

Optimizing Coffee Shop Operations: A Data-Driven Approach to Understanding Sales Trends

Tarane Javaherpour and Edgar Rosales

Shiley-Marcos School of Engineering, University of San Diego

Exploratory Data Analysis (EDA) and Data Quality Assessment

1. Introduction

This section provides an in-depth analysis of the coffee shop transactional dataset, covering the exploratory data analysis (EDA) steps and the assessment of data quality. The dataset spans from January to June 2023, with variables related to transaction date, transaction quantity, and unit price. The goal is to understand patterns in the data, identify any data quality issues, and assess its suitability for forecasting future coffee shop sales.

2. Data Preparation and Cleaning

a. Date Conversion: To facilitate analysis, the `transaction_date` variable was converted from a character string to the Date format using `lubridate::mdy()`. This step ensured that the dates were correctly recognized and enabled time-based aggregation (weekly and daily sales).

b. Aggregation: The sales data were aggregated at two time levels:

- **Weekly Sales:** Sales were aggregated into weekly totals by using the `floor_date()` function to group by week.
- **Daily Sales:** Sales were also aggregated into daily totals by directly grouping by `transaction_date`.

c. Handling Missing Values: There were no missing or invalid dates in the dataset. Each transaction had a valid `transaction_date`, ensuring the integrity of time-series analysis.

d. Outliers: Outliers were identified in both the weekly and daily datasets, particularly in extreme sales values. For example, certain days displayed spikes in sales, likely due to specific promotions or customer behavior. While these outliers were not removed during the initial exploration, their impact was mitigated through smoothing techniques (e.g., moving averages).

3. Exploratory Data Analysis (EDA)

a. Sales Trends: We analyzed both weekly and daily sales data, observing an overall upward trend in sales from January to June 2023. A key finding was that sales increased steadily, particularly in the second quarter of the year, suggesting positive business growth or increased customer demand.

b. Weekly Sales Trend: The weekly sales plot shows a consistent increase in sales from January to June, with notable spikes in April and May. The 3-week moving average smooths out short-term fluctuations and highlights the underlying upward trend, indicating that the coffee

shop is experiencing growing demand. The plot and moving average together offer insights into business performance over time.

c. Daily Sales Trend: The daily sales plot revealed more volatility compared to the weekly data, with sharp fluctuations occurring from day to day. Despite this variability, a general upward trend emerges, particularly towards the end of the period. The 7-day moving average smooths out the daily fluctuations, providing a clearer picture of sales growth.

d. Seasonality and Trends: Due to the short six-month dataset, we were unable to detect clear seasonal patterns. However, the increasing trend across both daily and weekly aggregations suggests that the business is gaining traction. To better understand seasonality, data spanning over a year would be required.

e. Smoothing: To address the variability in daily sales, we applied a 7-day moving average to the daily data, and a 3-week moving average to the weekly data. These transformations helped smooth out extreme fluctuations and provided a clearer view of the underlying sales trends.

4. Data Quality Assessment

a. Completeness: The dataset is complete with no missing values in key variables (e.g., `transaction_date`, `transaction_qty`, `unit_price`). There were no missing records or discrepancies found during the data preparation process.

b. Consistency: The data is consistent across the variables. The `unit_price` variable, for example, aligns with expected price ranges based on product categories. No anomalies were found in the transactional data that would suggest inconsistency in data recording.

c. Transformation Needs: While the data is generally well-structured, smoothing techniques were applied to both daily and weekly sales to reduce noise and improve trend visibility. No further transformations were required at this stage, although future analyses might benefit from applying logarithmic transformations to stabilize variance if the data exhibits skewness.

d. Outliers and Extreme Values: Outliers in the sales data were observed, especially in daily sales. These outliers likely correspond to specific high-demand days or events. While they were not removed, smoothing techniques were applied to minimize their impact on the analysis. Further analysis could consider the removal or adjustment of extreme values based on business knowledge or statistical methods.

5. Conclusion and Next Steps

This section of the report has provided an overview of the exploratory data analysis and data quality assessment for the coffee shop dataset. The data has shown consistent growth in sales over the observed period, and the moving averages have helped highlight the trend by smoothing short-term fluctuations. However, further exploration with additional data, especially spanning over a year, would be beneficial to capture seasonal patterns and provide a more robust forecast for business planning. Future work will involve examining the effects of external

factors like promotions or local events on sales, and applying advanced forecasting methods based on the cleaned and prepared data.