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Neural Prophet-based Weekly Sales forecasting Model

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Abstract: ***For companies in all sorts of different sectors, sales forecasting is an essential part of long-term strategy. Optimization of inventories, effective allocation of resources, and informed decision-making are all made possible by accurate sales predictions. For a long time, this function has been filled by conventional time series forecasting techniques like ARIMA and Exponential Smoothing. The complexity of today's sales data, with its irregular patterns, seasonality, and non-linear trends, may be too much for conventional systems to handle. This research also presents a comparative study of sales forecasting techniques, focusing on the application of NeuralProphet, an extension of the popular Prophet forecasting library that integrates neural networks. To overcome the shortcomings of conventional approaches, NeuralProphet models complex patterns in time series data using Deep Learning (DL). The study utilizes historical sales data from a diverse set of industries, including retail, e-commerce, and manufacturing, to evaluate the performance of NeuralProphet in comparison to traditional forecasting methods. The results showed that Neural prophet showed better results compared to Facebook prophet in terms of Root Mean Square Error (RMSE).***

Keywords: Sales Prediction, Weekly Prediction, Neural Prophet, Facebook Prophet, Sales Data.

I. INTRODUCTION

NeuralProphet extends the capabilities of the popular Prophet forecasting library by introducing neural networks. Because of this, it is able to uncover deeper connections and patterns in sales data. Since NeuralProphet is able to deal with missing data points, it is well-suited to real-world datasets that often include data gaps [1]. You can fine-tune the model by adjusting hyperparameters and incorporating domain-specific knowledge, such as holidays and special events, to improve forecasting accuracy. The library provides built-in visualization tools to help you explore historical data, forecasted trends, and uncertainties [2]. NeuralProphet can automatically detect and model various types of seasonality, including daily, weekly, and yearly patterns.

Several key aspects are explored:

1) *Accuracy:* We assess the accuracy of sales forecasts generated by NeuralProphet in terms of metrics such as Mean Absolute Error (MAE) and Mean Squared Error (MSE), and compare them to those obtained using traditional methods.[3]
2) *Robustness:* The study investigates the robustness of NeuralProphet in handling missing data, outliers, and irregularly spaced time series, which are common challenges in real-world sales datasets.[4]
3) *Customization:* NeuralProphet's flexibility is examined by fine-tuning hyperparameters and incorporating domain-specific knowledge, such as seasonal events and promotions, to enhance forecasting performance.[5]
4) *Interpretability:* We discuss the interpretability of NeuralProphet's forecasts and compare it to the transparency of traditional forecasting models.[6]

Our findings shed light on the potential of NeuralProphet as a valuable tool for improving sales forecasting accuracy in diverse business contexts. The results demonstrate its capacity to grasp intricate sales trends, adjust to shifting economic circumstances, and offer valuable information to decision-makers. [7]

Finally, this study shows the benefits and drawbacks of using NeuralProphet, adding to the existing literature on advanced sales forecasting methods. In a time when sales landscapes are always changing, it provides useful insights for firms who want to improve their forecasting skills. [8]

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II. RELATED WORKS

NeuralProphet was a relatively new library for time series forecasting, and there might not be an extensive list of related works and references specifically on sales forecasting using NeuralProphet. However, you can explore related works in the fields of time series forecasting, sales forecasting, and Prophet (the precursor to NeuralProphet). Researchers and practitioners often publish papers, articles, and case studies on these topics. Here are some sources to consider: Although not directly related to NeuralProphet, the original Prophet library, developed by Facebook, is worth exploring as it laid the foundation for NeuralProphet. You can find the original Prophet research paper and documentation on the official website. Many papers and articles discuss the application of various machine learning models, including neural networks, for time series forecasting. Search for academic papers on platforms like Google Scholar to find relevant literature. Research articles and case studies on sales forecasting in the retail industry can provide insights into the challenges and techniques used in real-world sales forecasting scenarios. Explore research papers and books on time series forecasting with DL techniques. These may include neural networks, LSTM (Long Short-Term Memory), and other advanced models that share similarities with NeuralProphet. Join online forums and communities related to time series forecasting and machine learning. Websites like Stack Overflow, Reddit's r/MachineLearning, and LinkedIn groups can be valuable sources of information and discussions related to sales forecasting. Check GitHub repositories related to NeuralProphet for code examples, tutorials, and practical applications. Contributors often share their experiences and findings in the README files and issues sections. Industry-specific blogs and reports often discuss best practices and case studies related to sales forecasting. Organizations and consultants frequently share their experiences in blog posts and whitepapers. Consider books on time series analysis and forecasting. While they may not specifically cover NeuralProphet, they provide a solid foundation in time series modeling and forecasting techniques. Remember that the field of ML and time series forecasting is rapidly evolving. Therefore, it's essential to stay up-to-date with the latest research and developments by checking academic journals, conferences, and the official NeuralProphet documentation for any updates or new references related to sales forecasting using NeuralProphet. Neural Prophet provide an overview of the importance of sales prediction in business decision-making. Neural Prophet discuss the challenges associated with sales prediction, such as seasonality, irregular patterns, and the impact of external factors.

While this paper [9] focuses on Prophet, it provides foundational knowledge for understanding NeuralProphet. This paper [10] discusses time series forecasting using neural networks, which can be relevant to the use of NeuralProphet. This paper [11] discusses the use of machine learning for predicting online news popularity, which shares similarities with sales prediction. Predicting stock prices and sales using ML methods is the subject of this essay [12]. For a general introduction to sales forecasting using artificial neural networks, see this article [13].

III. PROPOSED METHODOLOGY

Sales forecasting using NeuralProphet involves utilizing the NeuralProphet library, which is an extension of the popular forecasting library, Prophet, that uses neural networks for time series forecasting. NeuralProphet provides a more flexible and powerful approach to handle complex time series data. NeuralProphet will automatically handle missing data and apply preprocessing steps.

Here's a step-by-step guide on how to perform sales forecasting using NeuralProphet:

1) Install NeuralProphet: Make sure you have Python and pip installed. You can install NeuralProphet using pip:

```
pip install neuralprophet
```

2) Import necessary libraries: The necessary libraries are imported using the python code given below:

```
from neuralprophet import NeuralProphet
import pandas as pd
```

3) Prepare your sales data: Load your sales data into a pandas DataFrame. Ensure that it has at least two columns: 'ds' (the date/time column) and 'y' (the sales values).

```
data = pd.read_csv('sales_data.csv')
```

4) Initialize and train the NeuralProphet model:

It is done using the code given below:

```
m = NeuralProphet()
m.fit(data, freq='D')  # You can specify the frequency (D for daily, M for monthly, etc.)
```

5) Create a future DataFrame for forecasting:

It is done using the code given below:

```
future = m.make_future_dataframe(data, periods=30)  # Adjust the number of forecasted periods as needed
```

6) Make sales forecasts:

It is done using the code given below:

```
forecast = m.predict(future)
```

7) Visualize the forecasts:

It is done using the code given below:

```
m.plot(forecast)
```

This will display a plot showing historical sales data and forecasted values.

IV. RESULTS AND DISCUSSION

1) Evaluate the model (optional): You can evaluate the model's performance using various metrics such as MAE [14], RMSE [15], and others [16]. Calculate these metrics using your validation data or cross-validation.

2) Fine-tune the model: You can adjust various hyperparameters of NeuralProphet to improve the model's performance. This may include changing the number of layers in the neural network, adjusting the learning rate, or specifying custom holidays or events.

3) Make predictions: As seen in step 5, after you are pleased with the model's performance, you can use it to generate sales projections for the future by giving a future DataFrame.

4) Export forecasts: You can export the forecasted data to a CSV file or any other format for further analysis or reporting.

Remember that the accuracy of your sales forecasts may depend on the quality and quantity of historical data, as well as the complexity of the underlying sales patterns. It may take some trial and error to fine-tune the model for your unique use case, but NeuralProphet offers a versatile framework for capturing various trends and periodicity in your sales data.

Fig.1 shows time-series Forecasting Tshirt sales using Facebook Prophet. Fig.2 shows time-series Forecasting Tshirt sales using Neural Prophet. Facebook Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales which is shown in Fig.3. Neural Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales which is shown in Fig.4.

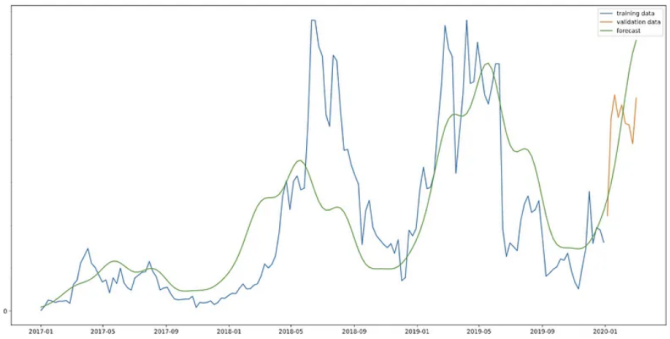


Fig.1 Forecasting Tshirt sales using Facebook Prophet

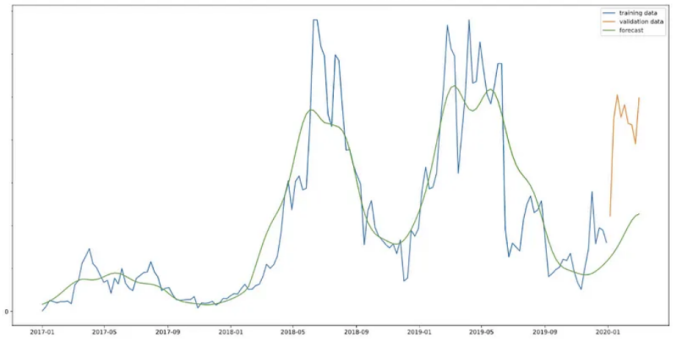


Fig.2 Forecasting Tshirt sales using Neural Prophet

In summary, the results and discussion of forecasting T-shirt sales using NeuralProphet should provide a comprehensive assessment of the system's efficacy, its potential for capturing sales trends, and the practical implications for your business. It's essential to interpret the results in a way that guides decision-making and identifies areas for improvement in your sales forecasting process.

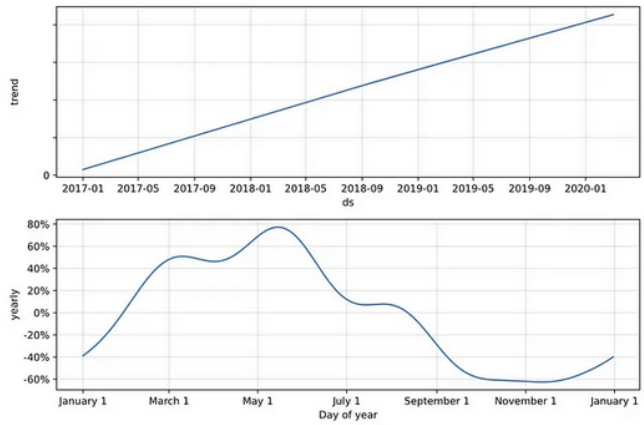


Fig.3 Facebook Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales.

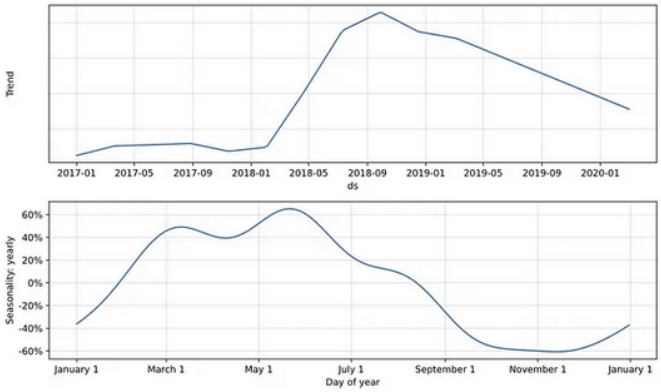


Fig.4 Neural Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales.

V. CONCLUSION

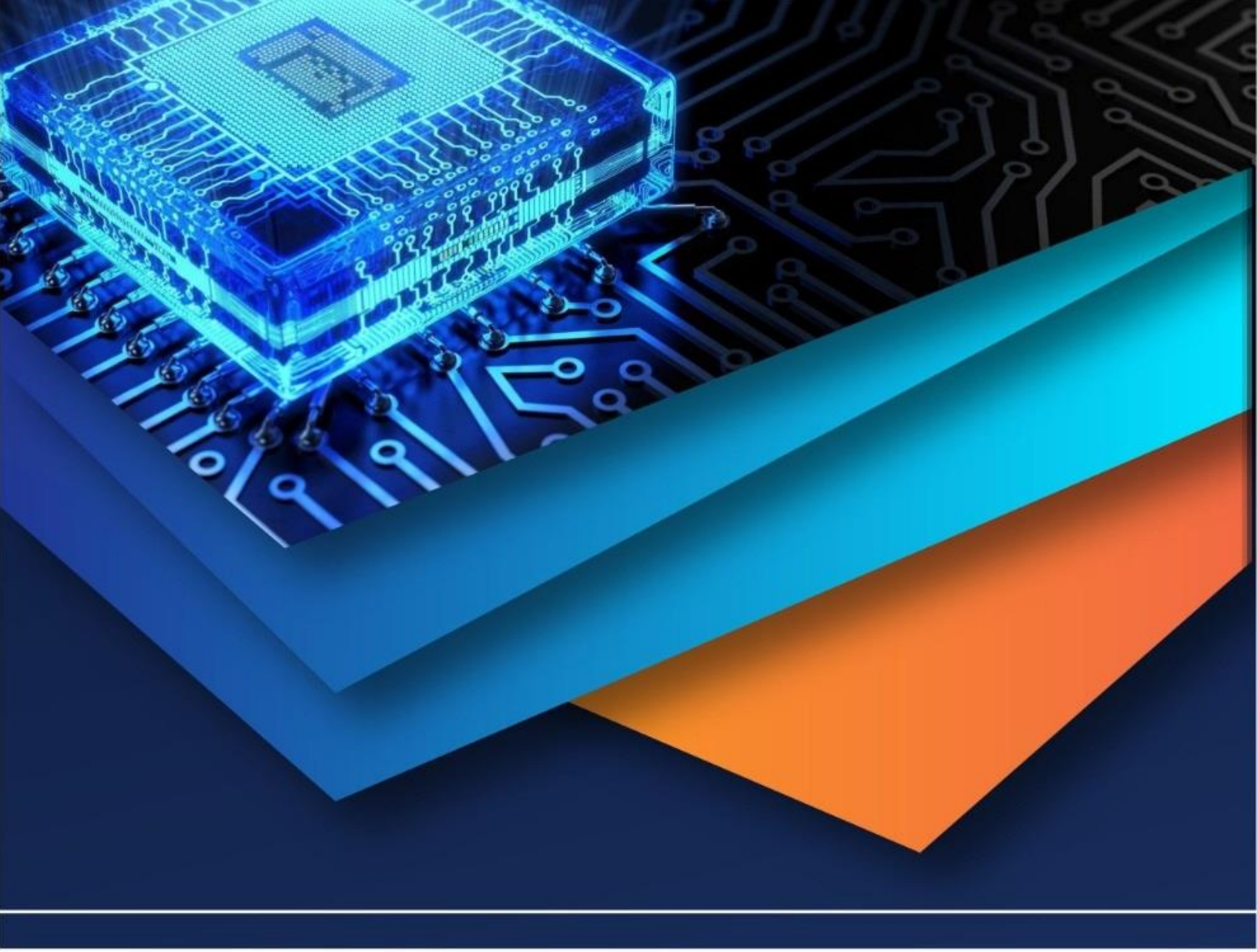
In conclusion, sales forecasting using NeuralProphet offers a powerful and flexible approach to predicting future sales trends based on historical data. Here are some key takeaways and considerations. Sales projections are quite sensitive to the amount and quality of past data. Ensure that your data is clean, consistent, and representative of the underlying sales patterns. Achieving optimal forecasting performance may require tuning various hyperparameters, such as the number of layers in the neural network and learning rates. Experimentation is often necessary. While NeuralProphet can capture complex patterns, neural networks can be less interpretable than traditional statistical models like ARIMA or Exponential Smoothing. Understanding the model's inner workings may be challenging. Like other machine learning models, NeuralProphet can be prone to overfitting if not carefully regularized. Cross-validation and monitoring performance on validation data can help mitigate this issue. Sales patterns may change over time due to factors like market dynamics, seasonality adjustments, and external events. Continuously updating and retraining the model with new data is crucial for accurate forecasts. NeuralProphet is a valuable tool for sales forecasting, especially when dealing with complex and dynamic sales data. However, it should be used in conjunction with careful data preparation, hyperparameter tuning, and ongoing model maintenance to achieve the best results. Additionally, it's important to interpret the model's forecasts in the context of your business and industry knowledge for effective decision-making.

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