Final project(Gurobi Food Truck)

Team 5

Round 1 Day 1

The goal of the Burrito truck grand opening was to determine the maximum profit achievable by strategically placing burrito trucks to serve customer demands optimally.

Key Metrics (Optimal Solution)

```
Optimal solution found (tolerance 1.00e-04)
Best objective 8.850000000000e+02, best bound 8.850000000000e+02, gap 0.0000%
Optimal Solution Found:
Objective Value: $885.0
Trucks Placed: ['truck17', 'truck38']
Truck truck17 serves: [('demand2', 1.0), ('demand11', 30.0), ('demand12', 24.0), ('demand13', 24.0), ('demand14', 6.0), ('demand18', 8.0),
('demand19', 16.0), ('demand21', 34.0), ('demand22', 18.0), ('demand34', 2.0), ('demand51', 5.0)]
Truck truck38 serves: [('demand28', 23.0), ('demand29', 36.0), ('demand32', 5.0), ('demand41', 3.0), ('demand45', 42.0)]
```

Sales Revenue: $2,770

Ingredient Cost: $1,385

Truck Cost: $500 (for two trucks at $250 each)

Total Profit: $885

Truck Placement : Truck 17, Truck 38

Profit Breakdown

Each burrito sold generated a net profit of $5 ($10 sales revenue minus $5 ingredient cost per burrito).

The fixed cost for opening each truck was $250.

The total profit of $885 reflects the balance between maximizing sales and minimizing operational costs.

Comparison with Optimal Solution

The solution achieved in our Gurobi's burrito truck optimal solution, as indicated by the identical profit of $885. This confirms that our truck placement strategy was as efficient as the algorithmically determined optimal placement.

Conclusion

We successfully implemented an optimal strategy for the grand opening, achieving maximum profitability with two trucks. This demonstrates a strong understanding of demand distribution and cost management within the constraints.

Our resource allocation effectively balances deployment costs with high-revenue opportunities, confirming that our targeted truck placements maximize profit under the given constraints.

Round 1 Day 2

Word is spreading and business is picking up! Can you keep up with the demand?

On Day 2 of Round 1, the challenge was to keep up with increasing demand while managing costs effectively.

Optimal Solution

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Optimal solution found (tolerance 1.00e-04)
Best objective 4.775000000000e+03, best bound 4.775000000000e+03, gap 0.0000%
Optimal Solution Found:
Objective Value: $4775.0
Trucks Placed: ['truck12', 'truck17', 'truck23', 'truck34', 'truck38', 'truck43']
Truck truck12 serves: [('demand2', 50.0), ('demand12', 53.0), ('demand14', 51.0), ('demand53', 32.0)]
Truck truck17 serves: [('demand9', 10.0), ('demand11', 45.0), ('demand13', 73.0), ('demand21', 54.0), ('demand22', 36.0), ('demand48', 42.0),
('demand50', 14.0), ('demand51', 39.0)]
Truck truck23 serves: [('demand15', 40.0), ('demand17', 47.0), ('demand18', 22.0), ('demand19', 50.0), ('demand20', 28.0), ('demand28', 54.
0)]
Truck truck34 serves: [('demand25', 22.0), ('demand26', 24.0), ('demand34', 15.0), ('demand35', 26.0), ('demand38', 18.0), ('demand47', 19.
0)]
Truck truck38 serves: [('demand29', 33.0), ('demand31', 75.0), ('demand32', 14.0), ('demand33', 40.0), ('demand45', 33.0), ('demand46', 75.
0)]
Truck truck43 serves: [('demand37', 36.0), ('demand40', 49.0), ('demand41', 36.0)]
```

Sales Revenue: $12,550

Ingredient Cost: $6,275

Truck Cost: $1,500

Total Profit: $4,775

Truck Placements : Truck : 12, 17, 23, 34, 38, 43

Optimal Solution Details:

Using Gurobi optimization, the solution achieved a total profit of $4,775 with zero gap , indicating that the solution is mathematically optimal. The trucks were placed at six (Truck 12, 17, 23, 34, 38, 43) strategic locations to serve demand efficiently.

Our Solution

Sales Revenue: $11,340

Ingredient Cost: $5,670

Truck Cost: $1,000

Total Profit: $4,670

Our solution achieved a profit only 2% worse than optimal, indicating a strong performance.
The optimal solution captured slightly more revenue and demand by strategically placing additional trucks.

Comparison:

The optimal solution captured an additional $1,210 in sales revenue by serving more customers across wider demand zones.
Our solution minimized truck costs by using fewer trucks but sacrificed potential revenue from underserved areas.
The optimal solution balanced truck placement across high-, medium-, and low-demand areas for maximum profitability.

Recommendations

The optimal solution utilized six trucks to cover more high-demand zones effectively.
Consider expanding truck placements in future rounds to capture additional revenue.
While ingredient costs increased in the optimal solution due to higher sales volume, the additional revenue outweighed these costs.
Focus on areas with concentrated demand to maximize truck efficiency and profitability.

Round 1 Day 3

A disruption in the cheese supply chain has driven ingredient costs up! How will you adapt?

The scenario introduces a disruption in the cheese supply chain, leading to an increase in ingredient costs. Specifically:

Ingredient cost: Increased to $7 per burrito sold.

Truck cost: Remains constant at $250 per truck opened.

The ingredient cost per burrito is $7 due to the disruption in the cheese supply chain.

This increase impacts overall profitability, as higher costs reduce margins.

Optimal Solution Analysis

Using Gurobi's optimization, the following solution was found with an objective value of $2555:

Trucks Placed: Truck 14, 18, 34, 38.

Sales Revenue: $11,850

Ingredient Cost: $8,295

Truck Cost: $1,000

Total Profit: $2,555

```
Optimal solution found (tolerance 1.00e-04)
Best objective 2.555000000000e+03, best bound 2.555000000000e+03, gap 0.0000%
Optimal Solution Found:
Objective Value: $2555.0
Trucks Placed: ['truck14', 'truck18', 'truck34', 'truck38']
Truck truck14 serves: [('demand2', 28.0), ('demand12', 40.0), ('demand14', 30.0), ('demand15', 68.0), ('demand17', 48.0), ('demand18', 7.0),
('demand19', 28.0), ('demand20', 24.0), ('demand53', 7.0)]
Truck truck18 serves: [('demand9', 58.0), ('demand11', 49.0), ('demand13', 28.0), ('demand21', 51.0), ('demand22', 55.0), ('demand48', 58.0),
('demand51', 65.0)]
Truck truck34 serves: [('demand25', 33.0), ('demand26', 17.0), ('demand34', 60.0), ('demand35', 22.0), ('demand37', 10.0), ('demand38', 49.
0), ('demand40', 5.0), ('demand47', 19.0)]
Truck truck38 serves: [('demand28', 58.0), ('demand29', 55.0), ('demand31', 50.0), ('demand32', 57.0), ('demand33', 16.0), ('demand41', 12.
0), ('demand45', 19.0), ('demand46', 45.0), ('demand50', 14.0)]
```

Our Solution Analysis:

Number of trucks placed : 4

Sales Revenue: $11,670

Ingredient Cost: $8,169

Truck Cost: $1,000

Total Profit: $2,501

Comparison

- Sales Revenue: The optimal solution generated $11,850 in revenue compared to $11,670 in our solution.
  This increase is a result of better truck placement, allowing more demands to be served efficiently.
- Ingredient Costs: The optimal solution incurred slightly higher ingredient costs ($8,295 vs. $8,169).
  This is due to serving more customers (higher sales), which offsets the cost increase.
- Profit: The optimal solution achieved a profit of $2,555, which is $54 higher than our solution. This represents a 2% improvement in profitability.
- **Truck Placement in our Solution**
  Demand Coverage: Some high-demand areas were missed or inefficiently served.
  Revenue Optimization: The placement did not fully maximize sales revenue potential.

Recommendations

- The increase in ingredient cost emphasizes the importance of maximizing revenue to maintain profitability.
- The optimal solution demonstrates that serving more customers (despite higher costs) leads to better overall profit.
- The optimal solution captures more high-demand zones by strategically placing trucks in areas with dense customer clusters.
- Our solution missed some of these opportunities, leading to lower revenue and profit.
- Even with higher ingredient costs, the optimal solution achieved a profit of $2,555 by balancing truck placement and maximizing sales revenue.
- Monitor ingredient usage closely to avoid waste and maintain cost control.

Round 1 Day 4

The cheese supply chain has been restored, but it’s rainy today, customers aren’t willing to walk as far to get burritos.

Optimal Solution

The Gurobi optimization algorithm identified the following solution:

Sales Revenue: $5,510

Ingredient Cost: $2,755

Truck Cost: $1,500

Total Profit: $1,255

Truck Placements : Truck : 12, 16, 18, 23, 38, 41

```
Optimal solution found (tolerance 1.00e-04)
Best objective 1.255000000000e+03, best bound 1.255000000000e+03, gap 0.0000%
Optimal Solution Found:
Objective Value: $1255.0
Trucks Placed: ['truck12', 'truck16', 'truck18', 'truck23', 'truck38', 'truck41']
Truck truck12 serves: [('demand2', 60.0), ('demand53', 16.0)]
Truck truck16 serves: [('demand11', 65.0), ('demand13', 37.0), ('demand21', 41.0)]
Truck truck18 serves: [('demand9', 2.0), ('demand22', 29.0), ('demand48', 15.0), ('demand51', 40.0)]
Truck truck23 serves: [('demand17', 24.0), ('demand19', 29.0), ('demand20', 4.0), ('demand28', 21.0)]
Truck truck38 serves: [('demand31', 8.0), ('demand32', 34.0), ('demand45', 31.0), ('demand46', 35.0)]
Truck truck41 serves: [('demand41', 60.0)]
```

Our Solution

Our solution matched the optimal solution generated by Gurobi:

Sales Revenue: $5,510

Ingredient Cost: $2,755

Truck Cost: $1,500

Total Profit: $1,255

Conclusion

Both solutions are identical in terms of revenue, costs, and profit. This indicates that our approach aligns perfectly with the Gurobi optimization results.

Our solution is as good as Gurobi's optimal solution for this scenario. By strategically placing trucks in high-demand areas and optimizing costs, we successfully maximized profit despite the challenges posed by rainy weather conditions.

Round 1 Day 5

Business is booming, the weather is good, and the supply disruption is over. Where will today’s trucks go?

Optimal Solution:

Total Profit: $7,850

Sales Revenue: $20,200

Ingredient Costs: $10,100

Truck Costs: $2,250

Truck Placements : Truck 3, 7, 15, 21, 26, 28, 40, 45, 56.

```
Optimal solution found (tolerance 1.00e-04)
Best objective 7.850000000000e+03, best bound 7.850000000000e+03, gap 0.0000%
Optimal Solution Found:
Objective Value: $7850.0
Trucks Placed: ['truck3', 'truck7', 'truck15', 'truck21', 'truck26', 'truck28', 'truck40', 'truck45', 'truck56']
Truck truck3 serves: [('demand3', 66.0), ('demand4', 30.0), ('demand5', 22.0), ('demand8', 55.0)]
Truck truck7 serves: [('demand0', 35.0), ('demand1', 70.0), ('demand2', 14.0), ('demand15', 34.0), ('demand52', 15.0)]
Truck truck15 serves: [('demand11', 75.0), ('demand12', 65.0), ('demand13', 45.0), ('demand14', 30.0), ('demand16', 21.0), ('demand18', 60.
0), ('demand19', 15.0), ('demand20', 40.0), ('demand21', 16.0), ('demand53', 14.0)]
Truck truck21 serves: [('demand6', 25.0), ('demand7', 42.0), ('demand9', 31.0), ('demand10', 55.0), ('demand51', 15.0)]
Truck truck26 serves: [('demand17', 14.0), ('demand28', 70.0), ('demand29', 50.0), ('demand30', 27.0), ('demand31', 43.0), ('demand50', 36.
0)]
Truck truck28 serves: [('demand27', 70.0), ('demand32', 10.0), ('demand33', 54.0)]
Truck truck40 serves: [('demand41', 26.0), ('demand42', 31.0), ('demand43', 59.0), ('demand44', 44.0), ('demand45', 19.0), ('demand46', 64.
0)]
Truck truck45 serves: [('demand36', 9.0), ('demand37', 67.0), ('demand38', 25.0), ('demand39', 33.0), ('demand40', 30.0), ('demand47', 56.0),
('demand49', 27.0)]
Truck truck56 serves: [('demand22', 20.0), ('demand23', 57.0), ('demand24', 60.0), ('demand25', 37.0), ('demand26', 30.0), ('demand34', 25.
0), ('demand35', 26.0), ('demand48', 11.0)]
```

Our Solution

Total Profit: $7,315

Sales Revenue: $18,630

Ingredient Costs: $9,315

Truck Costs: $2,000

Comparison

Truck Allocation: In our solution, trucks might be allocated less efficiently, leading to missed opportunities in high-demand areas.
Sales revenue was lower ($18,630 vs. $20,200).
Ingredient costs and truck costs were similar, but our solution was 7% less efficient in meeting demand. This highlights the importance of precise optimization for maximizing profitability.
Demand Coverage: Our solution might leave some high priority demands underserved or unserved, resulting in lost revenue.
Operational Costs: Although truck costs are slightly lower, the suboptimal solution fails to maximize revenue, leading to a lower overall profit.

Recommendations

- Implement real-time demand forecasting to adjust truck allocations based on changing demand patterns.
- Prioritize serving high-demand areas first to maximize revenue. Use data analytics to identify these areas and adjust truck allocations accordingly.
- Use real-time data to dynamically allocate trucks based on changing demand patterns. This ensures that trucks are always serving the most profitable demands
- Conduct thorough market analysis to identify areas with high demand potential that are not being fully served. Adjust truck routes to cover these areas.