Project Title: Market Basket Insights: Unveiling Customer Behavior through Market Basket Analysis
DOCUMENTATION

Phase 1: Problem Definition and Design Thinking

Problem Definition:

The challenge at hand involves implementing an insightful Market Basket Analysis using the Apriori algorithm, aiming to uncover hidden patterns and associations within a provided dataset. The primary objective is to comprehend customer purchasing behavior and identify potential cross-selling opportunities for a retail business. This unsupervised learning technique of Association Rules will be employed to explore dependencies among different items in the dataset, providing valuable insights for strategic decision-making.

What I Understood:

1. Objective: The retailer desires to offer customers personalized suggestions for item sets that are likely to be purchased, thereby enhancing customer engagement and experience.

2. Dataset: The provided dataset encompasses transactional data, offering a comprehensive view of all transactions over a given period.

3. Association Rules: The focus is on utilizing Association Rules, specifically the Apriori algorithm, to uncover frequent patterns in the transaction database. This facilitates understanding which items customers frequently purchase together, revealing relationships between different products.

Design Thinking:

Empathize:

- Initiate by empathizing with retail business stakeholders to grasp their challenges, aspirations, and expectations regarding market basket insights.

Define:

- Clearly define project objectives, centering on improving the accuracy of market basket analysis, minimizing false positives/negatives, and enhancing the overall user experience.

Ideate:

- Explore various algorithms and techniques, considering the applicability and feasibility of NLP and ML approaches for market basket analysis.

Prototype:

- Develop a basic prototype of the market basket analysis system based on initial research, aiming to build a proof of concept for subsequent development.

Test:

- Subject the prototype to rigorous testing using diverse datasets, simulating real-world retail scenarios. Gather feedback to refine the system's performance iteratively.

In this design thinking approach, it serves as the initial framework for tackling the market basket insights challenge, guided by user empathy, clear project objectives, creative ideation, and an iterative development process.

Phase 2: Innovation

In this crucial phase, we embark on an iterative innovation process, drawing inspiration from a structured four-step approach:

1. Idea:

Collection of Innovation Potentials:

- Engage in thorough research to identify potential areas for innovation within market basket analysis.
- Consider emerging technologies, industry trends, and feedback from stakeholders to pinpoint opportunities.
- Collaborate with cross-functional teams to gather diverse insights and perspectives.

Derivation of Ideas:

- Brainstorm and derive specific ideas for advancing association analysis techniques and visualization tools.
- Foster a collaborative environment to encourage diverse perspectives and creative thinking.
- Prioritize ideas based on their potential impact, feasibility, and alignment with business goals.

Evaluation and Release of Ideas:

- Implement a robust evaluation process to assess the feasibility, impact, and alignment with project objectives for each idea.
- Leverage criteria such as cost-effectiveness, technical feasibility, and strategic fit.
- Prioritize and release the most promising ideas, considering short-term and long-term goals.

2. Concept:

Extensive Analysis:

- Conduct an in-depth analysis of the chosen ideas, exploring their technical feasibility and alignment with user requirements.
- Consider the scalability, adaptability, and integration aspects of advanced association analysis techniques and visualization tools.
- Perform a risk analysis to anticipate and mitigate potential challenges.

Derivation of Concepts for the Solution:

- Develop detailed concepts outlining how the chosen ideas will be integrated into the existing market basket analysis framework.
- Ensure the concepts align with the identified needs and objectives from the Idea phase.
- Collaborate with domain experts and end-users to refine and validate the proposed concepts.

Implementation and Marketing:

- Formulate a comprehensive plan for the implementation of the chosen concepts, detailing the development roadmap.
- Simultaneously, strategize marketing approaches to communicate the innovative features to stakeholders.
- Develop a marketing strategy that includes communication channels, target audiences, and key messages.

3. Solution:

Development and Testing:

- Initiate the development phase, translating the chosen concepts into tangible solutions.
- Rigorously test these solutions with real or simulated datasets, addressing any issues and optimizing performance.
- Adopt an agile development methodology to accommodate evolving requirements.

To the Finished Product:

- Refine and finalize the solutions, ensuring they meet the quality standards and objectives set during the Idea and Concept phases.
- Consider user feedback from prototype testing to fine-tune the features and functionalities.
- Document the development process and create user manuals for seamless adoption.

Scalability and Future-Proofing:

- Assess the scalability of the developed solutions to accommodate growing data volumes and user demands.
- Implement measures for future-proofing the solutions by considering emerging technologies and industry trends.

4. Market:

Arouse and Fulfill Customer Needs:

- Implement the solutions in procurement, production, and logistics to ensure a seamless integration into the existing retail business processes.
- Align marketing and sales strategies to effectively communicate the enhanced market basket analysis capabilities to end-users.
- Develop training programs and support systems for users to maximize the benefits of the innovations.

Iterative Enhancement:

- Continuously gather feedback from users and stakeholders as the solutions are deployed in real-world scenarios.
- Iterate on the solutions based on market feedback, striving for continuous improvement.
- Consider the implementation of user-driven features and enhancements.

Monitoring and Analytics:

- Implement monitoring mechanisms to track the performance of the innovations in real-time.
- Utilize analytics to derive actionable insights from user interactions, facilitating data-driven decision-making.
- Establish key performance indicators (KPIs) to measure the success and impact of the innovations.

By incorporating this structured innovation process, we aim not only to enhance market basket analysis with advanced techniques and visualization tools but also to ensure a dynamic and iterative approach that evolves in response to real-world usage and market dynamics.

Phase 3: Development Part 1

```
#This is a kaggle notebook.

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/kaggle/input/market-basket-analysis/Assignment-1_Data.xlsx
/kaggle/input/market-basket-analysis/Assignment-1_Data.csv
```

Market Basket Analysis Project

Overview

This notebook is part of a project focused on market basket analysis. We will begin by loading and preprocessing the dataset.

Dataset Information

The dataset is stored in the file `Assignment-1_Data.xlsx` located at `/kaggle/input/market-basket-analysis/`. It contains information related to market transactions.

Loading the Dataset

Let's start by loading the dataset into a DataFrame using pandas.

```
import pandas as pd

# Load the dataset
dataset_path = '/kaggle/input/market-basket-analysis/Assignment-1_Data.xlsx'
df = pd.read_excel(dataset_path)
```

Initial Exploration

We'll perform an initial exploration of the dataset to understand its structure and characteristics.

```
# Display basic information about the dataset
print("Number of rows and columns:", df.shape)
print("\nData Types and Missing Values:")
print(df.info())
```

```
print("\nFirst few rows of the dataset:")
print(df.head())
```

```
Number of rows and columns: (522064, 7)

Data Types and Missing Values:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 522064 entries, 0 to 522063
Data columns (total 7 columns):
 #   Column      Non-Null Count   Dtype
---  ------      --------------   -----
 0   BillNo      522064 non-null  object
 1   Itemname    520609 non-null  object
 2   Quantity    522064 non-null  int64
 3   Date        522064 non-null  datetime64[ns]
 4   Price       522064 non-null  float64
 5   CustomerID  388023 non-null  float64
 6   Country     522064 non-null  object
dtypes: datetime64[ns](1), float64(2), int64(1), object(3)
memory usage: 27.9+ MB
None

First few rows of the dataset:
   BillNo                                 Itemname  Quantity                 Date
\
0  536365   WHITE HANGING HEART T-LIGHT HOLDER         6 2010-12-01 08:26:00
1  536365                  WHITE METAL LANTERN         6 2010-12-01 08:26:00
2  536365       CREAM CUPID HEARTS COAT HANGER         8 2010-12-01 08:26:00
3  536365  KNITTED UNION FLAG HOT WATER BOTTLE         6 2010-12-01 08:26:00
4  536365       RED WOOLLY HOTTIE WHITE HEART.         6 2010-12-01 08:26:00

   Price  CustomerID         Country
0   2.55     17850.0  United Kingdom
1   3.39     17850.0  United Kingdom
2   2.75     17850.0  United Kingdom
3   3.39     17850.0  United Kingdom
4   3.39     17850.0  United Kingdom
```

Preprocessing

We'll preprocess the data to ensure it's ready for analysis.

```
#Check Missing Values
print("Missing Values:")
print(df.isnull().sum())

#Drop Rows with Missing Values
df.dropna(inplace=True)
```

```
Missing Values:
BillNo             0
Itemname        1455
Quantity           0
Date               0
Price              0
CustomerID    134041
Country            0
dtype: int64
```

```
# Convert dataframe into transaction data
transaction_data = df.groupby(['BillNo', 'Date'])['Itemname'].apply(lambda x:
', '.join(x)).reset_index()

#Drop Unnecessary Columns
columns_to_drop = ['BillNo', 'Date']
transaction_data.drop(columns=columns_to_drop, inplace=True)

# Save the transaction data to a CSV file
transaction_data_path = '/kaggle/working/transaction_data.csv'
transaction_data.to_csv(transaction_data_path, index=False)

# Display the first few rows of the transaction data
print("\nTransaction Data for Association Rule Mining:")
print(transaction_data.head())
transaction_data.shape
```

```
Transaction Data for Association Rule Mining:
                                            Itemname
0  WHITE HANGING HEART T-LIGHT HOLDER, WHITE META...
1  HAND WARMER UNION JACK, HAND WARMER RED POLKA DOT
2  ASSORTED COLOUR BIRD ORNAMENT, POPPY'S PLAYHOU...
3  JAM MAKING SET WITH JARS, RED COAT RACK PARIS ...
4                          BATH BUILDING BLOCK WORD

(18192, 1)
```

Phase 4: Development Part 2

Phase 4 starts from here

Formatting the transaction data in a suitable format for analysis

Developing the preprocessed data into analysis. Split the 'Itemname' column in `transaction_data` into individual items using `str.split(', '`,

expand=True).Concatenate the original DataFrame (transaction_data) with the items DataFrame (items_df) using pd.concat.Drop the original 'Itemname' column since individual items are now in separate columns.Display the resulting DataFrame.

```
# Split the 'Itemname' column into individual items
items_df = transaction_data['Itemname'].str.split(', ', expand=True)

# Concatenate the original DataFrame with the new items DataFrame
transaction_data = pd.concat([transaction_data, items_df], axis=1)

# Drop the original 'Itemname' column
transaction_data = transaction_data.drop('Itemname', axis=1)

# Display the resulting DataFrame
print(transaction_data.head())
```

```
                                  0                                1    \
0  WHITE HANGING HEART T-LIGHT HOLDER          WHITE METAL LANTERN
1              HAND WARMER UNION JACK    HAND WARMER RED POLKA DOT
2       ASSORTED COLOUR BIRD ORNAMENT    POPPY'S PLAYHOUSE BEDROOM
3            JAM MAKING SET WITH JARS  RED COAT RACK PARIS FASHION
4            BATH BUILDING BLOCK WORD                          None

                             2                                   3    \
0  CREAM CUPID HEARTS COAT HANGER  KNITTED UNION FLAG HOT WATER BOTTLE
1                            None                               None
2      POPPY'S PLAYHOUSE KITCHEN    FELTCRAFT PRINCESS CHARLOTTE DOLL
3  YELLOW COAT RACK PARIS FASHION         BLUE COAT RACK PARIS FASHION
4                            None                               None

                             4                                   5    \
0  RED WOOLLY HOTTIE WHITE HEART.        SET 7 BABUSHKA NESTING BOXES
1                            None                               None
2         IVORY KNITTED MUG COSY  BOX OF 6 ASSORTED COLOUR TEASPOONS
3                            None                               None
4                            None                               None

                               6                                   7    \
0  GLASS STAR FROSTED T-LIGHT HOLDER                            None
1                              None                            None
2       BOX OF VINTAGE JIGSAW BLOCKS  BOX OF VINTAGE ALPHABET BLOCKS
3                              None                            None
4                              None                            None

                       8                        9    ...   534   535   536
\
0                     None                     None  ...  None  None  None
1                     None                     None  ...  None  None  None
2  HOME BUILDING BLOCK WORD  LOVE BUILDING BLOCK WORD  ...  None  None  None
```

```
3                      None                      None  ...  None  None  None
4                      None                      None  ...  None  None  None

    537   538   539   540   541   542   543
0  None  None  None  None  None  None  None
1  None  None  None  None  None  None  None
2  None  None  None  None  None  None  None
3  None  None  None  None  None  None  None
4  None  None  None  None  None  None  None

[5 rows x 544 columns]
```

Association Rules - Data Mining

Converting Items to Boolean Columns

To prepare the data for association rule mining, we convert the items in the `transaction_data` DataFrame into boolean columns using one-hot encoding. This is achieved through the `pd.get_dummies` function, which creates a new DataFrame (`df_encoded`) with boolean columns representing the presence or absence of each item.

```
# Convert items to boolean columns
df_encoded = pd.get_dummies(transaction_data, prefix='', prefix_sep='').group
by(level=0, axis=1).max()

# Save the transaction data to a CSV file
df_encoded.to_csv('transaction_data_encoded.csv', index=False)
```

Association Rule Mining

We apply the Apriori algorithm to perform association rule mining on the encoded transaction data. The `min_support` parameter is set to 0.007 to filter out infrequent itemsets. The resulting frequent itemsets are then used to generate association rules based on a minimum confidence threshold of 0.5.Finally, we print the generated association rules.

```
# Load transaction data into a DataFrame
df_encoded = pd.read_csv('transaction_data_encoded.csv')

from mlxtend.frequent_patterns import apriori, association_rules

# Association Rule Mining
frequent_itemsets = apriori(df_encoded, min_support=0.007, use_colnames=True)
rules = association_rules(frequent_itemsets, metric="confidence", min_thresho
ld=0.5)

# Display information of the rules
print("Association Rules:")
print(rules.head())
```

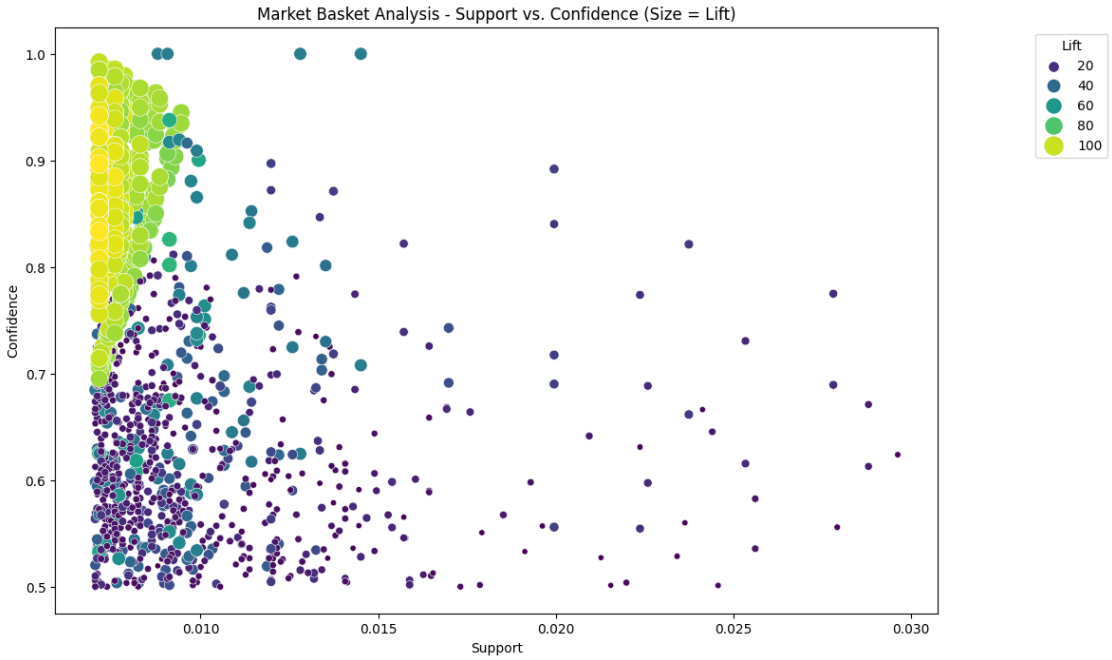
```
Association Rules:
                         antecedents                       consequents  \
0            (CHOCOLATE BOX RIBBONS)          (6 RIBBONS RUSTIC CHARM)
1  (60 CAKE CASES DOLLY GIRL DESIGN)  (PACK OF 72 RETROSPOT CAKE CASES)
2      (60 TEATIME FAIRY CAKE CASES)  (PACK OF 72 RETROSPOT CAKE CASES)
3   (ALARM CLOCK BAKELIKE CHOCOLATE)       (ALARM CLOCK BAKELIKE GREEN)
4   (ALARM CLOCK BAKELIKE CHOCOLATE)        (ALARM CLOCK BAKELIKE PINK)

   antecedent support  consequent support   support  confidence       lift  \
0            0.012368            0.039193  0.007036    0.568889  14.515044
1            0.018525            0.054529  0.010059    0.543027   9.958409
2            0.034631            0.054529  0.017315    0.500000   9.169355
3            0.017150            0.042931  0.011379    0.663462  15.454151
4            0.017150            0.032652  0.009125    0.532051  16.294742

   leverage  conviction  zhangs_metric
0  0.006551    2.228676       0.942766
1  0.009049    2.068984       0.916561
2  0.015427    1.890941       0.922902
3  0.010642    2.843862       0.951613
4  0.008565    2.067210       0.955009
```

Visualization

Visualizing Market Basket Analysis Results

We use matplotlib and seaborn libraries to create a scatterplot visualizing the results of the market basket analysis. The plot depicts the relationship between support, confidence, and lift for the generated association rules.

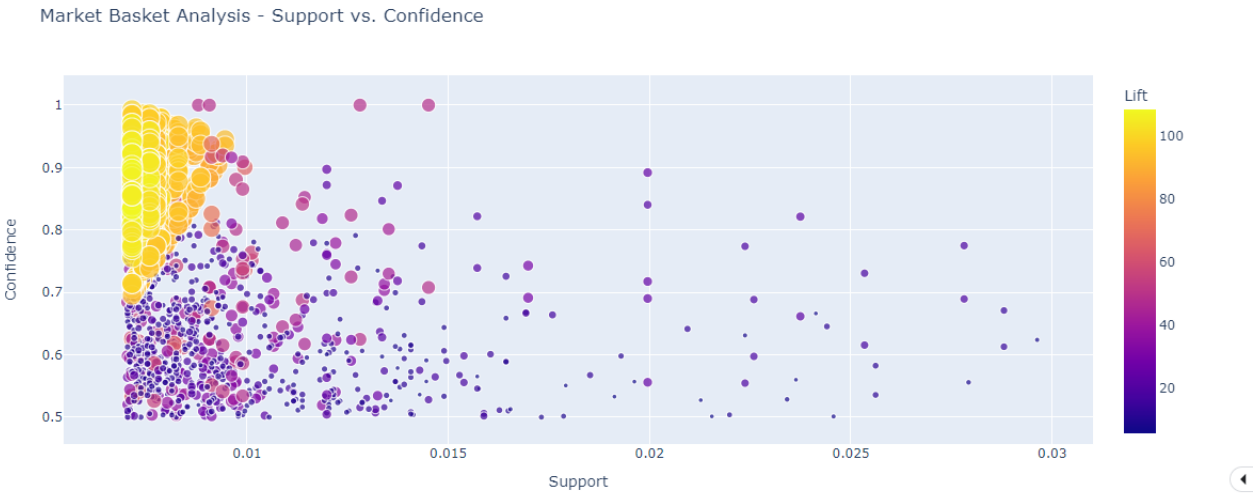
```
import matplotlib.pyplot as plt
import seaborn as sns

# Plot scatterplot for Support vs. Confidence
plt.figure(figsize=(12, 8))
sns.scatterplot(x="support", y="confidence", size="lift", data=rules, hue="li
ft", palette="viridis", sizes=(20, 200))
plt.title('Market Basket Analysis - Support vs. Confidence (Size = Lift)')
plt.xlabel('Support')
plt.ylabel('Confidence')
plt.legend(title='Lift', loc='upper right', bbox_to_anchor=(1.2, 1))
plt.show()
```



Interactive Market Basket Analysis Visualization

We leverage the Plotly Express library to create an interactive scatter plot visualizing the results of the market basket analysis. This plot provides an interactive exploration of the relationship between support, confidence, and lift for the generated association rules.

```
import plotly.express as px

# Convert frozensets to lists for serialization
rules['antecedents'] = rules['antecedents'].apply(list)
rules['consequents'] = rules['consequents'].apply(list)

# Create an interactive scatter plot using plotly express
fig = px.scatter(rules, x="support", y="confidence", size="lift",
                 color="lift", hover_name="consequents",
                 title='Market Basket Analysis - Support vs. Confidence',
                 labels={'support': 'Support', 'confidence': 'Confidence'})

# Customize the layout
fig.update_layout(
    xaxis_title='Support',
    yaxis_title='Confidence',
    coloraxis_colorbar_title='Lift',
    showlegend=True
)

# Show the interactive plot
fig.show()
```

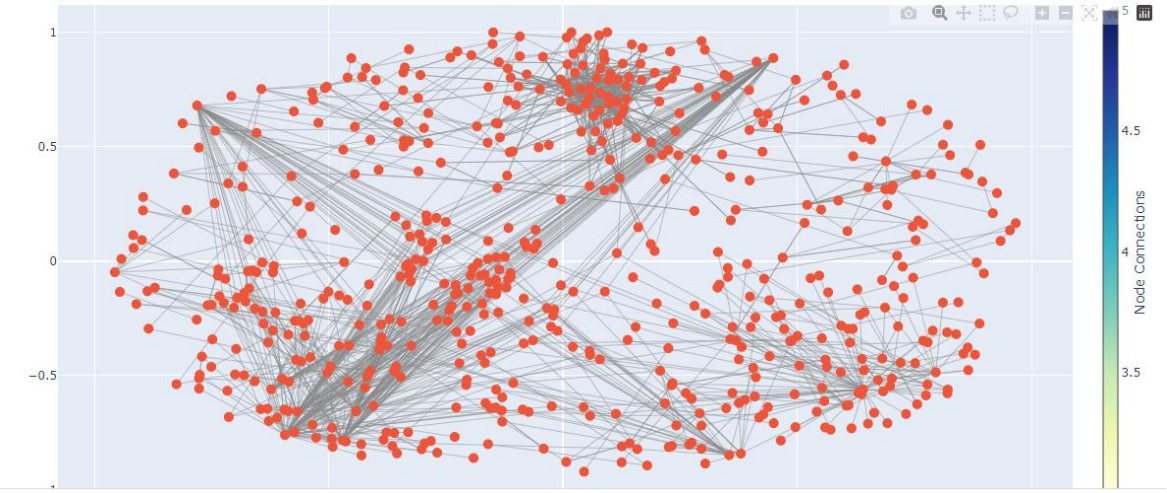


Interactive Network Visualization for Association Rules

We utilize the NetworkX and Plotly libraries to create an interactive network graph visualizing the association rules. This graph represents relationships between antecedent and consequent items, showcasing support as edge weights.

```
import networkx as nx
import matplotlib.pyplot as plt
import plotly.graph_objects as go

# Create a directed graph
G = nx.DiGraph()

# Add nodes and edges from association rules
for idx, row in rules.iterrows():
    G.add_node(tuple(row['antecedents']), color='skyblue')
    G.add_node(tuple(row['consequents']), color='orange')
    G.add_edge(tuple(row['antecedents']), tuple(row['consequents']), weight=r
ow['support'])

# Set node positions using a spring layout
pos = nx.spring_layout(G)

# Create an interactive plot using plotly
edge_x = []
edge_y = []
for edge in G.edges(data=True):
    x0, y0 = pos[edge[0]]
    x1, y1 = pos[edge[1]]
    edge_x.append(x0)
    edge_x.append(x1)
    edge_x.append(None)
    edge_y.append(y0)
```

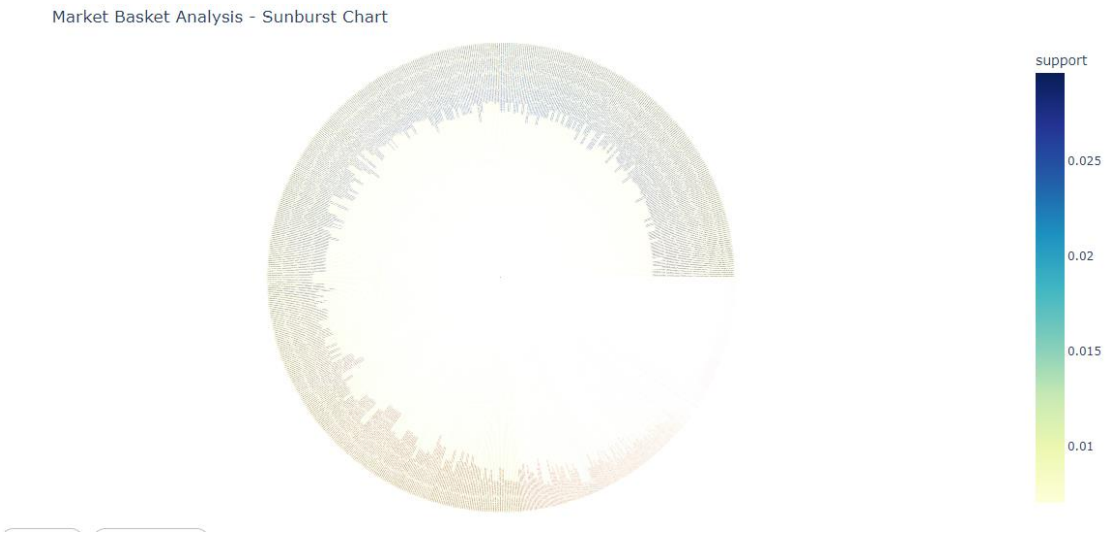
```
    edge_y.append(y1)
    edge_y.append(None)

edge_trace = go.Scatter(
    x=edge_x, y=edge_y,
    line=dict(width=0.5, color='#888'),
    hoverinfo='none',
    mode='lines')

node_x = []
node_y = []
for node in G.nodes():
    x, y = pos[node]
    node_x.append(x)
    node_y.append(y)

node_trace = go.Scatter(
    x=node_x, y=node_y,
    mode='markers',
    hoverinfo='text',
    marker=dict(
        showscale=True,
        colorscale='YlGnBu',
        size=10,
        colorbar=dict(
            thickness=15,
            title='Node Connections',
            xanchor='left',
            titleside='right'
        )
    )
)

# Customize the layout
layout = go.Layout(
    showlegend=False,
    hovermode='closest',
    margin=dict(b=0, l=0, r=0, t=0),
)

# Create the figure
fig = go.Figure(data=[edge_trace, node_trace], layout=layout)

# Show the interactive graph
fig.show()
```



Interactive Sunburst Chart for Association Rules

We use Plotly Express to create an interactive sunburst chart visualizing association rules. This chart represents the relationships between antecedent and consequent items, showcasing lift as well as support through color intensity.

```
import plotly.express as px

# Combine antecedents and consequents into a single column for each rule
rules['rule'] = rules['antecedents'].astype(str) + ' -> ' + rules['consequent
s'].astype(str)

# Create a sunburst chart
fig = px.sunburst(rules, path=['rule'], values='lift',
                  title='Market Basket Analysis - Sunburst Chart',
                  color='support', color_continuous_scale='YlGnBu')

# Customize the layout
fig.update_layout(
    margin=dict(l=0, r=0, b=0, t=40),
)

# Show the interactive plot

fig.show()
```



Phase 5: Project Documentation & Submission

Overview:

This project aims to perform Market Basket Analysis using the Apriori algorithm, exploring customer purchase patterns and generating association rules. The entire project lifecycle is documented in the following sections.

Project Structure:

1. **Problem Definition and Design Thinking:**
    - Clearly defined the problem statement and outlined a design thinking approach for solving the market basket analysis challenge.
    - Emphasized user empathy, ideation, prototyping, and iterative testing as key components of the design thinking process.
2. **Innovation:**
    - Identified innovation potentials by researching emerging technologies and industry trends.
    - Derived ideas through brainstorming and collaboration, evaluating and releasing the most promising concepts.

- Extensively analyzed and derived detailed concepts for the selected ideas.

3. **Development Part 1:**
    - Loaded and preprocessed the dataset, ensuring it is ready for association rule mining.
    - Performed an initial exploration of the dataset and addressed missing values.
    - Converted the dataset into transaction data and saved it for further analysis.
4. **Development Part 2:**
    - Formatted the transaction data for Apriori algorithm application.
    - Applied the Apriori algorithm to identify frequent itemsets.
    - Generated association rules based on the identified itemsets.
5. **Project Documentation & Submission:**
    - Compiled a comprehensive document outlining the entire project life cycle.
    - Included code snippets, explanations, and visualizations at each phase for clarity.
    - Emphasized user-centric design thinking and innovation in solving the market basket analysis problem.

Conclusion:

This project is structured to provide a detailed understanding of the market basket analysis process, from problem definition to innovative solutions and implementation. The documentation serves as a guide for replicating the analysis and understanding the decisions made at each step. The iterative nature of design thinking and innovation ensures adaptability to changing requirements and emerging trends.