# IMPROVING SALES PROJECTIONS: A NEURAL PROPHET-BASED APPROACH FOR WEEKLY FORECASTING

**Abstract**

Sales forecasting is a critical element in the strategic planning of businesses across various industries. Accurate sales forecasts enable organizations to optimize inventory, allocate resources efficiently, and make informed decisions. Traditional time series forecasting methods, such as ARIMA and Exponential Smoothing, have long been employed for this purpose. However, these methods may struggle to capture the complexity of modern sales data, characterized by irregular patterns, seasonality, and non-linear trends. 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. NeuralProphet is designed to address the limitations of traditional methods by harnessing the power of deep learning to model intricate patterns in time series data. 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

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## I. INTRODUCTION

Forecasting sales is a pivotal element in devising a thriving business strategy, offering a window into the forthcoming performance of products or services. This process entails the utilization of statistical models, machine learning algorithms, and adept data analysis techniques to project future sales trajectories based on historical data and pertinent market variables. Through scrutinizing patterns, discerning correlations, and pinpointing influential factors, enterprises can judiciously steer decisions regarding inventory management, marketing endeavors, and resource distribution. Furthermore, sales prediction serves as a guiding beacon for financial mapping and budgetary allocations, empowering organizations to establish pragmatic objectives and apportion resources judiciously. In this age of data-centric decision-making, the assimilation of sophisticated predictive models has risen to paramount importance. In recent years, advancements in data science and machine learning have revolutionized the field of sales forecasting, providing businesses with powerful tools to enhance prediction accuracy.

NeuralProphet extends the capabilities of the popular Prophet forecasting library by introducing neural networks. This allows it to capture more complex patterns and relationships in sales data. NeuralProphet can handle missing data points, making it suitable for real-world datasets where data gaps are common [1]. We 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 highlight its ability to capture complex sales patterns, adapt to changing market dynamics, and provide actionable insights for decision-makers [7]. In conclusion, this research contributes to the growing body of knowledge on advanced sales forecasting techniques, demonstrating the advantages and trade-offs associated with the adoption of NeuralProphet. It offers practical insights for businesses seeking to enhance their forecasting capabilities in an era of rapidly evolving sales landscapes [8].

 

## II. RELATED WORK

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, we explored 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.

We 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. 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. These may include neural networks, LSTM (Long Short-Term Memory), and other advanced models that share similarities with NeuralProphet. 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. While they may not specifically cover NeuralProphet, they provide a solid foundation in time series modeling and forecasting techniques. Remember that the field of machine learning and time series forecasting is rapidly evolving.

Neural Prophet provides an overview of the importance of sales prediction in business decision-making. Neural Prophet discusses 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. This article [12] explores the application of machine learning techniques to predict sales and stock prices. This paper [13] provides an overview of forecasting with artificial neural networks, which can be applied to sales prediction.

## 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 panda 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 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.
```

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## IV. RESULTS AND DISCUSSION

NeuralProphet provides a flexible framework to capture various patterns and seasonality in your sales data, but it may require experimentation to fine-tune the model for your specific use case. Remember that the accuracy of sales forecasts may depend on the quality and quantity of historical data, as well as the complexity of the underlying sales patterns.

1. **Evaluate the Model (Optional):** We evaluated the model's performance using various metrics such as Mean Absolute Error (MAE) [14], Root Mean Squared Error (RMSE) [15], and others [16]. Calculate these metrics using your validation data or cross-validation.

2. **Fine-Tune the Model:** We adjusted 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:** Once the model's performance is satisfied, we used it to make future sales predictions by providing a future DataFrame as shown in step 5.
4. **Export Forecasts:** We exported the forecast data to a CSV file or any other format for further analysis or reporting.

   We have considered the Tshirt Sales Data for forecasting the Tshirt sales using Facebook Prophet and Neural Prophet and obtained results from the datasets have been shown in below figures.

 

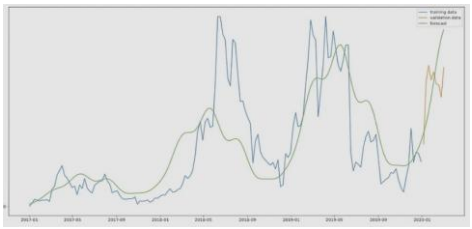

**Figure 1:** Forecasting Tshirt sales using Facebook Prophet

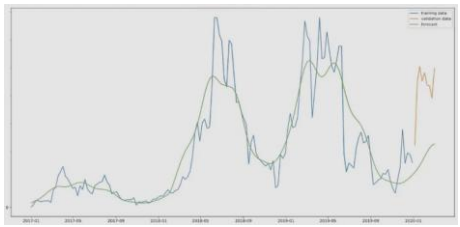

**Figure 2:** Forecasting Tshirt sales using Neural Prophet

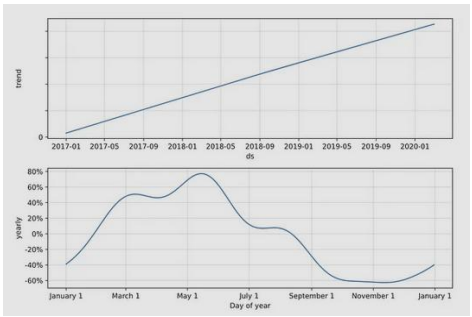


**Figure 3:** Facebook Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales

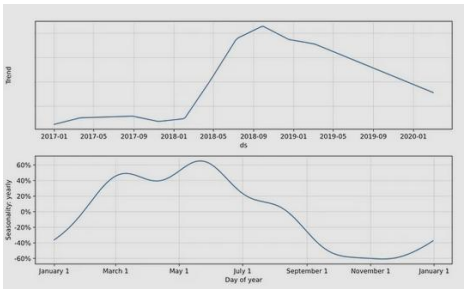


**Figure 4:** Neural Prophet discovered a pattern and annual periodicity in the weekly T-shirt sales

In summary, the results and discussion of forecasting T-shirt sales using NeuralProphet should provide a comprehensive assessment of the model's performance, its ability to capture sales patterns, and the practical implications for business. It's essential to interpret the results in a way that guides decision-making and identifies areas for improvement in the sales forecasting process.

## 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. The accuracy of sales forecasts heavily depends on the quality and quantity of historical 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. 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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