1. Introduction

Overview: Time series analysis involves examining data points collected or recorded at specific time intervals. It is crucial for forecasting future values based on historical trends. This study focuses on forecasting sales data to improve inventory management and demand planning.

Importance: Accurate sales forecasting helps businesses optimize inventory levels, reduce costs, and improve customer satisfaction. In this study, we aimed to predict the number of units sold for different items using various time series models.

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2. Research and Literature Review

Time Series Techniques:

- **ARIMA (AutoRegressive Integrated Moving Average):**
    - ARIMA models are used for stationary time series data. They combine autoregression, differencing, and moving averages.
    - Suitable for data with a clear trend and no seasonality.
- **Exponential Smoothing Methods:**
    - Includes models like Holt-Winters, which can handle both trend and seasonality.
    - Effective for time series data with clear seasonal patterns.
- **Prophet:**
    - Developed by Facebook, Prophet handles missing data, seasonal effects, and holiday effects.
    - It is designed for daily observations with strong seasonal effects and is robust to irregularities in the data.
- **LSTM (Long Short-Term Memory):**
    - A type of recurrent neural network (RNN) capable of learning long-term dependencies.
    - Useful for complex temporal patterns but requires more data and computational resources.

Model Selection Criteria:

- **Data Characteristics:**
    - Seasonal effects, trends, and noise levels influenced the choice of model.
- **Model Complexity:**
    - A trade-off between model accuracy and interpretability was considered.

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3. Data Exploration and Preparation

Dataset Description:

- The dataset included date, Item_Id, units sold, and ad_spend.

- It required preprocessing to handle missing values and scale features.

Preprocessing Steps:

- **Handling Missing Values:**
    - Missing data points were either imputed or removed.
- **Feature Scaling:**
    - Features were scaled to standardize the data.

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4. Model Selection and Rationale

Considered Models:

- **ARIMA:**
    - Not suitable due to non-stationary trends and complex seasonal patterns.
- **Prophet:**
    - Chosen for its ability to handle seasonal patterns and missing data effectively.

Final Model Rationale: Prophet was selected due to its robustness in capturing seasonal effects and trends without extensive parameter tuning.

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5. Model Implementation and Evaluation

Implementation:

- **Training Phase:**
    - The Prophet model was trained on historical data to capture trends and seasonal patterns.
- **Testing Phase:**
    - The model was applied to future data to generate forecasts.

Evaluation Metrics:

- **Mean Absolute Error (MAE):**
    - Used to evaluate the model's performance by comparing predicted values to actual values.

Results:

- **Best Parameters:**
    - Detailed hyperparameter tuning results.
- **Model Performance:**
    - MAE and other relevant metrics showed Prophet's effectiveness in forecasting.
