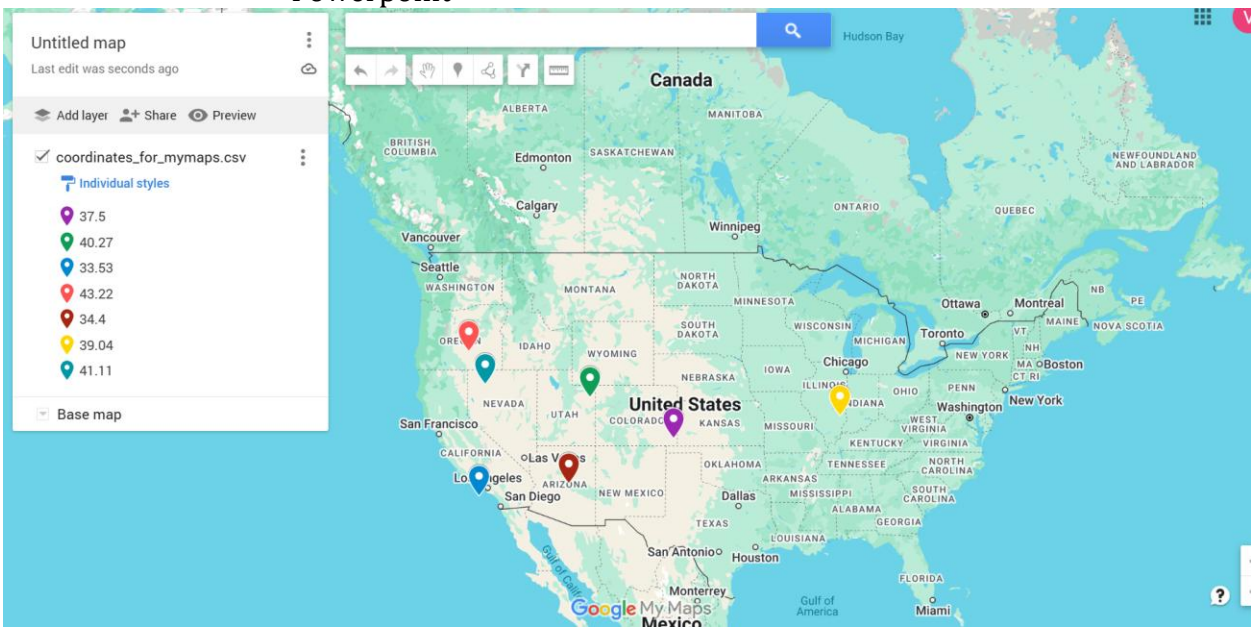
Module 10 – MOLP

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



Untitled map - Google My Maps

Model Formulation

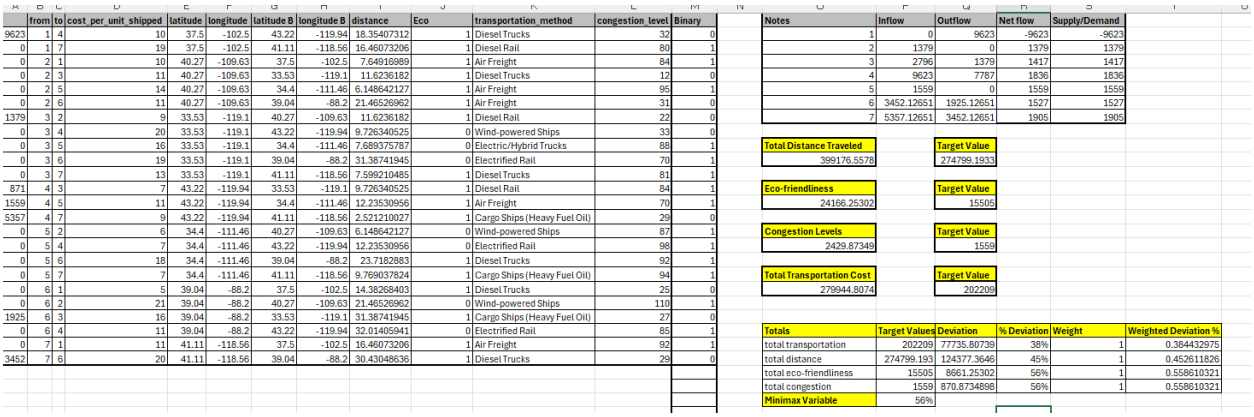
Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints. For this problem, I am only asking that you perform the model formulation for the MOLP model.

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*

The model recommends a transportation strategy that focuses primarily on minimizing total transportation cost while balancing environmental impact, congestion, and distance. The current weight distribution places equal importance on all four objectives, resulting in transportation cost having the lowest deviation from its target, while congestion has the highest deviation. This suggests that the chosen routes prioritize economic efficiency, utilizing lower-cost shipping methods even if they lead to slightly more congestion and environmental impact. The model highlights trade-offs among competing goals, indicating that in order to achieve cost savings, some compromise in eco-friendliness and traffic levels was necessary. This configuration could serve well in scenarios where budget constraints are tight, and sustainability remains important but not dominant.



	from	to	cost_per_unit_shipped	latitude	longitude	latitude B	longitude B	distance	Eco	transportation_method	congestion_level	Binary
9623	1	4	10	37.5	-102.5	43.22	-119.94	18.35407312	1	Diesel Trucks	32	0
0	1	7	19	37.5	-102.5	41.11	-118.56	16.46073206	1	Diesel Rail	80	1
0	2	1	10	40.27	-109.63	37.5	-102.5	7.64916989	1	Air Freight	84	1
0	2	3	11	40.27	-109.63	33.53	-119.1	11.6236182	1	Diesel Trucks	12	0
0	2	5	14	40.27	-109.63	34.4	-111.46	6.148642127	1	Air Freight	95	1
0	2	6	11	40.27	-109.63	39.04	-88.2	21.46526962	1	Air Freight	31	0
1379	3	2	9	33.53	-119.1	40.27	-109.63	11.6236182	1	Diesel Rail	22	0
0	3	4	20	33.53	-119.1	43.22	-119.94	9.726340525	0	Wind-powered Ships	33	0
0	3	5	16	33.53	-119.1	34.4	-111.46	7.689375787	0	Electric/Hybrid Trucks	88	1
0	3	6	19	33.53	-119.1	39.04	-88.2	31.38741945	0	Electrified Rail	70	1
0	3	7	13	33.53	-119.1	41.11	-118.56	7.599210485	1	Diesel Trucks	81	1
871	4	3	7	43.22	-119.94	33.53	-119.1	9.726340525	1	Diesel Rail	84	1
1559	4	5	11	43.22	-119.94	34.4	-111.46	12.23530956	1	Air Freight	70	1
5357	4	7	9	43.22	-119.94	41.11	-118.56	2.521210027	1	Cargo Ships (Heavy Fuel Oil)	29	0
0	5	2	6	34.4	-111.46	40.27	-109.63	6.148642127	0	Wind-powered Ships	87	1
0	5	4	7	34.4	-111.46	43.22	-119.94	12.23530956	0	Electrified Rail	98	1
0	5	6	18	34.4	-111.46	39.04	-88.2	23.7182883	1	Diesel Trucks	92	1
0	5	7	7	34.4	-111.46	41.11	-118.56	9.769037824	1	Cargo Ships (Heavy Fuel Oil)	94	1
0	6	1	5	39.04	-88.2	37.5	-102.5	14.38268403	1	Diesel Trucks	25	0
0	6	2	21	39.04	-88.2	40.27	-109.63	21.46526962	0	Wind-powered Ships	110	1
1925	6	3	16	39.04	-88.2	33.53	-119.1	31.38741945	1	Cargo Ships (Heavy Fuel Oil)	27	0
0	6	4	11	39.04	-88.2	43.22	-119.94	32.01405941	0	Electrified Rail	85	1
0	7	1	11	41.11	-118.56	37.5	-102.5	16.46073206	1	Air Freight	92	1
3452	7	6	20	41.11	-118.56	39.04	-88.2	30.43048636	1	Diesel Trucks	29	0

Notes	Inflow	Outflow	Net flow	Supply/Demand
1	0	9623	-9623	-9623
2	1379	0	1379	1379
3	2796	1379	1417	1417
4	9623	7787	1836	1836
5	1559	0	1559	1559
6	3452.12651	1925.12651	1527	1527
7	5357.12651	3452.12651	1905	1905

Total Distance Traveled	Target Value
399176.5578	274799.1933

Eco-friendliness	Target Value
24166.25302	15505

Congestion Levels	Target Value
2429.87349	1559

Total Transportation Cost	Target Value
279944.8074	202209

Totals	Target Values	Deviation	% Deviation	Weight	Weighted Deviation %
total transportation	202209	77735.80739	38%	1	0.384432975
total distance	274799.193	124377.3646	45%	1	0.452611826
total eco-friendliness	15505	8661.25302	56%	1	0.558610321
total congestion	1559	870.8734898	56%	1	0.558610321
Minimax Variable	56%				

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.

In my final model, I prioritized eco-friendliness and congestion by assigning them the highest weights, followed by transportation cost and then total distance. This reflects a shift toward more sustainable supply chain strategies, where minimizing environmental impact and avoiding congestion are more critical than purely focusing on cost. Although cost remains important, it's balanced against long-term goals like reducing emissions and improving delivery efficiency. This type of configured model is valuable for scenario planning because it allows companies to test different priority settings and see how changes in regulation, fuel prices, or sustainability targets might impact their logistics decisions.

	from	to	cost_per_unit_shipped	latitude	longitude	latitude B	longitude B	distance	Eco	transportation_method	congestion_level	Binary
9623	1	4	10	37.5	-102.5	43.22	-119.94	18.3540731	1	Diesel Trucks	32	0
0	1	7	19	37.5	-102.5	41.11	-118.56	16.4607321	1	Diesel Rail	80	1
0	2	1	10	40.27	-109.63	37.5	-102.5	7.64916989	1	Air Freight	84	1
0	2	3	11	40.27	-109.63	33.53	-119.1	11.6236182	1	Diesel Trucks	12	0
0	2	5	14	40.27	-109.63	34.4	-111.46	6.14864213	1	Air Freight	85	1
0	2	6	11	40.27	-109.63	39.04	-88.2	21.4652696	1	Air Freight	31	0
1379	3	2	9	33.53	-119.1	40.27	-109.63	11.6236182	1	Diesel Rail	22	0
0	3	4	20	33.53	-119.1	43.22	-119.94	9.72634052	0	Wind-powered Ships	33	0
0	3	5	16	33.53	-119.1	34.4	-111.46	7.68937579	0	Electric/Hybrid Trucks	88	1
0	3	6	19	33.53	-119.1	39.04	-88.2	31.3874195	0	Electrified Rail	70	1
0	3	7	13	33.53	-119.1	41.11	-118.56	7.59921049	1	Diesel Trucks	81	1
2087.428663	4	3	7	43.22	-119.94	33.53	-119.1	9.72634052	1	Diesel Rail	84	1
1559	4	5	11	43.22	-119.94	34.4	-111.46	12.2353096	1	Air Freight	70	1
4140.571337	4	7	9	43.22	-119.94	41.11	-118.56	2.52121003	1	Cargo Ships (Heavy Fuel Oil)	29	0
0	5	2	6	34.4	-111.46	40.27	-109.63	6.14864213	0	Wind-powered Ships	87	1
0	5	4	7	34.4	-111.46	43.22	-119.94	12.2353096	0	Electrified Rail	98	1
0	5	6	18	34.4	-111.46	39.04	-88.2	23.7182883	1	Diesel Trucks	92	1
0	5	7	7	34.4	-111.46	41.11	-118.56	9.76903782	1	Cargo Ships (Heavy Fuel Oil)	94	1
0	6	1	5	39.04	-88.2	37.5	-102.5	14.382684	1	Diesel Trucks	25	0
0	6	2	21	39.04	-88.2	40.27	-109.63	21.4652696	0	Wind-powered Ships	110	1
708.5713366	6	3	16	39.04	-88.2	33.53	-119.1	31.3874195	1	Cargo Ships (Heavy Fuel Oil)	27	0
0	6	4	11	39.04	-88.2	43.22	-119.94	32.0140594	0	Electrified Rail	85	1
0	7	1	11	41.11	-118.56	37.5	-102.5	16.4607321	1	Air Freight	92	1
2235.571337	7	6	20	41.11	-118.56	39.04	-88.2	30.4304864	1	Diesel Trucks	29	0

Notes	Inflow	Outflow	Net flow	Supply/Demand
1	0	9623	-9623	-9623
2	1379	0	1379	1379
3	2796	1379	1417	1417
4	9623	7787	1836	1836
5	1559	0	1559	1559
6	2235.57134	708.571337	1527	1527
7	4140.57134	2235.57134	1905	1905

Total Distance Traveled	Target Value
332737.1035	274799.193

Eco-friendliness	Target Value
21733.14267	15505

Congestion Levels	Target Value
3646.428663	1559

Total Transportation Cost	Target Value
233715.7108	202209

Totals	Target Value	Deviation	% Deviation	Weight	Weighted Deviation %
total transportation	202209	31506.7108	16%	2	0.311625208
total distance	274799.193	57937.9102	21%	10	2.108372646
total eco-friendliness	15505	6228.14267	40%	10	4.016860802
total congestion	1559	2087.42866	134%	3	4.016860802
Minimax Variable	402%				