AD654 Final Project: Fall 2024

Team: Version 5.0

Recommendations for Arundelle Ball using Conjoint Analysis

Aim

The aim of this analysis is to optimize the selection of event options for Lobster Land's Arundelle Ball to maximize guest experience while adhering to a strict budget constraint of $50 per attendee, as advised by the finance department. Using ratings-based conjoint analysis on the provided dataset, we will identify the optimal combination of options across various categories. The final deliverable will include a detailed proposal of the recommended set of options, along with justifications for each category, ensuring an unforgettable and cost-effective experience for all attendees.

Analysis

```
import pandas as pd
from sklearn.linear_model import LinearRegression
from sklearn import metrics
import pulp
from pulp import LpMaximize, LpProblem, LpStatus, lpSum, LpVariable
```

```
dance_options = pd.read_csv("/content/dance_options.csv")
```

```
dance_options.head()
```

	bundleID	musical_ambience	dress_code	dance_floor_setup	event_duration	decor_theme	additional_features	avg_rating
0	1	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Hot Cocoa and Cider Bar	9.772650
1	2	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Cozy Lounge Area with Fireplaces	9.486008
2	3	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Professional Photographer & Photo Booth	9.648572
3	4	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Vintage Glamour	Hot Cocoa and Cider Bar	5.508470
4	5	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Vintage Glamour	Cozy Lounge Area with Fireplaces	9.391018

Next steps: Generate code with `dance_options` | View recommended plots | New interactive sheet

```
# Checking for null values in the datset:
dance_options.isnull().values.any()
```

```
False
```

```
# Dropping bundleID:
dance_options = dance_options.drop('bundleID', axis=1)
```

```
dance_options.head()
```

	musical_ambience	dress_code	dance_floor_setup	event_duration	decor_theme	additional_features	avg_rating
0	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Hot Cocoa and Cider Bar	9.772650
1	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Cozy Lounge Area with Fireplaces	9.486008
2	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Professional Photographer & Photo Booth	9.648572
3	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Vintage Glamour	Hot Cocoa and Cider Bar	5.508470
4	Classical Quartet	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Vintage Glamour	Cozy Lounge Area with Fireplaces	9.391018

Next steps: Generate code with dance_options | View recommended plots | New interactive sheet

```
# Sorting the dataset:
dance_options.sort_values(by='avg_rating', ascending=False).head()
```

	musical_ambience	dress_code	dance_floor_setup	event_duration	decor_theme	additional_features	avg_rating
972	Contemporary DJ Set	Formal Attire Required	Central Dance Floor with Ambient Lighting	2	Ice Palace Elegance	Hot Cocoa and Cider Bar	9.993909
164	Classical Quartet	Winter Themed Semi-Formal	Starlit Ceiling with Glittering Chandeliers	4	Ice Palace Elegance	Professional Photographer & Photo Booth	9.988016
1026	Contemporary DJ Set	Formal Attire Required	Starlit Ceiling with Glittering Chandeliers	4	Ice Palace Elegance	Hot Cocoa and Cider Bar	9.984955
79	Classical Quartet	Formal Attire Required	Grand Ballroom Setting with Candles and Florals	2	Enchanted Forest	Cozy Lounge Area with Fireplaces	9.983904
937	Swing Band	Optional Dress	Grand Ballroom Setting with	2	Ice Palace	Cozy Lounge Area with	9.982571

```
dance_options.columns
```

```
Index(['musical_ambience', 'dress_code', 'dance_floor_setup', 'event_duration',
       'decor_theme', 'additional_features', 'avg_rating'],
      dtype='object')
```

```
# checking the unique values in categorical columns:
print(dance_options['musical_ambience'].unique())
print()
print(dance_options['dress_code'].unique())
print()
print(dance_options['dance_floor_setup'].unique())
print()
print(dance_options['event_duration'].unique())
print()
print(dance_options['decor_theme'].unique())
print()
print(dance_options['additional_features'].unique())
```

```
['Classical Quartet' 'Jazz Trio' 'Swing Band' 'Contemporary DJ Set']

['Formal Attire Required' 'Winter Themed Semi-Formal'
 'Optional Dress Code']
```

```
['Central Dance Floor with Ambient Lighting'
 'Starlit Ceiling with Glittering Chandeliers'
 'Grand Ballroom Setting with Candles and Florals']

[2 3 4 5]

['Ice Palace Elegance' 'Vintage Glamour' 'Enchanted Forest']

['Hot Cocoa and Cider Bar' 'Cozy Lounge Area with Fireplaces'
 'Professional Photographer & Photo Booth']
```

```
# Dummyfing all the categorical variables:
dance_options1 = pd.get_dummies(dance_options, drop_first=True, columns=['musical_ambience', 'dress_code', 'dance_floor_setup','event_duration','d
```

```
dance_options1.head()
```

	avg_rating	musical_ambience_Contemporary DJ Set	musical_ambience_Jazz Trio	musical_ambience_Swing Band	dress_code_Optional Dress Code	dress_code_Winter Themed Semi-Formal	dance_flo Ballroo Candl
0	9.772650	False	False	False	False	False	
1	9.486008	False	False	False	False	False	
2	9.648572	False	False	False	False	False	
3	5.508470	False	False	False	False	False	
4	9.391018	False	False	False	False	False	

Next steps: Generate code with dance_options1 | View recommended plots | New interactive sheet

```
dance_options1.columns
```

```
Index(['avg_rating', 'musical_ambience_Contemporary DJ Set',
       'musical_ambience_Jazz Trio', 'musical_ambience_Swing Band',
       'dress_code_Optional Dress Code',
       'dress_code_Winter Themed Semi-Formal',
       'dance_floor_setup_Grand Ballroom Setting with Candles and Florals',
       'dance_floor_setup_Starlit Ceiling with Glittering Chandeliers',
       'event_duration_3', 'event_duration_4', 'event_duration_5',
       'decor_theme_Ice Palace Elegance', 'decor_theme_Vintage Glamour',
       'additional_features_Hot Cocoa and Cider Bar',
```

```
       'additional_features_Professional Photographer & Photo Booth'],
      dtype='object')
```

```
X = dance_options1[['musical_ambience_Contemporary DJ Set',
       'musical_ambience_Jazz Trio', 'musical_ambience_Swing Band',
       'dress_code_Optional Dress Code',
       'dress_code_Winter Themed Semi-Formal',
       'dance_floor_setup_Grand Ballroom Setting with Candles and Florals',
       'dance_floor_setup_Starlit Ceiling with Glittering Chandeliers',
       'event_duration_3', 'event_duration_4', 'event_duration_5',
       'decor_theme_Ice Palace Elegance', 'decor_theme_Vintage Glamour',
       'additional_features_Hot Cocoa and Cider Bar',
       'additional_features_Professional Photographer & Photo Booth']]
y = dance_options1['avg_rating']
```

```
regressor = LinearRegression()
regressor.fit(X, y)
```

```
LinearRegression
LinearRegression()
```

```
Intercept = regressor.intercept_
Intercept
```

```
7.480086561029734
```

```
coef_df = pd.DataFrame(regressor.coef_, X.columns, columns=['Coefficient'])
coef_df
```

	Coefficient
musical_ambience_Contemporary DJ Set	-2.562119
musical_ambience_Jazz Trio	-1.586839
musical_ambience_Swing Band	-1.257074
dress_code_Optional Dress Code	-0.979247
dress_code_Winter Themed Semi-Formal	0.053121
dance_floor_setup_Grand Ballroom Setting with Candles and Florals	0.043410
dance_floor_setup_Starlit Ceiling with Glittering Chandeliers	1.090418
event_duration_3	0.031084
event_duration_4	0.519837
event_duration_5	-0.137005
decor_theme_Ice Palace Elegance	2.632346
decor_theme_Vintage Glamour	-0.024632
additional_features_Hot Cocoa and Cider Bar	-0.310096
additional_features_Professional Photographer & Photo Booth	0.138671

Next steps: Generate code with `coef_df` | View recommended plots | New interactive sheet

```
# Load the vendor costs data
cost_data = pd.read_csv('/content/dance_vendor_costs.csv')
```

```
# Display the loaded data
cost_data
```

	category	option	estimated cost per attendee
0	musical ambience	Classical Quartet	16
1	musical ambience	Jazz Trio	13
2	musical ambience	Swing Band	11
3	musical ambience	Contemporary DJ Set	9
4	dress code	Formal Attire Required	2
5	dress code	Winter Themed Semi-Formal	1
6	dress code	Optional Dress Code	0
7	dance floor setup	Central Dance Floor with Ambient Lighting	7
8	dance floor setup	Starlit Ceiling with Glittering Chandeliers	14
9	dance floor setup	Grand Ballroom Setting with Candles and Florals	9
10	event duration	2	2
11	event duration	3	5
12	event duration	4	9
13	event duration	5	11
14	decor theme	Ice Palace Elegance	8
15	decor theme	Vintage Glamour	6
16	decor theme	Enchanted Forest	6
17	additional features	Hot Cocoa & Cider Bar	6
18	additional features	Cozy Lounge Area with Fireplaces	5
19	additional features	Professional Photographer & Photo Booth	7

After reviewing the estimated cost per attendee from the dataset, we used a straightforward approach with Excel's Solver to optimize and maximize customer experience while adhering to the ticket price constraint of $50.

Approach:

The objective function was to maximize customer experience, calculated as the sum product of coefficients and the binary decision variables. The ticket price constraint of 50 usd was achieved by ensuring the sum product of the estimated cost per attendee and the binary decision

variables did not exceed 50 usd.

The intercept value of $7.48, representing the base cost, was treated as a compulsory selection and included as a constraint. The constraints also ensured that only one option was selected from each category. The decision variables were kept binary to indicate whether an option was selected (1) or not (0). Finally using simplexLP we solved the problem and obtained the optimized output.

OPTIMIZATION ANALYSIS FOR ENHANCING GUEST EXPERIENCE WITHIN BUDGETARY LIMITS

Category	Option	Cost Per Attendee	Coefficient
Intercept	Base cost	7.48	1
musical ambience	Classical Quartet	16	0
musical ambience	Jazz Trio	13	-1.586839
musical ambience	Swing Band	11	-1.257074
musical ambience	Contemporary DJ Set	9	-2.562119
dress code	Formal Attire Required	2	0
dress code	Winter Themed Semi-Formal	1	0.053121
dress code	Optional Dress Code	0	-0.979247
dance floor setup	Central Dance Floor with Ambient Lighting	7	0
dance floor setup	Starlit Ceiling with Glittering Chandeliers	14	1.090418
dance floor setup	Grand Ballroom Setting with Candles and Florals	9	0.04341
event duration	2	2	0
event duration	3	5	0.031084
event duration	4	9	0.519837
event duration	5	11	-0.137005
decor theme	Ice Palace Elegance	8	2.632346
decor theme	Vintage Glamour	6	-0.024632
decor theme	Enchanted Forest	6	0
additional features	Hot Cocoa & Cider Bar	6	-0.310096
additional features	Cozy Lounge Area with Fireplaces	5	0
additional features	Professional Photographer & Photo Booth	7	0.138671

Category	Option	Binary Decision	Constraint
Intercept	Base cost	1	1
musical ambience	Classical Quartet	1	
musical ambience	Jazz Trio	0	1
musical ambience	Swing Band	0	
musical ambience	Contemporary DJ Set	0	
dress code	Formal Attire Required	0	
dress code	Winter Themed Semi-Formal	1	1
dress code	Optional Dress Code	0	
dance floor setup	Central Dance Floor with Ambient Lighting	1	
dance floor setup	Starlit Ceiling with Glittering Chandeliers	0	1
dance floor setup	Grand Ballroom Setting with Candles and Florals	0	
event duration	2	1	
event duration	3	0	1
event duration	4	0	
event duration	5	0	
decor theme	Ice Palace Elegance	1	
decor theme	Vintage Glamour	0	1
decor theme	Enchanted Forest	0	
additional features	Hot Cocoa & Cider Bar	0	
additional features	Cozy Lounge Area with Fireplaces	0	1
additional features	Professional Photographer & Photo Booth	1	

		Per Attendee Cost Constraint
Total cost	$ 48.48	<= $50
Max Guest Experience	3.824138	

Please note: Kindly refer to the attached Excel file for the solver analysis included with these files.

To validate the results obtained from the Excel Solver model, we implemented the same optimization problem using the Simplex LP method in Python.

```
# Data
options = [
    'Base Cost',
    'Classical Quartet', 'Jazz Trio', 'Swing Band', 'Contemporary DJ Set',
    'Formal Attire Required', 'Winter Themed Semi-Formal', 'Optional Dress Code',
    'Central Dance Floor with Ambient Lighting', 'Starlit Ceiling with Glittering Chandeliers','Grand Ballroom Setting with Candles and Florals',
    '2 hours', '3 hours', '4 hours', '5 hours',
    'Ice Palace Elegance', 'Vintage Glamour', 'Enchanted Forest',
    'Hot Cocoa & Cider Bar', 'Cozy Lounge Area with Fireplaces', 'Professional Photographer & Photo Booth'
```

```
]

costs = [7.48,
         16, 13, 11, 9,
         2, 1, 0,
         7, 14, 9,
         2, 5, 9, 11,
         8, 6, 6,
         6, 5, 7]

coefficients = [
    1.0,
    0, -1.586839, -1.257074, -2.562119,
    0, 0.053121, -1.979247,
    0, 1.090418, 0.04341,
    0, 0.031084, 0.519837, -0.137005,
    2.632346, -0.024632, 0.0,
    -0.310096, 0.0, 0.138671
]

categories = {
    'musical ambiance': [1, 2, 3, 4],
    'dress code': [5, 6, 7],
    'dance floor setup': [8, 9, 10],
    'event duration': [11, 12, 13, 14],
    'decor theme': [15, 16, 17],
    'additional features': [18, 19, 20]
}

# Creating problem with lp:
problem = pulp.LpProblem("Maximize_Guest_Experience", pulp.LpMaximize)

# Decision Variables
decision_vars = [pulp.LpVariable(f"x_{i}", cat='Binary') for i in range(len(options))]

# Objective Function: Maximize guest experience
problem += pulp.lpSum(coefficients[i] * decision_vars[i] for i in range(len(options)))

# Constraints
problem += pulp.lpSum(costs[i] * decision_vars[i] for i in range(len(options))) <= 50, "Budget Constraint"

# Ensuring exactly one option is chosen per category
for category, indices in categories.items():
    problem += pulp.lpSum(decision_vars[i] for i in indices) == 1, f"{category}_constraint"

# Base cost is always selected
```

```
problem += decision_vars[0] == 1, "Base_Cost_Constraint"

# Solving the problem
problem.solve()

# Results
selected_options = [options[i] for i in range(len(options)) if decision_vars[i].value() == 1]
total_cost = sum(costs[i] for i in range(len(options)) if decision_vars[i].value() == 1)
max_experience = sum(coefficients[i] for i in range(len(options)) if decision_vars[i].value() == 1)

# Results
print(f"Type: LpProblem")
print(f"Status: {pulp.LpStatus[problem.status]}")
print(f"Total Cost: ${total_cost:.2f}")
print(f"Max Guest Experience: {max_experience:.6f}")
print()
# Printing selected options with categories
print("\033[1mSelected Options with Details:\033[0m")
for category, indices in categories.items():
    print(f"\n{category.capitalize()}:")
    for index in indices:
        if decision_vars[index].varValue == 1:
            print(f"  - {options[index]} (Cost: ${costs[index]:.2f}, Contribution: {coefficients[index]:.6f})")
```

```
Type: LpProblem
Status: Optimal
Total Cost: $48.48
Max Guest Experience: 3.824138

Selected Options with Details:

Musical ambiance:
  - Classical Quartet (Cost: $16.00, Contribution: 0.000000)

Dress code:
  - Winter Themed Semi-Formal (Cost: $1.00, Contribution: 0.053121)

Dance floor setup:
  - Central Dance Floor with Ambient Lighting (Cost: $7.00, Contribution: 0.000000)

Event duration:
  - 2 hours (Cost: $2.00, Contribution: 0.000000)

Decor theme:
  - Ice Palace Elegance (Cost: $8.00, Contribution: 2.632346)

Additional features:
```

- Professional Photographer & Photo Booth (Cost: $7.00, Contribution: 0.138671)

Conclusion

Final Recommendations for Arundelle Ball:

Based on the solver analysis from Excel and python using simplexLP, We are recommending the following set of options for Lobster Land's management to create an unforgettable Arundelle Ball experience that optimizes both guest satisfaction and stays within budget constraints.

The selected combination has a total cost per attendee of $48.48, ensuring an enjoyable experience while adhering to the budget.

Musical Ambiance: Classical Quartet

The Classical Quartet was chosen because it has a coefficient value of 0 compared to other musical options, which had negative coefficients. This indicates that while the Classical Quartet does not directly enhance guest experience significantly, it avoids detracting from it. Additionally, it aligns with the sophisticated theme of the Arundelle Ball and fits within the budget constraints.

Dress Code: Winter Themed Semi-Formal

The Winter Themed Semi-Formal dress code was selected as it provides a small positive contribution (coefficient: 0.053121) to the overall guest experience while being cost-effective. This option supports the elegant and magical atmosphere of the Arundelle Ball without imposing a high cost on attendees.

Dance Floor Setup: Central Dance Floor with Ambient Lighting

The Central Dance Floor with Ambient Lighting was chosen for its relatively low cost of $7.00 and its ability to create an inviting and warm environment. Although its coefficient indicates no direct contribution to guest experience, this option is essential for ensuring an enjoyable experience without exceeding budget constraints.

Event Duration: 2 Hours

The 2-hour event duration was selected as it balances costs and logistics while aligning with guest expectations for a compact yet fulfilling experience. While it does not directly contribute to the guest experience (coefficient: 0), this duration ensures optimal time for all planned activities.

Decor Theme: Ice Palace Elegance

Ice Palace Elegance offers the highest positive contribution to guest experience (coefficient: 2.632346) among decor options. This aligns perfectly with the Arundelle Ball's magical theme, creating a captivating and immersive environment. Despite its $8.00 cost, this option delivers exceptional value in enhancing the overall ambiance.

Additional Features: Professional Photographer & Photo Booth

The Professional Photographer & Photo Booth was chosen for its contribution to guest experience (coefficient: 0.138671). This option allows guests to capture memorable moments, enhancing their overall satisfaction. At $7.00, it adds significant value without straining the budget.

These carefully selected options maximize guest satisfaction while adhering to the $50 per ticket budget constraint, ensuring the Arundelle Ball is both unforgettable and financially viable.

```
Start coding or generate with AI.
```

```
Start coding or generate with AI.
```

```
Start coding or generate with AI.
```