CONCERT TOUR OPTIMIZATION

Optimization Methods

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AGENDA

- Overview
- Application of Concert Tour   Optimization
- Problem Statement
- Algebraic Formulation
- Modelling using Python
- Optimal Solution
- Conclusion

OVERVIEW

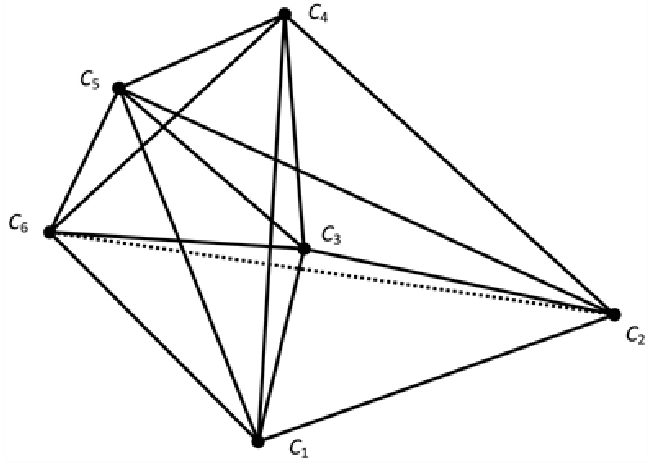
- **Purpose**: Optimize concert tour schedules to reduce travel costs and maximize audience engagement and revenue.
- **Challenges**: Navigate complex logistics, including managing travel routes, revenues, travel cost.
- **Approach**: Use optimization models(Excel, Python) to create efficient and profitable tour plans.
- **Benefits**: Improved tour efficiency leads to increased profitability and better experiences for both artists and fans.

APPLICATIONS

Logistics and Distribution: This is one of the primary applications where companies need to optimize the routes for delivery vehicles to minimize travel costs while maximizing revenue. For example, a delivery company could use this model to determine the most profitable sequence of stops for delivery trucks.

Sales and Marketing: Companies with field sales teams use such models to plan sales tours that maximize potential sales or client visits while minimizing travel expenses and time.

Airlines: For creating profitable flight routes, airlines might employ such models to determine the most profitable routes and schedules based on operational costs and expected revenues from passengers.



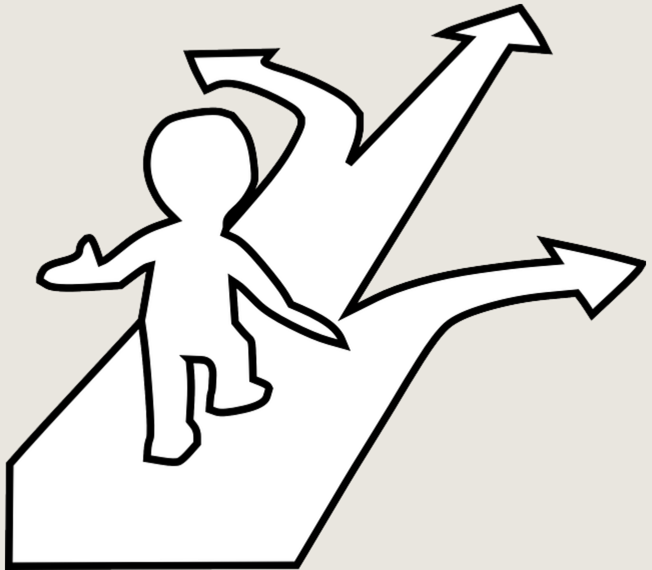
PROBLEM STATEMENT

“Design an optimization model that minimizes travel costs and logistical challenges for an artist's concert tour while maximizing audience reach and profitability.”

ALGEBRAIC FORMULATION

DECISION VARIABLES

- **x_i** : Binary Variable, 1 if city i is visited, 0 otherwise.
- **y_i** : Binary Variable, 1 if the trour travels directly from city i to city j, 0 otherwise.



OBJECTIVE FUNCTION

The goal is to maximize revenue and minimize travel costs.

$$\text{Maximize} \quad Z = \sum_{i \in C} R_i x_i - 0.01 \sum_{i \in C} \sum_{j \in C} C_{ij} y_{ij}$$

where,

- C is the set of all cities.
- R_i is the revenue from visiting city i.
- C_{ij} is the travel cost from city i to city j.
- 0.01 is a scaling factor for the travel costs.

CONSTRAINTS

Tour Continuity Constraint:

$$\sum_{j \neq i} y_{ij} = x_i \quad \text{for all } i$$
$$\sum_{j \neq i} y_{ji} = x_i \quad \text{for all } i$$

***Subtour Elimination*:**

u_i = Position of city i in the tour.

$$u_i - u_j + N y_{ij} \leq N - 1 \quad \text{for all } i \neq j, i, j = 2, \ldots, N$$

MODELLING USING PYTHON

```python
# Retrieve unique cities from the revenue DataFrame and generate a revenue dictionary and a cost matrix.
cities = revenues_df['City'].unique()
revenue_dict = revenues_df.set_index('City')['Revenue (USD)'].to_dict()
cost_matrix = pd.pivot_table(travel_costs_df, values='Cost (USD)', index='From', columns='To').fillna(0)
cost_matrix = cost_matrix.reindex(index=cities, columns=cities, fill_value=0)

# x[city]: Binary variable, 1 if city is visited, 0 otherwise.
# y[from_city, to_city]: Binary variable, 1 if traveling from 'from_city' to 'to_city', 0 otherwise.
x = {city: cp.Variable(boolean=True) for city in cities}
y = {(from_city, to_city): cp.Variable(boolean=True) for from_city in cities for to_city in cities}

# Maximize the total revenue from visiting cities minus a penalty for the travel costs between cities.
objective = cp.Maximize(sum(revenue_dict[city] * x[city] for city in cities) -
                        0.01 * sum(cost_matrix.at[from_city, to_city] * y[from_city, to_city] for from_city in cities for to_city in cities))

# Ensure that if a city is visited, there must be exactly one departure to another city and exactly one arrival from another city.
constraints = [
    sum(y[city, other] for other in cities if other != city) == x[city] for city in cities
]
constraints += [
    sum(y[other, city] for other in cities if other != city) == x[city] for city in cities
]

# Solve the initial problem
problem = cp.Problem(objective, constraints)
problem.solve()
```

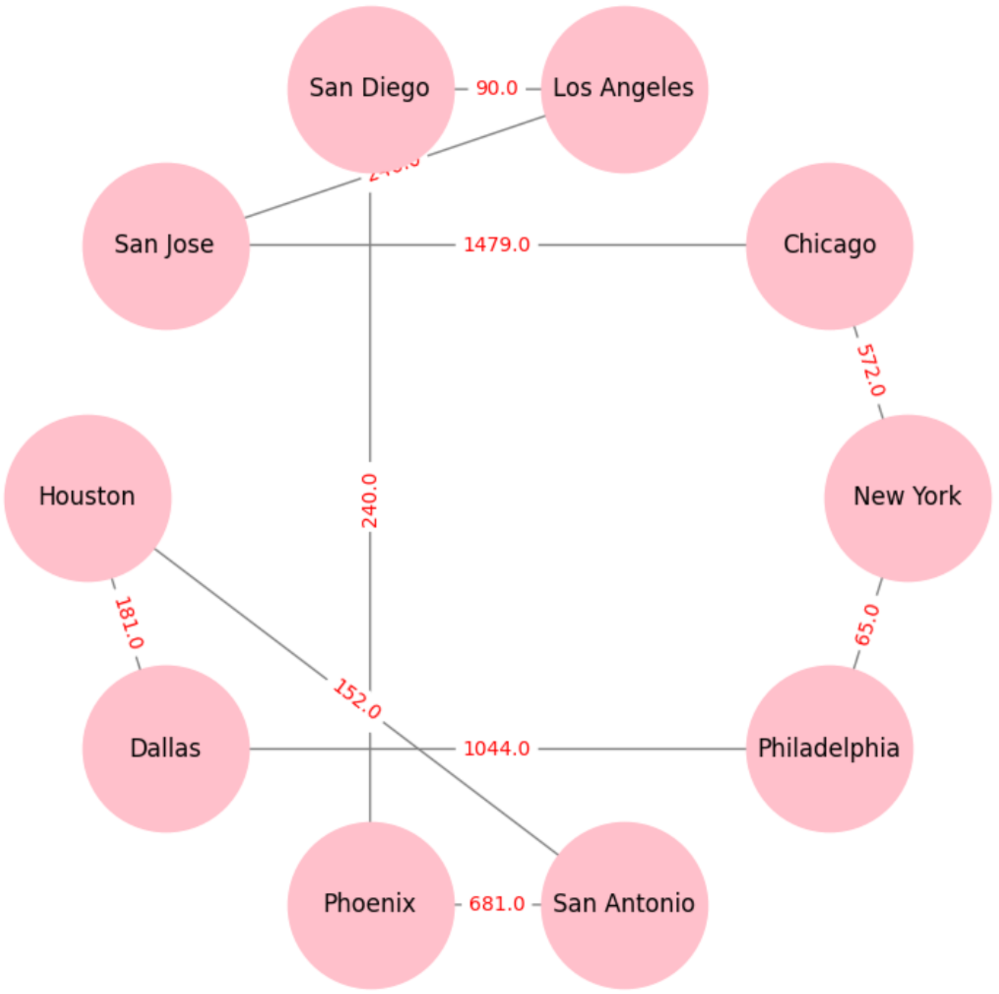
OPTIMAL SOLUTION

Tour sequence: [('New York', 'Chicago'), ('Los Angeles', 'San Diego'), ('Chicago', 'San Jose'), ('Houston', 'Dallas'), ('Phoenix', 'San Antonio'), ('Philadelphia', 'New York'), ('San Antonio', 'Houston'), ('San Diego', 'Phoenix'), ('Dallas', 'Philadelphia'), ('San Jose', 'Los Angeles’)]

Maximum Revenue: $157952.5

DIGRAPH

The optimal concert tour path includes carefully chosen transitions between cities such as New York to Chicago and Los Angeles to San Diego, culminating in a total revenue of $157,952.5. This route leverages strategic city pairings to maximize profitability and minimize travel overhead, demonstrating effective tour planning.



CONCLUSION

Efficiency Improvement: Optimization models like the one used in your project significantly enhance operational efficiency by identifying the most effective routes and schedules.

Cost Reduction: These models help minimize costs associated with travel and logistics, allowing organizations to allocate resources more effectively.

Revenue Maximization: By strategically selecting locations or routes that generate the highest returns, companies can maximize their revenue potential.

Strategic Decision-Making: The integration of mathematical modeling into decision-making processes supports strategic planning and enables better long-term outcomes.

THANK YOU