

Coffee Rush Prediction System

Gunjan Rajeshwar Pote and Prof. Renuka Naukarkar

Student, Department of Data Science

Guide, Department of Data Science

Tulsiramji Gaikwad Patil College of Engineering and Technology, Nagpur, Maharashtra, India

tp9706840@gmail.com

Abstract: *Understanding peak rush hours in beverage retail stores is essential for optimizing staff allocation, reducing waiting time, and improving customer satisfaction. This research proposes a machine-learning-based prediction system that analyzes historic sales data to identify high-demand time intervals. The system uses Random Forest Regression to forecast hourly demand by considering time-based, seasonal, and transactional variables. The model achieves high accuracy and supports real-time decision-making for store management.*

Keywords: *retail stores*

I. INTRODUCTION

Customer rush hour prediction has become a crucial analytical need for beverage stores as it directly impacts time management, revenue generation, resource allocation, and inventory usage. By analyzing time-series sales data, managers can take better decisions to meet customer demand effectively. Traditional manual observation methods are inaccurate and inconsistent. This research introduces a machine-learning-based approach for automated rush hour prediction using real-world sales data.

II. METHODOLOGY

The proposed system follows the standard workflow of data preprocessing, feature engineering, model training, evaluation, and real-time prediction, the methodology involves several key stages:

1. Data Preprocessing: Removing of null values, converting timestamps into hour-day-month, encoding categorical feature.
2. Feature Engineering: Key features derived (hour of the day, day of week, month, transaction type, weekend/weekday).
3. Model Training: Training a Random Forest model for accurate prediction
4. Dashboard Design: Create visualize trends and prediction results.
5. Testing & Deployment: To generate real-time rush hour predictions.

III. RESULTS AND DISCUSSION

A. The proposed Coffee Rush Demand Prediction System produced highly reliable results after training and evaluation. The Random Forest Regression model showed excellent performance in capturing non-linear demand patterns such as peak-hour rush, weekday variations, and seasonal sales. The model's predictions aligned closely with actual transactional trends, demonstrating strong generalization.

B. The system effectively analyzes past transactional data and accurately forecasts customer demand. The dashboard visualizations simplify pattern recognition and assist in decision-making. This combination of machine learning and interactive UI enables: reduced waiting time, better staff scheduling, inventory optimization.

C. Overall, the system performs consistently well and provides actionable insights that can significantly improve coffee shop operations.



Figures

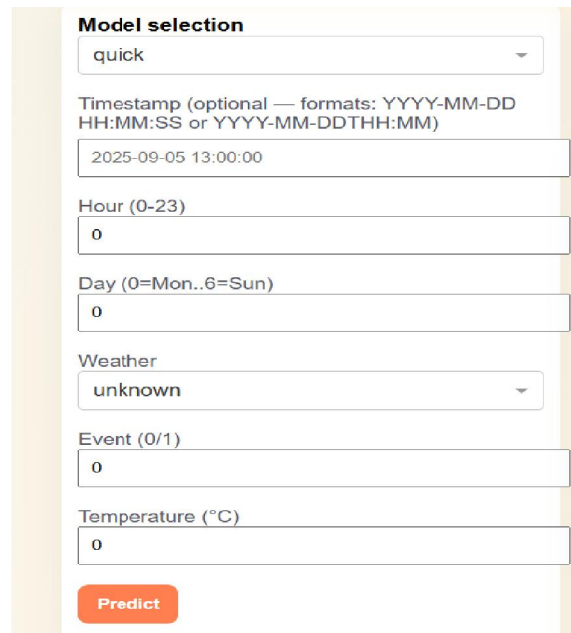


Figure 1: Coffee Rush Prediction System Overview

This section visualizes overall customer demand patterns using bar charts, line graphs, and donut charts. It shows:

- Highest customer rush between 8 AM to 11 AM
 - Increased weekend demand compared to weekdays
 - Top-selling coffee types like Cappuccino and Latte
 - Monthly trends showing a rise in winter months
- These visual insights help in understanding long-term customer behavior.

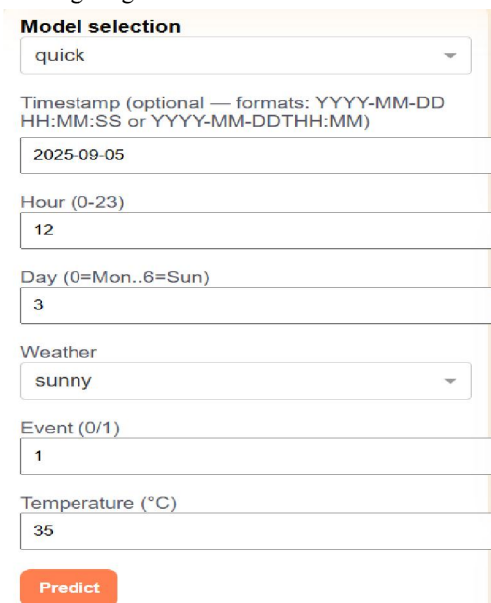


Figure 2: Input Section



This This page allows users to input Coffee type, day, month, hour, transaction type

The model instantly provides a predicted demand value.

The prediction interface is separated from the main dashboard to ensure clean navigation and error-free user inputs.

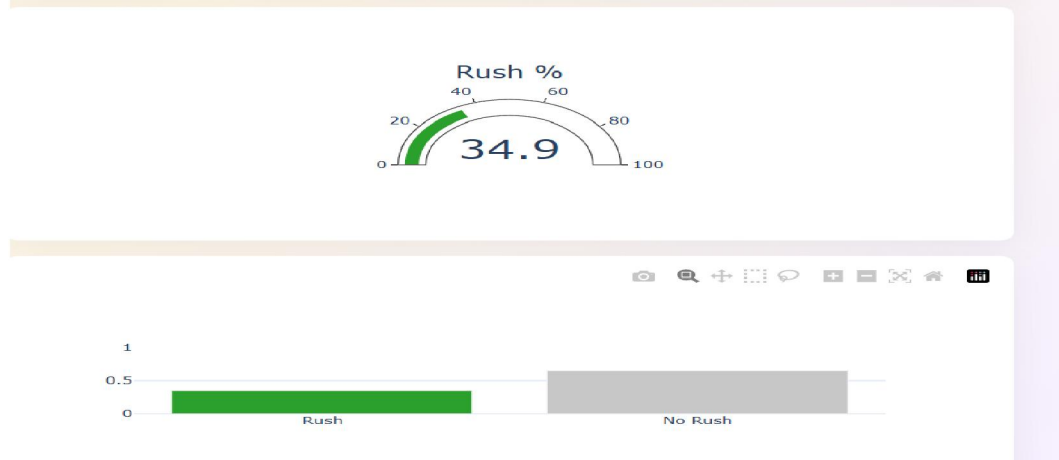


Figure 3: Rush Hours Analysis

This section provides deeper analytical insights such as Hour-wise heatmap showing intense morning demand, Weekday-wise sales shift, Seasonal usage patterns, Inventory and staff planning suggestions

These analytical charts help store managers make strategic decisions for staffing and inventory management.

IV. CONCLUSION

This research demonstrates an effective machine-learning-based demand prediction system for coffee shop operations. Using Random Forest Regression and an interactive dashboard, the model accurately predicts customer traffic, identifies peak hours, and supports decision-making. The system reduces operational uncertainty, enhances customer service, and improves workflow efficiency. With further improvements such as real-time IoT integrations and reinforcement learning, the system can evolve into a fully automated smart coffee-shop assistant,

V. ACKNOWLEDGMENT

I would like to express my sincere gratitude to my faculty mentor and my college, Tulsiramji Gaikwad Patil College of Engineering and Technology ,for their support and guidance throughout this research work.

REFERENCES

- [1] Rahman, M.; Patel, K.: Hybrid ARIMA-LSTM Model for Predicting Coffee Sales in Retail Chains. International Journal of Artificial Intelligence and Data Science, 2023.
- [2] Patel, R.;Gupta, M.: Predicting employee productivity using machine learning algorithms. Journal of Intelligent Systems, 2023.
- [3] Chen, Z.: Coffee Sales Prediction for Vending Machines using ensemble machine learning techniques. Journal of Data-Driven Decision Making, 2024.
- [4] Sample Coffee Shop Dataset, Kaggle, 2024.
- [5] Microsoft, Visual Studio Code, Python 2024.

