# Sales Forecasting and Predictive Analysis Project Report

## 1. Introduction

The aim of this project is to leverage historical sales data and advertising spend to predict future sales, identify demand fluctuations, and provide recommendations for inventory management. The project focuses on creating an accurate predictive model using a **Decision Tree** to forecast sales and optimize inventory based on the predictions.

## 2. Data Overview

The dataset contains the following columns:

* **TV**: Expenditure on TV advertising.
* **Radio**: Expenditure on Radio advertising.
* **Newspaper**: Expenditure on Newspaper advertising.
* **Sales**: Actual sales figures.

## 3. Methodology

### 3.1 Data Preprocessing

* **Data Cleaning**: The dataset was reviewed for missing values and cleaned accordingly.
* **Feature Selection**: TV, Radio, and Newspaper were selected as the independent variables to predict the target variable, Sales.

### 3.2 Exploratory Data Analysis (EDA)

* **Correlation Analysis**: A correlation matrix was created to assess relationships between the advertising spend (TV, Radio, Newspaper) and sales.
* **Visualization**: Scatter plots and pair plots were generated to visualize relationships between the features and sales.

### 3.3 Model Development

* **Model Selection**: A **Decision Tree** model was chosen for its ability to handle non-linear relationships and provide more accurate sales predictions.
* **Training and Testing Split**: The data was split into a training set (80%) and a test set (20%).

### 3.4 Model Evaluation

The Decision Tree model was evaluated using the following performance metrics:

* **Mean Absolute Error (MAE)**: 1.1600
* **Mean Squared Error (MSE)**: 2.5623
* **Root Mean Squared Error (RMSE)**: 1.6007
* **R² Score**: 0.9207

### Model Accuracy

The accuracy of the Decision Tree model is **92.07%**, which indicates that the model successfully captures the relationship between advertising expenditure and sales, explaining 92.07% of the variance in sales data.

## 4. Results

The Decision Tree model performed well on the test set, providing reliable predictions. Below are the visualizations:

### Future Sales Predictions Visualization

The future sales predictions made by the Decision Tree model are as follows:

* Predicted future sales values: **25.5, 25.5, 25.5**.

This chart shows a stable future sales forecast across the prediction points, reflecting consistent sales based on historical advertising spend patterns.

## 5. Visualization

* **Scatter Plots**: Scatter plots were created to visualize the relationship between individual advertising channels (TV, Radio, and Newspaper) and sales.
* **Bar Charts**: A bar chart was created to compare total advertising expenditure across different channels.
* **Decision Tree Predictions**: A line chart was used to represent the future sales predictions generated by the Decision Tree model.

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## 6. Recommendations for Inventory Management

Based on the Decision Tree sales predictions:

* **Increase Inventory**: For periods with expected higher sales, consider increasing inventory to meet demand.
* **Reduce Inventory**: For periods with lower forecasted sales, reduce inventory to avoid overstocking.
* **Dynamic Management**: Regularly update inventory management strategies in response to updated sales forecasts to maintain optimal stock levels.

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## 7. Conclusion

This project successfully applied the Decision Tree model to forecast future sales based on historical advertising expenditure data. The model achieved an accuracy of **92.07%**, providing useful insights for inventory management. In future work, more advanced models, such as random forests or boosting algorithms, could be explored to further enhance prediction accuracy.