A PRELIMINARY REPORT ON

DEMYSTIFICATION OF STOCK BROKERING : A DEEP CONVOLUTIONAL NEURAL NETWORK APPROACH FOR STOCK MARKET PREDICTION

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING
(COMPUTER ENGINEERING)

SUBMITTED BY

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UNDER THE GUIDENCE OF

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SAVITRIBAI PHULE PUNE UNIVERSITY

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Progressive Education Society's
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CERTIFICATE

This is to certify that the following students of Final Year Computer Engineering of PES's, Modern College of Engineering have successfully completed the preliminary analysis and design of project entitled "Demystification of Stock Brokering : A Deep Convolutional Neural Network Approach For Stock Market Prediction" under the guidance of Prof. Deipali Gore.

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This is in partial fulfillment of the award of the degree Bachelor of Computer Engineering of Savitribai Phule Pune University.

Date:

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Internal Guide

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Acknowledgement

It gives us pleasure in presenting the partial project report on **'Demystification of Stock Brokering : A Deep Convolutional Neural Network Approach For Stock Market Prediction'**.

Firstly, we would like to express our indebtedness appreciation to our internal guide **Prof. Deipali Gore**. Her constant guidance and advice played very important role in making the execution of the report.She always gave us his/her suggestions, that were crucial in making this report as flawless as possible.

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Also we wish to thank our Principal, **Prof. Dr. Mrs. K. R. Joshi** and all faculty members for their whole hearted co-operation for completion of this report. We also thank our laboratory assistants for their valuable help in laboratory.

Last but not the least, the backbone of our success and confidence lies solely on blessings of dear parents and lovely friends.

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Abstract

Stock also known as ‘equity’ or ‘shares’ is a type of security that signifies ownership in a corporation and represents a claim on part of the corporation’s assets and earnings whereas a stock market or share market is the aggregation of buyers and sellers of stocks. A stock exchange is an exchange where stock brokers and traders can buy and sell shares of stock, bonds, and other securities. Many large companies have their stocks listed on a stock exchange. This makes the stock more liquid and thus more attractive to many investors. Such type of an exchange deals with concentration and a focused mind as the entire process is dealing with valuable assets of a person.

Thus to ease the process of stock exchange many stock brokers use the act of stock market predication i.e. trying to determine the future value of a company stock or other financial instruments traded for exchange. Predication is done by fundamental analysis and technical analysis and also using machine learning.In this project we use a Convolutional Neural Network for predicting the stock in order to make profit.

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List of Abbreviations

NP ..... Non Polynomial Time

P ..... Polynomial Time

ReLU ..... Rectified Linear Unit

HTTP ..... Hyper Text Transfer Protocol

TCP/IP ..... Transmission Control Protocol Internet Protocol

RNN ..... Recurrent Neural Network

CNN ..... Convolutional Neural Network

RMSE ..... Root Mean Squared Error

R square ..... Coefficient of Determination

NSE ..... National Stock Exchange

1.

Introduction

1.1 Motivation

Stock broker is responsible for buying and selling of stocks for their customers. Many a times the guidance of buying and selling stocks comes from the brokers who are associated with a brokering firm and accept some amount of fee in return for their knowledge. Thus, customers are in confidence with the brokers and their actions. For efficient analysis and accurate prediction for help towards brokering we use machine learning, more specifically a neural network for prediction of stock prices.

1.2 Problem Definition

Predicting the movements in stock market with help of a Convolutional Neural Network using time series data of past stock indicators with a intent to use this information for buying and selling stock.

2.

Literature Survey

2.1 Literature Survey

Sr.	Title	Author(s)	Merits	Future Scope
1	Stock price prediction using LSTM, RNN and CNN-sliding window model.	Sreelekshmy Selvin,et.al.	• Linear Models like ARIMA DO NOT outperform deep learning models. • Experiment proves CNN to be most accurate against RNN and LSTM.	• Data set of more companies can be used for the price prediction and compare their performance. • We can apply a sliding window approach for predicting future values on a long term basis.
2	**Financial Time-series Data Analysis using Deep Convolutional Neural Networks.**	**Jou-Fan Chen,et al.**	• **CNN could extract useful features and recognize the behaviors of financial markets based on the proposed two-dimensional time-series data representation methods.** • **CNN can effectively classified the image graphs for some useful information that people can't grasp.**	• **United States or other global financial products are affected by the great impact of much more traders. It's worthy to discovery their trading behaviors.** • **Investment portfolio is also a popular financial application. It's interesting to predict the future profitability of a variety of investment portfolio with a certain amount of data as input.**
3	Deep learning for stock market prediction from financial news articles	Manuel R. Vargas, et.al.	• CNN architecture with recurrent layer for intraday stock price movement prediction is a better alternative that convolutional neural network.	• The future work will include the use of test methods for making better embedding vectors for the news titles. • Other research direction is the use a reinforcement learning algorithms to train the proposed model on market simulation (trading simulation).
4	Forecasting Stock Prices using Social Media Analysis.	Scott Coyne,et al.	• Filtered twits and important twits could predict stock price movements with greater accuracy (average around 65%) based on sentiment analysis and smart user. identification.	• If smart users can be identified, then perhaps sentiment can find smart companies, conversation threads, and followers as well. These are all bodies of work we expect to explore in the future.

Table 2.1: Literature Survey

3.

Software Requirements Specification

3.1 Introduction

3.1.1 Project Scope

1. **Dataset :**

   - The **NIFTY 50** is a diversified 50 stock index accounting for 12 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index based derivatives and index funds.
   - NIFTY 50 is owned and managed by NSE Indices Limited (formerly known as India Index Services Products Limited) (NSE Indices). NSE Indices is India's specialised company focused upon the index as a core product.
   - The NIFTY 50 Index represents about 62.9% of the free float market capitalization of the stocks listed on NSE as on March 31, 2017.
   - The total traded value of NIFTY 50 index constituents for the last six months ending March 2017 is approximately 43.8% of the traded value of all stocks on the NSE.
   - Impact cost of the NIFTY 50 for a portfolio size of Rs.50 lakhs is 0.02% for the month March 2017.
   - NIFTY 50 is ideal for derivatives trading.

2. **Neural Network:**

   - **Convolutional Neural Networks** are very similar to ordinary Neural Networks they are made up of neurons that have learnable weights and biases.
   - Each neuron receives some inputs,and transform it through a series of hidden layers. Each hidden layer is made up of a set of neurons, where each neuron is fully connected to all neurons in the previous layer, and where neurons in a single layer function completely independently and do not share any connections. The last fully-connected layer is called the "output layer" and in classification settings it represents the class scores.

3. **Activation function:**

   - They are used to determine the output of neural network like yes or no. It maps the resulting values in between 0 to 1 or -1 to 1 etc. (depending upon the function).
   - **ReLU (Rectified Linear Unit) Activation Function** is the most used activation function in the world right now. Since, it is used in almost all the convolutional neural networks or deep learning.It was recently proved that it had 6 times improvement in convergence from Tanh function.But its limitation is that it should only be used within Hidden layers of a Neural Network Model.
   - And if our model suffers from dead neurons during training we should use **Leaky ReLu or Maxout function**.The leak helps to increase the range of the ReLU function.

3.1.2 User Classes and Characteristics

1. **Broker Class (General User) :** A stockbroker is a professional individual who executes buy and sell orders on behalf of clients for stocks and other securities in a listed market or over the counter, usually for a fee or commission. They are users of the application and are equipped with:

   - Desktops with environment for running the application.
   - Access to various data and functions as per user's credentials.

2. **IT Class (Power User) :** A class of IT professional users who are responsible for development and maintenance of the application. They are responsible for:

   - Development of Application Front-end.
   - Development of Application Back-end.
   - Maintenance of the Application.

   They are equipped with:

   - Workstations with required hardware.
   - Necessary Development Tools.

3.1.3 Assumptions and Dependencies

1. Assumptions:

   - Convolutional Neural Network will outperform other neural networks for predicting stock prices.
   - Activation function ReLU(Rectified Linear Unit) is chosen to be the best for Convolutional Neural Network.
   - Leaky ReLU is chosen to be used if the model suffers from dead neurons during training.
   - Data is made available to public and can be used without any licence.

2. Dependencies:

   - National Stock Exchange data is available in the form of intra-day data.
   - Necessary hardware configuration is available for the neural network.

3.2 Functional Requirements

Functional requirement are the functions or features that must be included in any system to satisfy the business needs and be acceptable to the users. Based on this, the functional requirements that the system must require are as follows:

3.2.1 Collect accurate data from NSE website.

- The system to be developed should collect accurate data from National Stock Exchange website through an API.

3.2.2 Model must be trained on sufficient dataset.

- Convolutional Neural Network model must be trained with sufficient amount of data collected form NSE website for accurate prediction of stock prices.

3.2.3 User Login/Add stock to watchlist.

- The system should allow the user to login and add the stock to the watchlist in which the user is interested.

3.2.4 Generate approximate stock price.

- Approximate stock price patterns should be predicted by the system.

3.3 External Interface Requirements (If Any)

3.3.1 User Interfaces

In this project the user will be accessing the application with help of a Website. The web interface will allow the user to interact and navigate through the various functionalities of the application.

3.3.2 Hardware Interfaces

Application will run on the network thus all the hardware requires is to connect to the internet. Hardware needed:

- Workstation
- Ethernet Port and Cable
- Modem/Router/Switch

3.3.3 Software Interfaces

1. Results of prediction will be communicated to the website front-end from the back-end processing workstation.
2. Database will communicate the dataset stored, with the website for viewing and analyzing the intra-day data.

3.3.4 Communication Interfaces

1. **HTTP :** HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.For example, when you enter a URL in your browser, this actually sends an HTTP command to the Web server directing it to fetch and transmit the requested Web page.
2. **TCP/IP :** TCP/IP, or the Transmission Control Protocol/Internet Protocol, is a suite of communication protocols used to interconnect network devices on the internet. TCP/IP can also be used as a communications protocol in a private network (an intranet or an extranet).

3.4 Nonfunctional Requirements

3.4.1 Performance Requirements

1. CNN must be trained properly for all the available data-sets, thus should be able to work with any data given at the time.
2. CNN must satisfy the constraints of RMSE and R square that have been determined.
3. On the users-end, the website must be available for use 24x7 and must be easily hosted on the intranet.
4. It should be able to support large group of enterprise users.

3.4.2 Safety Requirements

1. Some limitations must be placed on the operation of the neural network as it is dependant on the resources available.

3.4.3 Security Requirements

1. The network credentials must be used in order to ensure the safety of enterprise information.
2. The server should be protected from any unauthorized access.
3. Proper constraints must be placed on the enterprise database for securing the data.
4. Access must be given to each user of enterprise according to their qualification.

3.4.4 Software Quality Attributes

1. Reliability: With given input data the application must be able to correctly predict the stock that will be profitable in the future.
2. Availability: The application must be available for use as and when required however availability is constrained by the availability of the web application server, database server, and other supporting software servers.
3. Portability: The application must be portable in our case it must be able to work with different browsers (Chrome, Opera, Safari). It should not face any difficulty due to change in environment of execution.
4. Extensibility: The application as and when required depending on the organization's need should be easy to extend in terms of functionality as well as usability.
5. Usability: The interface must be easy to understand and navigation through out must be consistent and interactive.
6. Security: The security constraints must be placed on the web server, database server, also the application use itself should be secured.
7. Maintainibility: After successful deployment of the application the maintainbility should be easy as it is web-based.

3.5 System Requirements

3.5.1 Database Requirements

For decades the most popular way to track the price of stocks on Wall Street was through ticker tape, the earliest digital communication medium. Stocks and their values were transmitted via telegraph to a small device called a "ticker" that printed onto a thin roll of paper called "ticker tape." While out of use for over 50 years, the idea of the ticker lives on in scrolling electronic tickers at brokerage walls and at the bottom of most news networks, sometimes two, three and four levels deep. Today there are many sources of data that, like ticker tape, represent observations ordered over time. For example: Financial markets generate prices.This data tends to be immutable, large in volume, ordered by time, and is primarily aggregated for access. It represents a history of what happened, and there are a number of use cases that involve analyzing this history to better predict what may happen in the future or to establish operational thresholds for the system. Time series data is a great fit for **MongoDB**.

- MongoDB is an open-source, document-oriented database, colloquially known as a NoSQL database, written in C and C++.
- It offers modeling primitives in the form of timestamps and bucketing, which give users the ability to store and query time series data.
- MongoDB is typically used to store large, variable-sized payloads represented as JSON or BSON objects.

3.5.2 Software Requirements(Platform Choice)

Various software packages required for development are:

- Language Support : Python, Java, HTML, CSS, PHP, JavaScript etc.
- Tensorflow/Keras/Scikit.
- Machine Learning Libraries.

3.5.3 Hardware Requirements

As the application runs on a network the most common hardware required for development are:

- Desktop with Ethernet Port
- Ethernet Cable
- Modem or Router or Switch

For back-end processing i.e. neural network minimum hardware requirements are:

- Intel Core i3-8145 or above
- 6GB RAM or above
- NVIDIA GTX 1050 Ti / AMD RX 570 or RX 580

3.6 Analysis Model

3.6.1 Agile Model

1. Agile SDLC model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product.
2. Agile Methods break the product into small incremental builds.These builds are provided in iterations.
3. Each iteration typically lasts from about one to three weeks. Every iteration involves cross functional teams working simultaneously on various areas like
   - Planning
   - Requirements Analysis
   - Design
   - Coding
   - Unit Testing and Acceptance Testing.
4. Agile model believes that every project needs to be handled differently and the existing methods need to be tailored to best suit the project requirements.
5. In Agile, the tasks are divided to time boxes (small time frames) to deliver specific features for a release. Iterative approach is taken and working software build is delivered after each iteration.
6. Each build is incremental in terms of features; the final build holds all the features required by the customer.
7. Following are the Agile Manifesto principles
   - Individuals and interactions In Agile development, self-organization and motivation are important, as are interactions like co-location and pair programming.
   - Working software Demo working software is considered the best means of communication with the customers to understand their requirements, instead of just depending on documentation.
   - Customer collaboration As the requirements cannot be gathered completely in the beginning of the project due to various factors, continuous customer interaction is very important to get proper product requirements.
   - Responding to change Agile Development is focused on quick responses to change and continuous development.
8. The advantages of the Agile Model are as follows
   - Promotes teamwork and cross training.
   - Functionality can be developed rapidly and demonstrated.
   - Resource requirements are minimum.
   - Suitable for fixed or changing requirements
   - Delivers early partial working solutions.
   - Easy to manage.
   - Gives flexibility to developers.

3.7 System Implementation Plan

1. **Development Approach:** AGILE methodology is a practice that promotes continuous iteration of development and testing throughout the software development lifecycle of the project. Both development and testing activities are concurrent unlike the Waterfall model. The agile software development emphasizes on four core values.

    - Individual and team interactions over processes and tools.
    - Working software over comprehensive documentation.
    - Customer collaboration over contract negotiation.
    - Responding to change over following a plan.

2. **Integration Approach:** Vertical integration is the process of integrating subsystems according to their functionality by creating functional entities. The benefit of this method is that the integration is performed quickly and involves only the necessary vendors, therefore, this method is cheaper in the short term.

3. **Implementation Approach:** The implementation will be done from the bottom, firstly beginning with implementation of the required environment and tools followed by the back-end processing system, which in our case would be the construction of the neural network. Other dependencies need also be satisfied such as database connection and working. Later followed by implementation of the user-accessible front-end in the form of a website. Deployment site identified as any stock brokering firm with the given deliverables.

4. **Deployment Strategy:** The project can be deployed to any stock marketing firm. Stock Brokers are the users of the system and the project will be deployed as an intranet website accessible to all the employees in the firm.

4.

System Design

4.1 System Architecture

4.1.1 Architectural Block Diagram

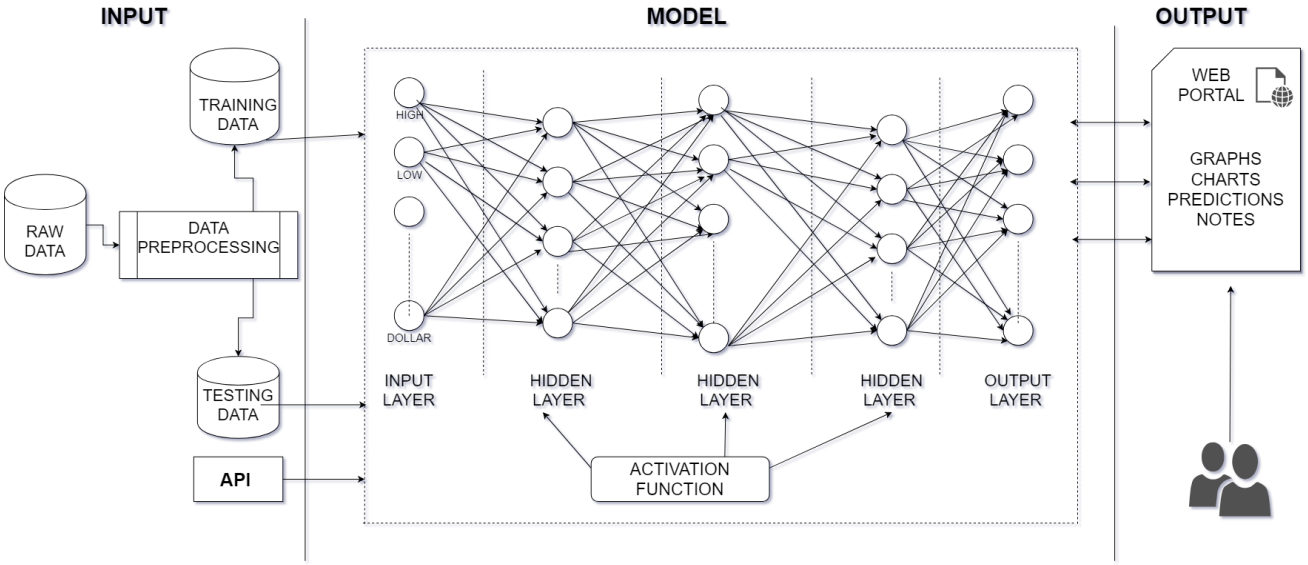

Figure 4.1: Architectural Block Diagram

4.2 Data Flow Diagrams / UML Diagrams

4.2.1 Activity Diagram

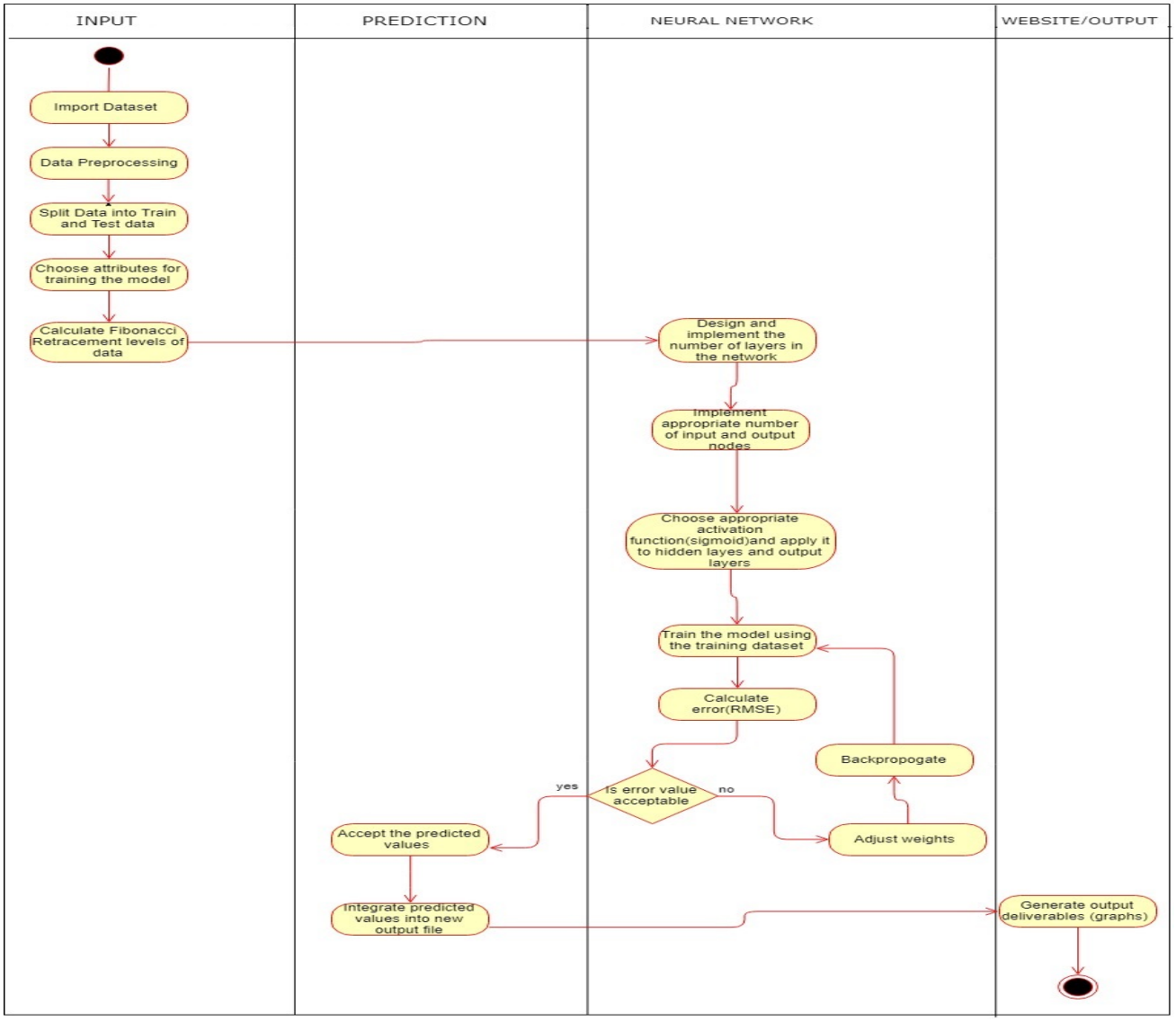

Figure 4.2: Activity Diagram

4.2.2 Sequence Diagram

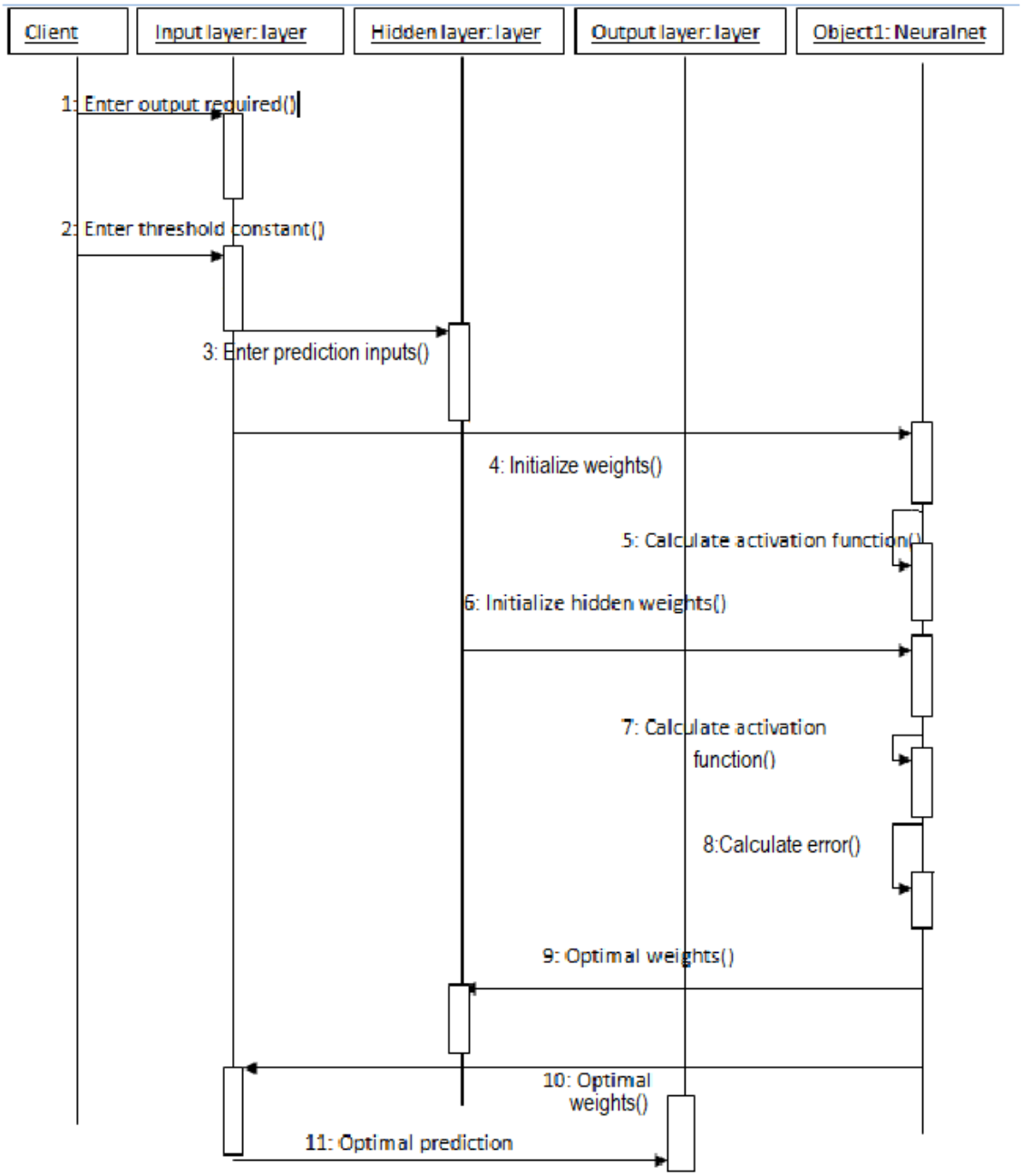

Figure 4.3: Sequence Diagram

4.2.3 Package Diagram

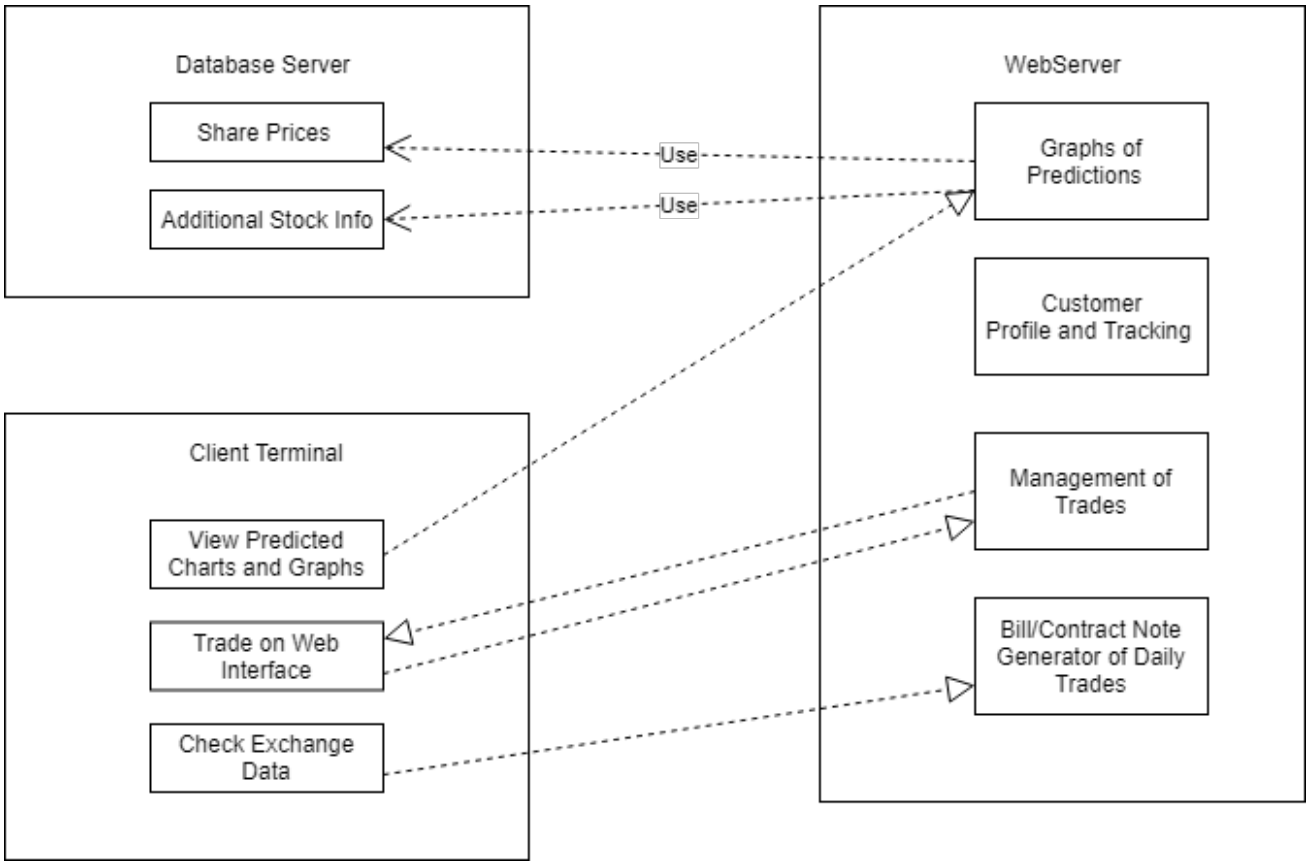

Figure 4.4: Package Diagram

4.2.4 Use Case Diagram

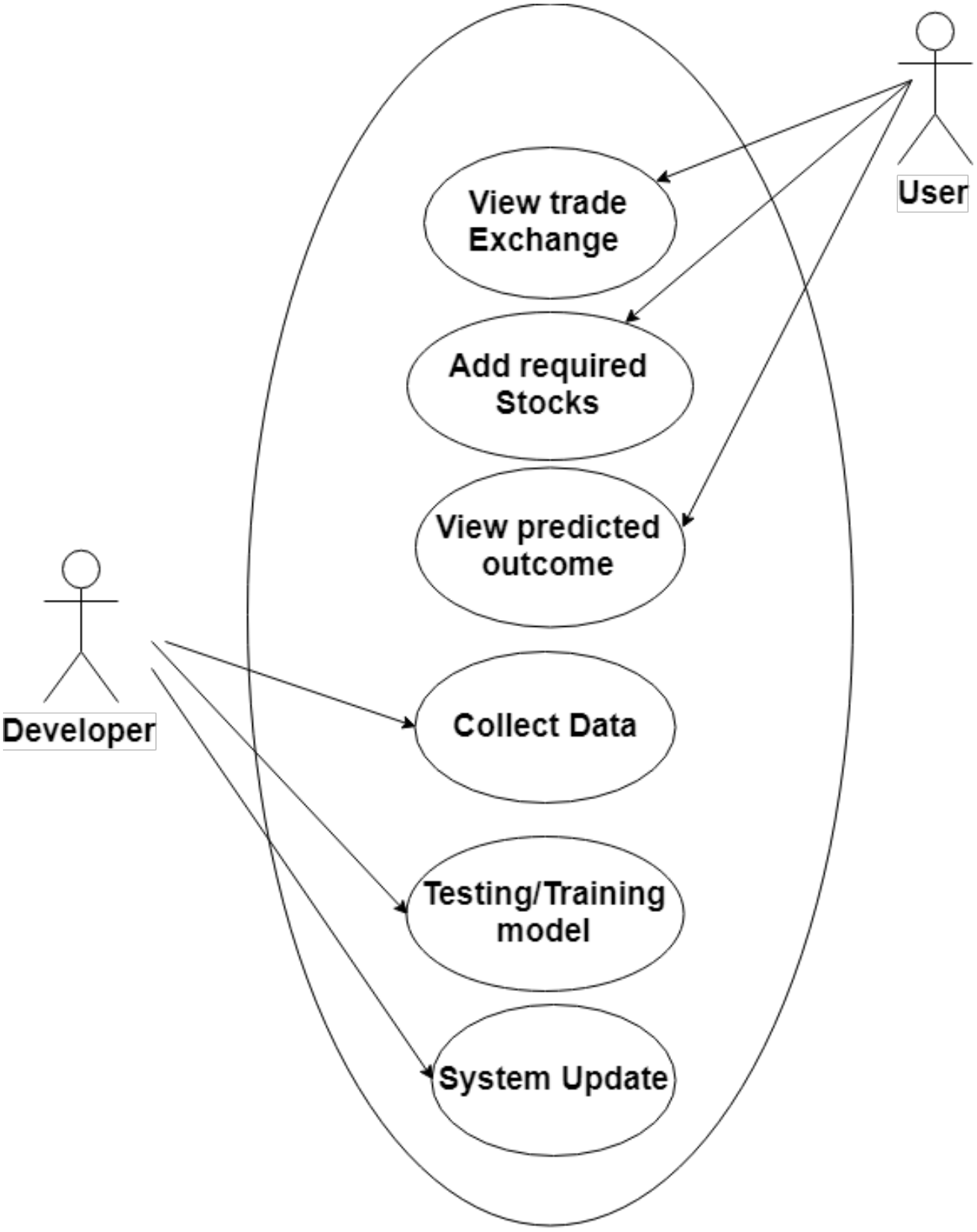

Figure 4.5: Use Case Diagram

4.2.5 Communication Diagram

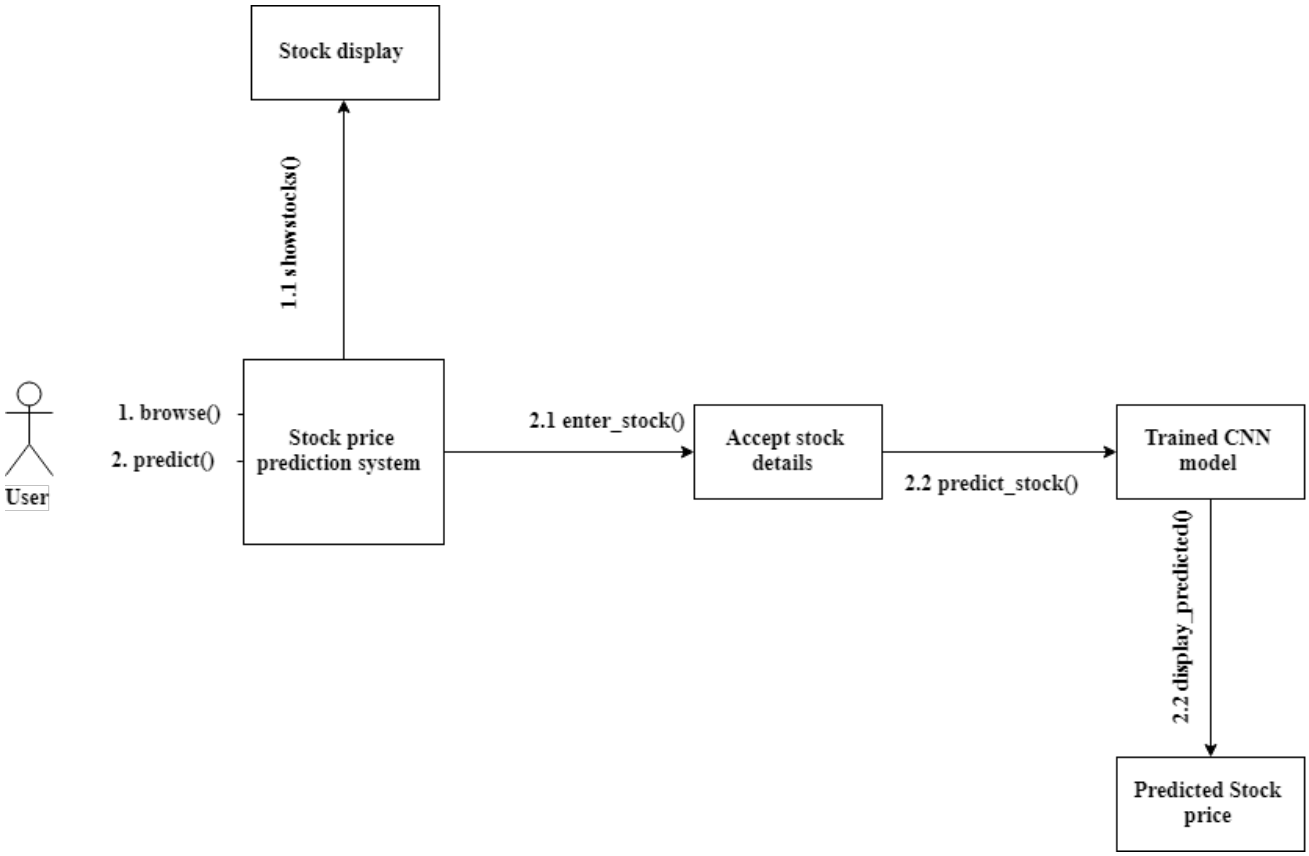

Figure 4.6: Communication Diagram

4.2.6 Class Diagram

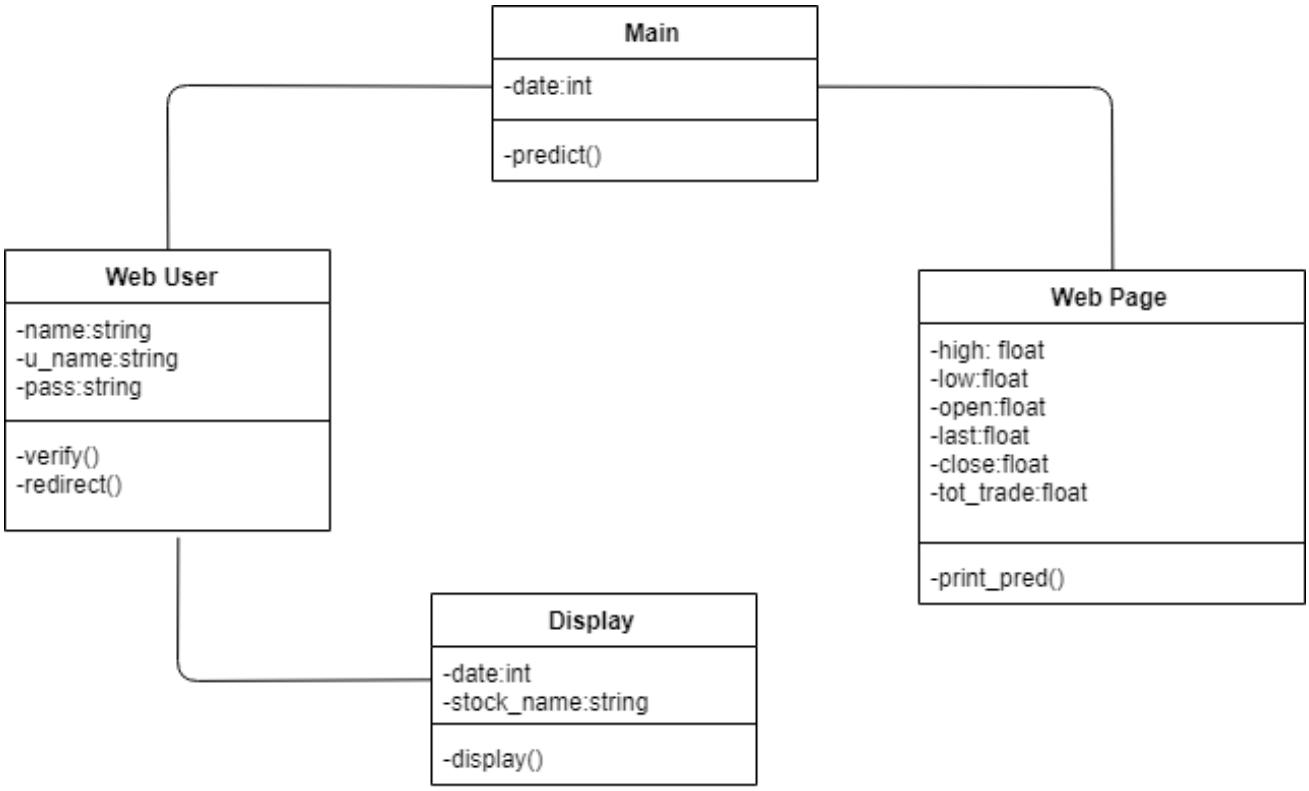

Figure 4.7: Class Diagram

4.2.7 Deployment Diagram

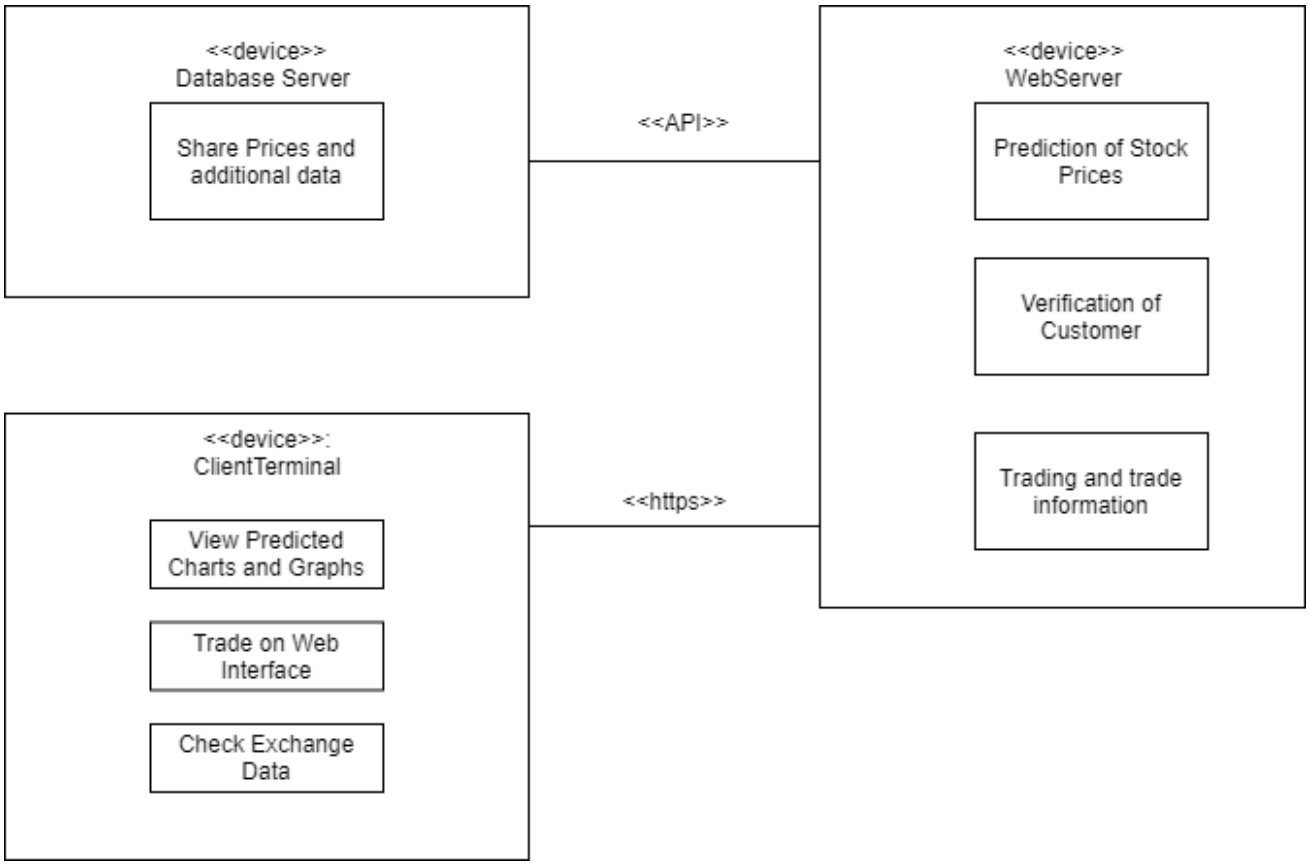

Figure 4.8: Deployment Diagram

4.2.8 Entity Relationship Diagram

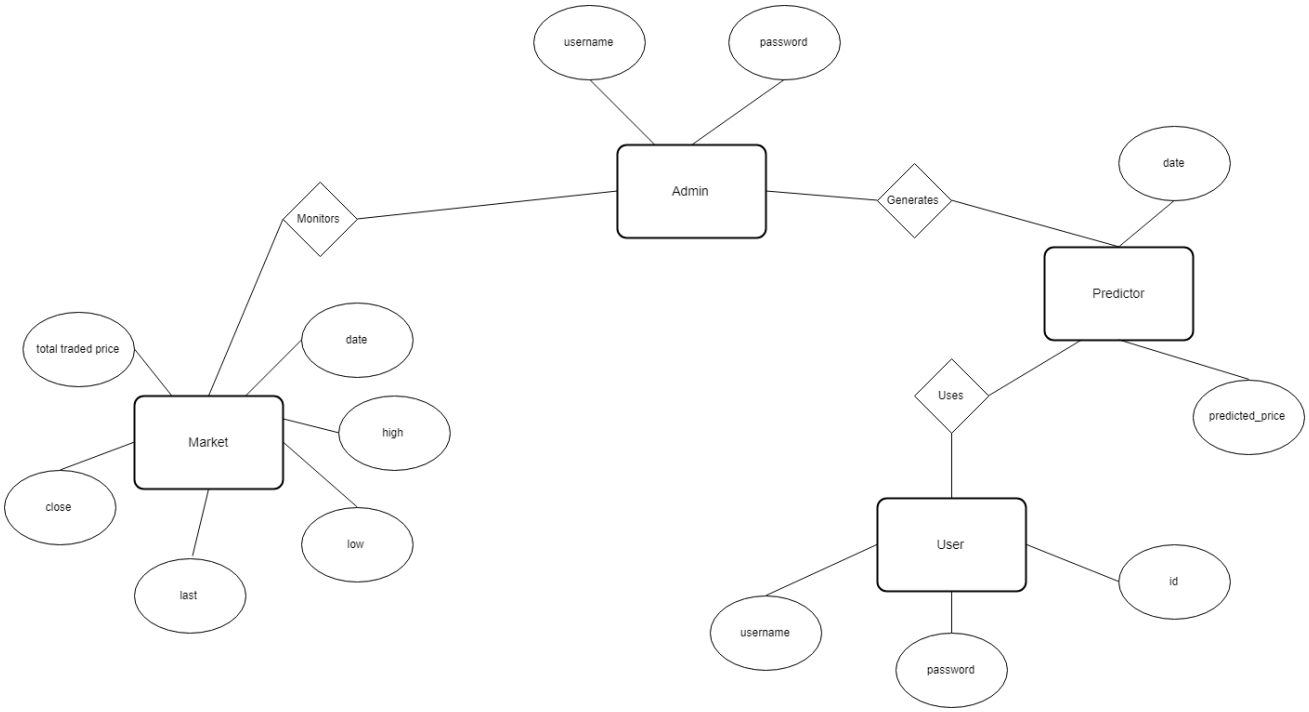

Figure 4.9: Entity Relationship Diagram

5.

Other Specification

5.1 Advantages

1. The major advantage of this project is that the people with minimum knowledge of the stock market can make use of the predictions for a relatively safer investment plan.
2. The human element often restricts the outcome of the results. Often biases or human delays reduce the consistency of the results expected. With stock market software by your side, one is capable of simply running the results based on the latest data that is fed-in or directly extracted from sources.

5.2 Limitations

1. One of the limitation is that the neural network will be working with minimum available data as no international stock data is available at hand.
2. The CNN might give a comparatively less accurate result as it is feed with numerical data and not image data.
3. Accuracy might vary depending on the activation functions selected.

5.3 Applications

1. Stock Market Prediction: Predicting the stocks for various companies is the main focus of this project.
2. Character Recognition: Neural networks can be used to recognize handwritten characters.
3. Image Compression: Neural networks can receive and process vast amounts of information at once, making them useful in image compression.
4. Miscellaneous Applications: A neural network can be used to decide whether or not to grant a loan.

6.

Conclusion

By the use of available model training techniques like Convolutional neural network, it is possible to predict the future trends in stock market. It is possible to utilize the features discussed which are highs, lows of the day, dollar , Fibonacci retracement, market cap etc to develop a hybrid system for the prediction of financial status of a company accurately. We restrict our model with respect to the activation function used, which is ReLU and Sigmoid that are most popularly used and advantageous over other activation functions. These activation function will be powered by the 3 hidden layers of the Convolutional Neural Network.It is important to design the system accordingly by which the accuracy and performance can be increased with less computational complexity.

7.

Appendix - A

Mathematical Model

S={I,P,O}
where S=Selection set
I = Input set
O = Output set

I = {I1,I2}
where I1 = Training set
I2 = Testing set

P = {F1}
where F1 = Convolutional Neural Network

O = {P}
$where P(prediction) = \{P \in \mathbb{R}\}$

1. F1 - Convolutional Neural Network

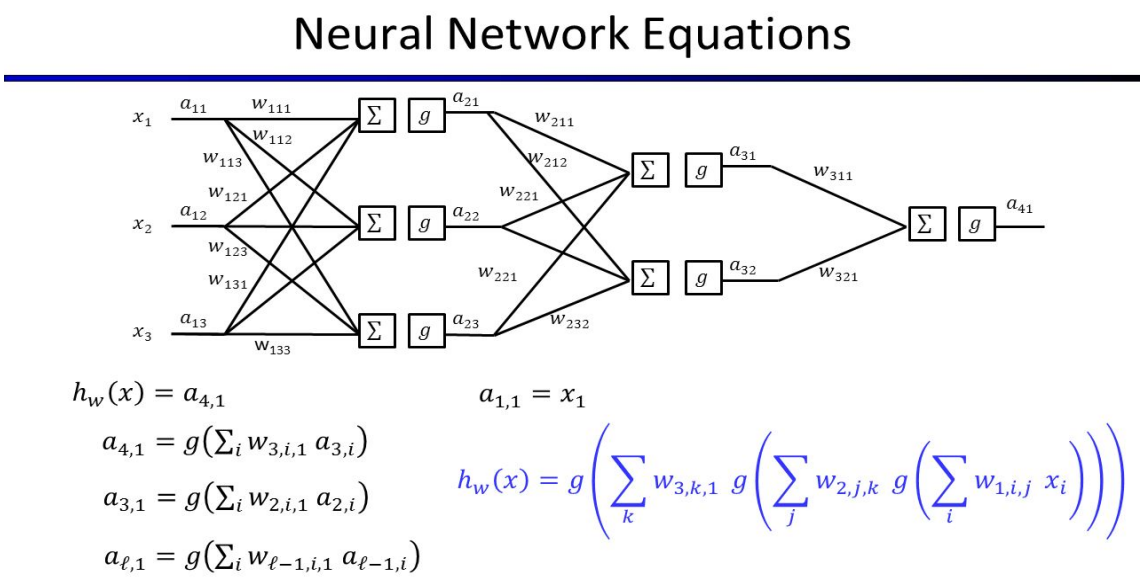

Figure 7.1: Mathematical Model : CNN

2. ReLu - (Rectified Linear Unit) Activation Function)
   F(x) = Max (x,0)

8.

Appendix - B

1. J. Chen, W. Chen, C. Huang, S. Huang and A. Chen, "Financial Time-Series Data Analysis Using Deep Convolutional Neural Networks" In Proceedings 7th International Conference on Cloud Computing and Big Data (CCBD), Macau, 2016, IEEE Computer Society.

   Summary:

   - Results show that the deep learning technique is effective in our trading simulation application, and may have greater potentialities to model the noisy financial data and complex social science problems.
   - The major contribution of this paper is to improve the algorithmic trading framework with the proposed deep convolutional neural networks (CNN).

2. S. Coyne, P. Madiraju and J. Coelho, "Forecasting Stock Prices Using Social Media Analysis" In Proceedings 2017 IEEE 15th Intl Conf on Dependable, Autonomic and Secure Computing, 15th Intl Conf on Pervasive Intelligence and Computing, 3rd Intl Conf on Big Data Intelligence and Computing and Cyber Science and Technology Congress(DASC/PiCom/DataCom/CyberSciTech), Orlando, FL, 2017, IEEE Computer Society.

   Summary:

   - Understanding how information can be extracted for feeding the neural network.
   - Understanding how social media data can help in predicting the individual stock prices.
   - Helps to better understand how sentiment analysis may come to play in such situations.

3. M. R. Vargas, B. S. L. P. de Lima and A. G. Evsukoff, "Deep learning for stock market prediction from financial news articles" In Proceedings 2017 IEEE International Conference on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA), Annecy, 2017, IEEE Computer Society.

   Summary:

   - How to use deep learning methods for intraday directional movements prediction.
   - Focus on architectures such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), which have had good results in traditional NLP tasks.
   - CNN is better than RNN on catching semantic from texts.

4. S. Selvin, R. Vinayakumar, E. A. Gopalakrishnan, V. K. Menon and K. P. Soman, "Stock price prediction using LSTM, RNN and CNN-sliding window model" In Proceedings 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Udupi, 2017, IEEE Computer Society.

   Summary:

   - CNN is giving more accurate results than the other two models. This is due to the reason that CNN does not depend on any previous information for prediction.
   - Enables the model (CNN) to understand the dynamical changes and patterns occurring in the current window.

9.

Appendix - C

Plagiarism Report

from 2018-11-22 19-26-29.png from 2018-11-22 19-26-29.png

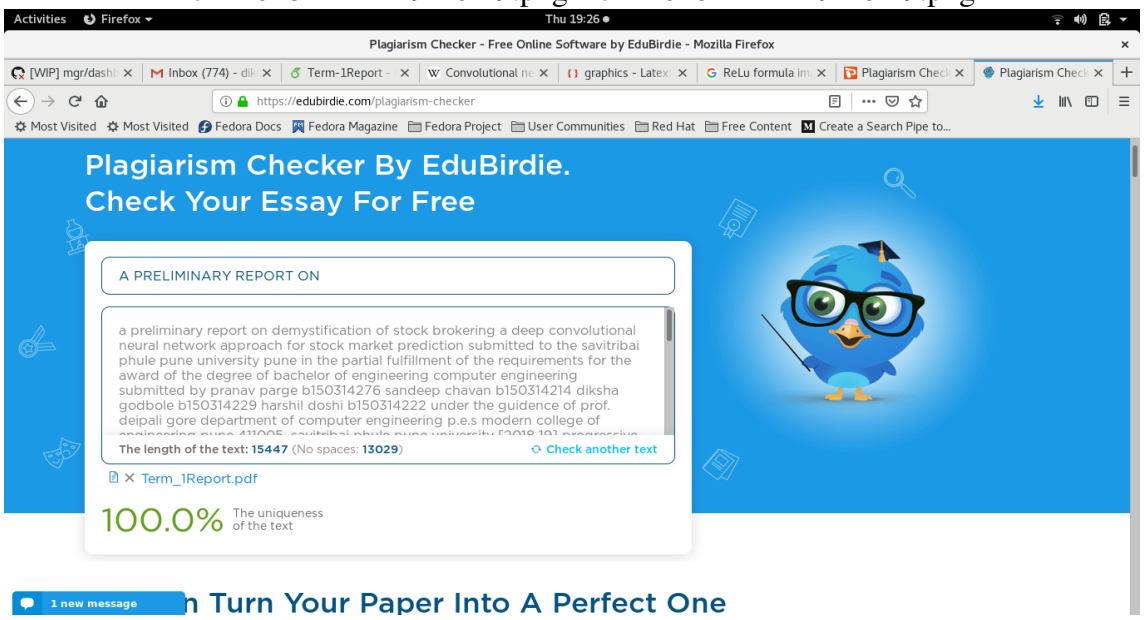

Figure 9.1: Plagiarism report

10.

References

[1] J. Chen, W. Chen, C. Huang, S. Huang and A. Chen, Financial Time-Series Data Analysis Using Deep Convolutional Neural Networks In Proceedings 7th International Conference on Cloud Computing and Big Data (CCBD), Macau, 2016, IEEE Computer Society.

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