyzing trends, and predicting future market movements for better investment decision-making.

2. Task 1: Data Preprocessing and Exploratory Data Analysis (EDA)

2.1. Data Extraction

To obtain financial data, we used the **Yahoo Finance (YFinance) Python library**. The dataset includes historical stock prices from **January 1, 2015, to January 31, 2025**, for the following assets:

- **Tesla (TSLA)** – A high-growth, high-risk automobile stock.
- **Vanguard Total Bond Market ETF (BND)** – A bond ETF providing portfolio stability.
- **S&P 500 ETF (SPY)** – An index fund offering diversified, moderate-risk market exposure.

The extracted data includes the following attributes for each asset:

- **Date:** Trading day timestamp.
 - **Open, High, Low, Close:** Daily stock price variations.
 - **Volume:** Total number of shares traded per day.
 - **Adj Close:** Adjusted closing price accounting for stock splits and dividends.
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2.2. Data Cleaning and Preprocessing

The raw data extracted from YFinance underwent the following preprocessing steps:

1. Handling Missing Values:

- Identified any missing data points.
- Applied **forward-fill** and **interpolation** techniques to fill missing values.

2. Data Type Validation:

- Ensured all columns had correct data types (e.g., Date column converted to `datetime` format).

3. Normalization and Scaling:

- Used **MinMaxScaler** to normalize stock prices and prevent bias in machine learning models.
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2.3. Exploratory Data Analysis (EDA)

EDA was performed to understand the stock price patterns and volatility. The following steps were undertaken:

2.3.1. Trend Analysis

- Visualized **closing price trends** over time for each asset.
- Observed long-term price movements and market cycles.

2.3.2. Volatility Analysis

- Calculated and plotted **daily percentage change** to measure market fluctuations.
- Used **rolling mean and standard deviation** to analyze short-term price variations.

2.3.3. Outlier Detection

- Identified price anomalies using **box plots** and **z-score analysis**.
- Analyzed days with **unusually high or low returns**.

2.3.4. Seasonality and Trends

- Applied **time series decomposition** to break down stock movements into **trend, seasonality, and residual components**.

2.3.5. Risk Assessment

- Computed **Value at Risk (VaR)** to estimate potential losses in a given period.
 - Calculated **Sharpe Ratio** to evaluate risk-adjusted returns.
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2.4. Key Insights from Task 1

- **Tesla (TSLA)**: Exhibits high volatility with potential for large gains and losses.

- **Vanguard BND ETF:** Stable asset with low fluctuations.
 - **S&P 500 ETF (SPY):** Moderate-risk investment with steady growth.
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3. Next Steps

- Implement **time series forecasting models** (ARIMA, Prophet) to predict stock trends.
 - Develop a strategy to **optimize asset allocation** based on forecasted movements.
 - Evaluate model accuracy using **RMSE and MAPE**.
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4. Contributor

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