Optimizing Rate of Return from Donation Campaigns using ML Modeling & Feature Analysis

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Introduction

In recent years, nonprofits such as The River Food Pantry, **Wisconsin's largest food pantry**, has faced challenges in maintaining and growing donations due to fluctuating economic conditions. By leveraging donation data, the initiative aims to refine campaign strategies, optimize timing, and better target donor segments.

Objective:
This study applies machine learning to predict donation patterns and enhance campaign efficiency, complemented by a dashboard for real-time data visualization.

Methods

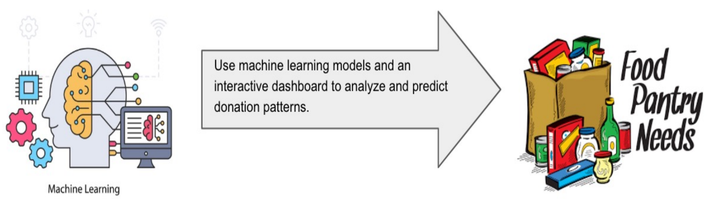
Data Preparation: Analyzed donation from 1/1/23 to 9/25/24 with fields including Date, Amount, Campaign, and Zip Code. Data Cleaning focused on standardizing entries.

Machine Learning Models:

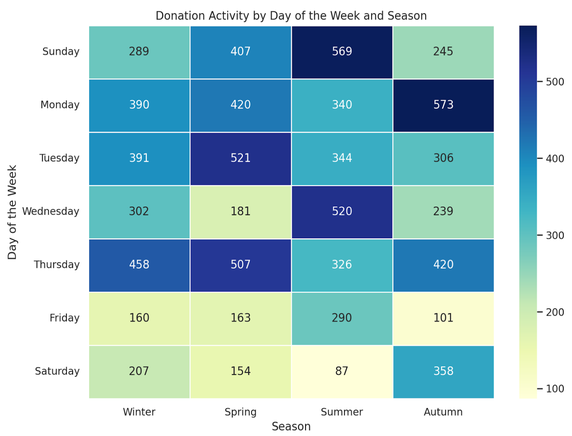
- Random Forest & XGBoost: Used to predict donation patterns and impact different campaigns. Models were evaluated using Mean Squared Error (MSE).

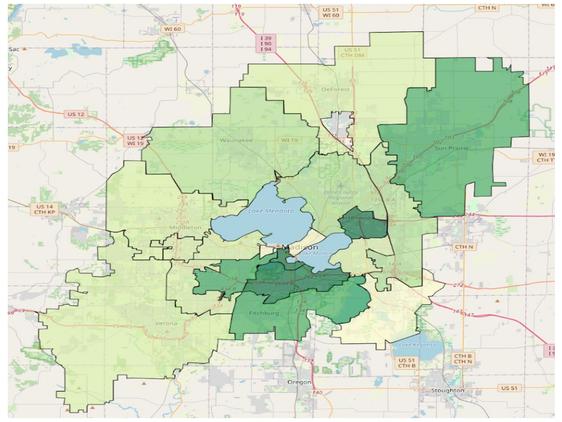
Data Visualizations:

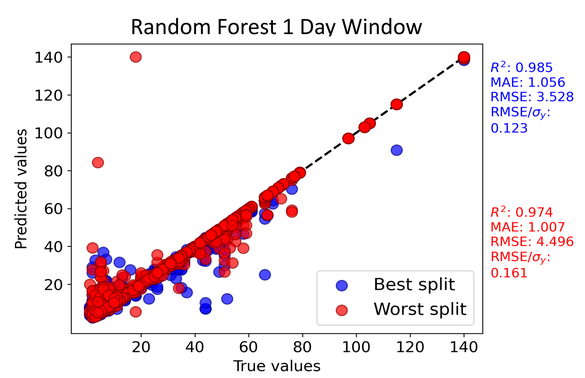
- Interactive Dashboard: Developed dynamic dashboard using Streamlit, Plotly and geopy to dynamically explore donation data.

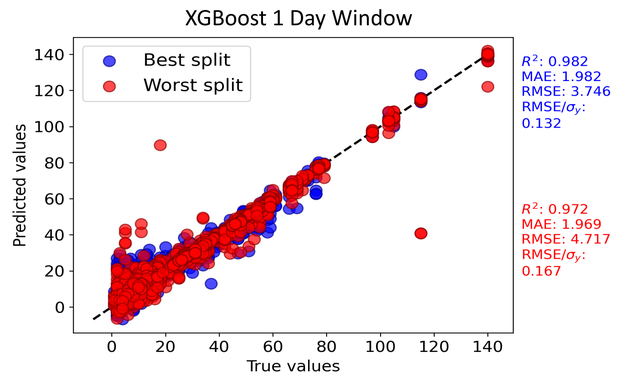


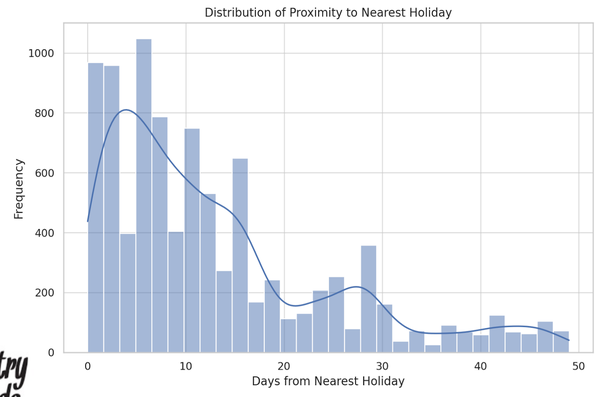
Results

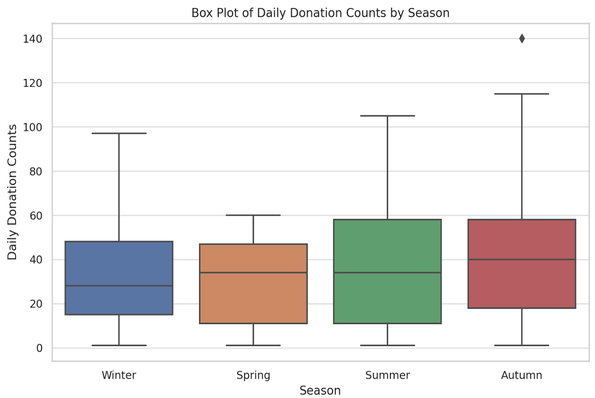












Discussion

- The Random Forest model outperformed XGBoost to prove to be the better fit for our data.
- We addressed inconsistencies in ZIP codes and donation amount through data cleaning.
- Our geographical analysis revealed that certain regions are particularly responsive to targeted campaigns.
- We found notable increases in donations around major holidays.
- The Streamlit dashboard we developed allowed us to show real time data visualizations for the food pantry.

Conclusion & Future Work

This study validated the effectiveness of Random Forest over XGBoost in predicting donation patterns. Through geographical analysis and seasonal timing, our approach pinpointed optimal periods for campaigns. Efforts. The Streamlit dashboard proved instrumental to improve real time data visualization and decision making.

1. Integrate more predictive factors such as economic indicators and demographic data to refine and enhance model prediction.
2. Use other machine learning models such as neural networks to compare effectiveness.

References

PLOS ONE. *Predictive models for charitable giving using machine learning techniques*. PLOS ONE.

Firefly Giving. *AI donation timing: How machine learning optimizes charitable giving impact*. Firefly Giving.