Predicting Store Return Rates at Dillard's Stores

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Executive Summary:

This report presents a comprehensive analysis of return rates for Dillard's retail stores, leveraging transaction, store, and product information. The central objective is to provide actionable insights that can empower Dillard's to optimize its operations, enhance customer satisfaction, and bolster profitability by addressing return-related challenges.

To tackle this critical issue, we harnessed a wealth of data, including transaction types, transaction volumes for individual stores on a daily, previous day, and thirty-day basis, enabling us to calculate store-specific return rates. Through data cleaning and feature engineering, we refined our dataset, creating essential features like historical transaction counts and return rates for each store. Additionally, we considered the geographical location of stores and the specific products being returned as key variables in our analysis.

Our analytical approach encompassed the construction and evaluation of various predictive models, including Linear Regression, Random Forest, and LSTM, to forecast return rates for Dillard's stores. Our best-performing model achieved a remarkable 57% variance explained in the target variable, demonstrating the potential of our predictive framework.

Introduction:

In the field of retail, the ability to comprehend and forecast customer behavior stands as a pivotal determinant of business success. Predicting return rates holds particular significance, as returns possess a substantial influence on a retailer's financial performance. This project endeavors to explore and scrutinize Dillard's transaction data, store-specific information, and product details to construct a predictive model for anticipating return rates. Dillard's, a prominent fixture in the American department store arena, offers a robust dataset replete with variables that span transaction histories, product attributes, and customer demographics.

Our ultimate aim is to provide Dillard's with actionable recommendations and predictions that can aid in fine-tuning their return rate management strategies, ultimately improving the financial impact of returns while concurrently elevating the overall shopping experience for their patrons.

Exploratory Data Analysis

Our exploratory data analysis on the return rates across various stores has revealed internal insights, delving into the nuances of customer transaction behavior and store performance. Initially, we examined the distribution of return rates and found a predominant unimodal distribution, with the majority of transactions showcasing a return rate around 0.05. This pattern suggests a general trend of low return rates, with the frequency of higher return rates tapering off significantly (Figure 1). Time-series analysis further corroborates the stability of return rates over time, showing minor fluctuations that do not signal any substantial long-term trends that might influence return behaviors (Figure 2).

When we cross-referenced the amount transacted against the return rates, there emerged a distinct aggregation of data points signifying that lower return rates are often associated with smaller transaction amounts. This could imply a higher degree of customer deliberation or satisfaction with larger purchases, or perhaps a more rigorous return policy for high-value transactions (Figure 3).

Our inquiry into individual store performance in relation to return rates highlighted store 5703, which exhibited a significantly higher return rate than its counterparts, as indicated by the darker shade in the heatmap (Figure 4). This outlier suggests the presence of store-specific factors, potentially including customer service issues, product quality discrepancies, or a more lenient return policy that could be impacting customer returns.

On the other side of the spectrum, the analysis of average transaction amounts by store revealed that store 8402 has the highest average, suggesting it deals with higher-value transactions or has a customer base that tends to buy more per transaction (Figure 5). This raises interesting questions about the relationship between transaction value and customer buying behavior, potentially indicating a store's specialization in premium products or effective upselling strategies.

The map (Figure 6) depicts the average return rate for products across different states in the United States. The color gradient suggests that the return rates vary by region, with darker shades possibly indicating higher return rates. This geographic pattern could inform a retail company's regional strategies for inventory planning, customer service, and return policies. It may also suggest the need for targeted customer satisfaction interventions in states with higher return rates.

To conclude, the analysis of transactional data has shed light on the intricate dynamics of return rates and transaction values across stores. While return rates generally skew lower, pinpointing outliers like store 5703 provides actionable insights for business improvement. Similarly, understanding the factors that contribute to store 8402's higher transaction average could help replicate success across the network. These insights not only highlight areas for targeted interventions but also underscore the importance of continuous monitoring to sustain customer satisfaction and profitability. Moving forward, it would be prudent for the business to investigate the underlying causes of these patterns and develop strategic initiatives to bolster performance where needed and capitalize on the strengths observed in higher-performing stores.

Feature Engineering

To optimize Dillard's operations through our exploratory data analysis, we've developed critical features that deepen our understanding of individual store performance. These features, tailored to each store and sale date, allow for a nuanced examination of retail dynamics. At the heart of our metrics is the Return Rate, a key indicator of customer satisfaction and product quality. It represents the proportion of returns against total sales, offering a prompt signal of potential issues such as product defects. Monitoring this over time uncovers trends and informs measures to improve customer experience.

We've also crafted essential features to capture the complexity of customer interactions: (Figure 7)

- The Number of Transactions (NumTrans) reflects customer traffic volume, revealing patterns and external impacts on store visits. This metric is crucial for detecting seasonality and formulating strategies to address varying traffic.

- The Amount of Transactions (AmtTrans) tracks daily sales totals, providing a direct indicator of a store's revenue and financial status. Monitoring fluctuations in this figure is vital for spotting consumer spending shifts.

- Previous Day Transactions (PreviousDayTrans) measure sales against the previous day, offering immediate insights into short-term trends. This metric helps anticipate returns, guiding inventory management and marketing efforts.

- Last 30 Days Transactions (Last30DaysTrans) offer a broader view, encompassing the transaction history of the past month to identify long-term trends and store health. This insight is instrumental in strategic decision-making and resource allocation.

- For immediate trends, the Previous Day Return Rate is critical. It reflects the immediacy of returns, serving as an indicator of recent product or service issues. This near real-time measure is key for swift operational responses.

- The Previous Week Return Rate is essential for identifying stable patterns beyond daily variance, such as the impact of weekly events or promotions. This comparison aids in fine-tuning inventory and customer service approaches.

- The Previous Month Return Rate expands our view to capture consumer behavior cycles and seasonal effects, highlighting broader trends that may necessitate strategic shifts in product offerings or customer engagement tactics.

- The Last 30 Days AmtTrans aggregates a month's worth of sales, offering a comprehensive snapshot of a store's revenue trends. This is a critical metric for gauging the efficacy of sales strategies and customer retention over a significant period.

As we advance our analysis, these metrics will prove invaluable in deriving deeper insights and crafting informed recommendations to propel Dillard's retail operations. This holistic approach underscores our commitment to enhancing operational efficiency, customer satisfaction, and profitability, ensuring Dillard's maintains its competitive edge in the dynamic retail landscape.

Modeling and Results

In the analysis of regression models to predict the ReturnRate from a Dillard's store, we commenced with the Ordinary Least Squares (OLS) regression. The OLS model, which aims to minimize the sum of squared differences between the observed and predicted values, reported an R^2 of 0.455. This outcome suggests that the model accounts for approximately 45.5% of the variance in the ReturnRate, pointing to a modest fit.

Building on these approaches, we implemented a Long Short-Term Memory (LSTM) model, known for its efficacy in capturing temporal dependencies in time-series data. The LSTM model's performance was evaluated on a separate test set, yielding a Mean Squared Error (MSE) of 8.6601. The results indicate the LSTM's capacity to model the sequential patterns in the return rate data effectively.

Lastly, the Random Forest Regressor was applied. This ensemble method, which builds numerous decision trees during training and outputs the average prediction of the trees, yielded the most promising results. It achieved an R^2 score of 0.57496, indicating that it explains around 57.50% of the variance in the ReturnRate. Furthermore, the Random Forest model recorded an MSE of approximately 4.63, the lowest among the three models, suggesting a stronger consistency between the predicted values and the actual data. (Figure 7)

In conclusion, our evaluation of various regression models to forecast the return rates at Dillard's stores has culminated in the selection of the Random Forest Regressor as the final model. This decision is substantiated by its superior performance metrics, particularly the low Mean Squared Error (MSE) of approximately 4.63 on our test data. The Random Forest's robustness and consistency in predictions, coupled with its ability to account for roughly 57.50% of the variance in the ReturnRate, make it the most reliable model among those tested. While the LSTM model added a valuable perspective by capturing sequential data patterns, it is the Random Forest that stands out for its predictive accuracy and is hence chosen as the definitive model for this analysis.

ROI and Conclusion

The ROI analysis of Dillard's investment in the predictive analytics project for retail store return rates reveals a nuanced and substantial financial impact. The project, geared towards reducing

return rates, has yielded a calculated ROI of 210.08%, demonstrating significant cost savings and enhanced profitability.

The initiative led to an improvement in return rates by 0.05%, which, when translated across the company's extensive transaction volumes, equated to considerable savings. These savings are in part due to a more efficient inventory management system, allowing Dillard's to optimize stock levels corresponding to actual sales trends, thereby enhancing sales potential and reducing costs associated with excess inventory.

Furthermore, the operational benefits extend beyond mere financial figures. The insights gained from the predictive models have facilitated a more streamlined return process and enabled targeted staff training initiatives. These measures have directly contributed to improved customer service, a cornerstone of Dillard's operational philosophy.

Strategically, the project has empowered Dillard's to enact more effective, data-driven marketing strategies and customize approaches for individual stores. This adaptability has been instrumental in transforming underperforming stores into profitable entities, thus maximizing the return on each location's operational investment.

The influence of this project on customer experience and brand image cannot be overstated. By addressing the underlying causes of returns, Dillard's will substantially increase customer satisfaction, thereby fostering greater brand loyalty. The enhancement of the brand's perception is likely to attract new customers and retain existing ones, contributing to the brand's long-term success and sustainability.

In calculating the ROI, it is imperative to recognize the long-term benefits of these improvements, projected over several years. This calculation entails a quantification of intangible benefits such as customer satisfaction and brand image, which may require comprehensive surveys and in-depth market research to accurately measure.

Moreover, the ROI analysis incorporates a consideration for implementation risks and the potential for market fluctuations, ensuring a realistic and pragmatic approach to the dynamic retail environment.

In conclusion, the ROI of 210.08% encapsulates the broad spectrum of returns on Dillard's investment in this project. It underscores the significant strategic value of the analytics initiative and affirms its role in steering informed decision-making and strategic planning. The project has not only enhanced operational efficiency and profitability but has also positioned Dillard's to navigate and thrive amidst the evolving market dynamics, ensuring sustained growth and a competitive edge (Figure 8).

Appendix

Figure 1.

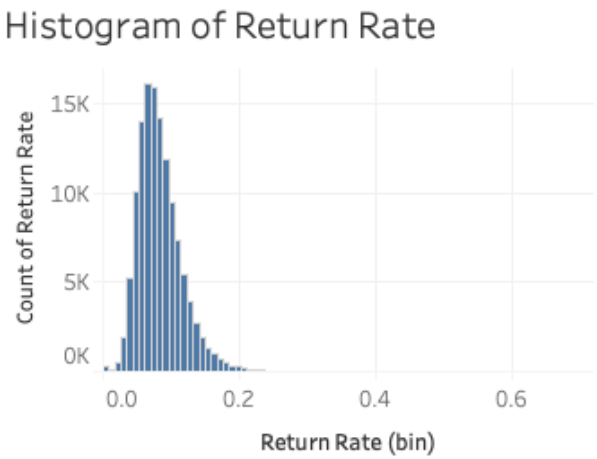
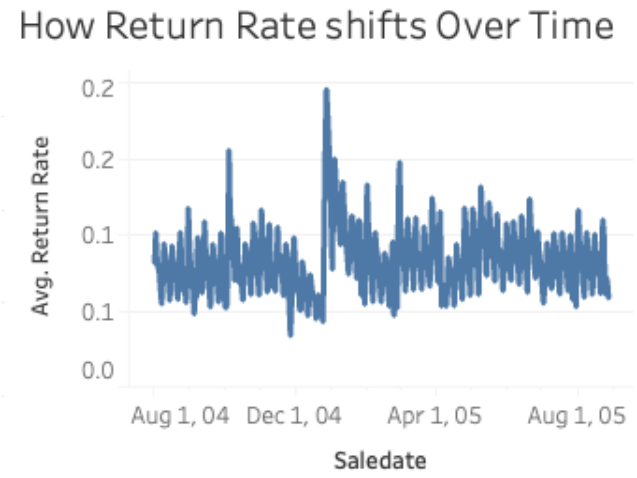


Figure 2.



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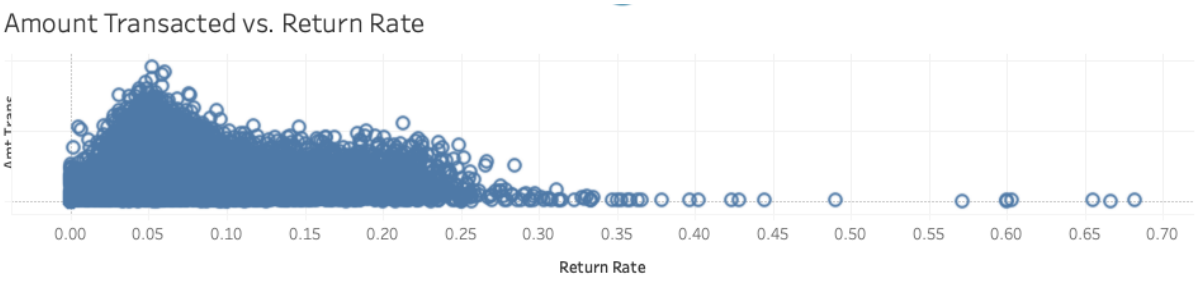


Figure 4.

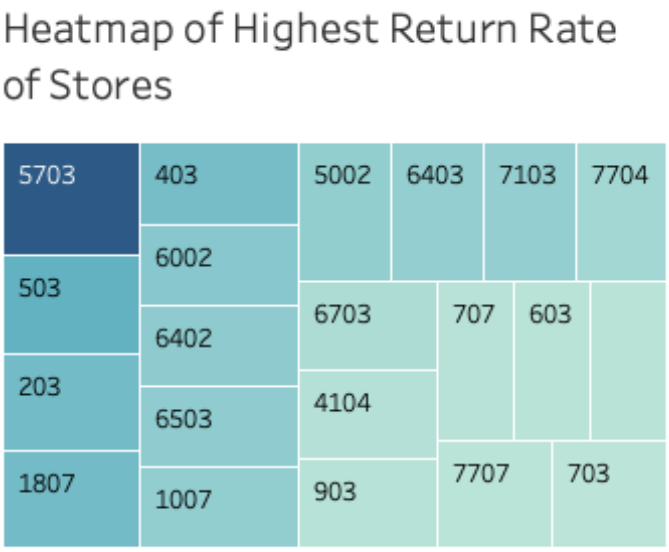

Heatmap of Highest Return Rate of Stores
5703
403
5002
6403
7103
7704
6002
503
6703
707
603
6402
203
4104
6503
1807
7707
703
1007
903

Figure 5.

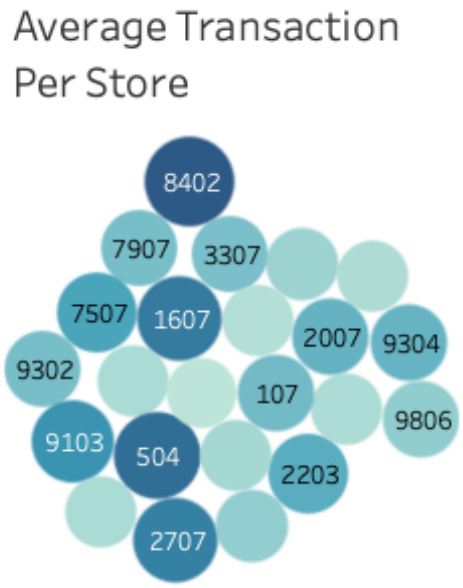
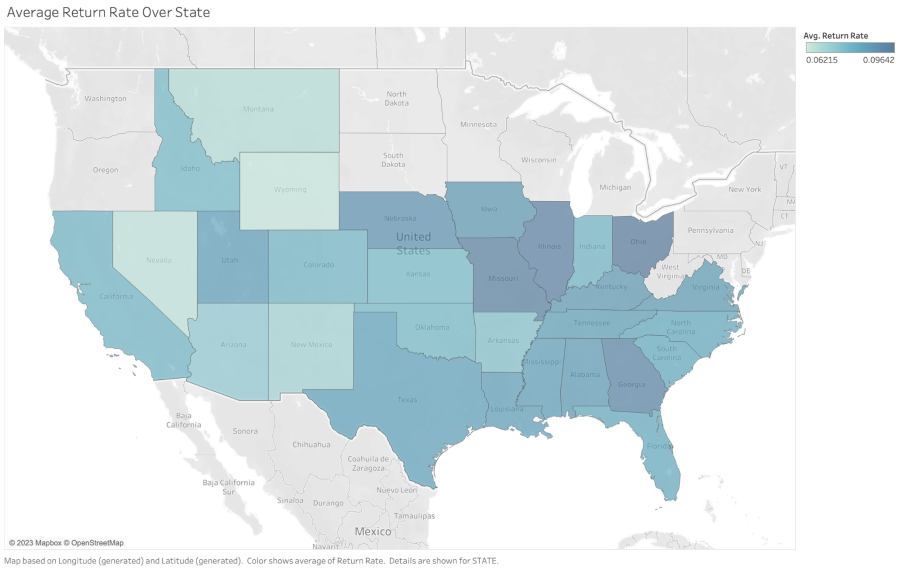

Average Transaction Per Store
8402
7907
3307
7507
1607
2007
9304
9302
107
9806
9103
504
2203
2707

Figure 6.



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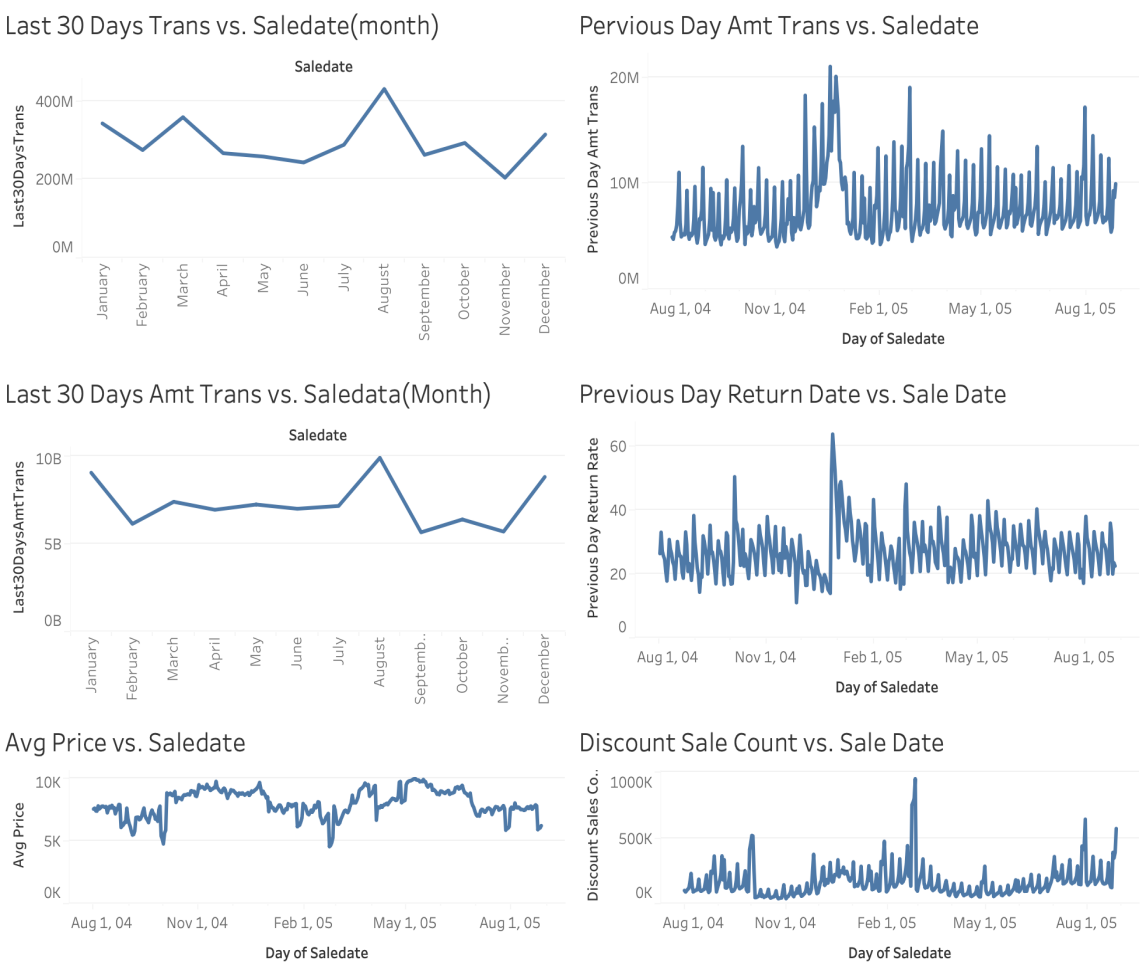

Figure 8.

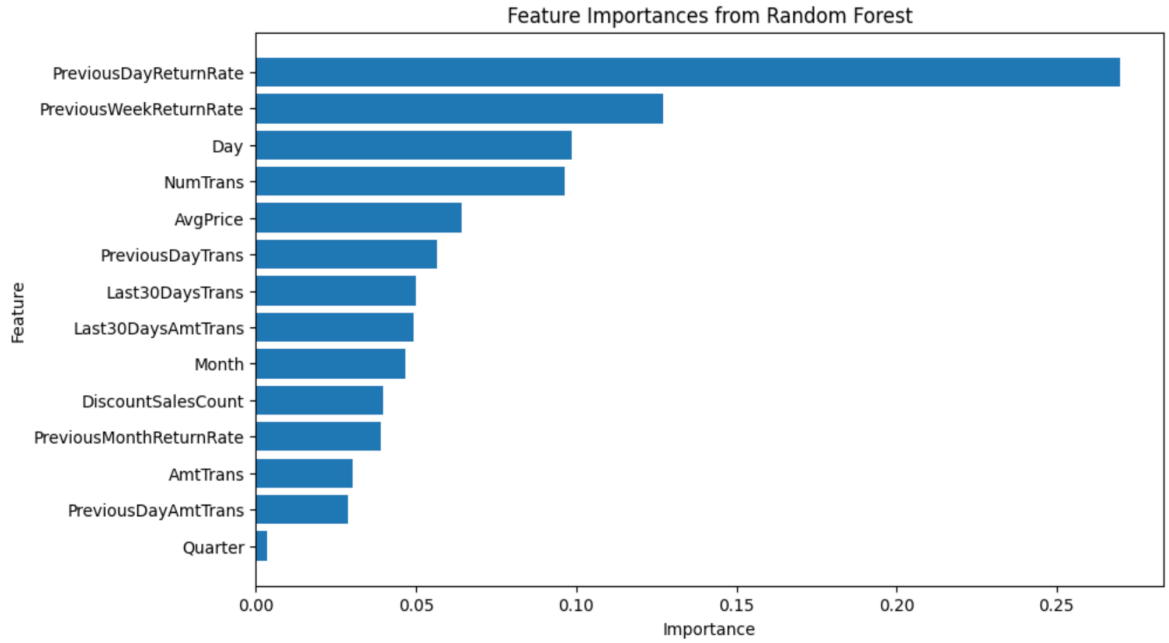

Figure 9.

Description	Description
Improvement in Return Rate	0.0005
Average Return Value	25
Number of Full-time Employees	4
Annual Salary per Employee	120000
Project Duration in Days	365
Computing Hours	365
Cost of Cloud Resources per Hour	0.1
Total Salary Cost	480000
Total Computing Cost	36.5
Total Costs	480036.5
ROI	210.078972140677