SAIT SCHOOL FOR
ADVANCED DIGITAL
TECHNOLOGY

Capstone Project

Data-Driven Hotel Revenue Strategies

December 2024

Introduction

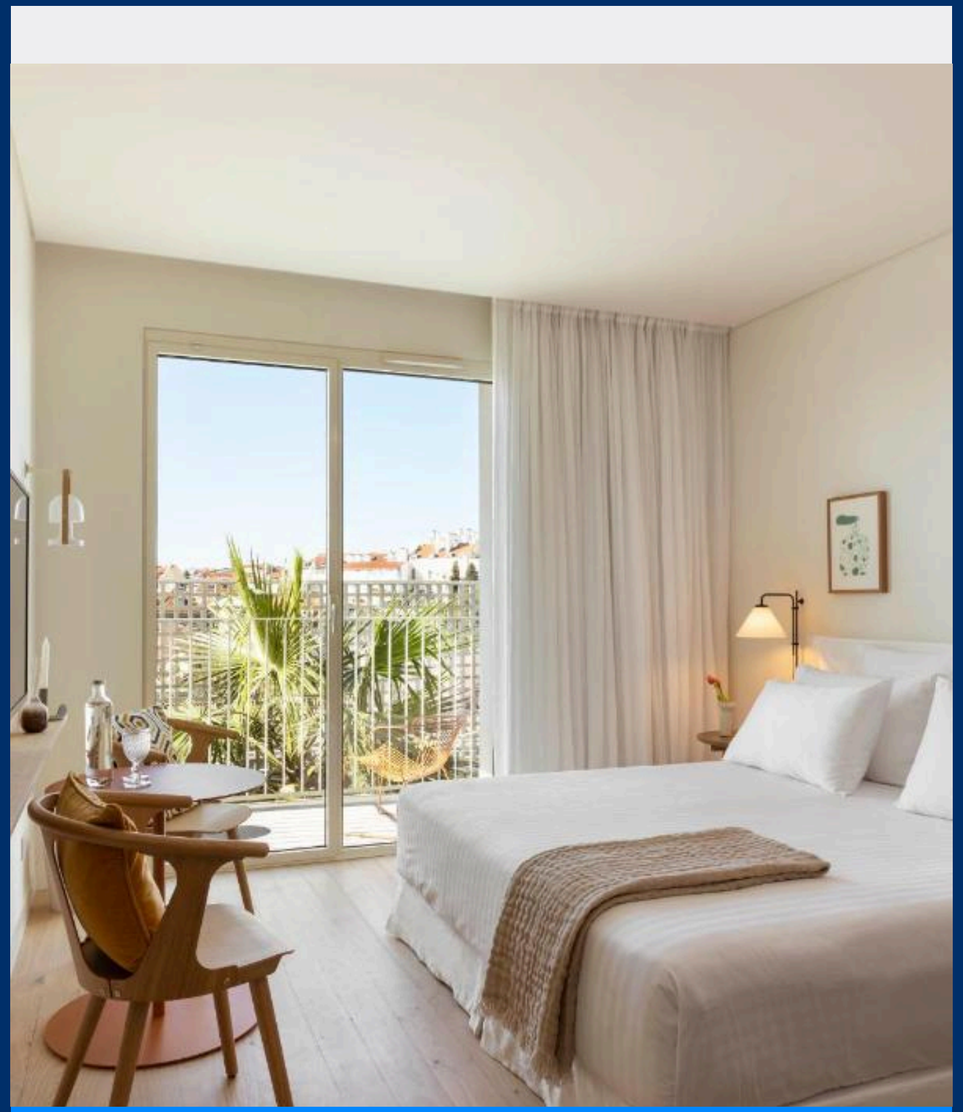
Two hotels in Portugal, one a resort in Algarve and the other a city hotel in Lisbon seek a better understanding of their booking patterns to boost revenue. Their datasets, covering bookings from July 2015 to August 2017, including bookings that effectively arrived and bookings that were canceled, provide detailed insights into each reservation. Both hotels face challenges with cancellations, seasonal variations, and demand forecasting, which are essential for effective revenue management.

Business Demands

Cancellation Prediction

Seasonality Forecast

Customer Behavior Understanding

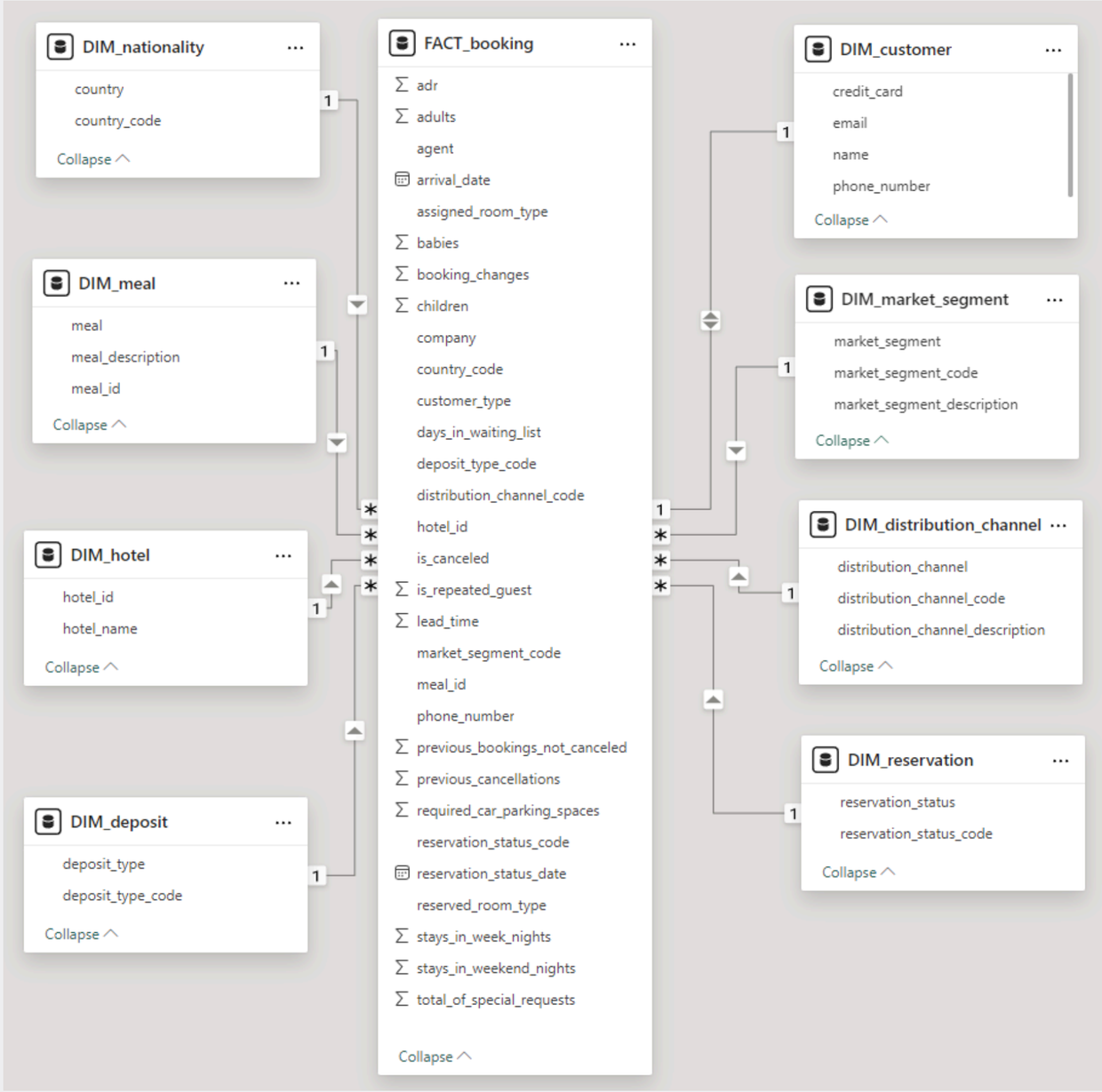


Business Questions

- How to reduce the hotel room cancellation rate by 10%?
- What are the peak seasons and low-demand periods of each hotel? - What is the sales and number of bookings forecast for the next 12 months?
- How can we divide customers into groups for marketing campaigns and tailored services?

Data Preparation

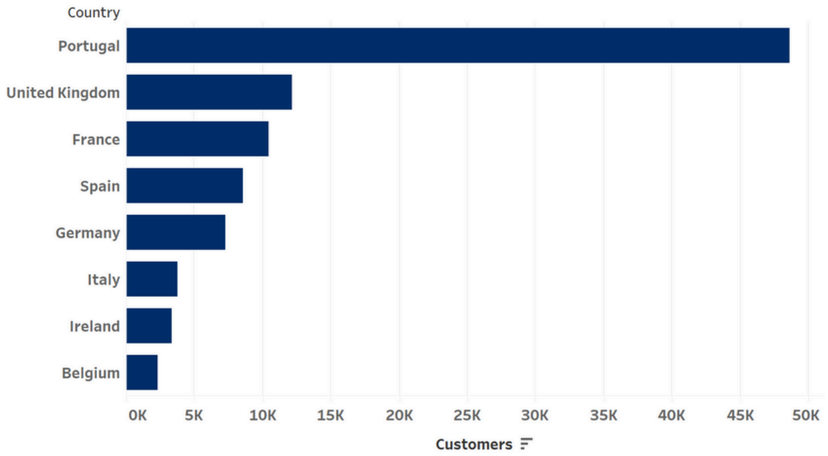
- Design and implement data modeling in SQL Server
- Convert null values to 0 or ‘Undefined’ strings
- Remove rows with abnormal prices
- Create a country name column based on the Country Code
- Create an arrival date column using day, month, and year



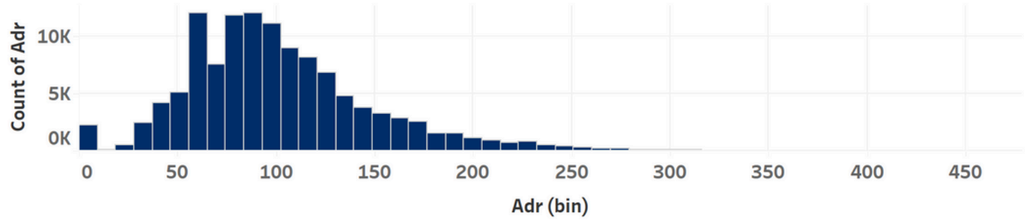
Data Source: https://www.sciencedirect.com/science/article/pii/S2352340918315191

Data Inspection

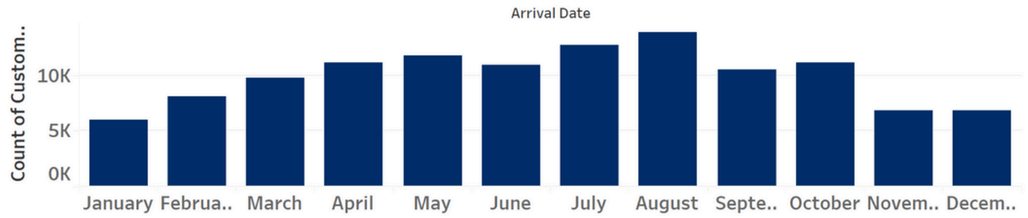
Top 8 Countries



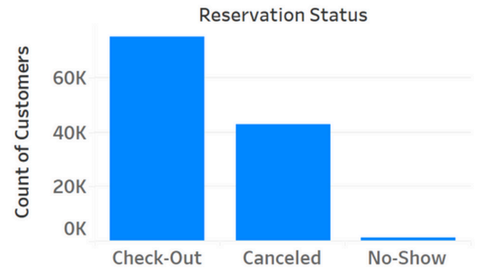
Average Daily Rates



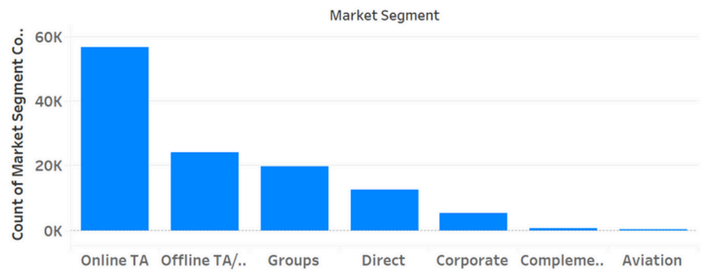
Arrival Month



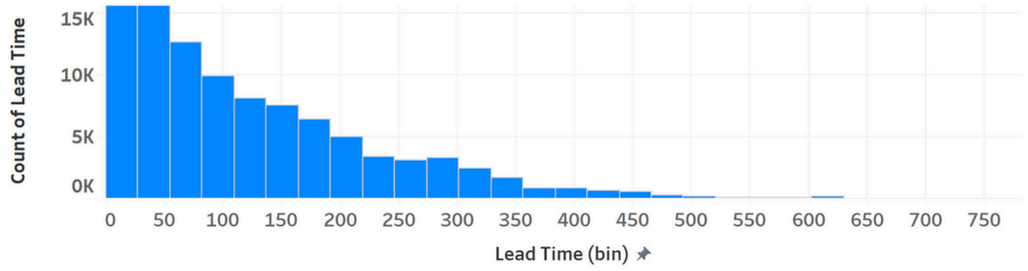
Reservation Status



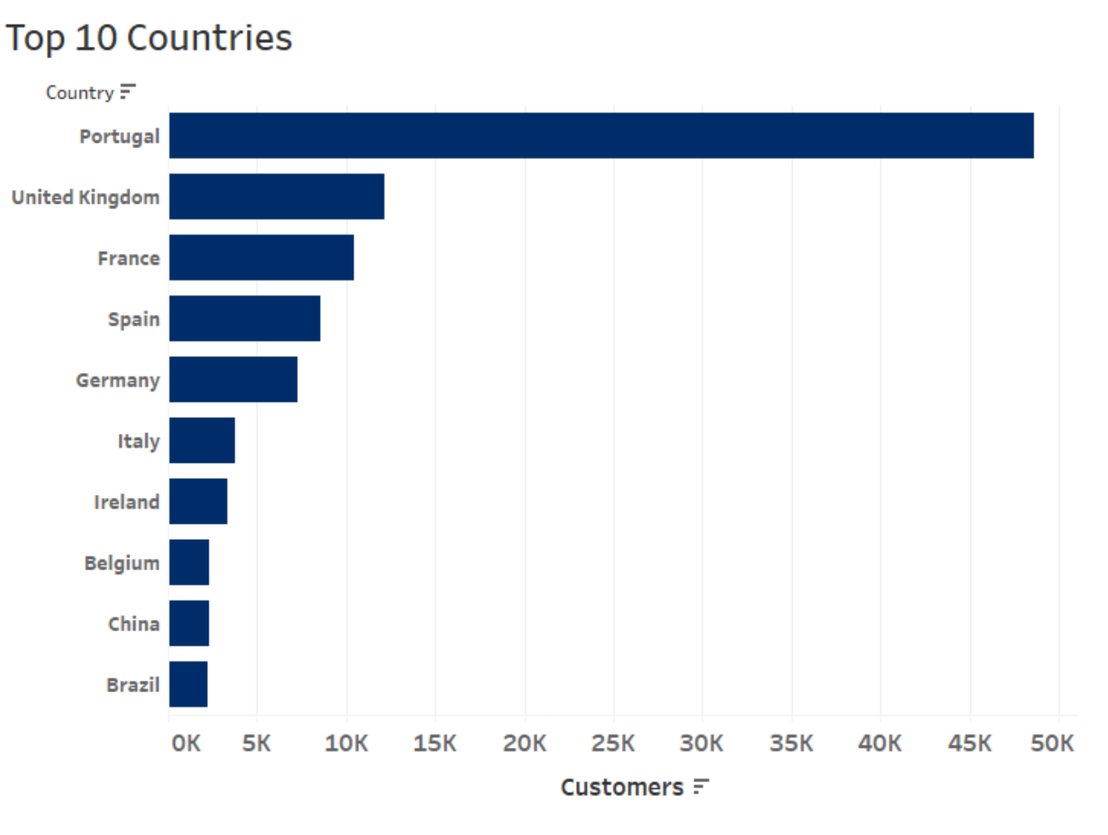
Market Segment

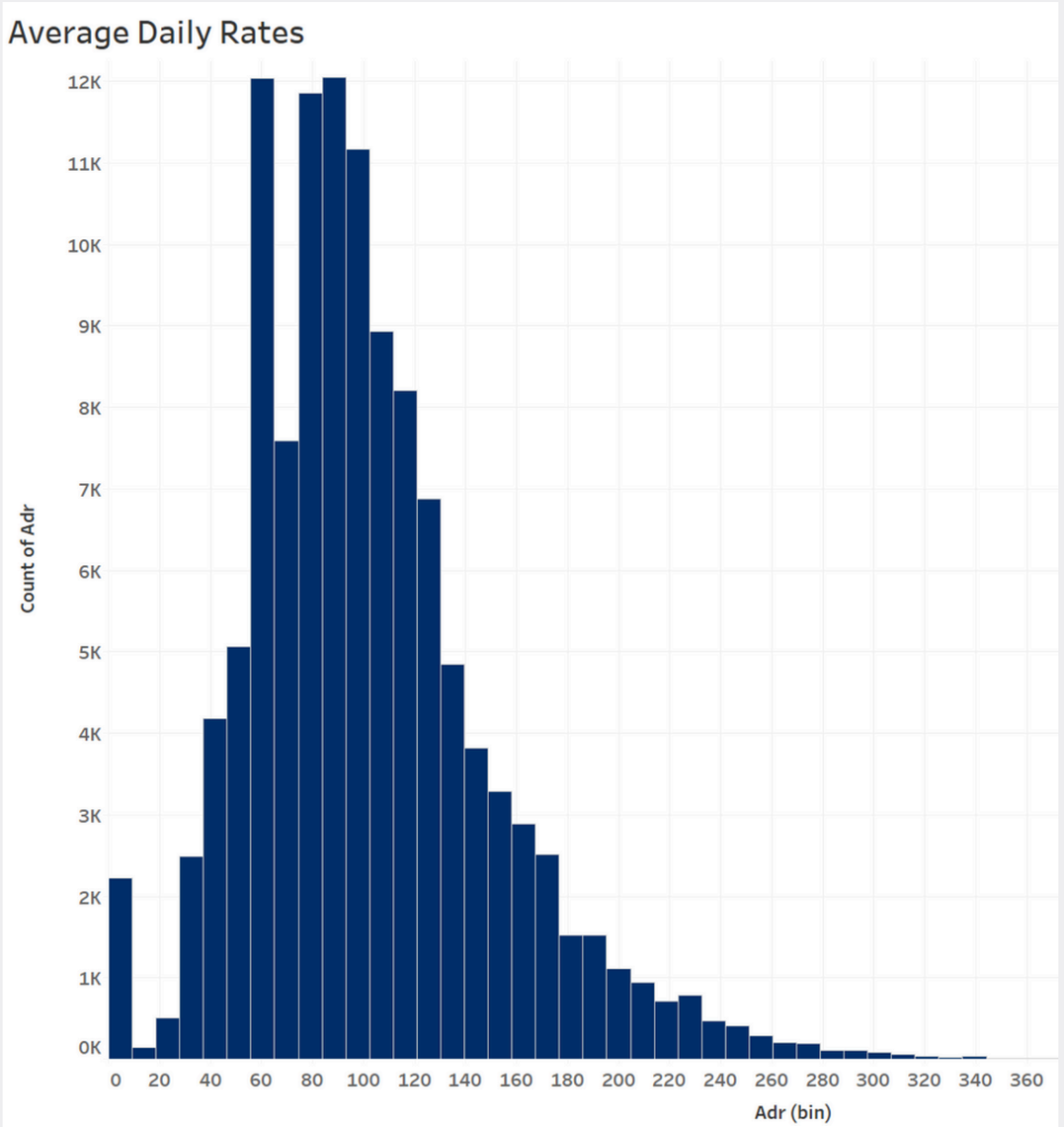


Lead Time

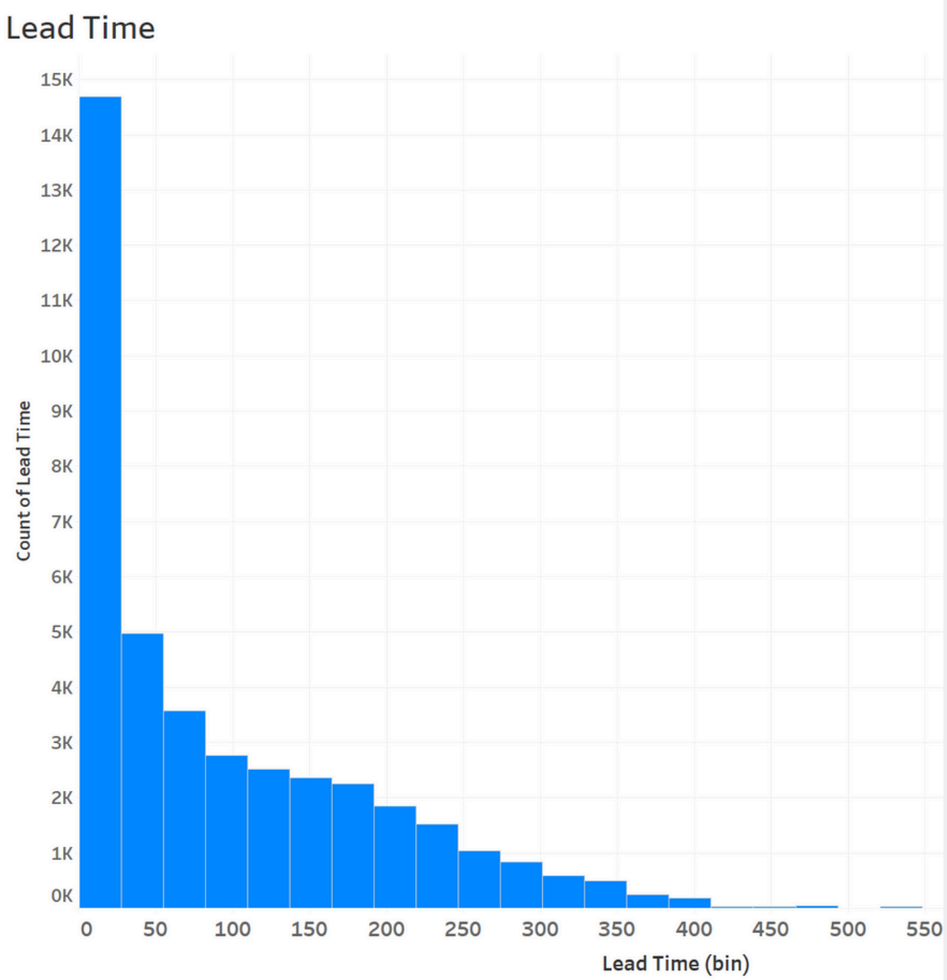


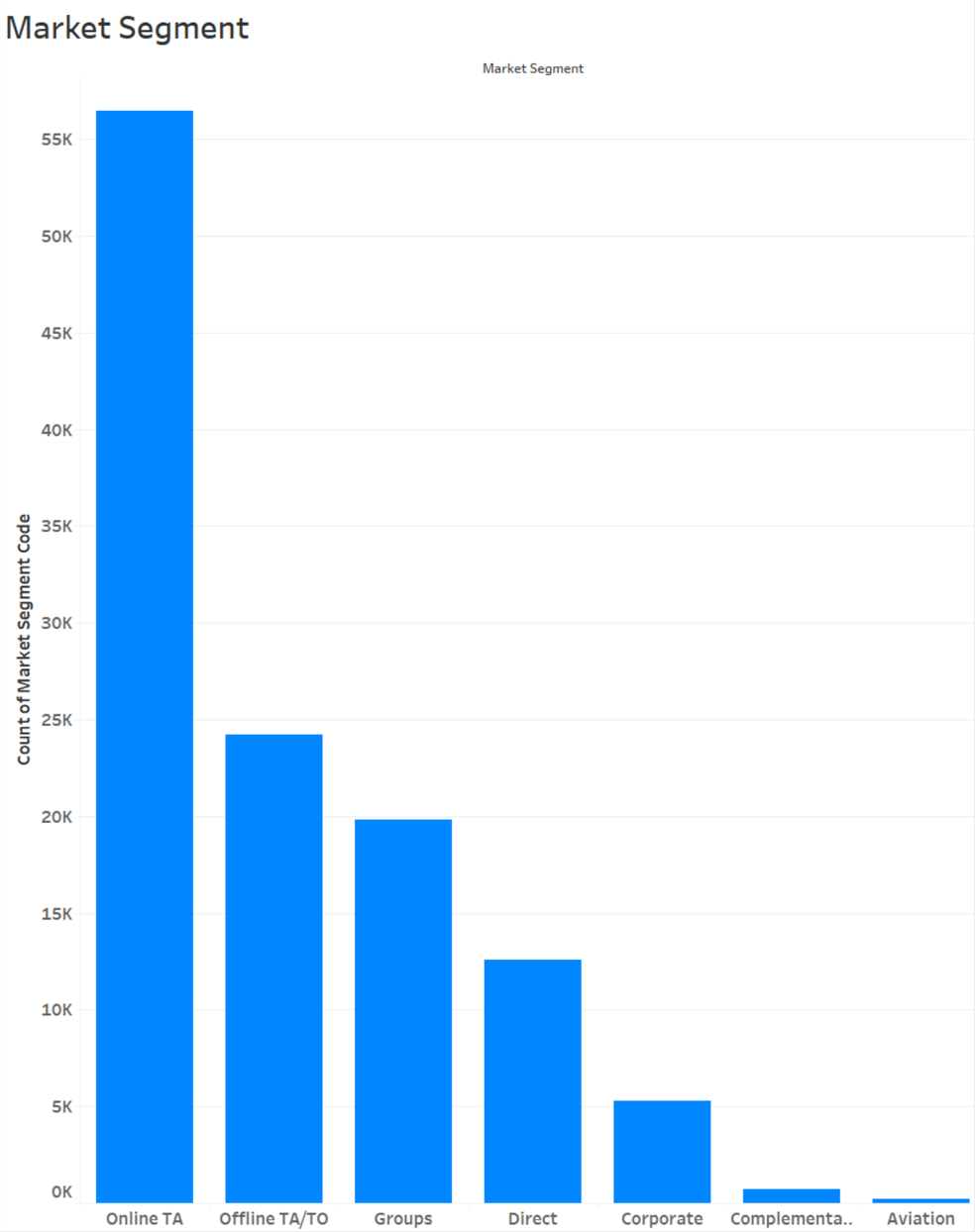
Data Inspection



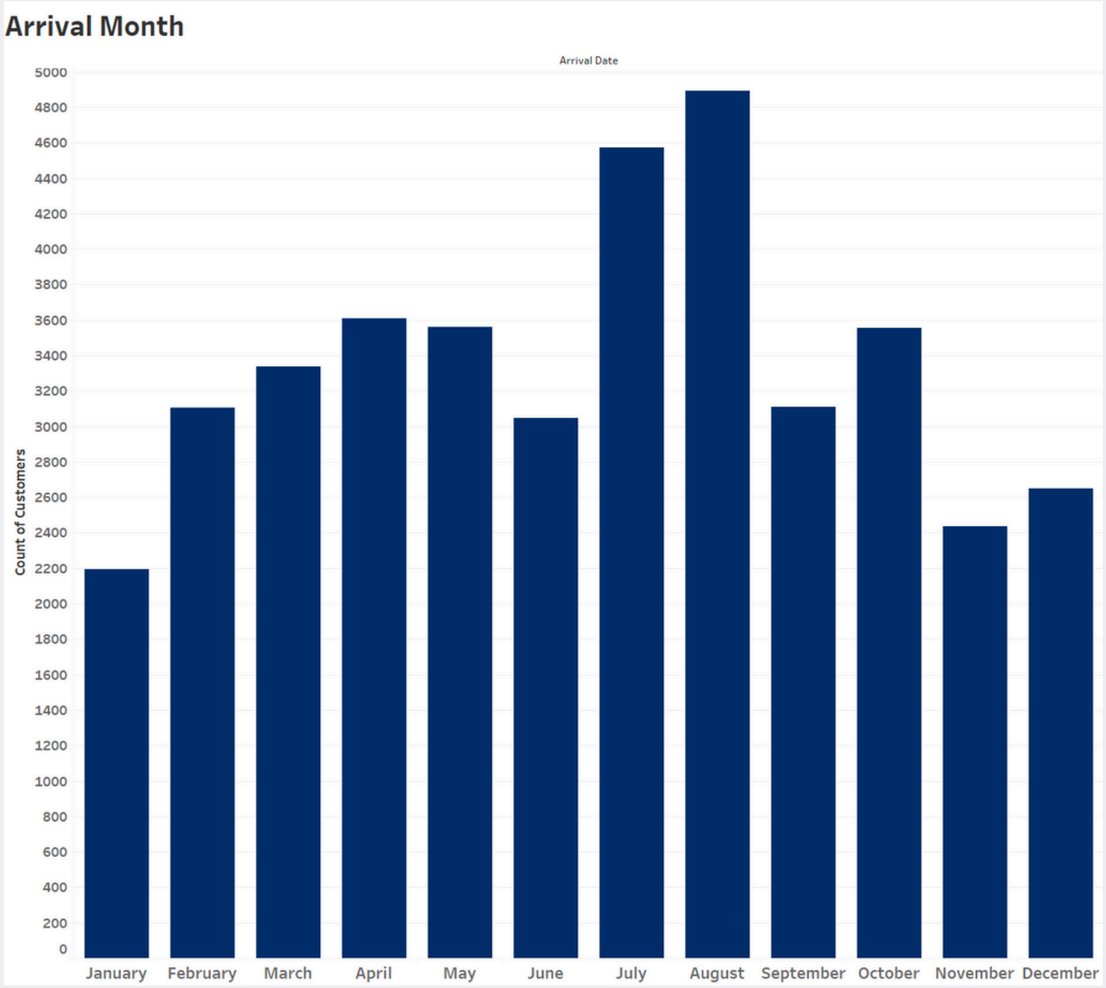


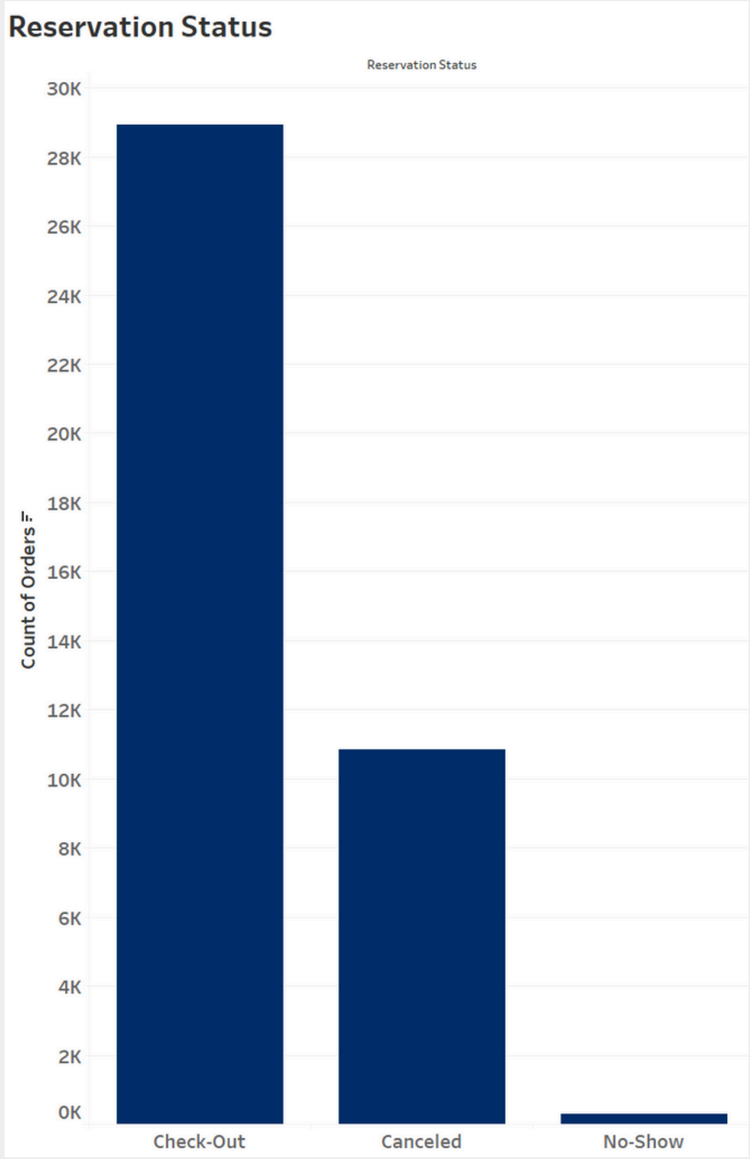
Data Inspection





Data Inspection





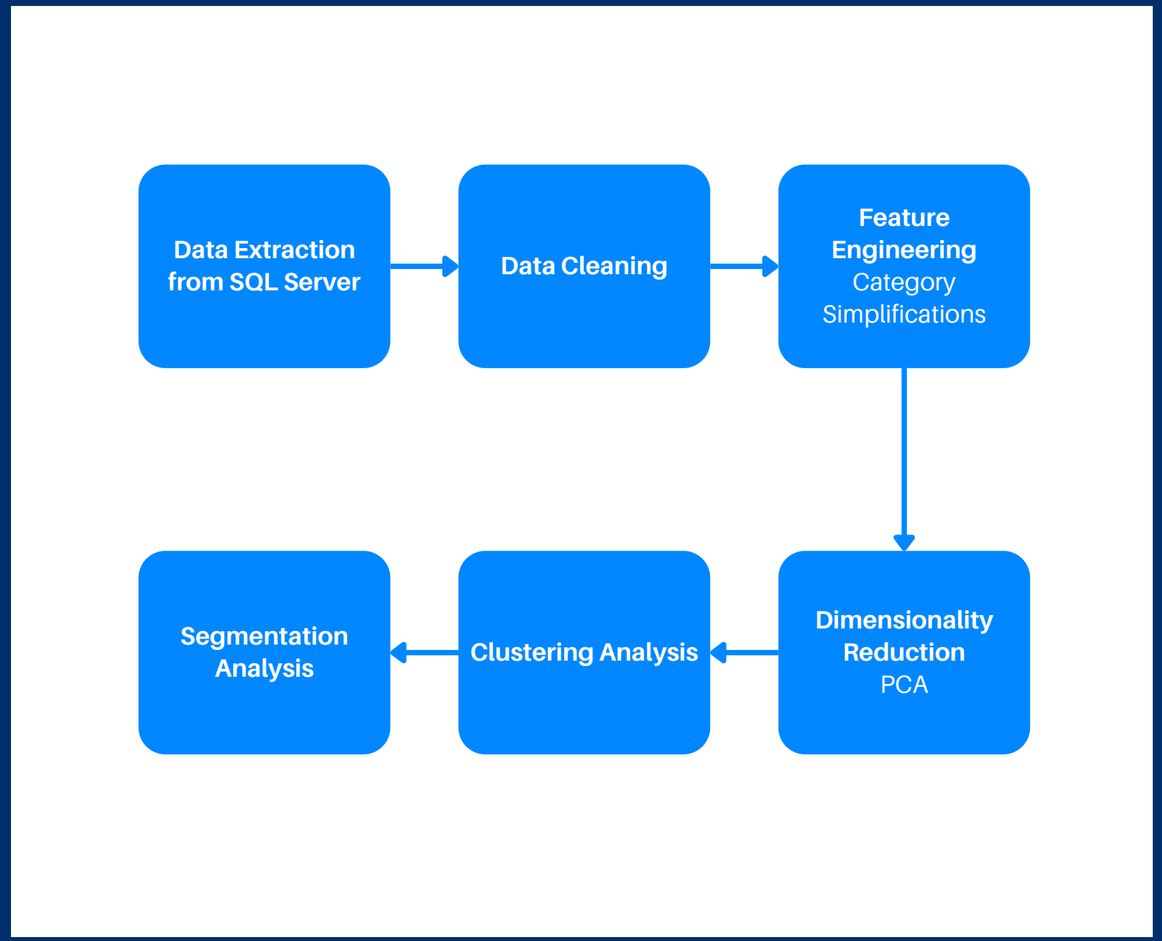
How can we divide customers into groups for marketing campaigns and tailored services?

Prepare the data through category simplifications.

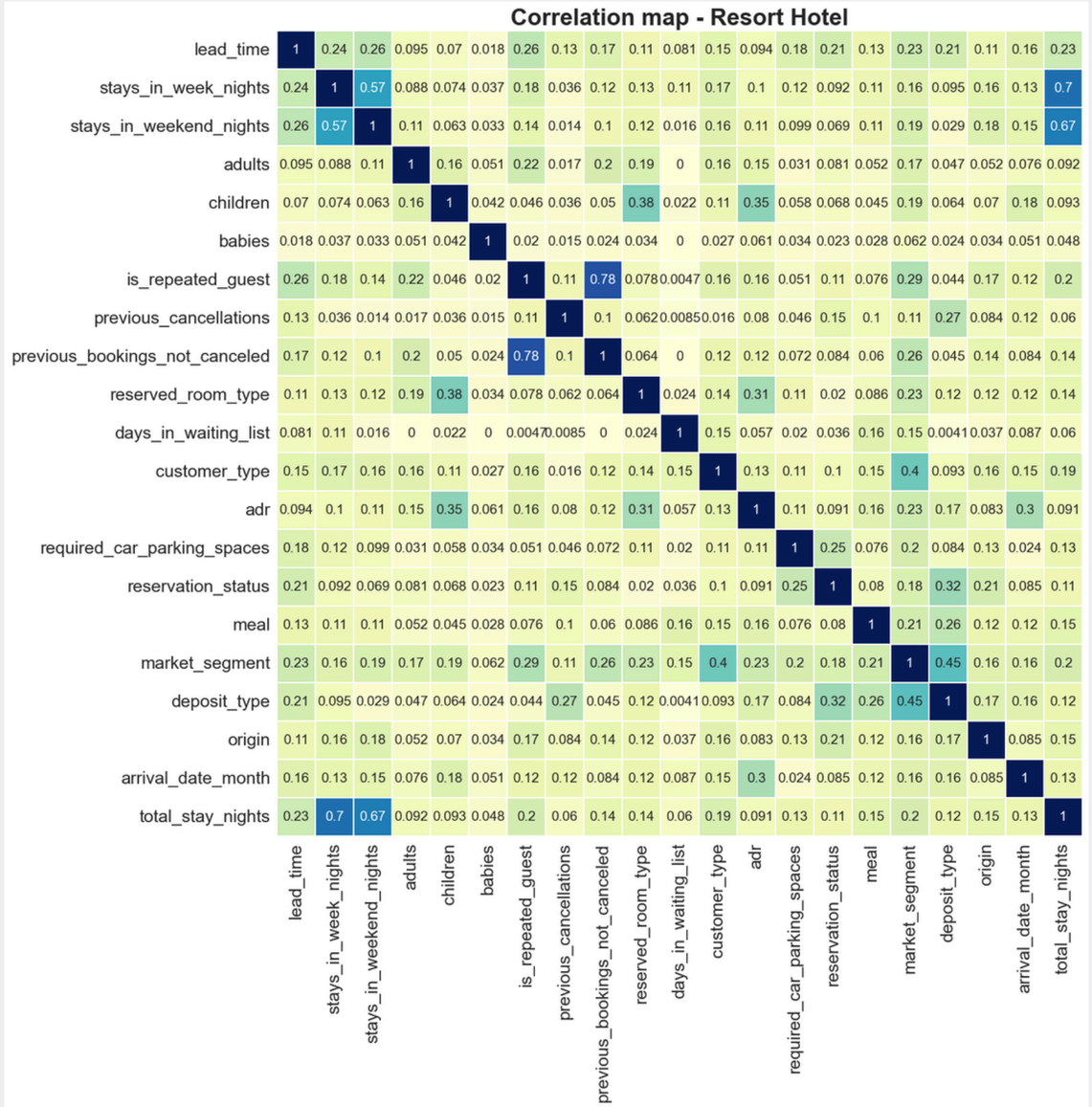
Perform clustering using different algorithms:

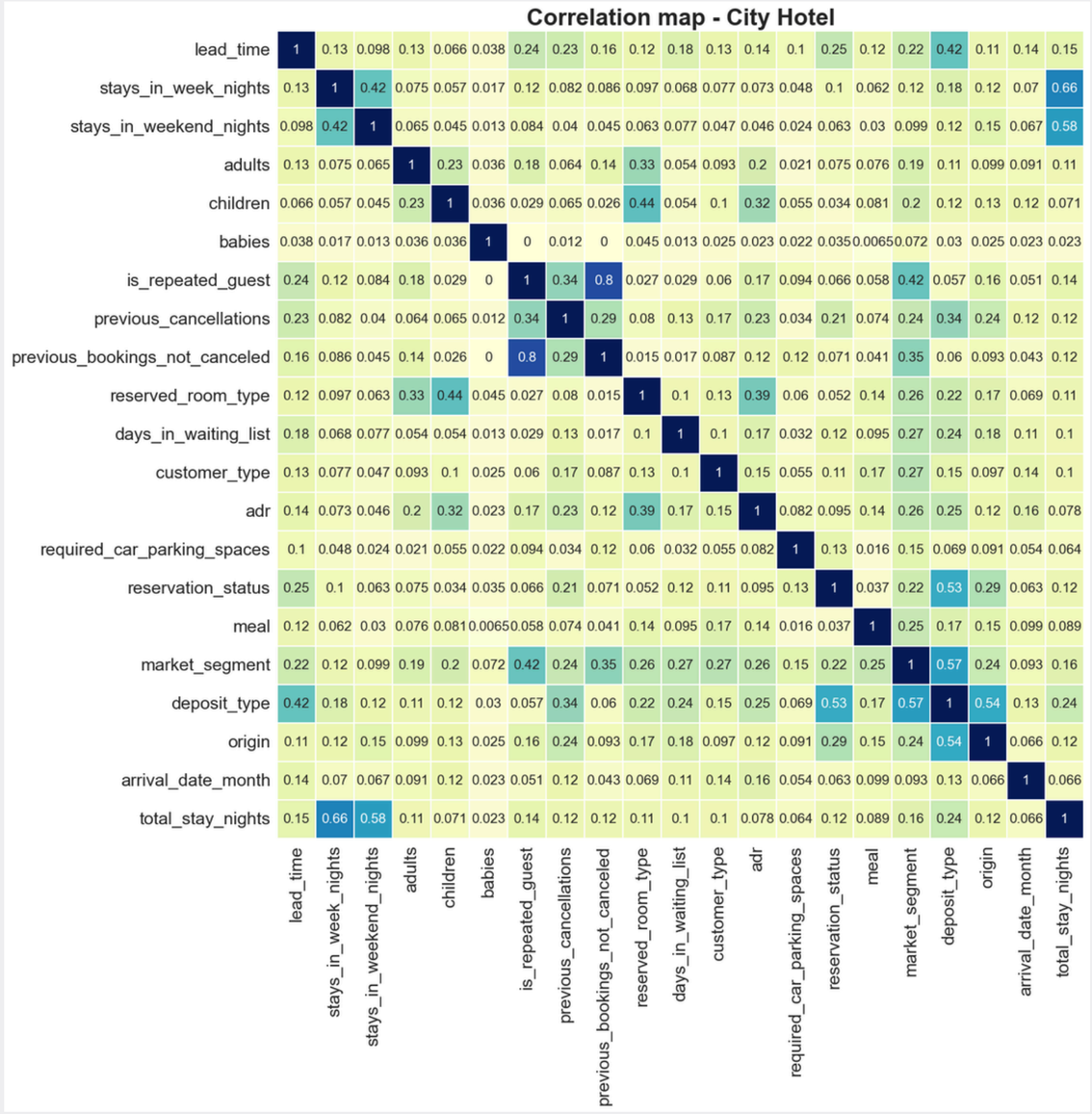
- K-Means: Optimize the number of clusters using the elbow method.
- Agglomerative Clustering.
- Mean Shift Clustering: Estimate the bandwidth and identify cluster sizes.

Compare clustering results based on silhouette scores.



Analysis


Correlation map - Resort Hotel
lead_time 1 0.24 0.26 0.095 0.07 0.018 0.26 0.13 0.17 0.11 0.081 0.15 0.094 0.18 0.21 0.13 0.23 0.21 0.11 0.16 0.23
stays_in_week_nights 0.24 1 0.57 0.088 0.074 0.037 0.18 0.036 0.12 0.13 0.11 0.17 0.1 0.12 0.092 0.11 0.16 0.095 0.16 0.13 0.7
stays_in_weekend_nights 0.26 0.57 1 0.11 0.063 0.033 0.14 0.014 0.1 0.12 0.016 0.16 0.11 0.099 0.069 0.11 0.19 0.029 0.18 0.15 0.67
adults 0.095 0.088 0.11 1 0.16 0.051 0.22 0.017 0.2 0.19 0 0.16 0.15 0.031 0.081 0.052 0.17 0.047 0.052 0.076 0.092
children 0.07 0.074 0.063 0.16 1 0.042 0.046 0.036 0.05 0.38 0.022 0.11 0.35 0.058 0.068 0.045 0.19 0.064 0.07 0.18 0.093
babies 0.018 0.037 0.033 0.051 0.042 1 0.02 0.015 0.024 0.034 0 0.027 0.061 0.034 0.023 0.028 0.062 0.024 0.034 0.051 0.048
is_repeated_guest 0.26 0.18 0.14 0.22 0.046 0.02 1 0.11 0.78 0.078 0.0047 0.16 0.16 0.051 0.11 0.076 0.29 0.044 0.17 0.12 0.2
previous_cancellations 0.13 0.036 0.014 0.017 0.036 0.015 0.11 1 0.1 0.062 0.0085 0.016 0.08 0.046 0.15 0.1 0.11 0.27 0.084 0.12 0.06
previous_bookings_not_canceled 0.17 0.12 0.1 0.2 0.05 0.024 0.78 0.1 1 0.064 0 0.12 0.12 0.072 0.084 0.06 0.26 0.045 0.14 0.084 0.14
reserved_room_type 0.11 0.13 0.12 0.19 0.38 0.034 0.078 0.062 0.064 1 0.024 0.14 0.31 0.11 0.02 0.086 0.23 0.12 0.12 0.12 0.14
days_in_waiting_list 0.081 0.11 0.016 0 0.022 0 0.0047 0.0085 0 0.024 1 0.15 0.057 0.02 0.036 0.16 0.15 0.0041 0.037 0.087 0.06
customer_type 0.15 0.17 0.16 0.16 0.11 0.027 0.16 0.016 0.12 0.14 0.15 1 0.13 0.11 0.1 0.15 0.4 0.093 0.16 0.15 0.19
adr 0.094 0.1 0.11 0.15 0.35 0.061 0.16 0.08 0.12 0.31 0.057 0.13 1 0.11 0.091 0.16 0.23 0.17 0.083 0.3 0.091
required_car_parking_spaces 0.18 0.12 0.099 0.031 0.058 0.034 0.051 0.046 0.072 0.11 0.02 0.11 0.11 1 0.25 0.076 0.2 0.084 0.13 0.024 0.13
reservation_status 0.21 0.092 0.069 0.081 0.068 0.023 0.11 0.15 0.084 0.02 0.036 0.1 0.091 0.25 1 0.08 0.18 0.32 0.21 0.085 0.11
meal 0.13 0.11 0.11 0.052 0.045 0.028 0.076 0.1 0.06 0.086 0.16 0.15 0.16 0.076 0.08 1 0.21 0.26 0.12 0.12 0.15
market_segment 0.23 0.16 0.19 0.17 0.19 0.062 0.29 0.11 0.26 0.23 0.15 0.4 0.23 0.2 0.18 0.21 1 0.45 0.16 0.16 0.2
deposit_type 0.21 0.095 0.029 0.047 0.064 0.024 0.044 0.27 0.045 0.12 0.0041 0.093 0.17 0.084 0.32 0.26 0.45 1 0.17 0.16 0.12
origin 0.11 0.16 0.18 0.052 0.07 0.034 0.17 0.084 0.14 0.12 0.037 0.16 0.083 0.13 0.21 0.12 0.16 0.17 1 0.085 0.15
arrival_date_month 0.16 0.13 0.15 0.076 0.18 0.051 0.12 0.12 0.084 0.12 0.087 0.15 0.3 0.024 0.085 0.12 0.16 0.16 0.085 1 0.13
total_stay_nights 0.23 0.7 0.67 0.092 0.093 0.048 0.2 0.06 0.14 0.14 0.06 0.19 0.091 0.13 0.11 0.15 0.2 0.12 0.15 0.13 1
lead_time
stays_in_week_nights
stays_in_weekend_nights
adults
children
babies
is_repeated_guest
previous_cancellations
previous_bookings_not_canceled
reserved_room_type
days_in_waiting_list
customer_type
adr
required_car_parking_spaces
reservation_status
meal
market_segment
deposit_type
origin
arrival_date_month
total_stay_nights


Correlation map - City Hotel
lead_time 1 0.13 0.098 0.13 0.066 0.038 0.24 0.23 0.16 0.12 0.18 0.13 0.14 0.1 0.25 0.12 0.22 0.42 0.11 0.14 0.15
stays_in_week_nights 0.13 1 0.42 0.075 0.057 0.017 0.12 0.082 0.086 0.097 0.068 0.077 0.073 0.048 0.1 0.062 0.12 0.18 0.12 0.07 0.66
stays_in_weekend_nights 0.098 0.42 1 0.065 0.045 0.013 0.084 0.04 0.045 0.063 0.077 0.047 0.046 0.024 0.063 0.03 0.099 0.12 0.15 0.067 0.58
adults 0.13 0.075 0.065 1 0.23 0.036 0.18 0.064 0.14 0.33 0.054 0.093 0.2 0.021 0.075 0.076 0.19 0.11 0.099 0.091 0.11
children 0.066 0.057 0.045 0.23 1 0.036 0.029 0.065 0.026 0.44 0.054 0.1 0.32 0.055 0.034 0.081 0.2 0.12 0.13 0.12 0.071
babies 0.038 0.017 0.013 0.036 0.036 1 0 0.012 0 0.045 0.013 0.025 0.023 0.022 0.035 0.0065 0.072 0.03 0.025 0.023 0.023
is_repeated_guest 0.24 0.12 0.084 0.18 0.029 0 1 0.34 0.8 0.027 0.029 0.06 0.17 0.094 0.066 0.058 0.42 0.057 0.16 0.051 0.14
previous_cancellations 0.23 0.082 0.04 0.064 0.065 0.012 0.34 1 0.29 0.08 0.13 0.17 0.23 0.034 0.21 0.074 0.24 0.34 0.24 0.12 0.12
previous_bookings_not_canceled 0.16 0.086 0.045 0.14 0.026 0 0.8 0.29 1 0.015 0.017 0.087 0.12 0.12 0.071 0.041 0.35 0.06 0.093 0.043 0.12
reserved_room_type 0.12 0.097 0.063 0.33 0.44 0.045 0.027 0.08 0.015 1 0.1 0.13 0.39 0.06 0.052 0.14 0.26 0.22 0.17 0.069 0.11
days_in_waiting_list 0.18 0.068 0.077 0.054 0.054 0.013 0.029 0.13 0.017 0.1 1 0.1 0.17 0.032 0.12 0.095 0.27 0.24 0.18 0.11 0.1
customer_type 0.13 0.077 0.047 0.093 0.1 0.025 0.06 0.17 0.087 0.13 0.1 1 0.15 0.055 0.11 0.17 0.27 0.15 0.097 0.14 0.1
adr 0.14 0.073 0.046 0.2 0.32 0.023 0.17 0.23 0.12 0.39 0.17 0.15 1 0.082 0.095 0.14 0.26 0.25 0.12 0.16 0.078
required_car_parking_spaces 0.1 0.048 0.024 0.021 0.055 0.022 0.094 0.034 0.12 0.06 0.032 0.055 0.082 1 0.13 0.016 0.15 0.069 0.091 0.054 0.064
reservation_status 0.25 0.1 0.063 0.075 0.034 0.035 0.066 0.21 0.071 0.052 0.12 0.11 0.095 0.13 1 0.037 0.22 0.53 0.29 0.063 0.12
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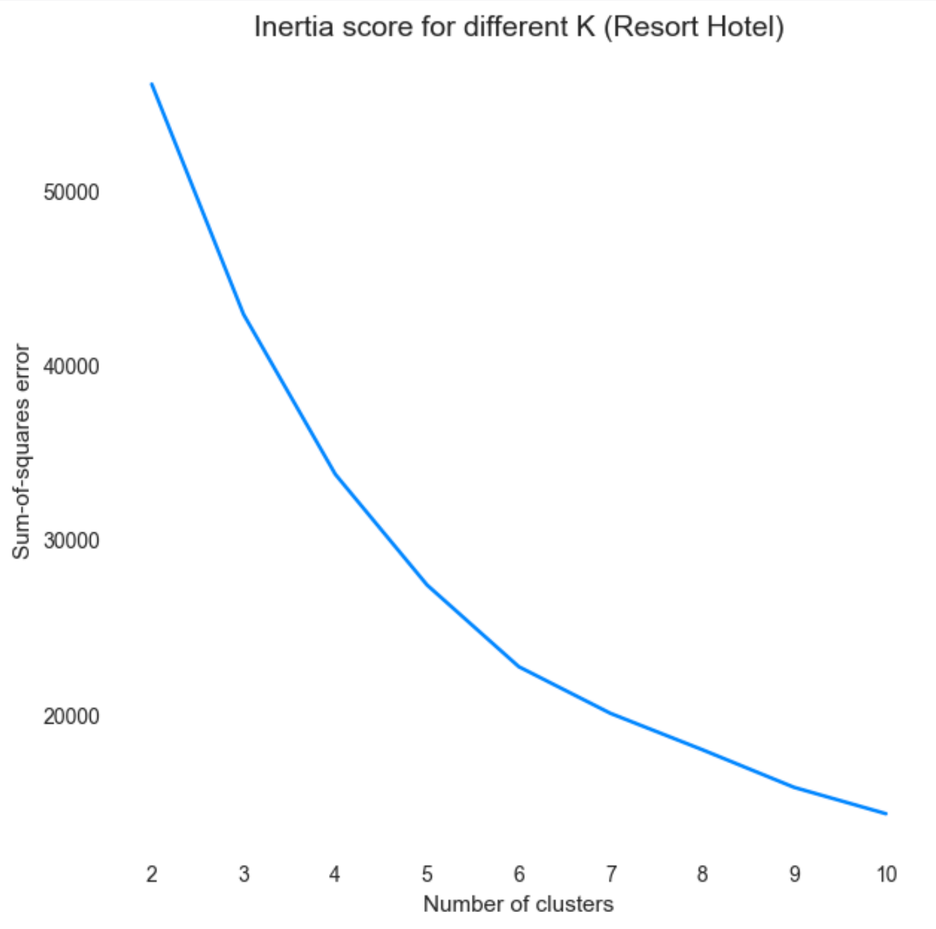
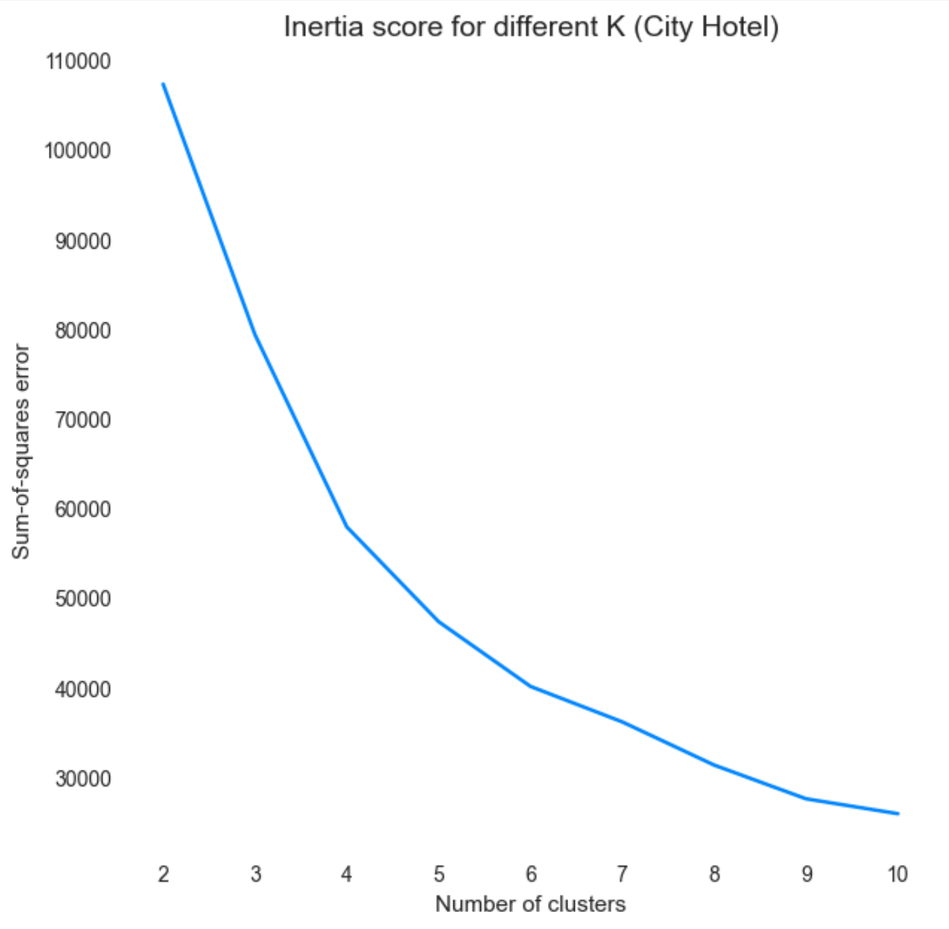
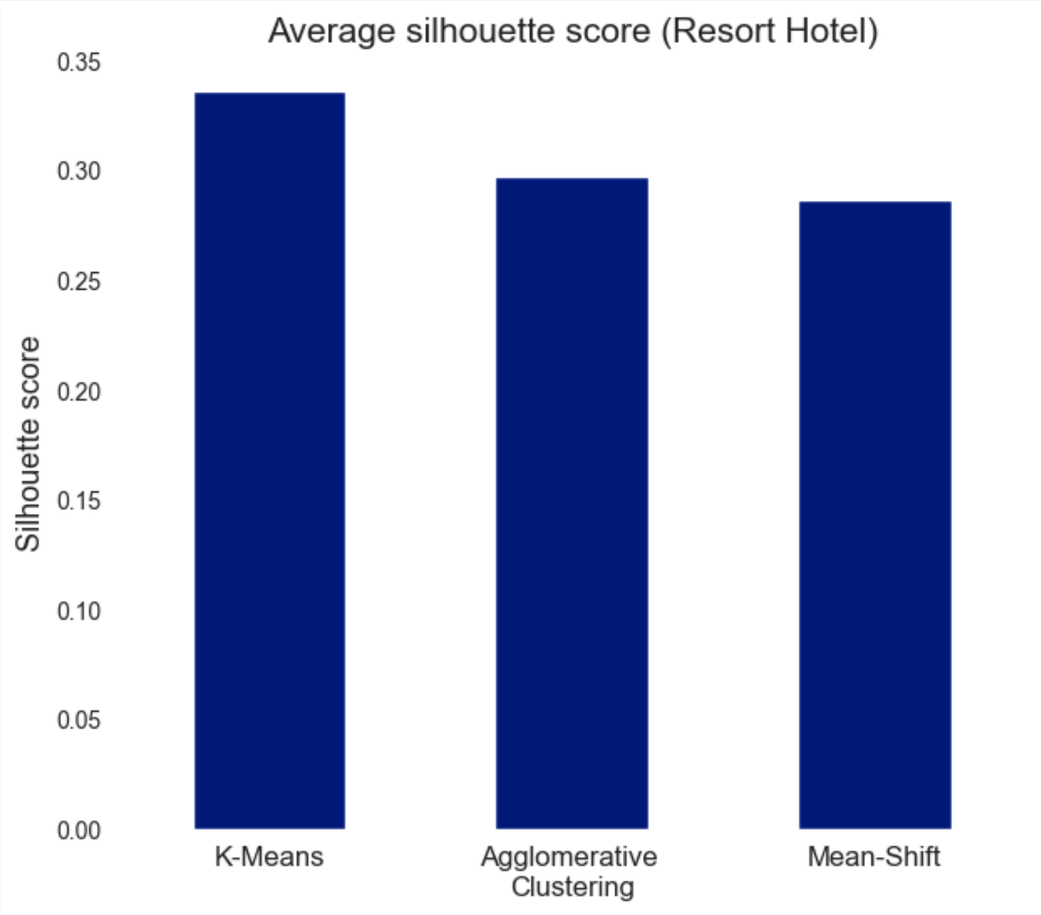
market_segment 0.22 0.12 0.099 0.19 0.2 0.072 0.42 0.24 0.35 0.26 0.27 0.27 0.26 0.15 0.22 0.25 1 0.57 0.24 0.093 0.16
deposit_type 0.42 0.18 0.12 0.11 0.12 0.03 0.057 0.34 0.06 0.22 0.24 0.15 0.25 0.069 0.53 0.17 0.57 1 0.54 0.13 0.24
origin 0.11 0.12 0.15 0.099 0.13 0.025 0.16 0.24 0.093 0.17 0.18 0.097 0.12 0.091 0.29 0.15 0.24 0.54 1 0.066 0.12
arrival_date_month 0.14 0.07 0.067 0.091 0.12 0.023 0.051 0.12 0.043 0.069 0.11 0.14 0.16 0.054 0.063 0.099 0.093 0.13 0.066 1 0.066
total_stay_nights 0.15 0.66 0.58 0.11 0.071 0.023 0.14 0.12 0.12 0.11 0.1 0.1 0.078 0.064 0.12 0.089 0.16 0.24 0.12 0.066 1
lead_time
stays_in_week_nights
stays_in_weekend_nights
adults
children
babies
is_repeated_guest
previous_cancellations
previous_bookings_not_canceled
reserved_room_type
days_in_waiting_list
customer_type
adr
required_car_parking_spaces
reservation_status
meal
market_segment
deposit_type
origin
arrival_date_month
total_stay_nights

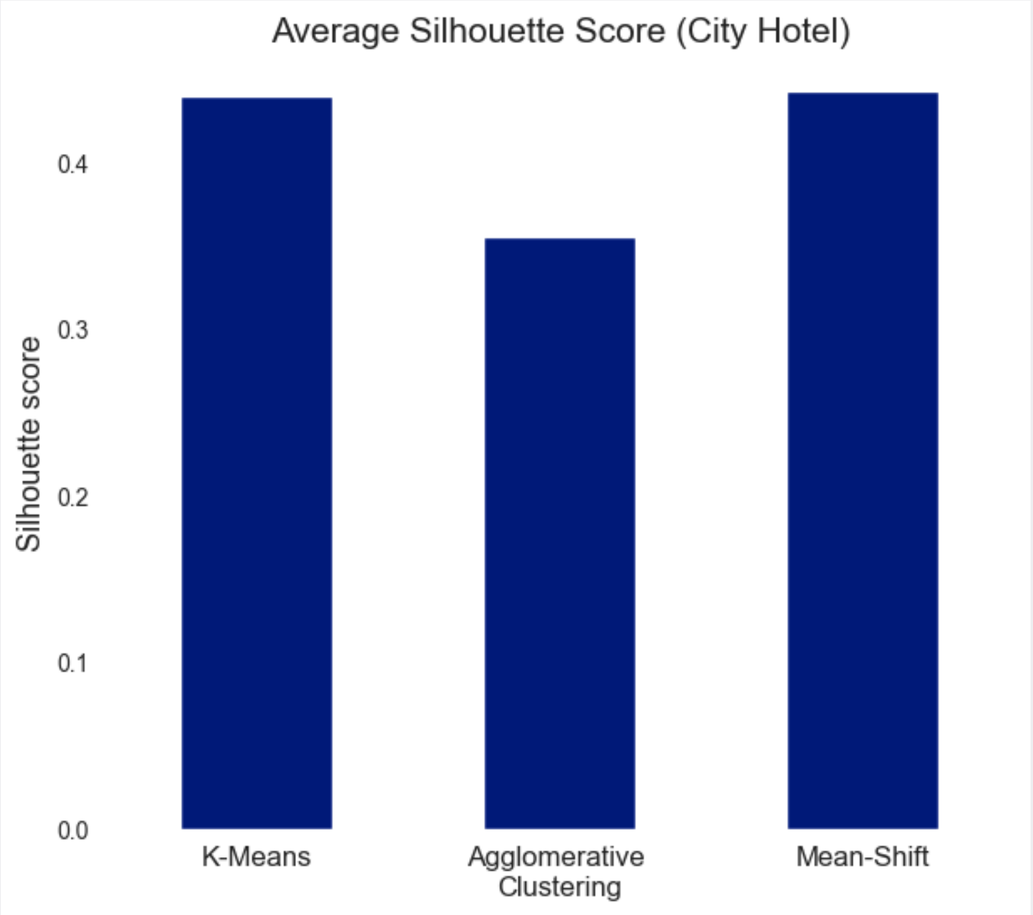
Analysis


Inertia score for different K (Resort Hotel)
Sum-of-squares error
50000
40000
30000
20000
2
3
4
5
6
7
8
9
10
Number of clusters

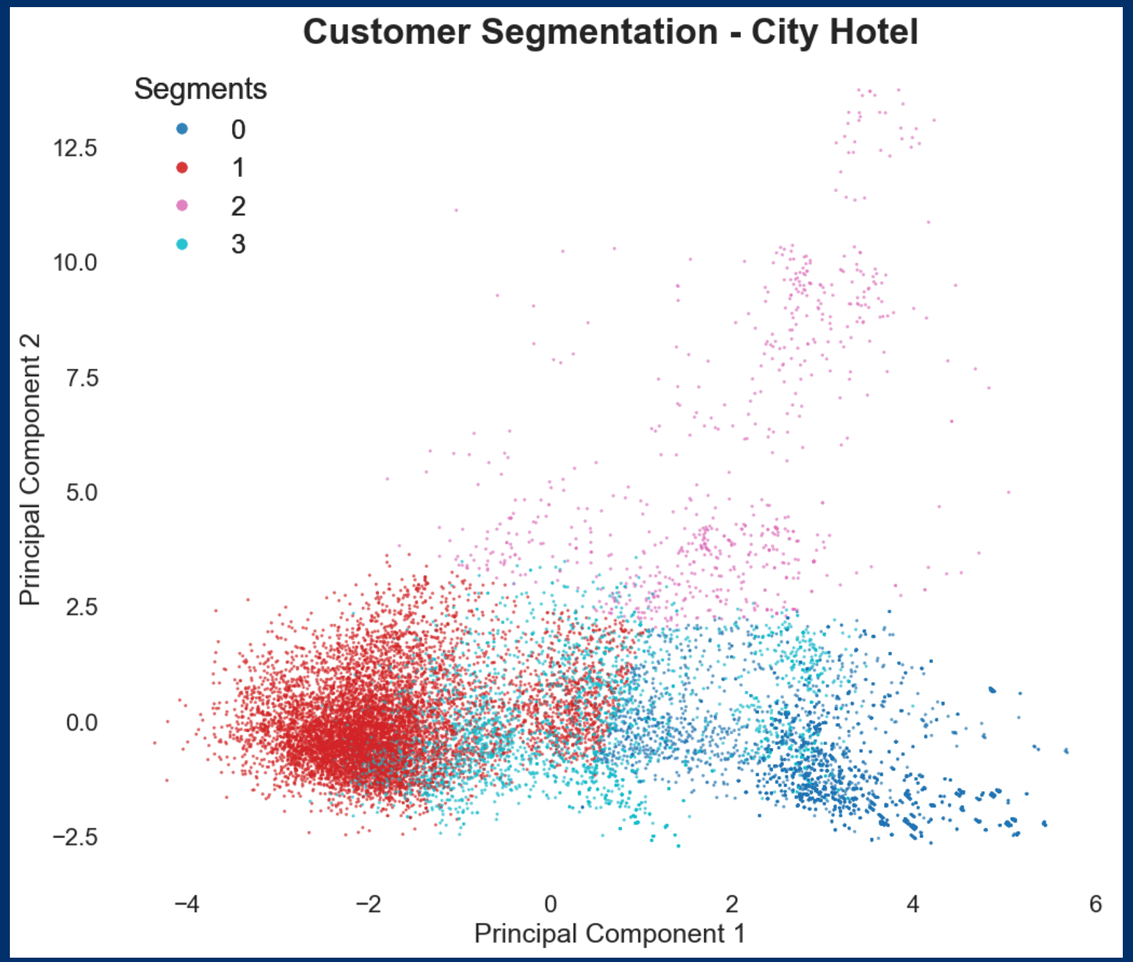

Inertia score for different K (City Hotel)
Sum-of-squares error
110000
100000
90000
80000
70000
60000
50000
40000
30000
2
3
4
5
6
7
8
9
10
Number of clusters

Analysis


Average silhouette score (Resort Hotel)
Silhouette score
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
K-Means
Agglomerative Clustering
Mean-Shift


Average Silhouette Score (City Hotel)
Silhouette score
0.4
0.3
0.2
0.1
0.0
K-Means
Agglomerative Clustering
Mean-Shift

Segmentation



Segmentation - Resort Hotel

cluster_id	0	1	2	3	4
stays_in_week_nights	1	5	5	5	2
stays_in_weekend_nights	0	2	2	2	0
adults	2.0	2.0	2.0	2.0	2.0
children	0.0	0.0	0.0	0.0	0.0
babies	0.0	0.0	0.0	0.0	0.0
is_repeated_guest	0	0	0	0	0
previous_cancellations	0	0	0	0	0
previous_bookings_not_canceled	0	0	0	0	0
reserved_room_type	A	A	A	A	A
customer_type	Transient	Transient	Transient-Party	Transient	Transient
required_car_parking_spaces	0	0	0	0	0
reservation_status	Check-Out	Check-Out	Check-Out	Canceled	Check-Out
country	Portugal	United Kingdom	United Kingdom	Portugal	Spain
meal	Bed & Breakfast	Bed & Breakfast	Bed & Breakfast	Bed & Breakfast	Bed & Breakfast
market_segment	Direct	Online TA	Groups	Online TA	Online TA
deposit_type	No Deposit	No Deposit	No Deposit	No Deposit	No Deposit
origin	Portugal	Other Europe	Other Europe	Portugal	Spain
arrival_date_month	February	July	October	August	August
lead_time	7.0	123.000000	144.00	90.000000	21.0
adr	51.0	98.019997	59.85	120.599998	91.0

Group 1

- Short stays (1 weekday, 0 weekend night) with direct bookings from Portugal.
- Very low ADR (€51.0) and short lead time (7 days).

Group 2

- Long stays (5 weekday, 2 weekend nights) via Online TA from the United Kingdom.
- Higher ADR (€98.0) and long lead time (123 days).

Group 3

- Similar to Cluster 1 but booked by Groups with lower ADR (€59.85) and slightly longer lead time (144 days).

Group 4

- Medium stays (5 weekday, 2 weekend nights) via Online TA from Portugal.
- Highest ADR (€120.6) and medium lead time (90 days).
- High cancellation rates.

Group 5

- Short stays (2 weekday nights, 0 weekend) via Online TA from Spain.
- Moderate ADR (€91.0) and short lead time (21 days).

Segmentation - City Hotel

cluster_id	0	1	2	3
stays_in_week_nights	2	2	1	2
stays_in_weekend_nights	0	0	0	0
adults	2.0	2.0	1.0	2.0
children	0.0	0.0	0.0	0.0
babies	0.0	0.0	0.0	0.0
is_repeated_guest	0	0	0	0
previous_cancellations	0	0	0	0
previous_bookings_not_canceled	0	0	0	0
reserved_room_type	A	A	A	A
customer_type	Transient	Transient	Transient	Transient-Party
required_car_parking_spaces	0	0	0	0
reservation_status	Canceled	Check-Out	Check-Out	Check-Out
country	Portugal	France	Portugal	Germany
meal	Bed & Breakfast	Bed & Breakfast	Bed & Breakfast	Bed & Breakfast
market_segment	Groups	Online TA	Corporate	Offline TA/TO
deposit_type	Non Refund	No Deposit	No Deposit	No Deposit
origin	Portugal	Other Europe	Portugal	Germany
arrival_date_month	September	August	January	October
lead_time	164.0	53.0	5.0	85.0
adr	85.0	116.0	75.0	91.0

Group 1

Travelers from Portugal booking as part of groups, staying 2 weekday nights. They have the longest lead time (164 days) but moderate ADR (€85) and high cancellation rates due to non-refundable deposits.

Group 2

Transient guests from France staying 2 weekday nights, booked through Online Travel Agents. With a 53-day lead time and the highest ADR (€116).

Group 3

Corporate guests from Portugal on short business trips, staying 1 weekday night with a very short lead time (5 days). They enjoy the lowest ADR (€75).

Group 4

Travelers from Germany booking medium stays (2 weekday nights) through Offline TA/TO. With an 85-day lead time and moderate ADR (€91),

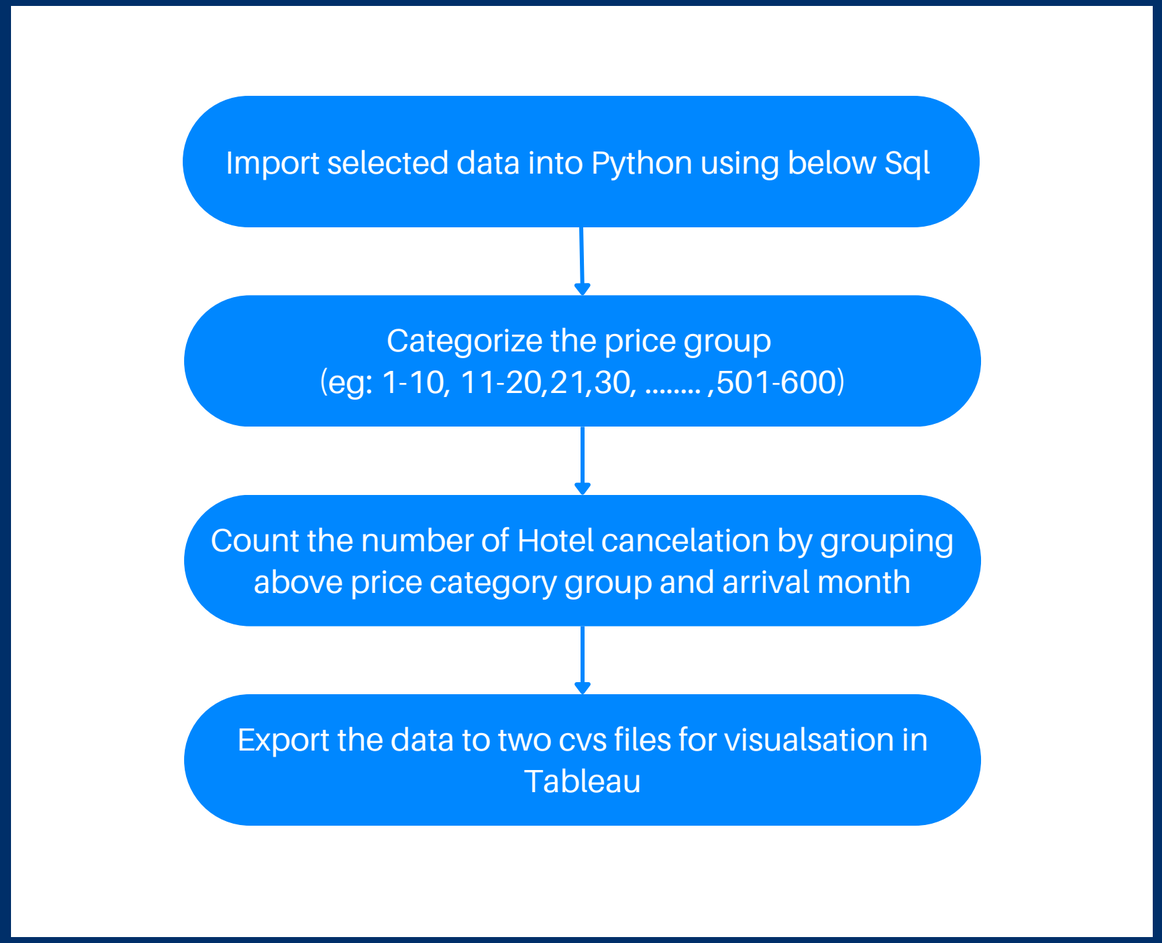
How to reduce the hotel room cancellation rate by 10%?

Analyze **room price** and **month** as factors to find out the reasons behind the hotel cancellation rate

Reason:

- Price Sensitivity, Promotional Impact
- Seasonality, Travel Trends

Analyzing these factors provides insights into how pricing strategies and seasonality affect cancellations.



Analysis

City Hotel Cancellation HeatMap by Price Category vs Month

	Month											
Price Categ..	January	Februa..	March	April	May	June	July	August	Septe..	October	Novem..	Decem..
1-10	1.0	0.0	4.0	6.0	1.0	1.0	1.0	3.0	5.0	1.0	2.0	2.0
11-20	0.0	6.0	7.0	5.0	9.0	0.0	2.0	19.0	6.0	9.0	2.0	1.0
21-30	0.0	0.0	0.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31-40	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	0.0	1.0	0.0	1.0
41-50	0.0	5.0	2.0	2.0	0.0	0.0	10.0	1.0	87.0	2.0	1.0	8.0
51-60	26.0	153.0	27.0	14.0	74.0	10.0	50.0	84.0	84.0	112.0	57.0	72.0
61-70	302.0	173.0	298.0	233.0	201.0	208.0	817.0	886.0	688.0	716.0	222.0	305.0
71-80	560.0	758.0	496.0	175.0	74.0	131.0	220.0	111.0	154.0	174.0	279.0	353.0
81-90	212.0	140.0	420.0	426.0	373.0	244.0	322.0	274.0	200.0	276.0	377.0	361.0
91-100	108.0	196.0	364.0	696.0	436.0	353.0	262.0	280.0	219.0	413.0	303.0	109.0
101-110	94.0	90.0	223.0	492.0	268.0	380.0	379.0	356.0	344.0	702.0	157.0	180.0
111-120	32.0	39.0	90.0	364.0	313.0	668.0	208.0	229.0	298.0	274.0	52.0	96.0
121-130	22.0	35.0	149.0	285.0	558.0	528.0	211.0	235.0	204.0	107.0	49.0	55.0
131-140	24.0	26.0	61.0	244.0	324.0	321.0	202.0	309.0	127.0	192.0	19.0	43.0
141-150	19.0	22.0	41.0	98.0	190.0	127.0	138.0	121.0	116.0	64.0	31.0	26.0
151-160	12.0	22.0	29.0	59.0	307.0	120.0	112.0	181.0	81.0	65.0	12.0	33.0
161-170	6.0	9.0	28.0	71.0	88.0	158.0	72.0	104.0	323.0	22.0	10.0	16.0
171-180	2.0	7.0	9.0	76.0	67.0	50.0	59.0	79.0	24.0	20.0	8.0	6.0
181-190	1.0	3.0	9.0	33.0	95.0	42.0	46.0	36.0	17.0	8.0	6.0	2.0
191-200	0.0	10.0	13.0	30.0	49.0	32.0	31.0	75.0	14.0	11.0	2.0	8.0
201-250	0.0	5.0	18.0	64.0	84.0	71.0	63.0	118.0	47.0	27.0	7.0	5.0
251-300	0.0	1.0	4.0	12.0	27.0	13.0	11.0	18.0	5.0	3.0	0.0	3.0
301-350	0.0	0.0	0.0	0.0	4.0	2.0	1.0	2.0	1.0	0.0	0.0	0.0
351-400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
401-500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
501-600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Resort Hotel Canellation HeatMap by Price Category Vs Month

	Month											
Price Categ..	January	Februa..	March	April	May	June	July	August	Septe..	October	Novem..	Decem..
1-10	2.0	3.0	5.0	1.0	6.0	4.0	4.0	3.0	40.0	8.0	2.0	2.0
11-20	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	2.0	0.0	0.0
21-30	12.0	30.0	61.0	2.0	3.0	1.0	1.0	0.0	4.0	0.0	45.0	9.0
31-40	54.0	99.0	78.0	9.0	5.0	0.0	3.0	1.0	85.0	158.0	176.0	69.0
41-50	71.0	200.0	125.0	103.0	107.0	7.0	1.0	0.0	81.0	179.0	69.0	70.0
51-60	68.0	94.0	117.0	114.0	138.0	41.0	8.0	1.0	92.0	163.0	64.0	87.0
61-70	19.0	141.0	116.0	134.0	119.0	54.0	9.0	1.0	66.0	123.0	50.0	135.0
71-80	45.0	111.0	72.0	202.0	138.0	130.0	24.0	1.0	110.0	112.0	13.0	96.0
81-90	20.0	45.0	90.0	213.0	166.0	93.0	30.0	10.0	149.0	64.0	13.0	31.0
91-100	7.0	19.0	25.0	64.0	56.0	81.0	52.0	15.0	59.0	48.0	3.0	21.0
101-110	1.0	3.0	18.0	36.0	44.0	129.0	56.0	18.0	28.0	15.0	0.0	14.0
111-120	1.0	2.0	10.0	51.0	58.0	68.0	90.0	48.0	63.0	24.0	0.0	16.0
121-130	1.0	0.0	2.0	36.0	44.0	62.0	106.0	70.0	39.0	18.0	0.0	5.0
131-140	0.0	1.0	0.0	16.0	22.0	73.0	103.0	90.0	36.0	6.0	1.0	4.0
141-150	0.0	2.0	3.0	12.0	28.0	37.0	59.0	50.0	30.0	5.0	1.0	7.0
151-160	0.0	1.0	0.0	14.0	23.0	44.0	138.0	101.0	31.0	1.0	0.0	1.0
161-170	0.0	0.0	0.0	8.0	12.0	39.0	87.0	74.0	16.0	9.0	0.0	4.0
171-180	0.0	0.0	0.0	7.0	8.0	34.0	111.0	89.0	8.0	3.0	0.0	6.0
181-190	0.0	0.0	0.0	7.0	2.0	14.0	63.0	135.0	10.0	0.0	0.0	0.0
191-200	0.0	0.0	0.0	7.0	2.0	23.0	99.0	117.0	15.0	1.0	0.0	1.0
201-250	0.0	0.0	0.0	4.0	5.0	40.0	274.0	558.0	14.0	1.0	0.0	3.0
251-300	0.0	0.0	0.0	0.0	0.0	8.0	70.0	182.0	4.0	0.0	0.0	5.0
301-350	0.0	0.0	0.0	0.0	0.0	1.0	18.0	37.0	0.0	0.0	0.0	2.0
351-400	0.0	0.0	0.0	0.0	0.0	0.0	3.0	9.0	0.0	0.0	0.0	2.0
401-500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
501-600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Analysis

Seasonality:
•Peak cancellation months are visible for certain price ranges:
•**July to August** shows high cancellations for resort hotel,
•**May to September** show has high cancellation rate for city hotel.
• The reason of highest cancellations, indicating a seasonal impact during the summer travel season.

Price Sensitivity:
•Price categories **61-100** experience the highest cancellation rates consistently across all months in city hotel, higher cancellation rate in higher prices category(**150-300**) for resort hotel particularly in July and Aug.
•Lower price categories (10-50) have relatively fewer cancellations, possibly due to their appeal to budget travelers who are less likely to change plans.

Potential Solution

Evaluation Method Used : **Scenario Analysis with Simulation**.

Scenario Analysis:

- Two strategies (stricter cancellation policies and discounts for non-cancellable bookings)
- Analyzing the impact of different interventions on the target group.

Simulation:

- By simulating a 10% cancellation reduction, the potential impact of the strategies without full implementation.
- The simulation provides a controlled way to forecast outcomes based on historical data or predictive models.

Desired Outcome

City Hotel Cancellation(After Simulation) HeatMap by Price Category vs Month

	Month											
Price Categ..	January	February	March	April	May	June	July	August	Septem..	October	Novem..	Decem..
1-10	0.9	0.0	3.6	5.4	0.9	0.9	0.9	2.7	4.5	0.9	1.8	1.8
11-20	0.0	5.4	6.3	4.5	8.1	0.0	1.8	17.1	5.4	8.1	1.8	0.9
21-30	0.0	0.0	0.0	1.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31-40	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.7	0.0	0.9	0.0	0.9
41-50	0.0	4.5	1.8	1.8	0.0	0.0	9.0	0.9	78.3	1.8	0.9	7.2
51-60	23.4	137.7	24.3	12.6	66.6	9.0	45.0	75.6	75.6	100.8	51.3	64.8
61-70	271.8	155.7	268.2	209.7	180.9	187.2	735.3	797.4	619.2	644.4	199.8	274.5
71-80	504.0	682.2	446.4	157.5	66.6	117.9	198.0	99.9	138.6	156.6	251.1	317.7
81-90	190.8	126.0	378.0	383.4	335.7	219.6	289.8	246.6	180.0	248.4	339.3	324.9
91-100	97.2	176.4	327.6	626.4	392.4	317.7	235.8	252.0	197.1	371.7	272.7	98.1
101-110	84.6	81.0	200.7	442.8	241.2	342.0	341.1	320.4	309.6	631.8	141.3	162.0
111-120	28.8	35.1	81.0	327.6	281.7	601.2	187.2	206.1	268.2	246.6	46.8	86.4
121-130	19.8	31.5	134.1	256.5	502.2	475.2	189.9	211.5	183.6	96.3	44.1	49.5
131-140	21.6	23.4	54.9	219.6	291.6	288.9	181.8	278.1	114.3	172.8	17.1	38.7
141-150	17.1	19.8	36.9	88.2	171.0	114.3	124.2	108.9	104.4	57.6	27.9	23.4
151-160	10.8	19.8	26.1	53.1	276.3	108.0	100.8	162.9	72.9	58.5	10.8	29.7
161-170	5.4	8.1	25.2	63.9	79.2	142.2	64.8	93.6	290.7	19.8	9.0	14.4
171-180	1.8	6.3	8.1	68.4	60.3	45.0	53.1	71.1	21.6	18.0	7.2	5.4
181-190	0.9	2.7	8.1	29.7	85.5	37.8	41.4	32.4	15.3	7.2	5.4	1.8
191-200	0.0	9.0	11.7	27.0	44.1	28.8	27.9	67.5	12.6	9.9	1.8	7.2
201-250	0.0	4.5	16.2	57.6	75.6	63.9	56.7	106.2	42.3	24.3	6.3	4.5
251-300	0.0	0.9	3.6	10.8	24.3	11.7	9.9	16.2	4.5	2.7	0.0	2.7
301-350	0.0	0.0	0.0	0.0	3.6	1.8	0.9	1.8	0.9	0.0	0.0	0.0
351-400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
401-500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
501-600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ResortHotelCancellationAfterSimulation

	Month											
Price Categ..	January	Februa..	March	April	May	June	July	August	Septe..	October	Novem..	Decem..
1-10	1.8	2.7	4.5	0.9	5.4	3.6	3.6	2.7	36.0	7.2	1.8	1.8
11-20	0.0	0.9	0.9	0.9	0.9	0.0	0.9	0.9	0.9	1.8	0.0	0.0
21-30	10.8	27.0	54.9	1.8	2.7	0.9	0.9	0.0	3.6	0.0	40.5	8.1
31-40	48.6	89.1	70.2	8.1	4.5	0.0	2.7	0.9	76.5	142.2	158.4	62.1
41-50	63.9	180.0	112.5	92.7	96.3	6.3	0.9	0.0	72.9	161.1	62.1	63.0
51-60	61.2	84.6	105.3	102.6	124.2	36.9	7.2	0.9	82.8	146.7	57.6	78.3
61-70	17.1	126.9	104.4	120.6	107.1	48.6	8.1	0.9	59.4	110.7	45.0	121.5
71-80	40.5	99.9	64.8	181.8	124.2	117.0	21.6	0.9	99.0	100.8	11.7	86.4
81-90	18.0	40.5	81.0	191.7	149.4	83.7	27.0	9.0	134.1	57.6	11.7	27.9
91-100	6.3	17.1	22.5	57.6	50.4	72.9	46.8	13.5	53.1	43.2	2.7	18.9
101-110	0.9	2.7	16.2	32.4	39.6	116.1	50.4	16.2	25.2	13.5	0.0	12.6
111-120	0.9	1.8	9.0	45.9	52.2	61.2	81.0	43.2	56.7	21.6	0.0	14.4
121-130	0.9	0.0	1.8	32.4	39.6	55.8	95.4	63.0	35.1	16.2	0.0	4.5
131-140	0.0	0.9	0.0	14.4	19.8	65.7	92.7	81.0	32.4	5.4	0.9	3.6
141-150	0.0	1.8	2.7	10.8	25.2	33.3	53.1	45.0	27.0	4.5	0.9	6.3
151-160	0.0	0.9	0.0	12.6	20.7	39.6	124.2	90.9	27.9	0.9	0.0	0.9
161-170	0.0	0.0	0.0	7.2	10.8	35.1	78.3	66.6	14.4	8.1	0.0	3.6
171-180	0.0	0.0	0.0	6.3	7.2	30.6	99.9	80.1	7.2	2.7	0.0	5.4
181-190	0.0	0.0	0.0	6.3	1.8	12.6	56.7	121.5	9.0	0.0	0.0	0.0
191-200	0.0	0.0	0.0	6.3	1.8	20.7	89.1	105.3	13.5	0.9	0.0	0.9
201-250	0.0	0.0	0.0	3.6	4.5	36.0	246.6	502.2	12.6	0.9	0.0	2.7
251-300	0.0	0.0	0.0	0.0	0.0	7.2	63.0	163.8	3.6	0.0	0.0	4.5
301-350	0.0	0.0	0.0	0.0	0.0	0.9	16.2	33.3	0.0	0.0	0.0	1.8
351-400	0.0	0.0	0.0	0.0	0.0	0.0	2.7	8.1	0.0	0.0	0.0	1.8
401-500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0
501-600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Conclusion

Why this method?

Flexibility: Allows testing multiple strategies and understanding their impact without committing resources upfront.

Cost-Effectiveness: Simulations generate valuable insights without the expense of full-scale implementation.

Risk factors in the proposal

Customer Dissatisfaction: Stricter policies could frustrate customers, leading to negative reviews and reduced loyalty.

Revenue Impact: Discounts or giveaways might lower profit margins, especially if many customers take advantage of them.

Why this evaluation is the best?

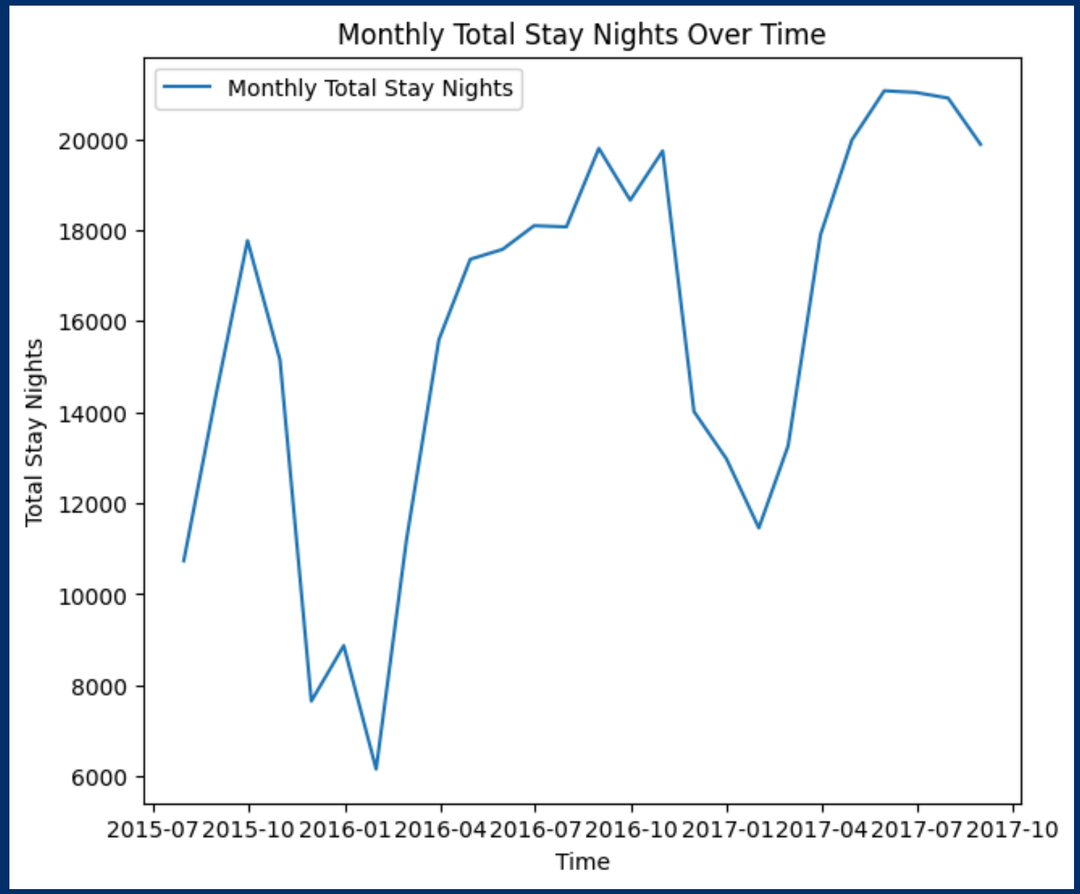
Data-Driven Decision-Making: The use of simulations ensures decisions are informed by data and predictive insights.
Strategic Exploration: Scenario analysis allows for comparing different approaches, identifying the most viable one.
Minimized Risk: Evaluating the impact through simulation mitigates the risks of applying untested strategies to all customers.

What are the peak seasons and low-demand periods of each hotel?

1.Summer Peaks:
The consistent **spikes in mid-year** (**June to August**) align with **summer vacations** in Europe, when tourists flock to Portugal for its warm climate, beaches, and vibrant festivals such as the Lisbon Festivities (June).Family travel during **school holidays** also contributes significantly to this high demand.

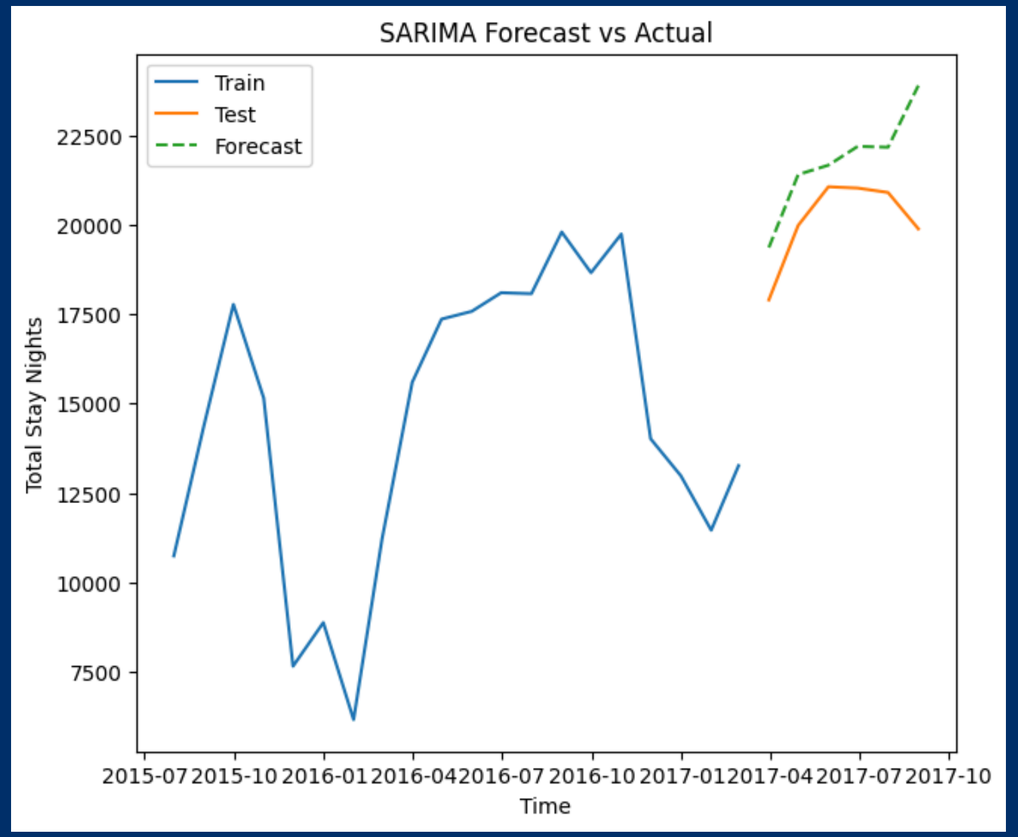
2. Winter Dips:
Early-year declines (January and February) coincide with **winter weather,** which is less favorable for travel. **Post-holiday financial constraints and reduced events** further reduce hotel bookings during this time.

3. Shoulder Seasons (Spring and Fall):
Spring (March to May) and **Fall** (September to October) often attract **cultural and historical tourism**, as mild weather makes sightseeing ideal. These periods may show moderate demand compared to summer but higher than winter.



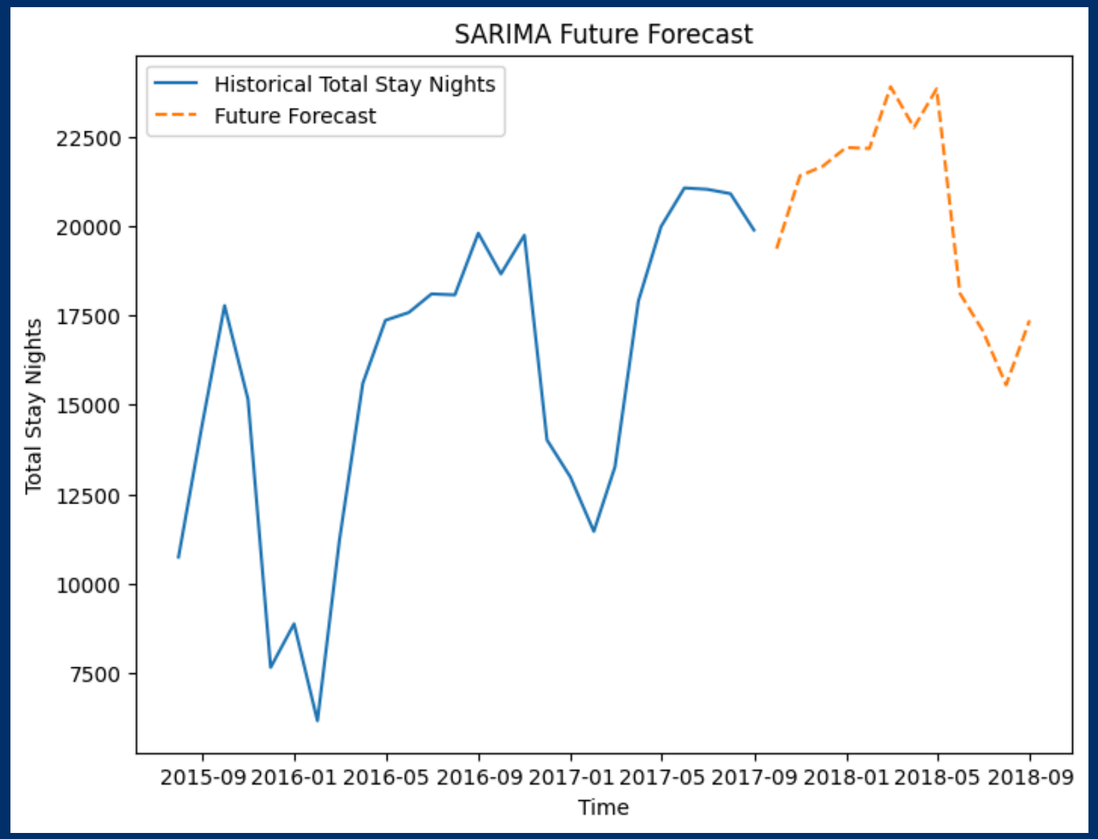
What is the sales and number of bookings forecast for the next 12 months?

1. The forecast predicts a peak in total stay nights during the summer months, reaching approximately **22,500 stay nights in August 2017**, which aligns closely with historical summer peaks. During the winter months, the forecast expects a significant dip, with total stay nights **dropping to around 9,000 in January 2018**, suggest a consistent cyclical pattern in booking behavior.
2. Forecast Accuracy: The SARIMA model provides a reasonably accurate prediction, **reflected by the normalized RMSE of 13.29%**. This level of error indicates that the model captures the overall trend and seasonality well, although minor deviations may occur.
3. Peaks and Troughs Alignment: High-demand periods in the forecast align with prior summer peaks (around July to August), while low-demand periods (around January to February) continue to show reduced activity.
4. Confidence in Historical Pattern Continuation: The forecast assumes a stable continuation of historical booking patterns, indicating that no significant external disruptions are factored in.



SARIMA (Seasonal Autoregressive Integrated Moving Average) model

1. Handles Seasonality: SARIMA explicitly models seasonal patterns, such as weekly, monthly, or yearly fluctuations, making it effective for capturing recurring data trends in industries like hospitality.
2. Autoregression and Moving Average: Incorporates both past values and errors, allowing it to capture dependencies and provide more accurate forecasts.
3. Flexibility: Adaptable to different seasonal periods and can be customized to fit specific data characteristics.
4. Forecasting Performance: Known for its accuracy in handling seasonal data, making it suitable for long-term predictions in industries with identifiable seasonality.



Business Recommendation

Address Low-Season Demand (Winter Months)

- **Offer Seasonal Discounts:** Provide attractive discounts and packages during low-demand months (e.g., January and February) to incentivize bookings.
- **Event Partnerships:** Collaborate with local events or festivals during winter to attract visitors, such as winter markets, holiday celebrations, or indoor cultural events.
- **Thematic Promotions:** Introduce winter-themed experiences like spa retreats, cozy culinary packages, or indoor activities tailored to families and couples.

Enhance Peak-Season Revenue (Summer Months)

- **Dynamic Pricing:** Room night is a perishable product, so we need to optimize revenue during summer by implementing dynamic pricing to capture higher earnings during peak demand.
- **Upsell Premium Experiences:** Offer value-added services such as private tours, exclusive dining, or adventure activities to capitalize on the influx of guests.
- **Capacity Management:** Expand capacity during summer by leveraging overflow agreements with nearby accommodations or providing temporary glamping or boutique setups.

Strengthen Marketing Efforts

- **Season-Specific Campaigns:** Tailor marketing efforts to highlight seasonal attractions, such as beaches in summer and cultural or wellness experiences in winter.
- **Leverage Digital Marketing:** Use targeted online ads, social media campaigns, and influencers to promote unique experiences offered by the hotels.
- **Partnerships with Travel Platforms:** Work with travel platforms like TripAdvisor, Booking.com, or Airbnb to boost visibility.

Thank You

Phyu Win Han

Thi Phuong Thao Tran

Zhen Jin