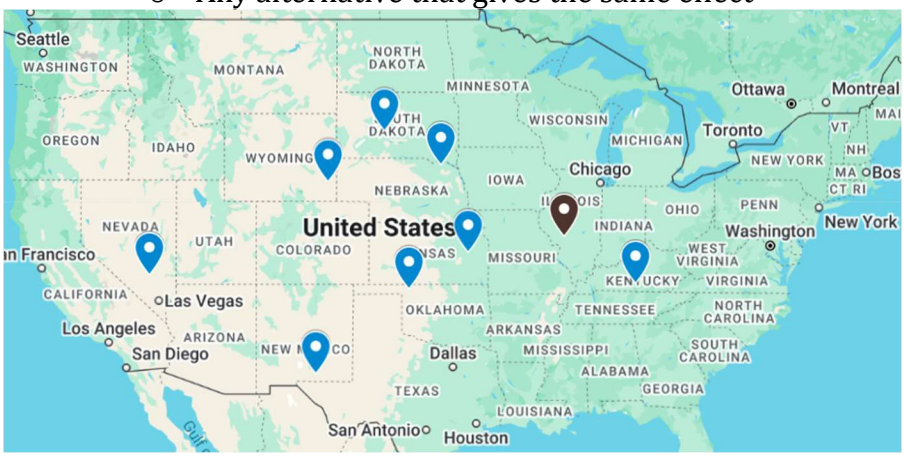
Module 12 – Location Graph

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:

- *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



- Use your available data to determine a good starting coordinate for the DC
  - Should you use the average of the ranges of lat longs of the stores?
  - Should you use the coordinates of the store furthest away from the current DC?
  - Can you think of something better to use?
  - Whatever you use, please record the optimal function with your starting coordinate to compare to your optimized model

Model Formulation

Try to 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. Hint: Linking constraints aren't needed since we are using Nonlinear GRG but refer to the associated PowerPoint in your data if you need help.

Min Distance:

Chocolate Chip Cliffs: $\sqrt{(X-41.9X1)^2+(Y+104.65Y1)^{\wedge}2}$

Crème Brulee Cliffs: $\sqrt{(X-32.45X2)^2+(Y+105.49Y2)^{\wedge}2}$

Gooey Ganache Grotto: $\sqrt{(X-37.51X3)^2+(Y+115.82Y3)^{\wedge}2}$

Hazelnut Haven: $\sqrt{(X-38.65X4)^2+(Y+96.95Y4)^{\wedge}2}$

Licorice Labyrinth: $\sqrt{(X-37.08X5)^2+(Y+85.48Y5)^{\wedge}2}$

Licorice Lanes: $\sqrt{(X-44.26X6)^2+(Y+101.17Y6)^{\wedge}2}$

Meringue Mountains: $\sqrt{(X-42.72X7)^2+(Y+97.68Y7)^{\wedge}2}$

Rainbow Ribbon Roads: $\sqrt{\ (X-36.79X8)^2+(Y+99.71Y8)\text{^}2}$

Model Optimized for Distance Reduction from DC to Store

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 by adding in your new DC and add indicators of which Stores are serviced by which DC*

Objective	49.75927					Lat	Long			
					New DC	40.51811	-103.002			
	Store Location		Current DC			New DC			Model Decision	
Stores	Lat	Long	Lat	Long	Current DC List			New DC Distance	Use New?	Distance
Chocolate Chip Cliffs	41.94	-104.65	39.38	-90.02	14.85	40.51811	-103.002	2.176954799	TRUE	2.176955
Creme Brulee Cliffs	32.45	-105.49	39.38	-90.02	16.95	40.51811	-103.002	8.443144735	TRUE	8.443145
Gooey Ganache Grotto	37.51	-115.82	39.38	-90.02	25.87	40.51811	-103.002	13.16666673	TRUE	13.16667
Hazelnut Haven	38.65	-95.96	39.38	-90.02	5.98	40.51811	-103.002	7.285148897	FALSE	5.984689
Licorice Labyrinth	37.08	-85.48	39.38	-90.02	5.09	40.51811	-103.002	17.85568962	FALSE	5.089361
Licorice Lanes	44.26	-101.17	39.38	-90.02	12.17	40.51811	-103.002	4.16609785	TRUE	4.166098
Meringue Mountains	42.72	-97.68	39.38	-90.02	8.36	40.51811	-103.002	5.759108618	TRUE	5.759109
Rainbow Ribbon Roads	36.79	-99.71	39.38	-90.02	10.03	40.51811	-103.002	4.973243804	TRUE	4.973244
	38.925	-100.745								

This model is deciding whether each candy store should keep using the current distribution center or switch to a new one at coordinates (40.51811, -103.002). It compares the distance from each store to both DCs and chooses the closer option. The goal is to minimize the total distance traveled for the stores to the DC's. Based on this, the model recommends that 6 of the 8 stores switches to the new DC, while 2 should stay with the current one.

Model with Stipulation

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

You should notice that while distance is minimized between each store and each DC, there is a discrepancy between how much demand is serviced between each DC (i.e. one DC may service a lot more demand than others). Please:

1. *Choose one:*
    a. *Implement a change that picks a location for the new DC to distance **AND** load. You can do this by multiplying distance by demand if a store is serviced by a particular DC.*

Objective	77842.04						Lat	Long				
					New DC		40.6609	-103.216				
	Store Location		Current DC				New DC			Model Decision		
Stores	Lat	Long	Lat	Long	Current DC List	Next Year Demand	Lat	Long	New DC Distance	Use New?	Distance	New Demand
Chocolate Chip Cliffs	41.94	-104.65	39.38	-90.02	21030.83	1416.00	40.6609	-103.216	2720.55096	TRUE	2720.551	3852297.17
Creme Brulee Cliffs	32.45	-105.49	39.38	-90.02	27545.83	1625.00	40.6609	-103.216	13844.80501	TRUE	13844.81	22497813.68
Gooey Ganache Grotto	37.51	-115.82	39.38	-90.02	42009.16	1624.00	40.6609	-103.216	21098.25377	TRUE	21098.25	34263604.20
Hazelnut Haven	38.65	-95.96	39.38	-90.02	8540.17	1427.00	40.6609	-103.216	10745.12892	FALSE	8540.174	12186860.26
Licorice Labyrinth	37.08	-85.48	39.38	-90.02	9272.79	1822.00	40.6609	-103.216	32967.64014	FALSE	9272.794	16894990.19
Licorice Lanes	44.26	-101.17	39.38	-90.02	20776.11	1707.00	40.6609	-103.216	7067.28114	TRUE	7067.281	12063822.05
Meringue Mountains	42.72	-97.68	39.38	-90.02	11999.95	1436.00	40.6609	-103.216	8482.291136	TRUE	8482.291	12180573.46
Rainbow Ribbon Roads	36.79	-99.71	39.38	-90.02	13089.41	1305.00	40.6609	-103.216	6815.889078	TRUE	6815.889	8894763.19
	38.925	-100.745										

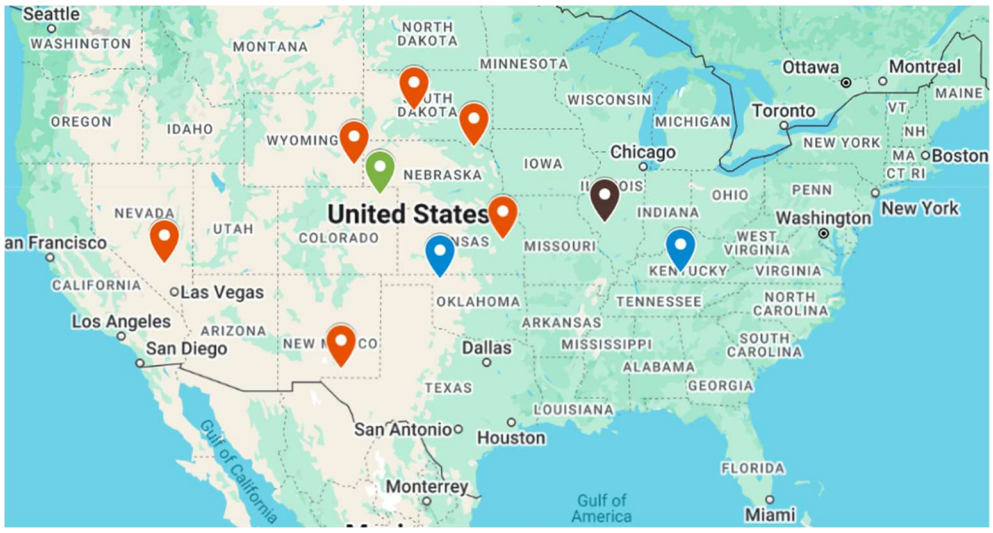
b. Instead of just summing the distance, also add the difference between demand serviced between each DC (i.e. if the old DC serves stores with 8000 total demand and the new DC does 3000 then the difference would be 5000). Be sure to not remove the sum of distance too, it should be both. You may want to add weights and such but not necessary

2. *Provide a text explanation on what your model is recommending now with this change.*

I added next year's demand for each store into the decision-making process. Instead of just minimizing distance, the model now minimizes the total demand and distance. So this means it prioritizes moving high-demand stores closer to the distribution center. As a result, 6 out of 8 stores are now assigned to the new DC, even if they're not the absolute closest, because serving them from the new location reduces the total transportation impact.

3. *Explain the changes to your Solver/Model.*

To objective function of my original model was 49.76 an the objective function after my model stipulation was 77842.04. Multiplying the current distance by demand if they don't use the new DC. Then, we would multiply the new DC's distance by the next year's demand.



Here, the stores that will be going to the new DC are in red, and the new DC is in green. The old DC is in black.