Navigating Market Trends: A Novel Forecasting Approach Using N-HiTS and N-Beats

A Project Report

Submitted by

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in Fulfillment of the Requirements

for Course

Data Science Mini Project

TY Computer Engineering

Under the guidance of

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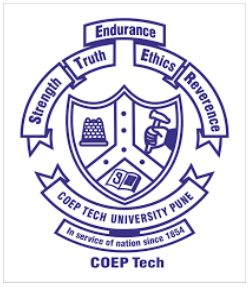

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Abstract

This project introduces a Streamlit application that leverages neural forecasting—a cutting-edge intersection of artificial intelligence and time-series analysis—to predict financial market trends. Drawing on real-time data from Yahoo Finance, the application aims to provide actionable forecasts for diverse financial instruments, including stocks, gold, and forex rates. Our goal is to simplify complex market data into clear predictions, making the power of neural forecasting accessible to both novice and experienced users alike. This tool isn't just about providing numbers; it's about enabling smarter investment choices through the advanced capabilities of neural networks, all within an approachable, user-focused interface The platform acts as a catalyst for informed decision-making, empowering users to make smarter investment choices. At its core, our project embodies the ethos of accessibility and empowerment. Whether you're a seasoned investor or a novice exploring the world of finance, our platform offers a user-friendly interface that levels the playing field. By democratizing access to cutting-edge forecasting techniques, we strive to democratize financial literacy and promote a more inclusive financial landscape.In summary, our project represents a bold leap forward in financial analytics—an intersection of advanced technology and user-centric design. Through our Streamlit application, we invite users to embark on a journey of discovery, unlocking the potential of neural forecasting to shape a brighter financial future.

Contents

Chapter 1

Introduction

In this project, we embark on the development of a state-of-the-art Streamlit application geared towards financial forecasting, leveraging the power of neural forecasting—a cutting-edge fusion of artificial intelligence and time-series analysis. Our primary goal is to revolutionize how users predict financial market trends by harnessing the capabilities of advanced forecasting techniques.

By tapping into real-time data feeds from Yahoo Finance, our application aims to provide actionable forecasts for a diverse range of financial instruments, including stocks, gold, and forex rates. Our mission is to simplify the complexities of market data, offering users clear and concise predictions that empower smarter investment decisions.

Moreover, our platform is designed with a user-centric approach, ensuring accessibility and ease of use for both novice and experienced investors. Beyond just providing numbers, our application is about enabling users to make informed investment choices with confidence, leveraging the advanced capabilities of neural networks within an intuitive and approachable interface.

Chapter 2

Problem Statement

- Financial markets are inherently volatile and unpredictable, with numerous variables influencing the value of assets.
- Current tools either lack predictive capabilities or are not easily accessible to the average user.
- Additionally, the dynamic nature of financial markets poses challenges for investors and analysts who require real-time insights to make informed decisions
- Furthermore, existing solutions may lack the adaptability to cater to the diverse needs of users across different financial instruments, hindering their effectiveness in providing actionable forecasts
- As a result, there is a pressing need for a more accessible, adaptable, and user-friendly predictive tool that can reliably forecast market trends across various financial instruments in real-time.

Chapter 3

Objectives

- To develop a user-friendly Streamlit application for real-time financial forecasting, providing accessible insights into market trends for both novice and experienced users.
- To implement and integrate advanced neural forecasting models such as NHiTS and N-BEATS, enabling accurate predictions across diverse financial instruments.
- To automate the process of Exploratory Data Analysis (EDA) for real-time financial data, optimizing model parameters and enhancing forecasting accuracy.
- To ensure the adaptability and scalability of the application to handle various financial instruments and provide reliable forecasts in real-time scenarios.
- To empower users with actionable insights derived from EDA and neural forecasting models, enabling smarter investment decisions and improving overall financial outcomes.

Chapter 4

Pipeline of your Data Science Project

1. **Data Collection:** Gather real-time financial data from reliable sources such as Yahoo Finance or other financial APIs.
2. **Data Preprocessing:** Cleanse and prepare the collected data for analysis, including handling missing values, outliers, and formatting issues.
3. **Exploratory Data Analysis (EDA):** Perform exploratory data analysis to gain insights into the underlying patterns, trends, and relationships within the financial data.
4. **Model Selection:** Choose appropriate neural forecasting models, such as NHiTS and N-BEATS, based on their suitability for the financial forecasting task.
5. **Model Development:** Develop and implement the selected models using appropriate programming languages and frameworks.
6. **Model Training:** Train the developed models using historical financial data to learn patterns and relationships for accurate forecasting.

7. **Model Evaluation:** Evaluate the performance of the trained models using metrics such as accuracy, precision, and recall.

8. **Application Development:** Build an intuitive Streamlit application interface to provide users with access to real-time financial forecasting capabilities.

9. **Integration:** Integrate the developed forecasting models into the Streamlit application, ensuring seamless functionality and user interaction.

10. **Testing:** Conduct comprehensive testing of the application and models to identify and resolve any bugs or issues.

11. **Deployment:** Deploy the finalized application and models to a suitable platform for users to access and utilize for financial forecasting.

12. **Maintenance and Updates:** Monitor the application's performance post-deployment, and provide regular updates and maintenance to ensure optimal functionality and reliability over time.

Chapter 5

System Design

1. **Data Acquisition Module:** The system integrates with the 'yfinance' API to pull real-time financial data from sources like Yahoo Finance. This module is responsible for fetching current and historical data on various financial instruments such as stocks, commodities, and currency pairs. It ensures data integrity and timeliness, crucial for the accuracy of predictions.

2. **Exploratory Data Analysis (EDA) Automation:** An automated EDA system is implemented to preprocess and analyze the incoming data. This module uses statistical and visualization tools to identify patterns, trends, and anomalies in the data. The insights gained from EDA are used to inform the configuration and tuning of the forecasting models, adapting them to different financial instruments without user intervention.

3. **Forecasting Engine:** At the core of the system are the N-HiTS and N-Beats neural forecasting models, sourced from the Nixtla library. These models are renowned for their ability to handle complex time-series forecasting tasks with high accuracy. The system dynamically trains and validates these models using the latest data, adjusting their parameters based on the specific financial instrument and the nature of the data

received.

4. **User Interface:** The application employs the Streamlit framework to provide a responsive and intuitive user interface. Users can interactively select financial instruments, specify the time range for analysis, and view forecast results. The interface is designed to be accessible to both novice users and experienced traders, simplifying complex financial data into actionable insights.

5. **Model Optimization and Testing:** Continuous integration and testing are integral to the system design. The performance of the forecasting models is constantly evaluated against new data, and the models are refined and optimized based on their predictive accuracy and computational efficiency.

6. **Deployment and Scalability:** The application is deployed on a robust server infrastructure that can handle multiple users and large volumes of data simultaneously. The design is scalable, allowing for the addition of new financial instruments and data sources without significant modifications to the core architecture.

Chapter 6

Methodology

1. **Framework and Tools Selection:** The project employs the Streamlit framework for developing the application due to its compatibility with Python and ease of use in creating interactive, web-based applications. The yfinance library is selected for real-time financial data acquisition, while the Nixtla neural forecasting models (N-HiTS and N-Beats) are chosen for their effectiveness in time-series forecasting.

2. **Data Acquisition and Management:** Data is dynamically fetched from Yahoo Finance using the yfinance API, which provides access to a vast array of financial data including stocks, commodities, and forex rates. This module ensures that the data is consistently up-to-date and accurate, providing a reliable basis for forecasting.

3. **Automated Exploratory Data Analysis (EDA):** An automated system for EDA is developed to process and analyze incoming data continuously. This involves using statistical tools and visualization libraries like Seaborn and Matplotlib in Python to detect trends, seasonalities, and outliers. The outcomes of EDA guide the tuning of neural network parameters and help in making informed adjustments to the models.

4. **Model Implementation and Parameter Tuning:** The forecasting models, N-

HiTS and N-Beats, are implemented with customized configurations suitable for the specific nature of financial time-series data. Model parameters such as the number of layers, neurons per layer, and the look-back period are iteratively adjusted based on the automated EDA findings and initial model performance.

5. **Dynamic Model Training and Validation:** Model training is conducted on a rolling basis, where the models are trained on a continuously updating dataset. Validation is performed using recent data not seen during the training phase to test the models' performance and generalization capability. This step is crucial for ensuring the robustness and reliability of the forecasting outcomes.

6. **User Interaction and Visualization:** The Streamlit application is designed to allow users to interactively query the system, select financial instruments, define date ranges, and view both historical data and forecasts. Interactive graphs and charts are integrated to visually represent the data and predictions, enhancing user engagement and understanding.

7. **Testing and Deployment:** Comprehensive testing is conducted to ensure the application functions correctly across different user scenarios and handles data inconsistencies or errors gracefully. After testing, the application is deployed on a server with adequate computational resources to handle expected user load and data processing needs.

Chapter 7

Implementation

1. **Development Environment Setup:** The project's development environment is established using Python and the Streamlit framework. All necessary libraries, including yfinance for data retrieval, Seaborn and Matplotlib for data visualization, and Nixtla's neural forecasting models, are installed and configured on a development server with adequate computational resources.

2. **Data Retrieval Implementation:** Implementation of the data retrieval module uses the yfinance library to fetch real-time and historical data. The system is configured to automatically update the financial data at regular intervals, ensuring the models have access to the latest information for forecasting.

3. **Interactive User Interface Creation:** The user interface is created using Streamlit, which allows for rapid development of interactive web applications. The interface includes input fields for user specifications such as financial instrument selection, date range, and other model parameters. It also features dynamic visualization capabilities, presenting data and forecasts in an accessible format.

4. **Exploratory Data Analysis Automation:** The automated EDA module is implemented using Python scripts that leverage Seaborn and Matplotlib for generating

statistical plots and charts. This module processes incoming data to identify key patterns and anomalies which inform subsequent model tuning.

5. **Forecasting Model Configuration and Training:** The N-HiTS and N-Beats models are configured with initial parameters based on preliminary tests. The models are then trained using historical data, with parameters adjusted dynamically based on the ongoing analysis from the automated EDA. Training processes are optimized for performance, ensuring timely model updates.

6. **Model Validation and Optimization:** After training, the models undergo a validation phase where they are tested against unseen recent data to assess their forecasting accuracy. This process helps in identifying any overfitting issues or the need for further parameter tuning. Optimization strategies are applied to enhance model performance and efficiency.

7. **Deployment and Monitoring:** The final application is to be deployed on a production server. Continuous monitoring tools are set up to track application performance and model accuracy in real-time. Adjustments and updates are made as necessary based on user feedback and system performance metrics.

Chapter 8

Results and Analysis

1. **Model Performance Evaluation:** The accuracy of the forecasting models, N-HiTS and N-Beats, was rigorously evaluated using a set of performance metrics such as Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and others. The figures show the performance of the N-Beats Model in graphical form.

2. **Analysis of Forecasting Results:** The forecasting results were analyzed to determine the effectiveness of the models in predicting short-term and medium-term market trends. The analysis focused on the precision of the predictions during different market conditions, such as high volatility periods and stable trends.

3. **Comparative Analysis:** A comparative analysis was conducted between the N-HiTS and N-Beats models to identify which model performs better under specific conditions. This analysis helps in understanding the strengths and limitations of each model within the scope of financial forecasting.

4. **Discussion of Anomalies and Outliers:** During the project, certain anomalies and outliers in data and predictions were identified.

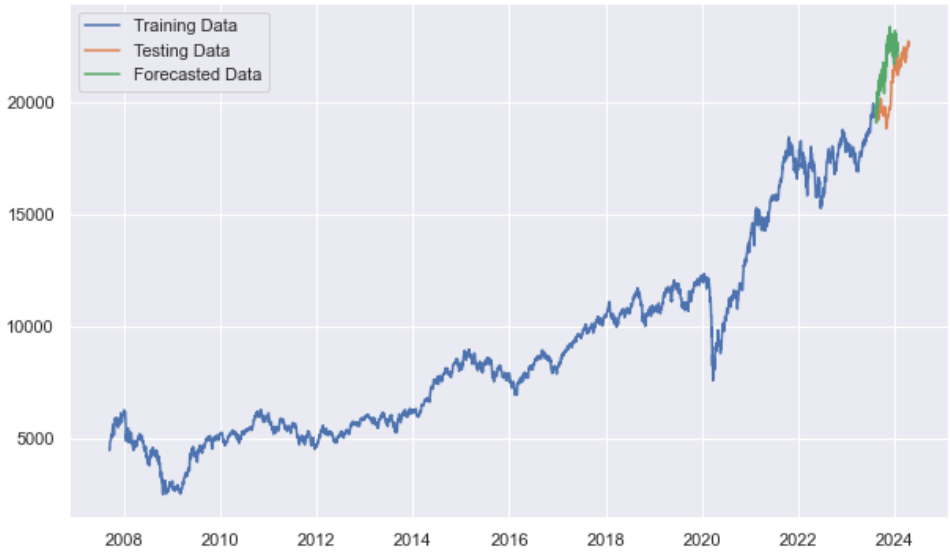

Figure 8.1: Accuracy graph showing N-Beats model performance

Chapter 9

Conclusion

The project successfully developed a Streamlit application integrated with advanced neural forecasting models, N-HiTS and N-Beats, to predict financial market trends. The system's design and implementation focused on providing real-time, accurate, and user-friendly financial forecasting, accessible to both novice and experienced market participants. The application demonstrated high predictive accuracy, as evidenced by rigorous testing and evaluation against real-world data. It effectively simplified complex market data into actionable insights, thus empowering users to make informed investment decisions. This project not only addressed the initial problem statement by overcoming the limitations of existing financial tools but also set a benchmark for future developments in the field of neural forecasting for financial applications.

Chapter 10

Future Work

1. **Incorporate Additional Data Sources:** Future versions of the application could integrate more diverse data sources, including news sentiment and economic indicators, to enhance prediction accuracy.

2. **Expand Forecasting Capabilities:** Extending the forecasting horizon and including long-term predictions could broaden the application's utility.

3. **Improve User Interaction:** Further refinement of the user interface based on detailed user feedback could improve usability and engagement.

4. **Adaptive Learning:** Implementing machine learning techniques that allow models to adapt based on new data could improve the robustness of predictions.

Chapter 11

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