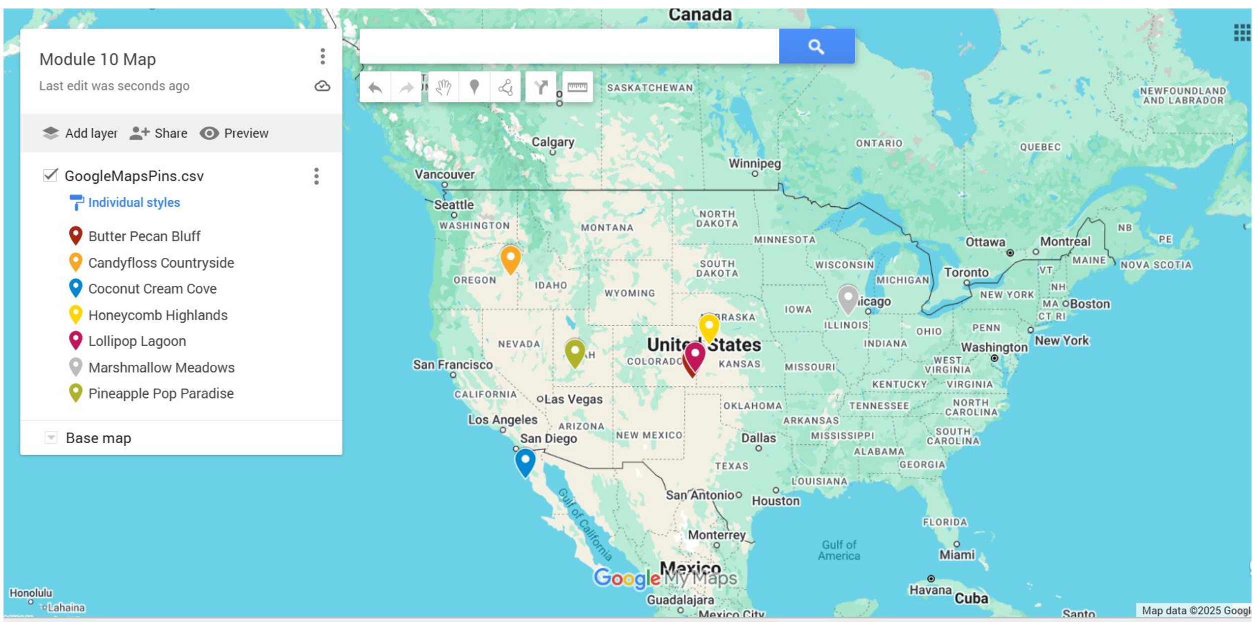
Valeria Santoni

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:Q

$W_1(\ ((X_1*C_1)+(\ X_2*C_2)+..\ (X_{24}*C_{24}))-\ 148{,}117/\ 148{,}117)\leq Q$

$W_2(\ ((X_1*D_1)+(\ X_2*D_2)+..\ (X_{24}*D_{24}))-\ 107{,}790/\ 107{,}790)\leq Q$

$W_3(\ ((X_1*E_1)+(\ X_2*E_2)+..\ (X_{24}*E_{24}))-\ 3{,}235/\ 3235)\leq Q$

$W_4(\ ((X_1*CN_1)+(\ X_2*CN_2)+..\ (X_{24}*CN_{24}))-\ 6{,}150/6{,}150)\leq Q$

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Nodes

$-X_{14} - X_{16} - X_{17} + X_{31} + X_{41} \geq -9665$ } Node 1

$-X_{25} - X_{26} + X_{52} + X_{72} \geq 1245$ } Node 2

$-X_{31} - X_{36} - X_{37} + X_{43} + X_{53} + X_{63} + X_{73} \geq 1632$ } Node 3

$-X_{41} - X_{43} - X_{45} + X_{14} + X_{54} + X_{64} + X_{74} \geq 1279$ } Node 4

$-X_{52} - X_{53} - X_{54} - X_{56} + X_{25} + X_{65} + X_{75} \geq 1994$ } Node 5

$-X_{63} - X_{64} - X_{65} - X_{67} + X_{16} + X_{26} + X_{36} + X_{56} + X_{76} \geq 1990$ } Node 6

$-X_{72} - X_{73} - X_{74} - X_{75} - X_{76} + X_{17} + X_{37} + X_{67} \geq 1525$ } Node 7

X1,…X24 ≥
0 X1,…X24 = Int

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*

		X1	X2		Y1	Y2						
Units Shipped	**From**	**Latitude**	**Longitude**	**To**	**Latitude**	**Longitude**	**Euclidean Distance**	**Transpotation Method**	**Binary**	**Congestion Level**	**Binary**	**Cost per Unit Shipped**
5587.055468	1	37.5	-102.5	4	39.79	-101.09	2.69	Wind-powered Ships	0	81	1	14
1990	1	37.5	-102.5	6	41.57	-89.35	13.77	Diesel Rail	1	26	0	9
2087.944532	1	37.5	-102.5	7	38.11	-112.36	9.88	Cargo Ships (Heavy Fuel Oil)	1	83	1	7
0	2	44.03	-117.68	5	37.94	-102.2	16.63	Diesel Rail	1	91	1	15
0	2	44.03	-117.68	6	41.57	-89.35	28.44	Electric/Hybrid Trucks	0	89	1	7
0	3	30.63	-116.43	1	37.5	-102.5	15.53	Cargo Ships (Heavy Fuel Oil)	1	26	0	14
0	3	30.63	-116.43	6	41.57	-89.35	29.21	Diesel Rail	1	76	1	6
682.0554675	3	30.63	-116.43	7	38.11	-112.36	8.52	Electric/Hybrid Trucks	0	89	1	17
0	4	39.79	-101.09	1	37.5	-102.5	2.69	Electrified Rail	0	95	1	20
2314.055468	4	39.79	-101.09	3	30.63	-116.43	17.87	Wind-powered Ships	0	78	1	10
1994	4	39.79	-101.09	5	37.94	-102.2	2.16	Air Freight	1	78	1	19
0	5	37.94	-102.2	2	44.03	-117.68	16.63	Diesel Rail	1	92	1	13
0	5	37.94	-102.2	3	30.63	-116.43	16.00	Electrified Rail	0	73	1	18
0	5	37.94	-102.2	4	39.79	-101.09	2.16	Diesel Trucks	1	80	1	8
0	5	37.94	-102.2	6	41.57	-89.35	13.35	Cargo Ships (Heavy Fuel Oil)	1	95	1	10
0	6	41.57	-89.35	3	30.63	-116.43	29.21	Wind-powered Ships	0	100	1	23
0	6	41.57	-89.35	4	39.79	-101.09	11.87	Cargo Ships (Heavy Fuel Oil)	1	105	1	14
0	6	41.57	-89.35	5	37.94	-102.2	13.35	Air Freight	1	101	1	20
0	6	41.57	-89.35	7	38.11	-112.36	23.27	Air Freight	1	36	0	21
1245	7	38.11	-112.36	2	44.03	-117.68	7.96	Diesel Rail	1	101	1	19
0	7	38.11	-112.36	3	30.63	-116.43	8.52	Cargo Ships (Heavy Fuel Oil)	1	86	1	11
0	7	38.11	-112.36	4	39.79	-101.09	11.39	Air Freight	1	95	1	22
0	7	38.11	-112.36	5	37.94	-102.2	10.16	Slow Steaming Cargo Ships	0	103	1	13
0	7	38.11	-112.36	6	41.57	-89.35	23.27	Air Freight	1	30	0	23

	Nodes	**Inflow**	**Outflow**	**Net Flow**	**Supply/demand**	**Distance**	
1	Butter Pecan Bluff	0	9665	-9665	-9665		
2	Candyfloss Countryside	1245	0	1245	1245		
3	Coconut Cream Cove	2314.05547	682.055468	1632	1632		
4	Honeycomb Highlands	5587.05547	4308.05547	1279	1279		
5	Lollipop Lagoon	1994	0	1994	1994		
6	Marshmallow Meadows	1990	0	1990	1990		
7	Pineapple Pop Paradise	2770	1245	1525	1525		
	Objectives	Totals	Target value	Deviation	% Deviation	Weight	Weighted Deviation %
	Total Transportation Cost	**$207,021**	$148,117	$58,904	39.77%	1	39.8%
	Total Distance Traveled	$124,408.8	$107,790.5	$16,618	15.42%	1	15.4%
	Eco- Friendliness	$7,317	$ 3,235	$4,082	126.18%	1	126.2%
	Minimize Congestion	$ 13,910	6150	$ 7,760	126.18%	1	126.2%
	Objective						
	MiniMax	126%					

Recommendation:

This model recommends a shipping strategy that minimizes the maximum deviation across four objectives: Total Transportation Cost, Total Distance Traveled, eco-friendliness and Minimize Congestion. The optimal solution or MiniMax results in a 126% deviation from the target values, meaning the model is focusing on reducing the worst-case scenario across these objectives. It suggests using a combination of transportation methods, such as cargo ships and air freight, to balance cost efficiency, distance, and congestion.

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Model with Stipulation

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

		X1	X2		Y1	Y2						
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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.

I prioritized Minimize Congestion because I am trying to streamline my distribution network, increasing the weight from 1 to 10. Also, I increased weight in Total making the cost of transportation a higher priority. There was a big difference in Total cost and Target cost so I wanted to better cost control. A higher weight on cost can help you focus on reducing expenses through more cost-effective transportation methods. Reducing the weight on Minimize Congestion and Total Distance could be a conscious decision to allow flexibility in routing decisions.