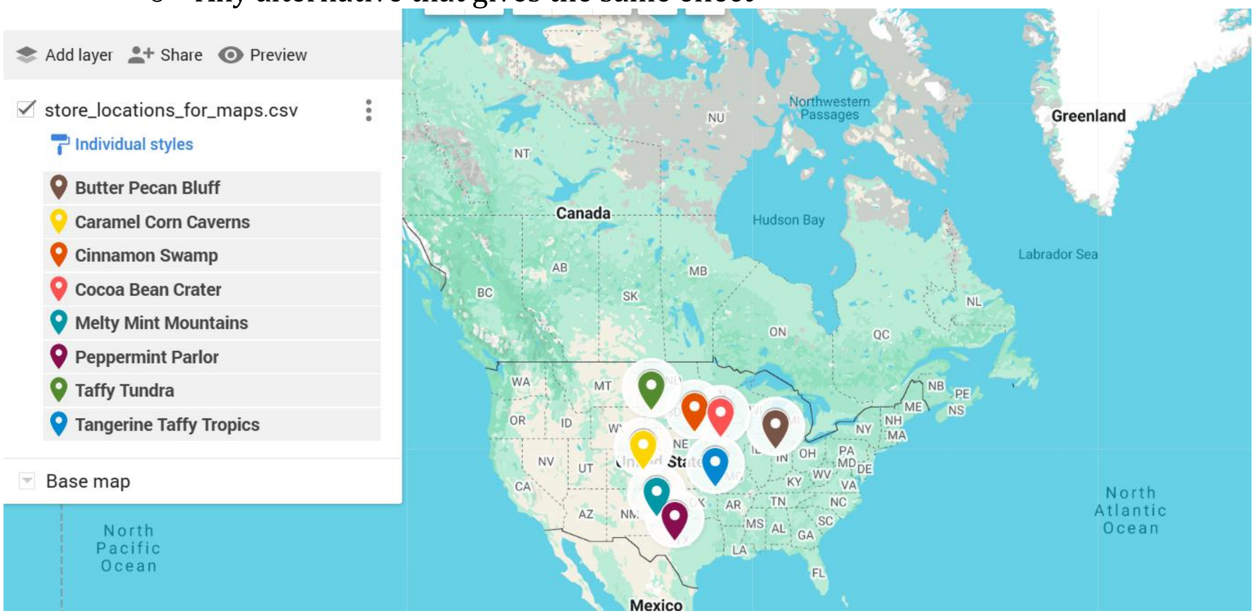
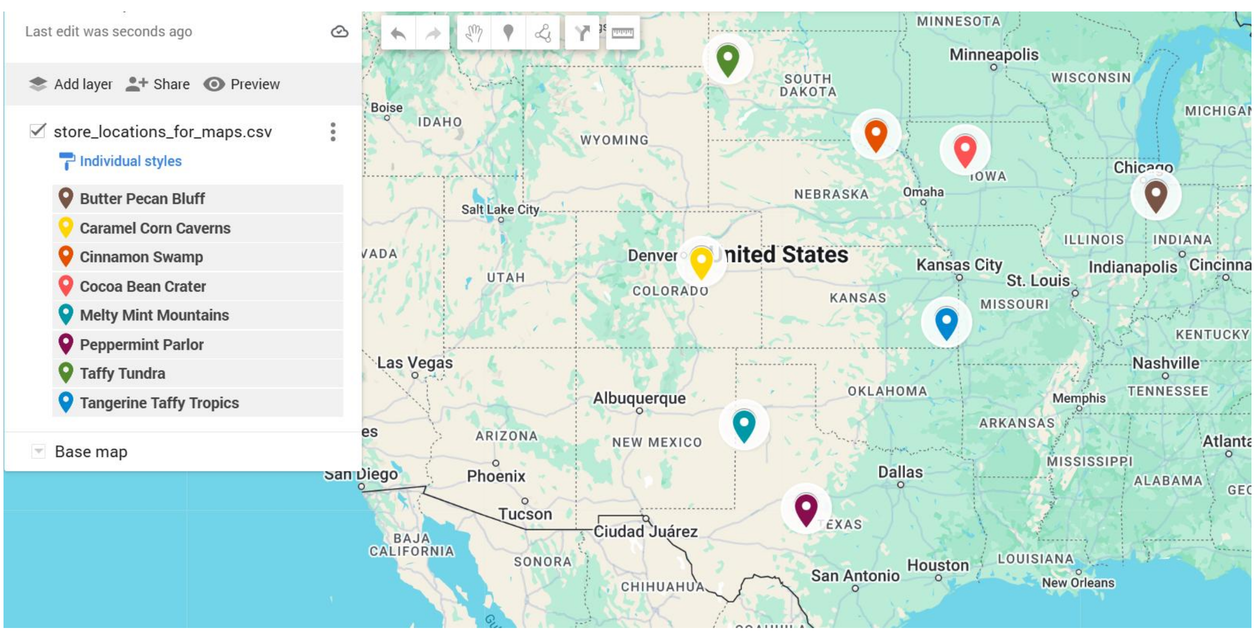
Module 12 – Location Graph

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

- Average Latitude= 39.0075
- Average Longitude= -73.065

This shows that it gives a 'middle' point that's balanced among the stores, but may not account for store demand. This could be important to determine an optimal location.

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.

$$\sqrt{(40.92 - X1)^2 + (-87.18 - Y1)^2} + \sqrt{(38.98 - X1)^2 + (-104.35 - Y1)^2} + \sqrt{(42.63 - X1)^2 + (-97.8 - Y1)^2} + \sqrt{(42.21 - X1)^2 + (-94.39 - Y1)^2} + \sqrt{(34.04 - X1)^2 + (-102.74 - Y1)^2} + \sqrt{(31.4 - X1)^2 + (-100.4 - Y1)^2} + \sqrt{(44.69 - X1)^2 + (-103.35 - Y1)^2} + \sqrt{(37.19 - X1)^2 + (-95.11 - Y1)^2}$$

$$\sqrt{(40.92 - X1)^2 + (-87.18 - Y1)^2} \leq 22.95 \; \textit{Butter Pecan Bluff}$$

$$\sqrt{(38.98 - X1)^2 + (-104.35 - Y1)^2} \leq 6.43 \; \textit{Caramel Corn Caverns}$$

$$\sqrt{(42.63 - X1)^2 + (-97.8 - Y1)^2} \leq 13.87 \; \textit{Cinanamon Swap}$$

$$(42.21 - X1)^2 + (-94.39 - Y1)^2 \leq 16.63 \; \textit{Cocoa Bean Crater}$$

$$\sqrt{(34.04 - X1)^2 + (-102.74 - Y1)^2} \leq 6.65 \; \textit{Melty Mint Mountains}$$

$$\sqrt{(34.04 - X1)^2 + (-102.74 - Y1)^2} \leq 9.60 \; \textit{Peppermint Parlor}$$

$$\sqrt{(31.4 - X1)^2 + (-100.4 - Y1)^2} \leq 9.60 \; \textit{Peppermint PARLOR}$$

$$\sqrt{(44.69 - X1)^2 + (-103.35 - Y1)^2} \leq \textit{Taffy Tundra}$$

$$\sqrt{(37.19 - X1)^2 + (-95.11 - Y1)^2} \leq \textit{Tangerine Taffy Tropics}$$

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*

dc_name	lat	long		lat	long
Toffee Town	34.92	-109.34	New DC:	41.78989281	-95.1846

	Store Location			New DC			Model Decision	
Stores	lat	long	Current DC Dist	lat	long	New DC Dist	Use New?	Dist
Butter Pecan Bluff	40.92	-87.18	22.95790931	40.92	-87.18	8.05174516	2	8.051745
Caramel Corn Caverns	38.98	-104.35	6.4330164	38.98	-104.35	9.58643577	1	6.433016
Cinnamon Swamp	42.63	-97.8	13.87860584	42.63	-97.8	2.74700027	2	2.747
Cocoa Bean Crater	42.21	-94.39	16.63269671	42.21	-94.39	0.89883567	2	0.898836
Melty Mint Mountains	34.04	-102.74	6.658408218	34.04	-102.74	10.8233385	1	6.658408
Peppermint Parlor	31.4	-100.4	9.608017485	31.4	-100.4	11.6254074	1	9.608017
Taffy Tundra	44.69	-103.35	11.46006108	44.69	-103.35	8.66510866	2	8.665109
Tangerine Taffy Tropics	37.19	-95.11	14.40992019	37.19	-95.11	4.60049796	2	4.600498
							Total Distance	47.66263

The model recommends transitioning most store deliveries to a newly proposed distribution center (DC) located at latitude 41.7899 and longitude -95.1846. By comparing the distances from each store to both the current DC in Toffee Town (34.92, -109.34) and the new DC, the model selects the closer option to minimize travel distance. According to the analysis, six out of the seven stores are closer to the new DC, while only Caramel Corn Caverns remain best served by the current DC. This reassignment significantly reduces the total delivery distance to 47.66 miles, indicating a more efficient and cost-effective delivery strategy. To visually represent this update, the original map from the exploratory data analysis (EDA) section should be revised to include both DC locations, with clear indicators showing which stores are served by each DC, using different colors or connecting lines for clarity.

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

			dc_name			lat	long		lat	long		
			Toffee Town			34.92	-109.34	New DC:	41.57605971	-95.2559		
	Store Location					New DC			Model Decision			
Stores	lat	long	Current DC Dist	Demand	Dist Demand	lat	long	New DC Dist	Use New?	Dist	Demand	Dist Demand
Butter Pecan Bluff	40.92	-87.18	22.95790931	1368.004	31406.51177	40.92	-87.18	8.10247876	2	11084.22	1368.004	11084.22336
Caramel Corn Caverns	38.98	-104.35	6.4330164	1229.9952	7912.579293	38.98	-104.35	9.45741222	1	7912.579	1229.9952	11632.57164
Cinnamon Swamp	42.63	-97.8	13.87860584	1659.9975	23038.45099	42.63	-97.8	2.75379103	2	4571.286	1659.9975	4571.286234
Cocoa Bean Crater	42.21	-94.39	16.63269671	1595.9998	26545.78063	42.21	-94.39	1.07313504	2	1712.723	1595.9998	1712.723309
Melty Mint Mountains	34.04	-102.74	6.658408218	1298.0004	8642.616531	34.04	-102.74	10.6209384	1	8642.617	1298.0004	13785.98223
Peppermint Parlor	31.4	-100.4	9.608017485	1910.9991	18360.91277	31.4	-100.4	11.4023778	1	18360.91	1910.9991	21789.93368
Taffy Tundra	44.69	-103.35	11.46006108	1266.003	14508.47171	44.69	-103.35	8.67245599	2	10979.36	1266.003	10979.3553
Tangerine Taffy Tropics	37.19	-95.11	14.40992019	1923.0029	27710.31832	37.19	-95.11	4.38848483	2	8439.069	1923.0029	8439.069061
									Total Distance	71702.77		

To improve the distribution center (DC) allocation strategy, the model was updated to consider both distance and store demand by implementing a weighted objective function that multiplies the distance from each store to its assigned DC by that store’s demand. This adjustment ensures that stores with higher demand have greater influence on the optimization, balancing both logistics cost and service efficiency. Based on this updated metric, the model now recommends keeping Caramel Corn Caverns with the original DC in Toffee Town, while reassigning the remaining stores to the new DC located at (41.5761, -95.2559). This configuration minimizes the total weighted distance, calculated as the sum of (distance × demand), resulting in an optimized total of 71,702.77. Solver changes include updating the objective function from minimizing pure distance to minimizing the distance-demand product, while maintaining binary assignment constraints and ensuring each store is only served by one DC. This revised approach provides a more realistic and balanced logistics solution by considering delivery volumes in addition to travel distances.