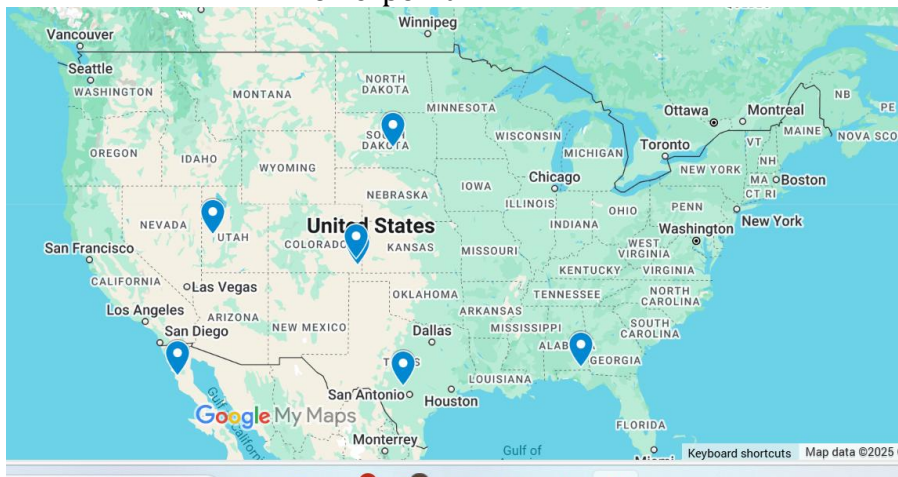


# Module 10 – MOLP

## Exploratory Data Analysis

*In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:*

- Choose a visualization method (expect 7 nodes and ~24 arcs):
  - Make a visual graph of your data on a map (coordinates should be within US borders)
    - <https://mymaps.google.com/>
    - Find a map with latitude/longitude and place them approximately
    - Any alternative that gives the same effect
  - Make a visual graph of your data like what we saw for the sample problem
    - <https://excalidraw.com>
    - <https://mermaid.live>
    - <https://dreampuf.github.io/GraphvizOnline>
    - Powerpoint



## Model Formulation

*Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints. For this problem, I am only asking that you perform the model formulation for the MOLP model.*

MIN transportation cost:

$$21X_1 + 20X_2 + 16X_3 + 9X_4 + 18X_5 + 8X_6 + 21X_7 + 22X_8 + 18X_9 + 22X_{10} + 8X_{11} + 24Z_{12} + 22X_{13} + 16X_{14} + 12X_{15} + 19X_{16} + 24X_{17} + 22X_{18} + 24X_{19} + 5X_{20} + 15X_{21} + 24X_{22} + 13X_{23} + 6X_{24}$$

MIN Non-eco transportation:  $1X_1 + 1X_2 + 0X_3 + 1X_4 + 1X_5 + 1X_6 + 1X_7 + 1X_8 + 1X_9 + 1X_{10} + 1X_{11} + 1X_{12} + 1X_{13} + 1X_{14} + 1X_{15} + 1X_{16} + 1X_{17} + 1X_{18} + 1X_{19} + 1X_{20} + 1X_{21} + 1X_{22} + 1X_{23} + 1X_{24}$

MIN congestion levels

$$70X_1 + 104X_2 + 88X_3 + 102X_4 + 93X_5 + 88X_6 + 85X_7 + 70X_8 + 98X_9 + 72X_{10} + 94X_{11} + 92X_{12} + 36X_{13} + 82X_{14} + 91X_{15} + 89X_{16} + 93X_{17} + 25X_{18} + 93X_{19} + 88X_{20} + 102X_{21} + 107X_{22} + 85X_{23} + 96X_{24}$$

## Model Optimized for Equally Weighted Objectives

Implement your formulation into Excel and be sure to make it neat. This section should include:

- A screenshot of your optimized final model (formatted nicely, of course)
- A text explanation of what your model is recommending
- Update your graph from the EDA section to indicate which arcs are used

Ship	No.	From	Lat x1	Lat x2	Long y1	Long y2	Eco Friendliness	Binary	Congestion Lev	Levels	No.	To	Unit Cost	Eco.																												
1907	1	Bunter Pecan Bluff	2	-92.5	0	37.5	44.15	Desert Rail	1	70	1	2	Jellybean Jungle	21	7.15																											
1457	1	Bunter Pecan Bluff	3	-92.5	-115.9	37.5	30.65	Air Freight	1	84	1	3	Pudding Peaks	20	15.03																											
6154	1	Bunter Pecan Bluff	6	-92.5	-85.76	37.5	31.24	Slow Steaming C	0	88	1	6	Tangerine Tally Tropics	16	17.87																											
0	2	Jellybean Jungle	1	-93.87	-92.5	44.15	37.5	Desert Rail	1	92	1	1	Bunter Pecan Bluff	9	7.15																											
0	2	Jellybean Jungle	5	-93.87	-93.03	44.15	30.02	Desert Rail	1	93	1	5	Sprinkle Street	18	14.15																											
0	3	Pudding Peaks	1	-115.9	-92.5	30.65	37.5	Cargo Ships (He	1	88	1	1	Bunter Pecan Bluff	8	15.03																											
0	3	Pudding Peaks	4	-115.9	-113.29	30.65	33.31	Cargo Ships (He	1	85	1	4	Snickerdoodle Slopes	21	9.01																											
0	3	Pudding Peaks	5	-115.9	-93.03	30.65	30.02	Slow Steaming C	1	70	1	5	Sprinkle Street	22	15.18																											
0	3	Pudding Peaks	6	-115.9	-85.76	30.65	31.24	Slow Steaming C	1	88	1	6	Tangerine Tally Tropics	16	30.15																											
0	4	Snickerdoodle Slopes	2	-113.29	-93.87	33.31	44.15	Electric Rail	1	72	1	2	Jellybean Jungle	22	14.27																											
0	4	Snickerdoodle Slopes	3	-113.29	-115.9	33.31	30.65	Slow Steaming C	1	94	1	3	Pudding Peaks	8	9.01																											
0	4	Snickerdoodle Slopes	5	-113.29	-93.03	33.31	30.02	Air Freight	1	92	1	5	Sprinkle Street	24	17.02																											
0	4	Snickerdoodle Slopes	7	-113.29	-92.56	33.31	37.88	Desert Trucks	1	96	0	7	Whipped Wonderland	22	10.51																											
266	109	5 Sprinkle Street	2	-93.03	-93.87	30.02	44.15	Desert Trucks	1	82	1	2	Jellybean Jungle	16	14.15																											
0	11	5 Sprinkle Street	4	-93.03	-113.29	30.02	33.31	Cargo Ships (He	1	91	1	4	Snickerdoodle Slopes	12	17.02																											
0	5	Sprinkle Street	6	-93.03	-85.76	30.02	31.24	Desert Rail	1	89	1	6	Tangerine Tally Tropics	19	13.33																											
0	6	Tangerine Tally Trc	7	-93.03	-92.56	30.02	37.88	Desert Trucks	1	93	1	7	Whipped Wonderland	24	8.62																											
1088	83	6 Tangerine Tally Trc	3	-85.76	-115.9	31.24	30.65	Air Freight	1	25	0	3	Pudding Peaks	22	30.15																											
1765	11	7 Tangerine Tally Trc	4	-85.76	-113.29	31.24	33.31	Air Freight	1	81	1	4	Snickerdoodle Slopes	24	28.63																											
1971	6	8 Tangerine Tally Trc	5	-85.76	-93.03	31.24	30.02	Slow Steaming C	1	88	1	5	Sprinkle Street	5	13.33																											
0	7	Whipped Wonderland	7	-102.58	-92.56	37.88	37.88	Electric Hybrid T	1	82	1	7	Whipped Wonderland	15	10.08																											
0	7	Whipped Wonderland	3	-102.58	-115.9	37.88	30.65	Desert Rail	1	107	1	3	Pudding Peaks	24	15.14																											
0	7	Whipped Wonderland	4	-102.58	-113.29	37.88	33.31	Electric Hybrid T	1	85	1	4	Snickerdoodle Slopes	13	10.51																											
0	7	Whipped Wonderland	5	-102.58	-93.03	37.88	30.02	Desert Trucks	1	96	1	5	Sprinkle Street	6	8.62																											
<table><tr><th>Objectives</th><th>Totals</th><th>Target</th><th>Deviation</th><th>% Deviation</th><th>Weight</th><th>Weighted deviation %</th></tr><tr><td>Min Cost</td><td>\$ 235,368.23</td><td>\$ 227,746.00</td><td>\$ 7,622.23</td><td>3%</td><td>3%</td><td>3%</td></tr><tr><td>Min non-eco friendliness</td><td>\$ 8,455.11</td><td>\$ 8,189.00</td><td>\$ 266.11</td><td>3%</td><td>1</td><td>3%</td></tr><tr><td>Min Congestion</td><td>\$ 1,308,424.40</td><td>\$ 1,266,052.00</td><td>\$ 42,372.40</td><td>3%</td><td>1</td><td>3%</td></tr></table>															Objectives	Totals	Target	Deviation	% Deviation	Weight	Weighted deviation %	Min Cost	\$ 235,368.23	\$ 227,746.00	\$ 7,622.23	3%	3%	3%	Min non-eco friendliness	\$ 8,455.11	\$ 8,189.00	\$ 266.11	3%	1	3%	Min Congestion	\$ 1,308,424.40	\$ 1,266,052.00	\$ 42,372.40	3%	1	3%
Objectives	Totals	Target	Deviation	% Deviation	Weight	Weighted deviation %																																				
Min Cost	\$ 235,368.23	\$ 227,746.00	\$ 7,622.23	3%	3%	3%																																				
Min non-eco friendliness	\$ 8,455.11	\$ 8,189.00	\$ 266.11	3%	1	3%																																				
Min Congestion	\$ 1,308,424.40	\$ 1,266,052.00	\$ 42,372.40	3%	1	3%																																				
ObjectiveMinimax3%																																										

Objectives	Totals	Target	Deviation	% Deviation	Weight	Weighted deviation %
Min Cost	\$ 235,368.23	\$ 227,746.00	\$ 7,622.23		3%	1 3%
Min non-eco friendliness	\$ 8,455.11	\$ 8,189.00	\$ 266.11		3%	1 3%
Min Congestion	\$ 1,308,424.40	\$ 1,266,052.00	\$ 42,372.40		3%	1 3%

Objective  
Minimax

3%

**The model indicates which decision variables we should utilize to meet our objective functions. Objective function is hard to explain...**

### Model with Stipulation

*Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution.*

*Alter the weights of each objective to add weight to match what matters most to you. Perhaps run a few different scenarios to see how the routes change depending on the weights. When you find a weight mix and solution that satisfies you, please write a justification on why you chose the final model/weights and about how a configured model like yours can be used for scenario planning.*

Objectives	Totals	Target	Deviation	% Deviation	Weight	Weighted deviation %
Min Cost	\$ 236,972.96	\$ 227,746.00	\$ 9,226.96	4%	1	4%
Min non-eco friendliness	\$ 8,225.86	\$ 8,189.00	\$ 36.86	0%	9	4%
Min Congestion	\$ 1,288,709.26	\$ 1,266,052.00	\$ 22,657.26	2%	1	2%
Objective						
Minimax		4%				

Objectives	Totals	Target	Deviation	% Deviation	Weight	Weighted deviation %
Min Cost	\$ 235,368.23	\$ 227,746.00	\$ 7,622.23	3%	5	17%
Min non-eco friendliness	\$ 8,455.11	\$ 8,189.00	\$ 266.11	3%	5	16%
Min Congestion	\$ 1,308,424.40	\$ 1,266,052.00	\$ 42,372.40	3%	5	17%
Objective						
Minimax		17%				

*The approach I decided to do this approach more differently, I decided to apply equal weights to minimizing cost, non-eco friendliness, min congestion. As it reminded me of a balanced scorecard, when we are selecting weights to evaluate our suppliers. This approach gave me a higher percentage..*