Development Finance Models & Fintech:

Stocks Liquidity Analysis with Machine Learning Models

I. Background

Overview of Stock Markets

The stock market serves as a dynamic and complex platform where investors buy and sell financial instruments, primarily stocks, representing ownership in companies. This market is essential for capital formation, enabling businesses to raise funds for expansion and innovation, while providing investors with opportunities for wealth creation.

Transaction Mechanism

In the stock market, transactions occur through a well-established mechanism. Investors execute buy or sell orders through intermediaries known as brokers. These orders are matched electronically on a stock exchange, facilitating the transfer of ownership. The execution of transactions involves considerations such as market orders, limit orders, and stop orders, each influencing the price and quantity of securities traded.

Transaction Book: Supply and Demand Dynamics

At the heart of stock market transactions lies the concept of a transaction book, a record of buy and sell orders awaiting execution. The transaction book reflects the supply and demand for a particular security at various price levels. The highest bid and the lowest ask prices in this book establish the current market price, while the order book continuously evolves as new orders are placed or existing orders are canceled.

II. Basic Concepts

1. Capital Market

The capital market is a segment of the financial system where securities, such as stocks and bonds, are bought and sold. It facilitates the transfer of capital from investors to businesses or government entities seeking funding for various projects and activities. The capital market can be divided into primary and secondary markets, where new securities are issued and existing ones are traded, respectively.

2. Shares

Shares, commonly referred to as stocks or equity, represent ownership in a company. When investors buy shares, they become shareholders and have a proportional claim on the company's assets and earnings. Shareholders may also have voting rights, allowing them to participate in key corporate decisions.

3. Bonds

Bonds are debt securities that represent a loan made by an investor to a borrower, typically a government or corporation. Investors who purchase bonds receive periodic interest payments and, upon maturity, the return of the principal amount. Bonds are crucial for companies and governments to raise capital for projects or operations.

4. Liquidity

Liquidity refers to the ease with which an asset, such as a stock, can be bought or sold in the market without causing a significant impact on its price. High liquidity implies a robust market with ample trading activity, **while low liquidity suggests potential challenges in executing transactions without affecting prices adversely.**

5. Spreads

In the context of stock markets, a spread is the difference between the bid price (the price at which buyers are willing to purchase) and the ask price (the price at which sellers are willing to sell). **The bid-ask spread is a key indicator of liquidity; a narrower spread often signifies higher liquidity, while a wider spread may suggest lower liquidity and increased transaction costs.**

6. Indices in the Capital Market

Indices are statistical measures that represent the performance of a group of securities within a market. In the capital market, indices are used to gauge the overall market trends and provide benchmarks for investment performance. Examples include the TA-35, which tracks the performance of selected stocks in the Tel Aviv Stock Exchange, and other Tel Aviv indices that play a crucial role in assessing the Israeli market's health and direction.

III. Problem Description

The Tel Aviv stock market is grappling with a liquidity challenge in its stocks, leading to widened margins in the buying and selling processes.

This means that the actual value of a share is not accurately reflected in the execution of transactions, resulting in additional costs for both buyers and sellers. These unforeseen costs could be mitigated if the securities exhibited higher liquidity. In cases of low liquidity and limited trading activity, securities may fail to meet the necessary criteria for buying or selling, exacerbating the overall decline in the liquidity of the stock market.

This issue not only hinders the efficiency of transactions but also potentially deters market participants due to increased uncertainty and associated costs. Our project aims to address these liquidity concerns through the application of machine learning models, providing valuable insights to enhance decision-making and improve overall market liquidity.

IV. Project's Objective

The primary objective of our project is to design and implement a machine learning algorithm geared towards identifying shares that align with pre-defined criteria.

This algorithm will further endeavor to forecast if it is the optimal time for buying and selling shares, categorized by specific months, weeks, days, and hours. The overarching aim is to minimize the margin ('spread') between transaction prices and the actual value of a share, thereby mitigating additional costs for market participants.

In addition, we will develop a user-friendly query interface. This interface will facilitate seamless interaction with the stock exchange's data, empowering users to filter transactions based on criteria such as paper number, quantity, date, and time.

This collaborative effort aims to enhance the transparency and efficiency of stock market transactions, providing users with a valuable tool to navigate the complexities of the market while optimizing their investment decisions.

V. Target Audience

- **ML Algorithm**

  Investment houses, pension funds, professional traders in the high-scale capital market, venture capital funds.

- **Query interface**

  The Stock Exchange - Tel Aviv Stock Exchange employees.

VI. Key Features

- **ML Algorithm**

  The end user will enter a share for which he wishes to perform a buy/sell transaction. The algorithm will make a prediction based on the information and will give a recommendation as to whether this is currently the correct timing to carry out the transaction (at the level of liquidity only), or whether it is better to wait with the sell / buy order - and this is to maintain a minimum margin between the value of the stock and the price of the transaction.

- **Query interface**

  - Filtering securities by paper number, quantity, date, time, etc.
  - Querying the length of time it took to make a sale/purchase transaction of a share at a certain price (predefined price transaction) - according to the transaction history.
  - For a certain share and a certain price - what is the actual margin from the execution price of a specific transaction.

VII. External dependencies

The project is carried out in collaboration with the Tel Aviv Stock Exchange, and for the sake of the project we get access to real data of transactions in the stock exchange. The data is in binary format in MBO protocol, that developed by them. We will have to decipher and process the information, and cast the relevant database for the algorithm, as well as for the query interface.

Also, we will need credits to the cloud for uploading the databases, running a server for the user interface along with its database, as well as processing power (GPU) for calculating the data and performing the prediction of the machine learning models.

VIII. Technologies

- **ML Algorithm**
    - Preparing and processing the data and saving it in a database in the cloud - creating a script in the Python programming language, which will receive the data in binary format, decode the data, arrange the data in a file suitable for reading, and store them in a database in the cloud.
    - Prediction algorithm - we will combine several well-known models in the Python language and check their level of accuracy, in the end we will recommend using the model with the highest level of accuracy.
    - Libraries in Python that we will work with - Pandas, NumPy, Scikit-learn, TensorFlow, Seaborn, Matplotlib
    - Use of a log library for internal monitoring - Logging
- **Query interface**
    - Database - will be defined later. (PostgreSQL / mongoDB)
    - User interface - in Java Script / Django in Python
    - HTML, CSS, JS
    - Cloud – Microsoft Azure / Amazon AWS

- **Supporting technologies**
    - Docker
    - Git, GitHub - collaboration