INTELLIGENT REASONING SYSTEM

PROJECT REPORT

PORTFOLIO MANAGEMENT SYSTEM

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# Introduction

This report provides a detailed analysis and prediction of stocks and portfolio construction using machine learning and optimization techniques. The goal is to recognize the ideal stocks in the dataset suitable for the user to invest in. The model assigns weights to 4 types of portfolios. After optimization, these portfolios are passed to an LSTM layer where the relevant predictions are made based on certain input criterias to obtain relevant stocks. The accuracy of prediction is measured by metrics such as loss, MSE and MAE.

## Personal Contribution

* Market Research and Analysis of Business Case for the Stock prediction Application.
* Build the Apriori and Simulated Annealing based workflow of the project. This is outlined in the following parts.

## 1. Data Preprocessing and Feature Engineering

* **Data Loading:**

Loaded the dataset: final\_preprocessed\_data1.csv and financial\_input\_data.csv. The main dataset, final\_preprocessed\_data.csv, contains financial metrics for different stocks. This was loaded into df.

* **Data Normalization:**

Excluded Ticker from normalization. Standardized selected columns using StandardScaler, enabling fair comparisons across metrics. The output from scaler normalisation is ndarray, converted to pd.

## 2. Build Apriori rules

* The data is first prepared for Apriori by transposing to group the stocks by ticker values. This is done to generate the frequent itemsets from the required stocks.
* The numeric variables are converted to binary using range metrics and thresholds.
* Then Stock associations are generated.

## 3. Performing Clustering using Apriori rules

* Frequent itemsets are generated from the Apriori rules. A min\_support and threshold of 0.43 is taken to limit the number of Clusters to 4. Anything lesser outputs over 200 clusters.

## 4. Generate Portfolios

### Equal Weight (EW) Portfolio: Weight the clusters equally

### Market-Cap-Weighted (MCW) Portfolio: Calculate the weights proportional to each stock's Market Cap

### Global Minimum Variance (GMV) Portfolio: Minimizing how volatile the portfolio is.

### Maximum Sharpe Ratio (MSR) Portfolio: Maximize the Sharpe ratio

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### 5. Simulated Annealing Optimization

* Perform SA optimization on the data using the objective function for Simulated Annealing: return and volatility calculation.
* Keeps increasing to get global variances. Then Gradually cool down the temperature. In this case temperature. \*= 0.99
* Calculate the return and volatility of the portfolios.

**6. LSTM for Prediction**

#### **Historical Weight Data*:***

* Generated sample historical weights as a placeholder
* Scaled the weights between 0 and 1 using MinMaxScaler to normalize the data and improve LSTM performance.

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#### **Sample data for LSTM**:

* A sample cluster from the generated ones is taken as the data. This is done to obtain the prediction accuracy metrics. In the real world, synthetic data from users would be taken as input.
* For ease of calculation, cluster 0 from each portfolio is considered for weight metrics.
* A 2 layer LSTM with 25 units is used along with a dropout of 0.2.
* This is used to calculate metrics like loss, MSE and MAE for high return and low risk.

### Key Takeaways from the project

1. Being able to implement a machine learning framework to a real world scenario
2. The importance to research the market thoroughly for existing project and use them as a base to build upon
3. The importance of experimentation and failures which lead to more informed and accurate project works.
4. The essential need to coordinate with a team as it defines the pace and convenience with which the project progresses.

### How you can apply the knowledge and skills in other situations or your workplaces.

The future scope would involve many projects where I may require to implement various machine learning models. I have learnt the various methods of implementation that I will be able to use in the workplace.

Besides this I have also learnt to collaborate and communicate effectively with my team members and peers. This will help me interact socially more efficiently in the workspace.