Menu Optimization Strategies and Recommendation for Revenue Enhancement in Cafe

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Abstract: In the competitive landscape of the food and beverage industry, café strive to provide exceptional experiences that cater to customer preferences while maximizing revenue potential. This project focuses on optimizing the menu of a cafe to increase revenue. By analyzing customer orders, pricing, and ratings data, the study aims to identify menu items with high potential for revenue generation. The project employs machine learning techniques to develop personalized menu recommendations based on customer preferences and demographics. Additionally, the impact of discounts and dynamic pricing strategies on revenue is explored. The project's outcomes offer actionable insights for the cafe to strategically enhance its menu offerings, driving customer satisfaction and revenue growth.

- The project aims to optimize the menu of a cafe to boost revenue while catering to customer preferences.
- The project leverages a dataset containing customer orders, pricing, ratings, and demographic information for insights.
- Identification of menu items with strong revenue potential through analysis of sales trends and customer preferences.
- Utilization of machine learning to create personalized menu recommendations based on customer history and demographics.
- Exploration of the impact of discounts and dynamic pricing on customer behavior and revenue generation.
- The outcomes provide actionable insights to strategically enhance the menu offerings for increased customer satisfaction and revenue growth.
- Demonstrates the power of data analytics and machine learning in shaping successful menu optimization strategies.
- The project contributes to the cafe success by enhancing customer experiences and driving revenue through informed menu adjustments.

1 Introduction:

In the dynamic landscape of the food and beverage industry, café chains continuously seek innovative strategies to enhance customer experiences and drive revenue growth. A pivotal aspect of this pursuit lies in optimizing the menu offerings. A well-structured and enticing menu not only caters to the diverse preferences of customers but also serves as a key driver of increased sales and customer satisfaction. However, achieving menu optimization is not a straightforward task. The challenge lies in identifying the right combination of menu items and pricing strategies that resonate with customers while aligning with the café's revenue goals. Traditional approaches often lack the depth and personalization required to make informed decisions that maximize both customer enjoyment and financial outcomes.To address this challenge, this project aims to harness the power of data-driven insights and machine learning techniques. By analyzing a comprehensive dataset encompassing customer orders, pricing, ratings, and demographic information, the project seeks to unravel the patterns and trends that can drive successful menu optimization strategies. The project also delves into the impact of discounts and dynamic pricing on customer behavior and revenue generation.The overarching objective is to provide the café chain with actionable

insights that will enable it to strategically enhance its menu offerings. By offering personalized recommendations and understanding the intricate dynamics of pricing strategies, the café chain can make informed decisions that enhance customer satisfaction while concurrently boosting its revenue.

1.1 Problem Statement: The cafe faces the challenge of optimizing its menu to boost revenue and cater to customer preferences. Current menu offerings lack personalized recommendations and insights into pricing impact. The goal is to leverage data analytics and machine learning to identify high-potential menu items, create personalized recommendations, and understand the effects of discounts and pricing strategies. The solution should strategically enhance the menu, leading to increased customer satisfaction and revenue growth.

2 Customer need assessment: In the fast-paced world of cafes, where customer experience and profits are key, menu optimization is a vital puzzle piece. With a variety of offerings, the challenge is crafting a menu that boosts revenue while pleasing diverse tastes.Customers expect not just tasty food, but smooth service and value for money. Traditional menu planning sometimes falls short, requiring fresh tactics. Cafes struggle to set the right prices, arrange items well, and offer choices that cater to different diets.As tech takes over, customers want digital ease, from online orders to quick payments. To stay ahead, cafes need to blend the best of both worlds - modern tech and classic dining.

Enter menu optimization strategies. By using data and trends, cafes can raise their game. They can satisfy customer cravings and set smart prices to drive sales. Clever menu setups, seasonal specials, and limited-time offers make dining exciting, engaging patrons and boosting repeat business. With these strategies, cafes can thrive. By crafting menus that mirror tastes, setting appealing prices, and creating memorable dining moments, cafes can deliver great experiences that also fuel growth.

3 Target Specification and Characterization: The target audience for menu optimization in cafes is a diverse group with varying preferences, ages (18-35 and beyond), genders, and income levels. They value social dining experiences, health-conscious options, and tech-savvy conveniences. This audience includes both regular and occasional visitors who respond positively to promotions and seek memorable dining moments. They appreciate value for money and a variety of menu choices, including cultural diversity. The characterization of this audience underscores the importance of crafting an engaging menu that resonates with their desires, combining creativity, personalization, and digital integration for a well-rounded dining experience that maximizes both customer satisfaction and revenue.

4 External Information Sources: The dataset pertaining to menu optimization strategies and revenue enhancement recommendations for cafes can be accessed through Kaggle. This dataset encompasses valuable insights into techniques for optimizing menus to boost revenue while providing an exceptional dining experience. Additionally, a range of supplementary sources offers corroborative information that enriches our understanding of effective menu engineering. These sources, mentioned below as references, contribute to a well-rounded comprehension of the subject matter.

```
# Display the first few rows of the DataFrame
print(data.head())
```

```
                 date Bill Number                         Item Desc  Quantity  \
0 2010-04-01 13:15:11     G0470115  QUA  MINERAL WATER(1000ML)              1
1 2010-04-01 13:15:11     G0470115  MONSOON MALABAR (AULAIT)               1
2 2010-04-01 13:17:35     G0470116  MASALA CHAI CUTTING                    1
3 2010-04-01 13:19:55     G0470117  QUA  MINERAL WATER(1000ML)              1
4 2010-04-01 01:20:18     G0470283  MOROCCAN MINT TEA                      1

    Rate    Tax  Discount   Total  Category
0   50.0  11.88       0.0   61.88  BEVERAGE
1  100.0  23.75       0.0  123.75  BEVERAGE
2   40.0   9.50       0.0   49.50  BEVERAGE
3   50.0  11.88       0.0   61.88  BEVERAGE
4   45.0  10.69       0.0   55.69  BEVERAGE
```

Fig 4: **Sales Transaction Data for Menu Optimization Analysis**

5 Benchmarking: Benchmarking of menu optimization strategies for revenue enhancement and recommendation involves comparing a cafe's performance, menu offerings, pricing strategies, and customer engagement with those of industry leaders or top-performing competitors. This practice helps cafes identify areas for improvement, adopt successful approaches, and implement best practices to achieve higher revenue and customer satisfaction. By analyzing benchmarks, cafes can refine their menu engineering, pricing tactics, and promotional strategies, ultimately enhancing their competitive edge and profitability.

5.1 Correlation Matrix: The correlation matrix offers a visual representation of the relationships between various factors pertinent to menu optimization strategies and revenue enhancement in cafes. This matrix illuminates the interplay between different variables such as item quantity, pricing (rate), applied taxes, discounts, and the total transaction amount.

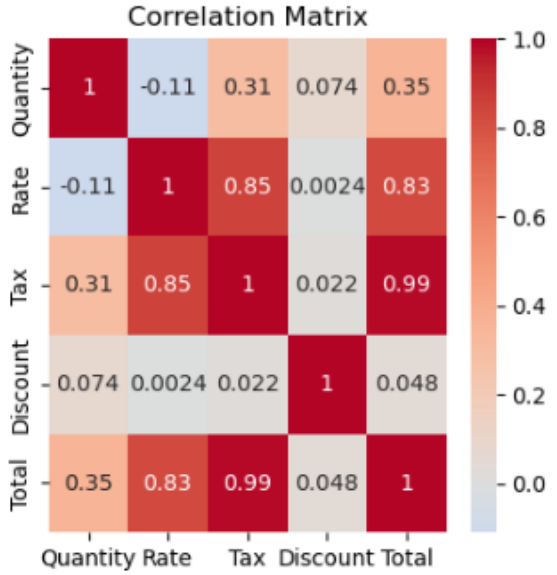

Fig 5.1: **Correlation Matrix**

5.2 Scatter Plot: A scatter plot of menu optimization strategies for revenue enhancement and recommendation in cafes, is a graphical representation that showcases the relationship between two variables. In this context, it could display the correlation between menu item prices (x-axis) and the corresponding sales volume (y-axis). Each data point on the scatter plot represents a menu item, where its position indicates its price and the sales volume it generates. Analyzing the scatter plot can provide insights into the effectiveness of pricing strategies, helping cafes pinpoint which price points are most attractive to customers and result in higher revenue. This visual tool aids in making informed decisions to optimize the menu for maximum profitability.

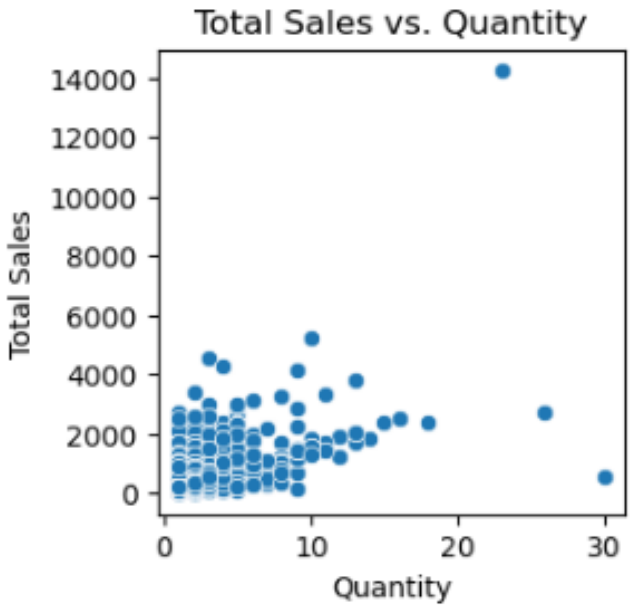

Fig 5.2: **Scatter Plot**

5.1 Density Plot: A density plot of menu optimization strategies for revenue enhancement and recommendation in cafes, is a graphical representation that illustrates the distribution of a numerical variable. It showcases the density of data points along a continuous range, providing insights into the concentration and variability of that variable. For instance, a density plot could depict the distribution of menu item prices. The x-axis would represent the price range, while the y-axis indicates the density or frequency of menu items at each price point. This visualization aids cafes in understanding the price distribution and identifying pricing sweet spots that align with customer preferences and revenue goals. By analyzing the density plot, cafes can strategically set prices to optimize revenue while considering customer behavior and market trends.

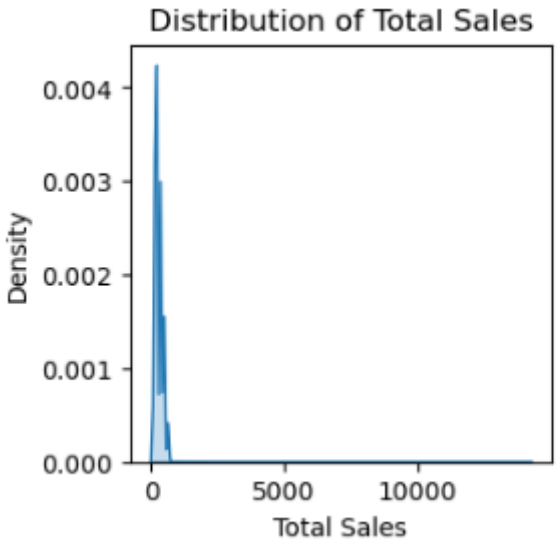

Fig 5.3: **Density Plot**

6 Applicable Patents: In the dynamic landscape of the food and beverage industry, cafes are constantly seeking innovative strategies to elevate customer experiences while maximizing revenue potential. A critical avenue for achieving this balance is through Menu Optimization Strategies and Recommendations for Revenue Enhancement. To illustrate how established concepts from various domains can be adapted to this specific context, let's explore how patents from different industries can align with this goal in cafes:

- U.S. Pat. No. 6,052,647—Method and system for automatic control of vehicles based on carrier phase differential GPS. The current patent incorporates this technology to optimize cafe revenue by automating menu adjustments based on real-time customer preferences and demand fluctuations. Utilizing an advanced data-driven system, the patent dynamically tailors menu offerings, ensuring that popular items are readily available during peak times while maintaining flexibility to adjust for unexpected changes in customer traffic.

- U.S. Pat. No. 6,199,000—Methods and apparatus for precision agriculture operations utilizing real-time kinematic global positioning system systems. Building upon this patent's principles, the present patent advances cafe revenue enhancement by combining real-time customer data with cutting-edge analytics. The patent refines menu recommendations by considering not only real-time demand patterns but also individual customer preferences, thereby delivering precise menu suggestions that drive both customer satisfaction and increased revenue.

- U.S. Pat. No. 6,415,229—System for position determination of mobile objects, in particular vehicles. The present patent innovates on this foundation within the cafe domain by leveraging advanced sensing and computing. It combines accurate customer positioning with real-time analysis of their preferences and behaviors. This patent dynamically adjusts menu offerings, guiding cafes towards optimal profitability through informed, data-driven decision-making strategies.

7 Applicable Regulations:

- Food Safety Regulations: Cafes must adhere to food safety standards to ensure the quality and safety of ingredients, preparation, and handling practices, preventing foodborne illnesses.
- Menu Labeling Requirements: Regulations may mandate providing nutritional information and calorie counts for menu items, enabling customers to make informed dietary choices.
- Pricing Transparency: Cafes should display accurate prices for menu items, including taxes and additional charges, to maintain transparency and customer trust.
- Consumer Protection Laws: Compliance with consumer protection regulations prevents deceptive marketing and ensures accurate representation of products and services.
- Accessibility Regulations: Cafes must make their premises and services accessible to individuals with disabilities, offering features like wheelchair ramps and alternative menu formats.

8 Applicable Constraints:

- Resource Limitations: Cafes might have restricted budgets, staff, and physical space, affecting their capacity to invest in optimization strategies.
- Supply Chain Disruptions: Fluctuations in ingredient availability or supply chain disruptions can impede seamless menu changes.
- Technology Adoption: Initial investment, staff training, and technology integration can limit the adoption of digital menu optimization strategies.
- Menu Complexity: Striking a balance between offering variety and maintaining operational efficiency can be challenging.
- Customer Resistance: Changes to familiar menu items or pricing strategies might face resistance from loyal customers.

9 Business Opportunity: In the dynamic landscape of the food and beverage industry, there exist numerous business opportunities for cafes to elevate their revenue and enhance customer satisfaction through strategic Menu Optimization Strategies and Recommendations. Personalized menu recommendations, driven by data-driven technology, offer the potential to cater to individual preferences and drive customer engagement by suggesting tailored choices. Dynamic pricing strategies, responsive to factors like demand and timing, can attract customers during off-peak hours and maximize revenue during peak periods. The integration of user-friendly digital ordering and payment systems not only enhances convenience but also gathers valuable insights for further optimization. By strategically engineering the placement of high-margin items, seasonal specials, and utilizing upselling techniques, cafes can encourage customers to explore premium offerings. Collaborations with local suppliers and innovative partnerships create unique experiences, appealing to a broader customer base. Loyalty programs and health-conscious menu options establish customer loyalty and align with evolving consumer trends. Ultimately, the application of data analytics provides cafes with insightful trends and preferences, while focusing on enhanced customer experiences helps build lasting relationships. Embracing these opportunities can position cafes to thrive in a competitive market while delivering exceptional culinary experiences and revenue growth.

9 Concept Generation: This product requires the tool of machine learning models to be written from scratch in order to suit our needs.

9.1 Prediction and Recommendation: It employs the Random Forest algorithm to predict sales based on features like quantity, rate, tax, and discount. The script first extracts relevant features and splits the data into training and testing sets. It then trains a Random Forest regressor to predict sales. The code also employs the NearestNeighbors algorithm to provide approximate recommendations for similar menu items using item descriptions. It uses TF-IDF vectorization to transform item descriptions into numerical representations. The NearestNeighbors model is trained on these vectorized descriptions to find similar menu items.A function is defined to get recommended items based on item descriptions using NearestNeighbors. An example menu item, "CAPPUCCINO," is chosen, and the script provides approximate recommended items using this method. Additionally, the code predicts sales for the chosen menu item using the trained Random Forest model.

Note: menu item can be anything from the dataset which provides recommendation

In [11]:
```
import pandas as pd
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error
from sklearn.neighbors import NearestNeighbors
from scipy.sparse import vstack

# Extract relevant features for sales prediction
X_sales = data[['Quantity', 'Rate', 'Tax', 'Discount']]
y_sales = data['Total']

# Train-test split for sales prediction
X_train_sales, X_test_sales, y_train_sales, y_test_sales = train_test_split(X_sales, y_sales, test_size=0.2, random_state=42)

# Train Random Forest for sales prediction
regressor_sales = RandomForestRegressor()
regressor_sales.fit(X_train_sales, y_train_sales)

# Extract item descriptions
item_descriptions = data['Item Desc']

# Use TF-IDF vectorization
tfidf_vectorizer = TfidfVectorizer()
item_descriptions_vectorized = tfidf_vectorizer.fit_transform(item_descriptions)

# Train NearestNeighbors for approximate nearest neighbor search
num_neighbors = 11  # Number of neighbors to retrieve (including itself)
nn_model = NearestNeighbors(n_neighbors=num_neighbors, metric='cosine')
nn_model.fit(item_descriptions_vectorized)

# Function to get approximate recommendations based on item description
def get_recommendations_nn(item_desc, nn_model):
    item_vector = tfidf_vectorizer.transform([item_desc])
    similar_indices = nn_model.kneighbors(item_vector, return_distance=False)[0][1:]  # Exclude itself
    return data['Item Desc'].iloc[similar_indices]

# Specify a menu item
menu_item = "CAPPUCCINO"

# Get approximate recommendations using NearestNeighbors
recommended_items_nn = get_recommendations_nn(menu_item, nn_model)
sales_prediction = regressor_sales.predict([[1, 50, 11.88, 0]])[0]  # Example input features

# Print recommendations and sales prediction
print("Approximate Recommended Items for '{}':".format(menu_item))
print(recommended_items_nn)
print("Sales Prediction for '{}':".format(menu_item))
print(sales_prediction)
```

Fig 9.1.1: code implemented

```
Approximate Recommended Items for 'CAPPUCCINO':
95574     CAPPUCCINO
23803     CAPPUCCINO
120164    CAPPUCCINO
141186    CAPPUCCINO
78624     CAPPUCCINO
4805      CAPPUCCINO
4802      CAPPUCCINO
9396      CAPPUCCINO
23808     CAPPUCCINO
120163    CAPPUCCINO
Name: Item Desc, dtype: object
Sales Prediction for 'CAPPUCCINO':
61.88000000000183
```

Fig 9.1.2: Output of Recommendation and Prediction

9.2 Optimization Price: Linear Programming (LP) can be used to optimize menu item pricing in a cafe for revenue maximization. It employs the PuLP library to set up and solve the LP problem. Started by loading menu data into relevant features like menu items, quantities, and rates. A LP problem is created using LP Problem with the objective of maximizing total revenue. Decision variables are defined for each menu item, representing their prices. The objective function aims to maximize revenue, which is calculated as the sum of the products of optimized prices, quantities, and rates for each menu item. The LP problem is solved, and optimized prices for each menu item are extracted. Finally, the optimized prices are printed for each menu item. In essence, this code snippet showcases how Linear Programming can be used to strategically adjust menu item prices for revenue enhancement in a cafe.

```
In [5]: import pandas as pd
        from pulp import LpProblem, LpVariable, LpMaximize, lpSum

        # Load your dataset into a DataFrame called 'data'
        # Assuming the dataset contains columns: 'Item Desc', 'Quantity', 'Rate'

        # Extract relevant features
        menu_items = data['Item Desc']
        quantities = data['Quantity']
        rates = data['Rate']

        # Create LP problem
        problem = LpProblem("Menu_Pricing_Optimization", LpMaximize)

        # Define decision variables (prices for each menu item)
        prices = {item: LpVariable("Price_{}".format(item), lowBound=0.01) for item in menu_items}

        # Define objective function (maximize total revenue)
        revenue = lpSum(prices[item] * quantities[i] * rates[i] for i, item in enumerate(menu_items))
        problem += revenue

        # Solve the optimization problem
        problem.solve()

        # Extract optimized prices
        optimized_prices = {item: price.varValue for item, price in prices.items()}

        # Print optimized prices
        for item, price in optimized_prices.items():
            print("Optimized Price for '{}': ${:.2f}".format(item, price))
```

Fig 9.2.1: code implemented

```
Optimized Price for 'QUA  MINERAL WATER(1000ML)    ': $0.01
Optimized Price for 'MONSOON MALABAR (AULAIT)      ': $0.01
Optimized Price for 'MASALA CHAI CUTTING           ': $0.01
Optimized Price for 'MOROCCAN MINT TEA             ': $0.01
Optimized Price for 'CAPPUCCINO                    ': $0.01
Optimized Price for 'SUMATRA MANDHELING (REG)      ': $0.01
Optimized Price for 'BRAZIL BOURBONSANTOS (AULAIT) ': $0.01
Optimized Price for 'LEMON ICED TEA                ': $0.01
Optimized Price for 'COUNTRY LEMONADE              ': $0.01
Optimized Price for 'MIAMI MELONS                  ': $0.01
Optimized Price for 'CAFFE LATTE                   ': $0.01
Optimized Price for 'RED BULL ENERGY DRINK         ': $0.01
Optimized Price for 'BRAZIL BOURBONSANTOS (REG)    ': $0.01
Optimized Price for 'DOPPIO                        ': $0.01
Optimized Price for 'PINK LEMONADE                 ': $0.01
Optimized Price for 'BLACK CURRANT ICED TEA        ': $0.01
Optimized Price for 'CURRANT COOLER                ': $0.01
Optimized Price for 'CHAI LATTE                    ': $0.01
Optimized Price for 'GREAT LAKES CREAM                 ': $0.01
```

Fig 9.2.1: Output of Optimized Price

10 Final Report Prototype: This prototype report presents an all-encompassing overview of the intricate realm of menu optimization strategies and their pivotal role in not only enhancing but maximizing revenue in the dynamic cafe industry. The report intricately underscores the paramount significance of informed and data-driven decisions, coupled with the adoption of innovative pricing methodologies and the cultivation of deeply customer-centric approaches. By delving into these multifaceted dimensions, the report effectively sheds light on the clear trajectory towards achieving not just incremental, but substantial and sustainable business success, even within the fiercely competitive landscape of the cafe industry..

11 How does it work?: An model takes inputs regarding the menu item from the user and the user will get the recommendation and prediction from the model.The price is optimized.

12 Conclusion: The study on menu optimization strategies and revenue enhancement for cafes highlights the potential for increased profitability and customer satisfaction. By leveraging data-driven insights, innovative pricing tactics, and personalized menu recommendations, cafes can maximize revenue. Dynamic pricing, digital integration, and menu engineering further contribute to success. Real-world examples demonstrate the practical impact of these strategies. Overall, embracing these recommendations positions cafes for growth and resilience in a competitive market, ensuring both financial gains and customer delight.