LLM-Powered Booking Analytics & QA System

Objective

Develop a system that processes hotel booking data, extracts insights, and enables retrieval-augmented question answering (RAG). The system should provide analytics as mentioned in below sections and answer user queries about the dat.

Contents

- Dataset Loading
- Data Preprocessing
- Data Analysis and Visaulization
- Processed Data CSV Export

Links:

- arindal1 github
- arindal1 linkedin
- dataseta

```
!pip install pandas numpy matplotlib seaborn fastapi uvicorn sentence-transformers
transformers faiss-cpu langchain
```

Data Collection and Pre

```
import pandas as pd
import numpy as np
```

```
# Load the dataset
df = pd.read_csv("data/hotel_bookings.csv")

# Display basic info
print("Dataset Shape:", df.shape)
print(df.info())
print(df.head())
```

```
Dataset Shape: (119390, 32)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 119390 entries, 0 to 119389
Data columns (total 32 columns):
 #   Column                          Non-Null Count   Dtype
```

```
---  ------                          --------------  -----
 0   hotel                           119390 non-null  object
 1   is_canceled                     119390 non-null  int64
 2   lead_time                       119390 non-null  int64
 3   arrival_date_year               119390 non-null  int64
 4   arrival_date_month              119390 non-null  object
 5   arrival_date_week_number        119390 non-null  int64
 6   arrival_date_day_of_month       119390 non-null  int64
 7   stays_in_weekend_nights         119390 non-null  int64
 8   stays_in_week_nights            119390 non-null  int64
 9   adults                          119390 non-null  int64
 10  children                        119386 non-null  float64
 11  babies                          119390 non-null  int64
 12  meal                            119390 non-null  object
 13  country                         118902 non-null  object
 14  market_segment                  119390 non-null  object
 15  distribution_channel            119390 non-null  object
 16  is_repeated_guest               119390 non-null  int64
 17  previous_cancellations          119390 non-null  int64
 18  previous_bookings_not_canceled  119390 non-null  int64
 19  reserved_room_type              119390 non-null  object
 20  assigned_room_type              119390 non-null  object
 21  booking_changes                 119390 non-null  int64
 22  deposit_type                    119390 non-null  object
 23  agent                           103050 non-null  float64
 24  company                         6797 non-null    float64
 25  days_in_waiting_list            119390 non-null  int64
 26  customer_type                   119390 non-null  object
 27  adr                             119390 non-null  float64
 28  required_car_parking_spaces     119390 non-null  int64
 29  total_of_special_requests       119390 non-null  int64
 30  reservation_status              119390 non-null  object
 31  reservation_status_date         119390 non-null  object
dtypes: float64(4), int64(16), object(12)
memory usage: 29.1+ MB
None
          hotel  is_canceled  lead_time  arrival_date_year arrival_date_month  \
0  Resort Hotel            0        342               2015               July
1  Resort Hotel            0        737               2015               July
2  Resort Hotel            0          7               2015               July
3  Resort Hotel            0         13               2015               July
4  Resort Hotel            0         14               2015               July

   arrival_date_week_number  arrival_date_day_of_month  \
0                        27                          1
1                        27                          1
2                        27                          1
3                        27                          1
4                        27                          1

   stays_in_weekend_nights  stays_in_week_nights  adults  ...  deposit_type  \
0                         0                      0       2  ...    No Deposit
1                         0                      0       2  ...    No Deposit
2                         0                      1       1  ...    No Deposit
3                         0                      1       1  ...    No Deposit
4                         0                      2       2  ...    No Deposit

   agent  company  days_in_waiting_list  customer_type   adr  \
0    NaN      NaN                     0      Transient   0.0
1    NaN      NaN                     0      Transient   0.0
2    NaN      NaN                     0      Transient  75.0
3  304.0      NaN                     0      Transient  75.0
4  240.0      NaN                     0      Transient  98.0

   required_car_parking_spaces  total_of_special_requests  reservation_status  \
0                            0                          0           Check-Out
1                            0                          0           Check-Out
2                            0                          0           Check-Out
3                            0                          0           Check-Out
4                            0                          1           Check-Out

  reservation_status_date
0                01-07-15
1                01-07-15
2                02-07-15
3                02-07-15
4                03-07-15

[5 rows x 32 columns]
```

```
# 1. Convert arrival date columns into a single datetime column.
# Note: 'arrival_date_month' is given as full month name (e.g., "July").

df['arrival_date'] = pd.to_datetime(
    df['arrival_date_year'].astype(str) + '-' +
    df['arrival_date_month'] + '-' +
    df['arrival_date_day_of_month'].astype(str),
    format='%Y-%B-%d',
    errors='coerce'  # in case some dates cannot be parsed
)
```

```
# 2. Convert reservation_status_date into datetime (assumed format: dd-mm-yy)
df['reservation_status_date'] = pd.to_datetime(df['reservation_status_date'],
format='%d-%m-%y', errors='coerce')
```

```
# 3. Handle missing values:
#    - For numerical columns like 'children', fill with 0 or median if
appropriate.
df['children'] = df['children'].fillna(0)
#    - For 'agent' and 'company', fill missing values with a placeholder (e.g., 0
or "Unknown")
df['agent'] = df['agent'].fillna(0)
df['company'] = df['company'].fillna(0)
#    - For 'country', fill missing with "Unknown"
df['country'] = df['country'].fillna("Unknown")
```

```
# 4. Derive additional columns:
# Total number of nights stayed (week + weekend)
df['total_stays'] = df['stays_in_week_nights'] + df['stays_in_weekend_nights']
```

```
# Calculate estimated revenue:
# Revenue = adr * total nights stayed.
# (Assuming each booking's revenue is approximated by the average daily rate times
total nights.)
df['revenue'] = df['adr'] * df['total_stays']
```

```
# Display the updated dataframe structure
print("\nPreprocessed Data:")
print(df[['arrival_date', 'reservation_status_date', 'total_stays',
'revenue']].head())
```

```
Preprocessed Data:
  arrival_date reservation_status_date  total_stays  revenue
0   2015-07-01              2015-07-01            0      0.0
1   2015-07-01              2015-07-01            0      0.0
2   2015-07-01              2015-07-02            1     75.0
3   2015-07-01              2015-07-02            1     75.0
4   2015-07-01              2015-07-03            2    196.0
```

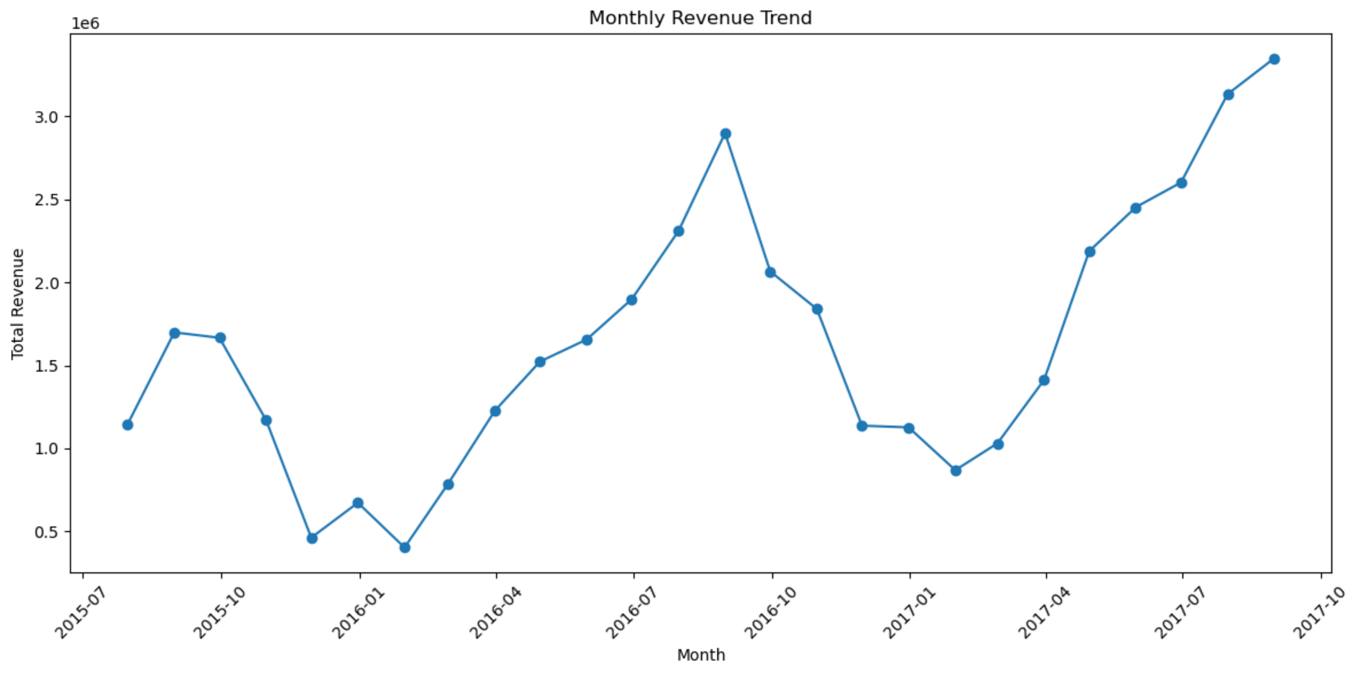
```
# Function to determine season based on the month (assuming northern hemisphere)
def get_season(date):
    month = date.month
    if month in [12, 1, 2]:
        return 'Winter'
    elif month in [3, 4, 5]:
        return 'Spring'
    elif month in [6, 7, 8]:
        return 'Summer'
    else:
        return 'Autumn'

# Apply function to create a new 'season' column (ensure arrival_date is in
datetime format)
df['season'] = df['arrival_date'].apply(lambda x: get_season(x) if pd.notnull(x)
else 'Unknown')

# Verify the new feature
print("Season distribution:")
print(df['season'].value_counts())
```

```
Season distribution:
season
Summer    37477
Spring    32674
Autumn    28462
Winter    20777
Name: count, dtype: int64
```

Analytics and Visualization

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

```
# Group by arrival_date (monthly)
revenue_trend = df.groupby(pd.Grouper(key='arrival_date', freq='M'))
['revenue'].sum()

plt.figure(figsize=(12, 6))
plt.plot(revenue_trend.index, revenue_trend.values, marker='o')
plt.title('Monthly Revenue Trend')
plt.xlabel('Month')
plt.ylabel('Total Revenue')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



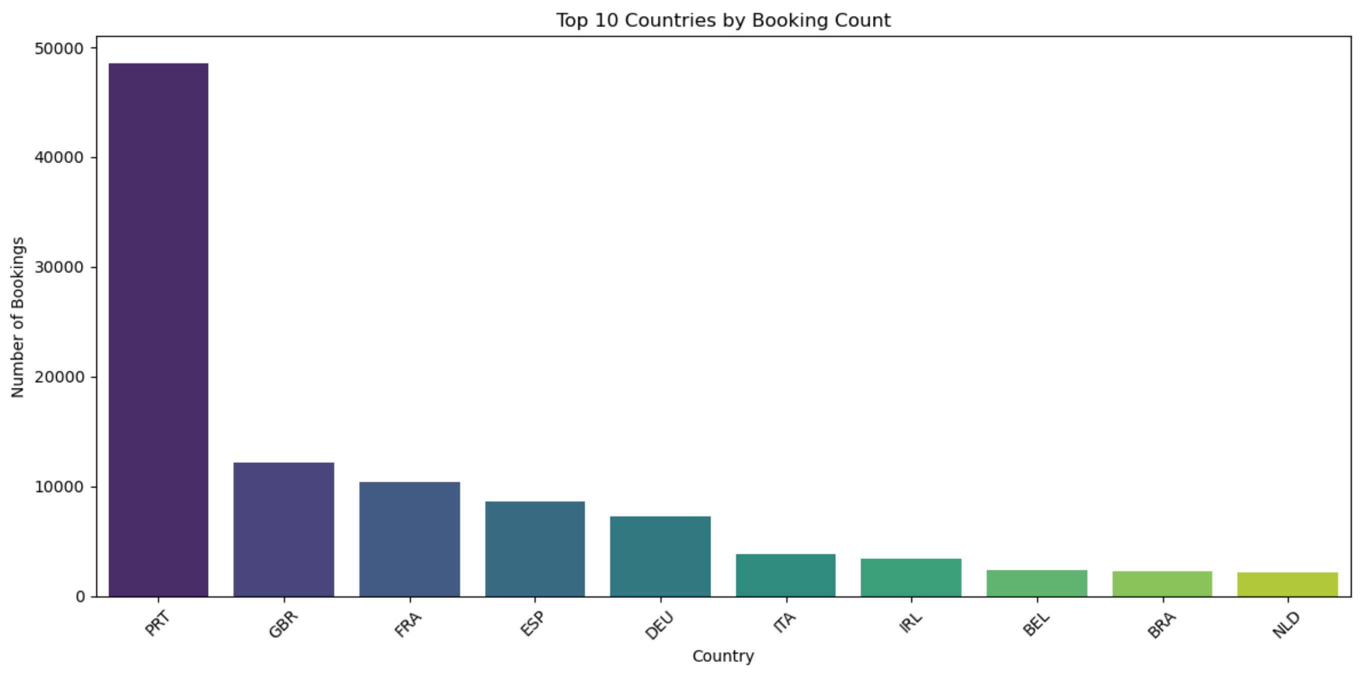
```
# is_canceled: 1 means canceled, 0 means not canceled.
total_bookings = len(df)
total_cancellations = df['is_canceled'].sum()
cancellation_rate = (total_cancellations / total_bookings) * 100

print(f"Overall Cancellation Rate: {cancellation_rate:.2f}%")
```

```
Overall Cancellation Rate: 37.04%
```

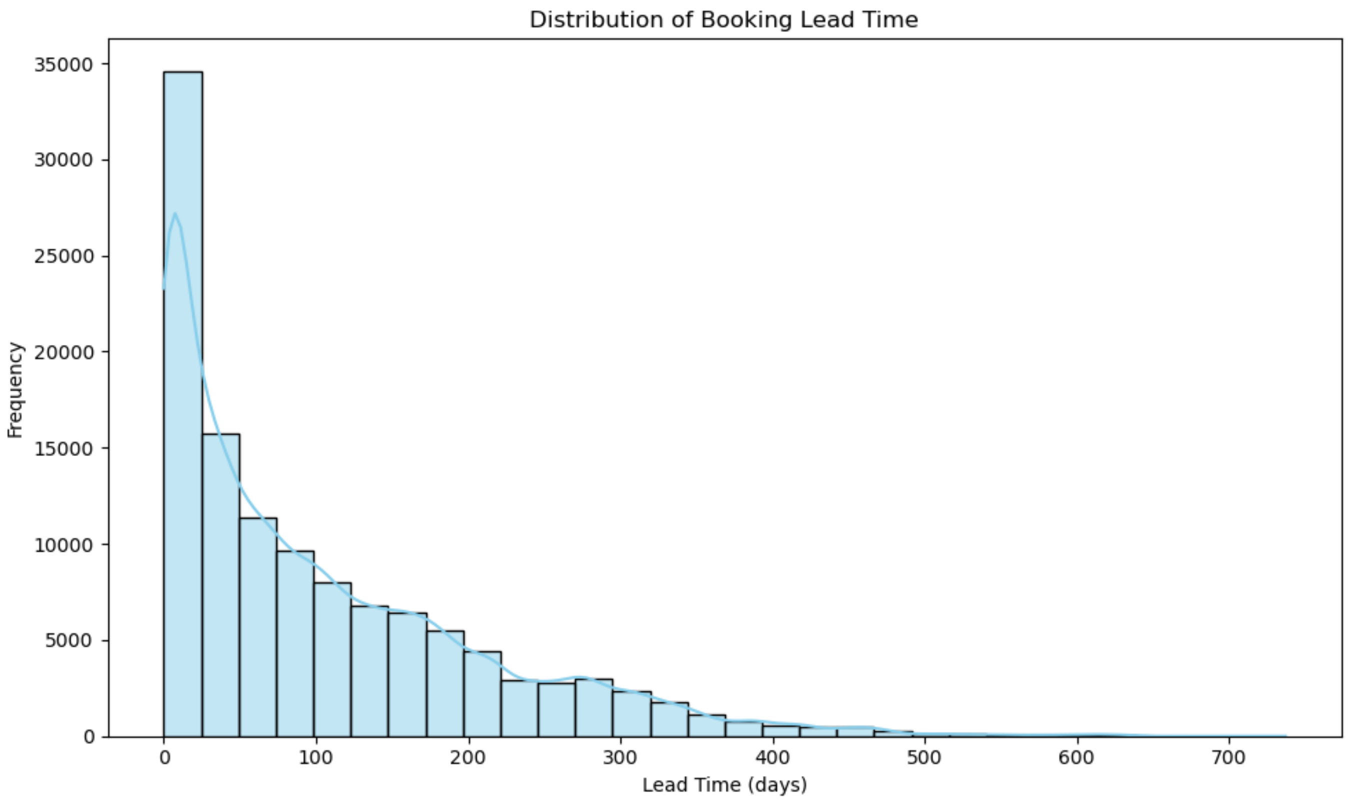
```
# Count bookings per country
country_counts = df['country'].value_counts().sort_values(ascending=False)

plt.figure(figsize=(12, 6))
sns.barplot(x=country_counts.index[:10], y=country_counts.values[:10],
palette='viridis')
plt.title('Top 10 Countries by Booking Count')
plt.xlabel('Country')
plt.ylabel('Number of Bookings')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

```
C:\Users\Arindal Char\AppData\Local\Temp\ipykernel_15688\2707114378.py:5:
FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
```

```
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
effect.

  sns.barplot(x=country_counts.index[:10], y=country_counts.values[:10],
palette='viridis')
```

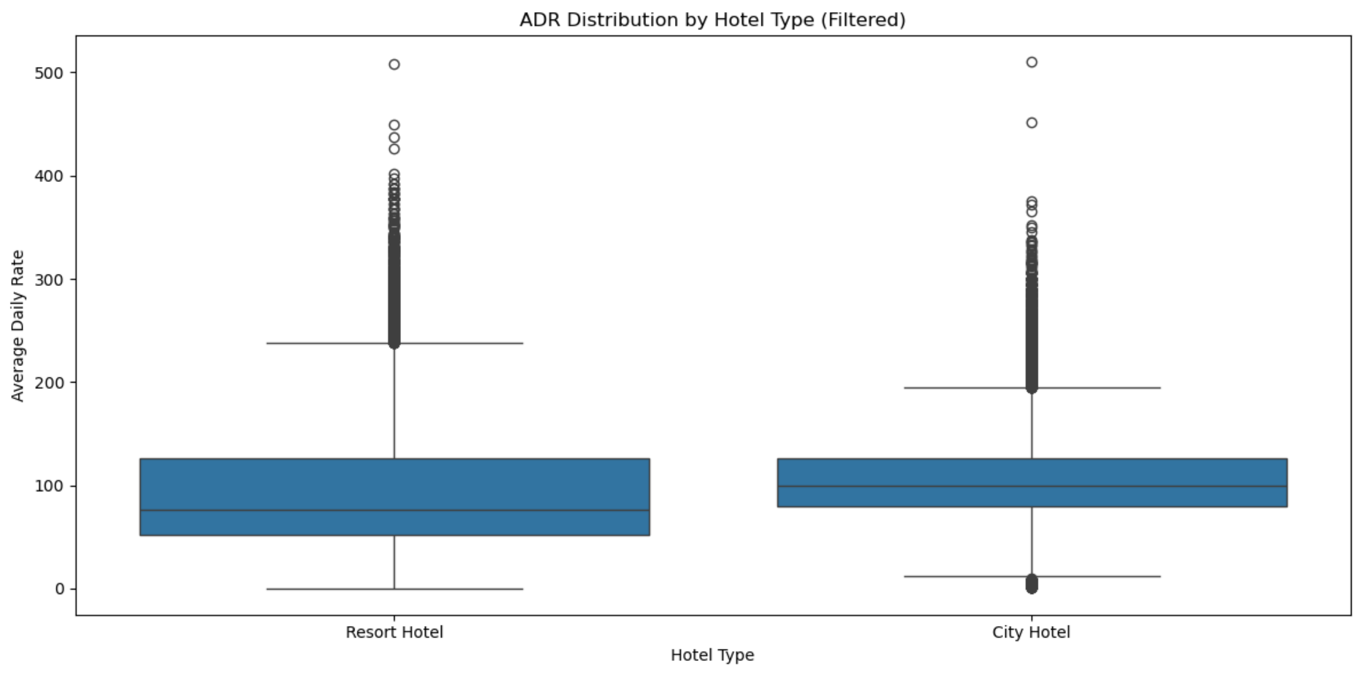


```
# Histogram of the lead times.

plt.figure(figsize=(10, 6))
sns.histplot(df['lead_time'], bins=30, kde=True, color='skyblue')
plt.title('Distribution of Booking Lead Time')
plt.xlabel('Lead Time (days)')
plt.ylabel('Frequency')
plt.tight_layout()
plt.show()
```



```
# Cap the ADR to a maximum value (optional, adjust threshold as per domain
knowledge)
adr_cap = 1000
df['adr_capped'] = df['adr'].apply(lambda x: min(x, adr_cap))
```

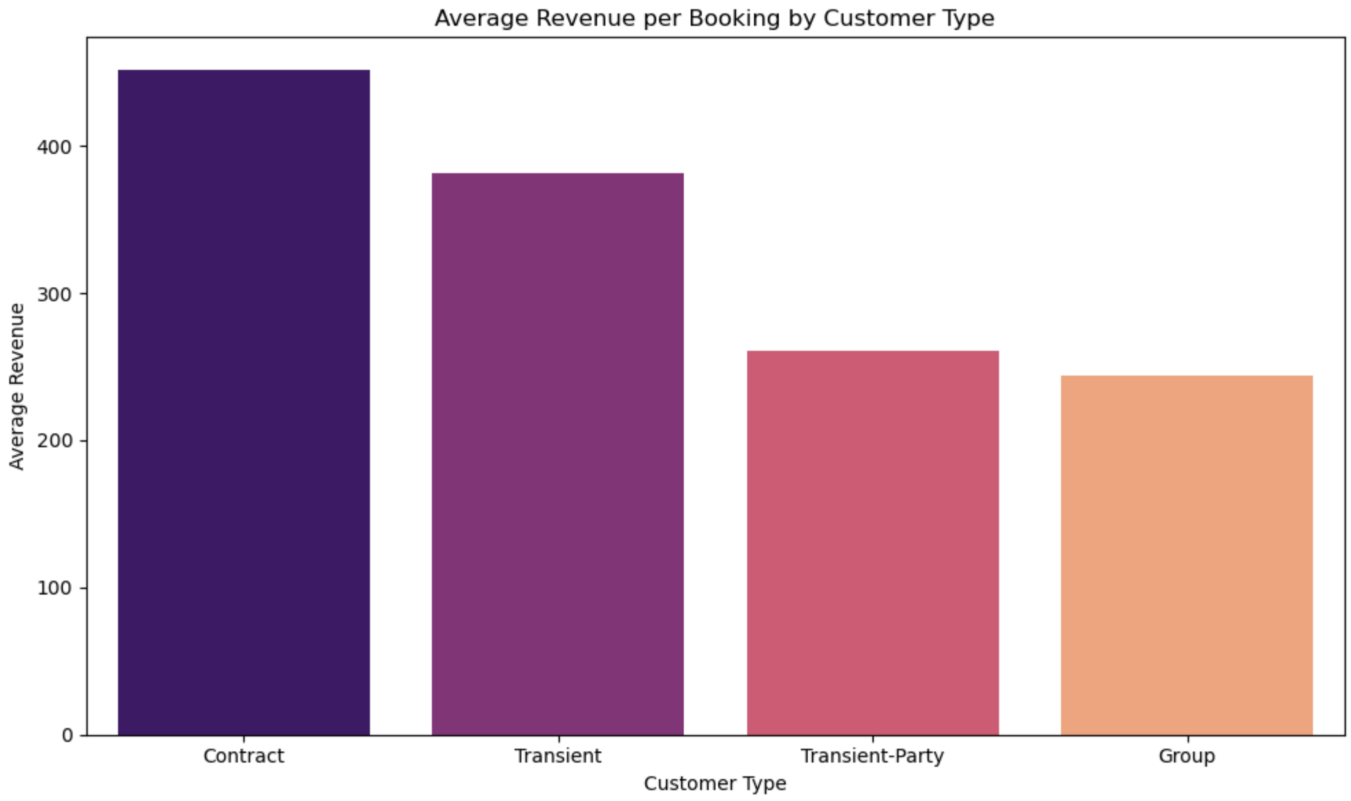
```
plt.figure(figsize=(12, 6))
sns.boxplot(x='hotel', y='adr', data=df_filtered)
plt.title('ADR Distribution by Hotel Type (Filtered)')
plt.xlabel('Hotel Type')
plt.ylabel('Average Daily Rate')
plt.tight_layout()
plt.show()
```



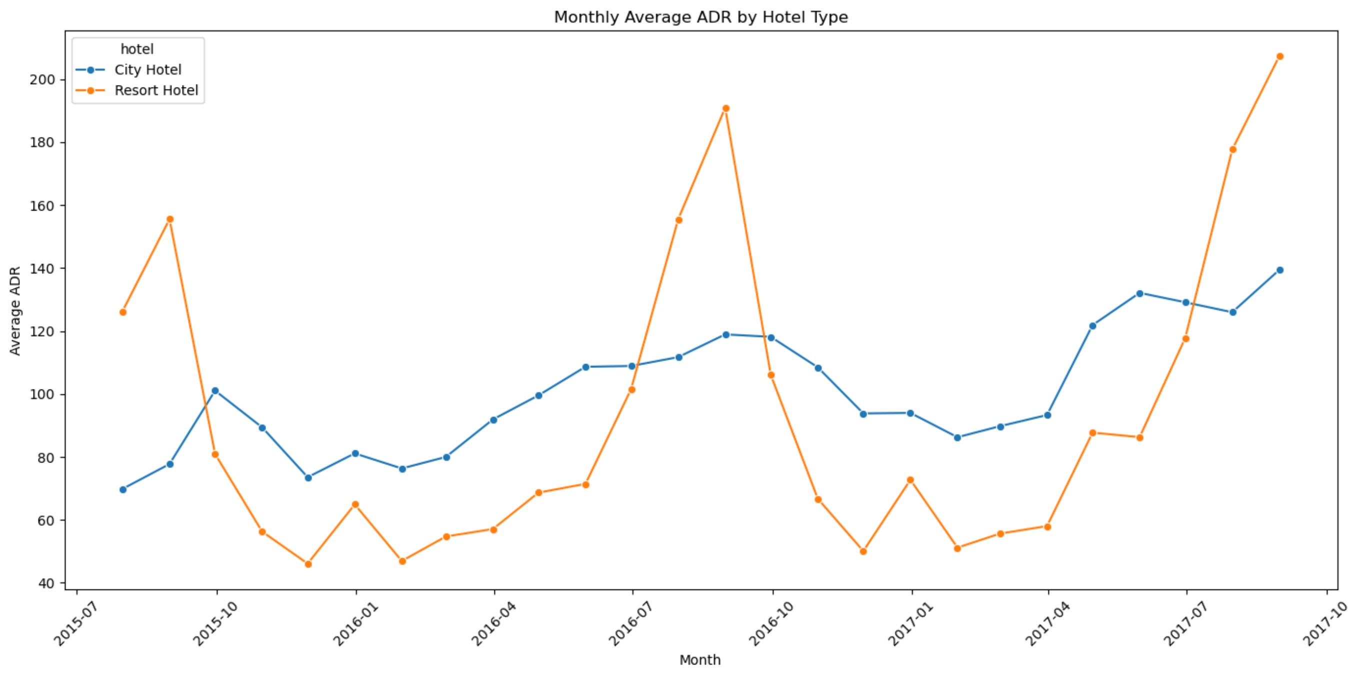
```python
# Average Revenue per Booking by Customer Type

# Group by customer_type and calculate average revenue
avg_revenue_by_customer = df.groupby('customer_type')
['revenue'].mean().sort_values(ascending=False)
print("Average Revenue by Customer Type:")
print(avg_revenue_by_customer)

plt.figure(figsize=(10, 6))
sns.barplot(x=avg_revenue_by_customer.index, y=avg_revenue_by_customer.values,
palette='magma')
plt.title('Average Revenue per Booking by Customer Type')
plt.xlabel('Customer Type')
plt.ylabel('Average Revenue')
plt.tight_layout()
plt.show()
```

```
Average Revenue by Customer Type:
customer_type
Contract           451.196700
Transient          381.631057
Transient-Party    260.493376
Group              243.813328
Name: revenue, dtype: float64


C:\Users\Arindal Char\AppData\Local\Temp\ipykernel_15688\282020276.py:9:
FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
```

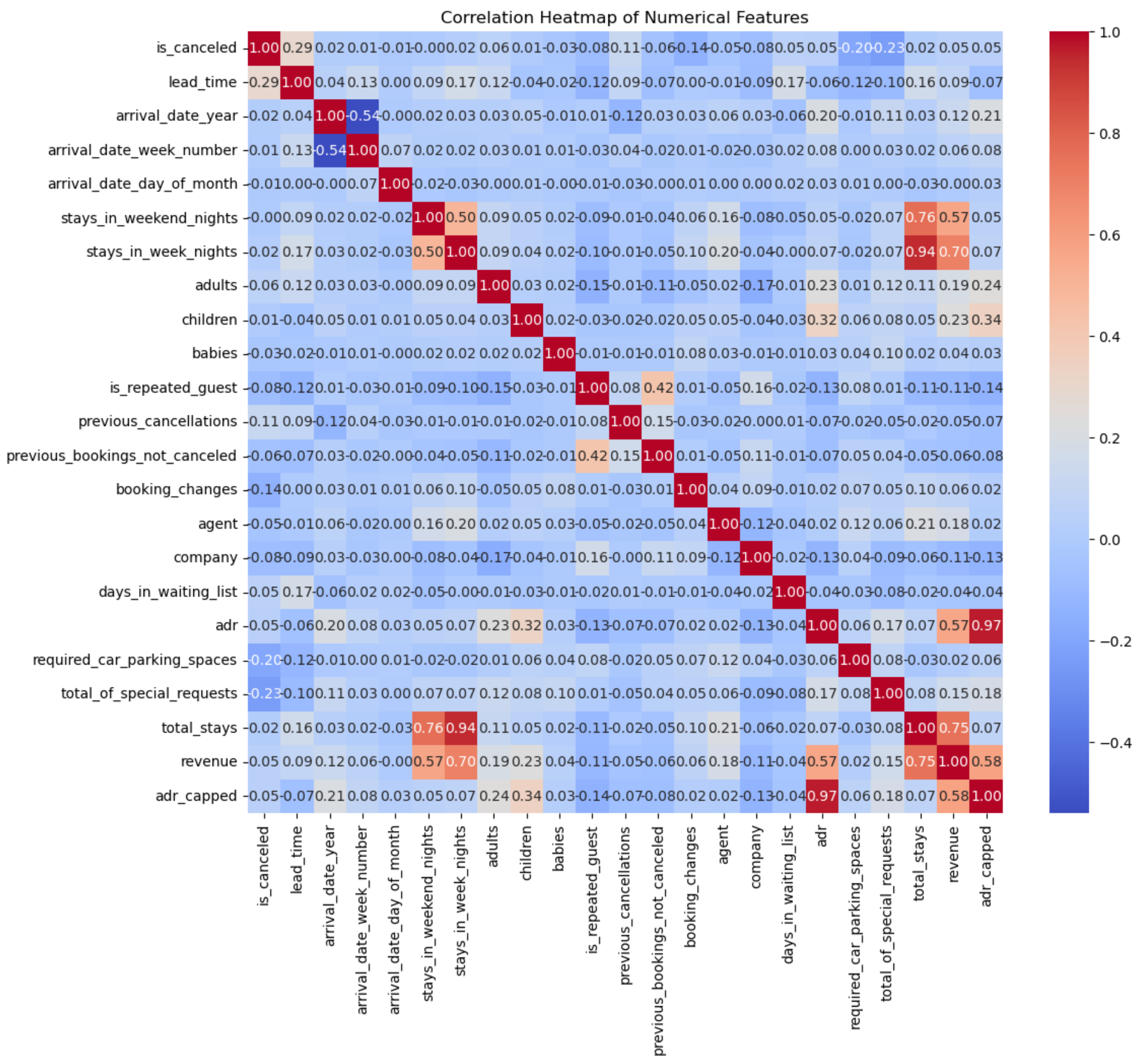
```
effect.

  sns.barplot(x=avg_revenue_by_customer.index, y=avg_revenue_by_customer.values,
palette='magma')
```



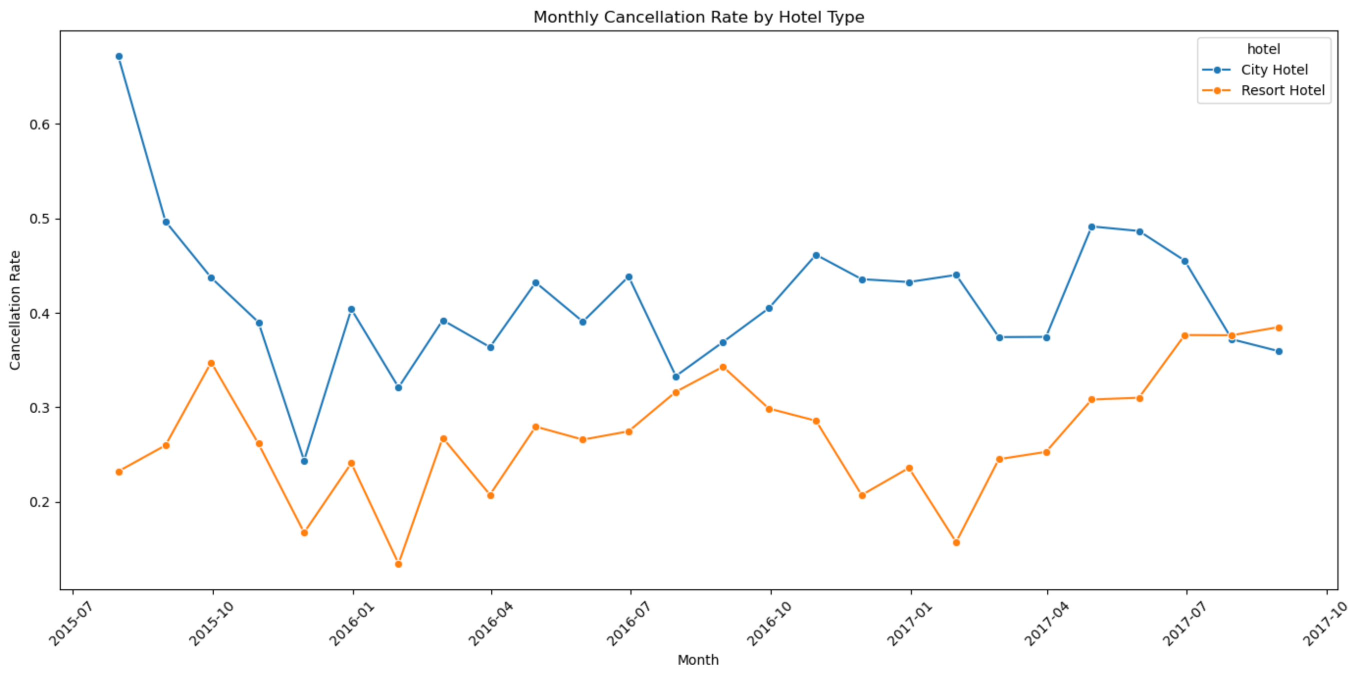
```
# Group by month and hotel type to calculate mean ADR
adr_trend_hotel = df.groupby([pd.Grouper(key='arrival_date', freq='M'), 'hotel'])
['adr'].mean().reset_index()

plt.figure(figsize=(14,7))
sns.lineplot(data=adr_trend_hotel, x='arrival_date', y='adr', hue='hotel',
marker='o')
plt.title('Monthly Average ADR by Hotel Type')
plt.xlabel('Month')
plt.ylabel('Average ADR')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



```python
# Correlation Heatmap of Numerical Features
numeric_cols = df.select_dtypes(include=[np.number])

plt.figure(figsize=(12, 10))
corr = numeric_cols.corr()
sns.heatmap(corr, annot=True, fmt=".2f", cmap="coolwarm")
plt.title('Correlation Heatmap of Numerical Features')
plt.show()
```



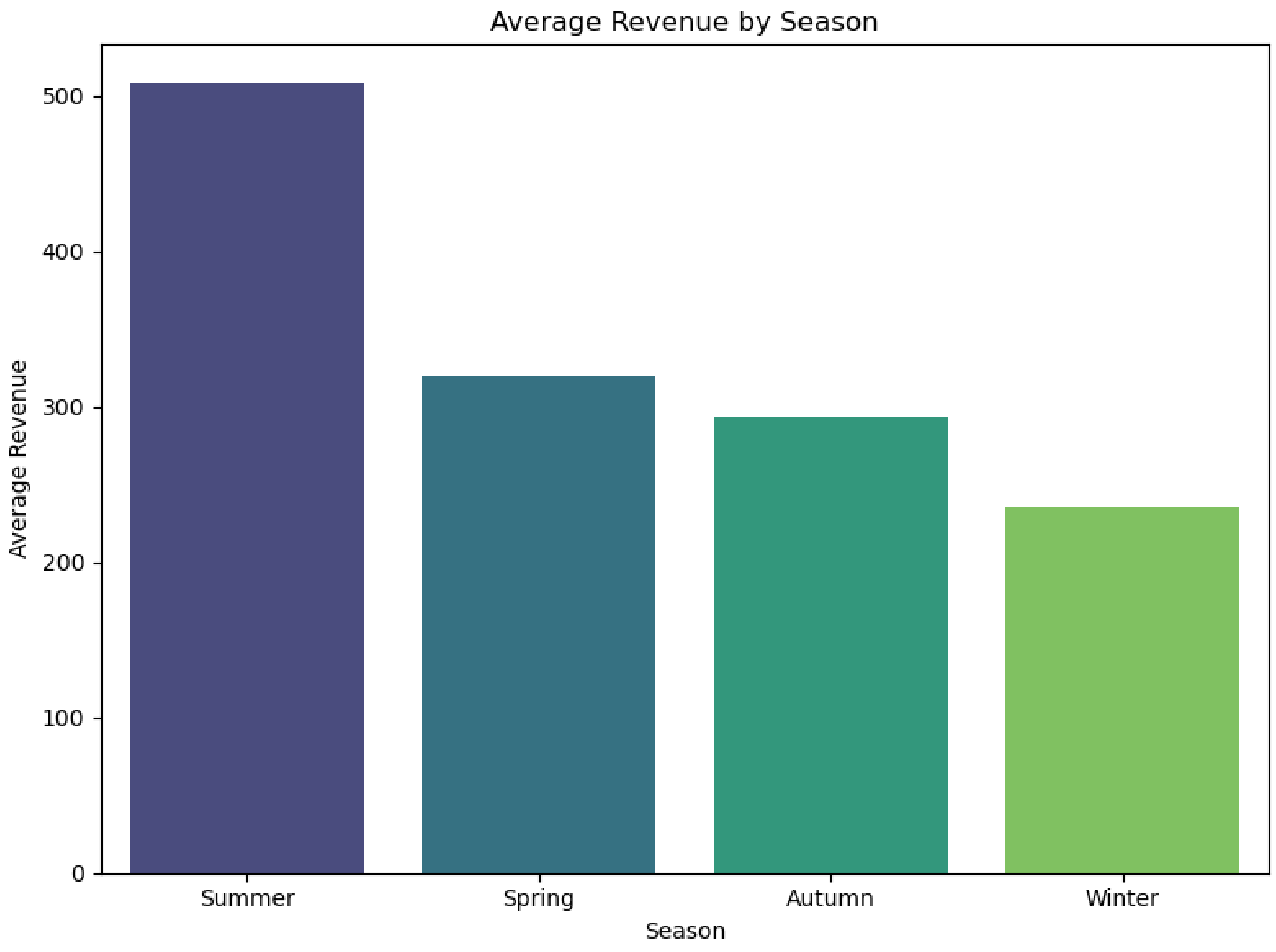
```
# Cancellation Rate by Month and Hotel Type

# Calculate monthly cancellation rate per hotel type (is_canceled is 1 for
canceled, 0 for not canceled)
cancellation_by_month_hotel = df.groupby([pd.Grouper(key='arrival_date',
freq='M'), 'hotel'])['is_canceled'].mean().reset_index()

plt.figure(figsize=(14,7))
sns.lineplot(data=cancellation_by_month_hotel, x='arrival_date', y='is_canceled',
hue='hotel', marker='o')
plt.title('Monthly Cancellation Rate by Hotel Type')
plt.xlabel('Month')
plt.ylabel('Cancellation Rate')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



```
# Average Revenue by Season

# Group by the new 'season' column and calculate average revenue
avg_revenue_by_season = df.groupby('season')
['revenue'].mean().sort_values(ascending=False)
print("Average Revenue by Season:")
print(avg_revenue_by_season)

plt.figure(figsize=(8,6))
sns.barplot(x=avg_revenue_by_season.index, y=avg_revenue_by_season.values,
palette='viridis')
plt.title('Average Revenue by Season')
plt.xlabel('Season')
plt.ylabel('Average Revenue')
plt.tight_layout()
plt.show()
```

```
Average Revenue by Season:
season
Summer    507.826623
Spring    320.065285
Autumn    293.079306
Winter    235.464351
Name: revenue, dtype: float64


C:\Users\Arindal Char\AppData\Local\Temp\ipykernel_15688\586029692.py:9:
FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same
```

```
effect.

  sns.barplot(x=avg_revenue_by_season.index, y=avg_revenue_by_season.values,
palette='viridis')
```



Export Processed Data

```
df.to_csv("hotel_bookings_preprocessed.csv", index=False)
```

```
```