Final Report
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AI Inventory Optimizer

Introduction

Retail stores operate under constant pressure to balance product availability, supply chain timing, and customer expectations. When shelves are empty, customers feel frustrated or disappointed, and when shelves are overloaded, the company wastes time, money, and labor managing the excess. Throughout this project, our team wanted to design a system that could help reduce these problems in a practical and supportive way.

The AI Inventory Optimizer is a predictive system that estimates weekly sales for Walmart stores. Our goal was to produce a tool that could genuinely help store employees make smarter decisions and help customers reliably find the items they need. Even though this is a student project, we approached it with the mindset that real people experience the effects of inventory mistakes. Creating something that could give clarity and support to both workers and shoppers was important to us.

Problem Statement

Large retail chains like Walmart deal with constant changes in customer demand. Sales vary throughout the year for reasons ranging from holidays to weather shifts, and managers often have to make ordering decisions without dependable data. When decisions are made through guesswork alone, stores risk running out of popular items or ordering far more than they can sell.

When shelves are empty, customers cannot purchase what they came for, and this affects their trust in the store. When shelves are overloaded, valuable resources are wasted on products that sit untouched. Employees feel the pressure of both outcomes. A prediction system that guides ordering decisions helps stores avoid both extremes and creates a more reliable, smoother experience for customers and staff.

Dataset Overview

To build our system, we used the publicly available Walmart Weekly Sales Dataset from Kaggle. This dataset contains real historical information such as store numbers, department numbers, weekly sales, temperature, economic indicators, and holiday details.

Our team prepared a cleaned version of this dataset by removing missing values, organizing fields, and selecting the most meaningful features. The final cleaned file is stored as walmart_preprocessed.csv, which serves as the foundation for all the work that followed.

Methodology

Our project followed a full data science workflow beginning with cleaning the dataset, analyzing it, and preparing it for machine learning. After preparing the data, we trained several models and eventually selected XGBoost because it produced the strongest and most consistent performance.

The training process included separating the data into training and testing sets, teaching the model to learn patterns from historical sales records, and evaluating how accurate the predictions were. We examined the model using measurements such as MAE, RMSE, and R^2. Although sales forecasting is naturally unpredictable, the model produced helpful estimates that can guide decision-making more effectively than guesswork alone.

After training the model, we created an interactive prototype called inventory_mvp.py. This script allows a user to type in a store number and a department number. The program then loads the trained model and returns a weekly sales prediction. This transforms the model from a research project into a small tool that can be used directly.

Conclusion

This project gave our team the chance to bring together everything we've learned in the program and turn it into something that feels real and genuinely useful. The AI Inventory Optimizer might be simple, but it reflects a meaningful goal: helping real people by providing something clear, supportive, and rooted in data instead of guesswork.

We hope this project shows both our technical ability and our understanding of how AI can meet human needs. At the end of the day, retail work is fast-paced and demanding, and customers rely on stores more than they realize. If an AI tool can make that whole system a little smoother, we consider that a success.