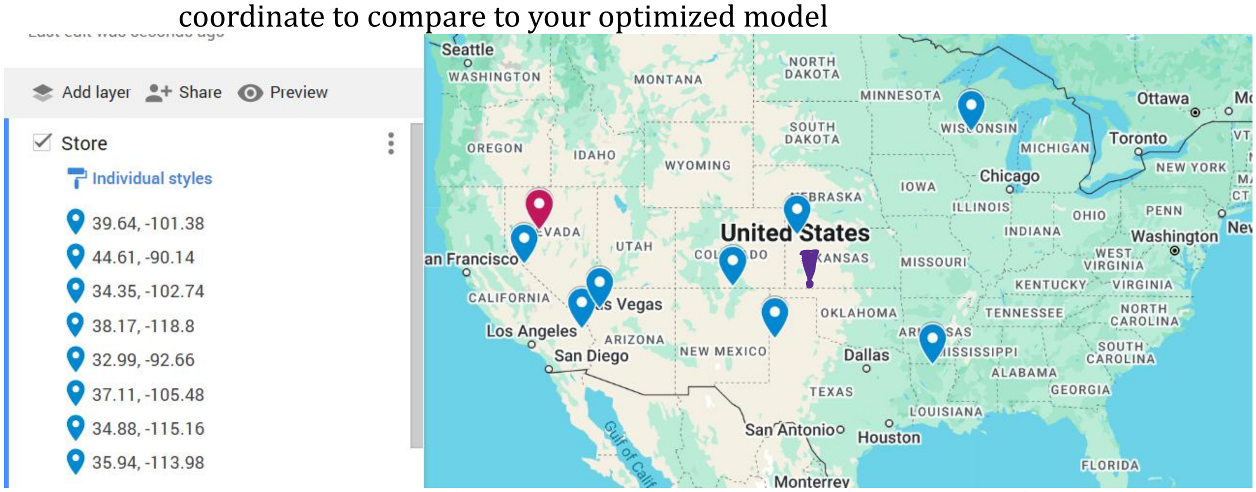
Module 12 – Location Graph

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)*
- 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



    - I used the average of Latitudes and the average of Longitudes for the collective store locations. This gave an adequate value of 37.21, -105.04. I imagine that if I were to hand-select, instead of using the averages, I could get an equally sufficient, if not more efficient. However that is as the crow flies, I am unsure of actual effective routes in between nodes.

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.

Decision Variable:

"New DC" – Latitude and Longitude (finding a more optimal new DC location, after using averages to find the previous basic New DC)

H2:I2

Objective Function:
Sum of "Dist." Column
Which is the distance from each store to either the Original or the New DC location

Constraints:
None in solver 😌

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*

	A	B	C	D	E	F	G	H	I	J	K	L
1								Lat	Long			
2		Objective:	55.67048				New DC:	37.11	-101.38			
3												
4		Store Location		Current DC				New DC			Model Decision	
5	Stores	Lat	Long	Lat	Long	Current DC Dist		Lat	Long	New DC Dist	Use New?	Dist
6	Cinnamon Swamp	39.64	-101.38	39.94	-117.9	16.52272375		37.11	-101.38	2.53	TRUE	2.53
7	Coconut Cluster Caves	44.61	-90.14	39.94	-117.9	28.15007105		37.11	-101.38	18.74	TRUE	18.74
8	Creme Brulee Cliffs	34.35	-102.74	39.94	-117.9	16.15777522		37.11	-101.38	4.12	TRUE	4.12
9	Marzipan Metropolis	38.17	-118.8	39.94	-117.9	1.985673689		37.11	-101.38	18.48	FALSE	1.985674
10	Meringue Mountains	32.99	-92.66	39.94	-117.9	26.17938311		37.11	-101.38	12.84	TRUE	12.84
11	Rock Candy Ridge	37.11	-105.48	39.94	-117.9	12.73833977		37.11	-101.38	4.1	TRUE	4.1
12	Smores Summit	34.88	-115.16	39.94	-117.9	5.754233224		37.11	-101.38	16.01	FALSE	5.754233
13	Starburst Starlit Skies	35.94	-113.98	39.94	-117.9	5.600571399		37.11	-101.38	13.77	FALSE	5.600571
14												
15												
16	New DC:	37.21125	-105.043									
17		(With averages)										

My model is ultimately recommending a new location for a distribution center that will provide relief for the only existing DC that is currently at capacity for fulfilling store orders. Our simple "New DC" was originally found by taking the average of the latitude and longitude values of the candy store locations. We calculated the Euclidean distance between those. As well as the distance between our stores and our "New DC," which we calculated the location of. With these in place, we set up columns to indicate that if the "New DC" is closer, it's true, and gives the Euclidean distance. I set the NEW DC (up top) as the decision variables in Solver, while the objective function is the sum of the far right Dist. Column. While minimizing this total distance, to mitigate the difference between the stores and the proposed NEW DC, solver found a new solution for a distribution center location. My initial proposal was (value found below the table) 37.21, -105.04. The NEW DC found by solver is slightly more optimized at 37.11, -101.38. This is just a proposed solution based on Euclidean distance, as a general optimization, not taking into account real-world obstacles.

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.*
2. *Provide a text explanation on what your model is recommending now with this change.*
3. *Explain the changes to your Solver/Model.*

L	M	N	O	P	Q	R	S
		Objective (#2)	82623.11428				
ion							
Dist	Last year demand	Expected YOY change	Next Year Demand	Current DC Weight	New DC Weight	Use New	Weight Chosen
2.53	1397.2	0.07	1495.004	24701.53809	3782.360108	TRUE	3782.360108
18.74	1411.11	-0.1	1269.999	35750.56208	23799.78123	TRUE	23799.78123
4.12	2020.88	-0.09	1839.0008	29714.16155	7576.683334	TRUE	7576.683334
98567	1257.66	0.11	1396.0026	2772.005633	25798.12804	FALSE	2772.005633
12.84	1574.77	0.07	1685.0039	44112.36264	21635.45009	TRUE	21635.45009
4.1	1221.7	0.06	1295.002	16496.17547	5309.508226	TRUE	5309.508226
75423	1438.68	0.06	1525.0008	8775.21027	24415.26284	FALSE	8775.21027
50057	1780	-0.1	1602	8972.115382	22059.54003	FALSE	8972.115382
		Total Expected Demand	12107.0131				

This stipulation on my existing model starts with gathering, and making a new column for the previous year's demand for each store. Next, gather the expected yearly change in demand, and calculate Next Year Demand. I also took into account the Load, as specified, multiplying the Current DC Dist. by Next Year's Demand for the Current DC Weight. And multiplying the New DC Dist. by Next Year's Demand for the New DC Weight. Pretty Straightforward. My next task was to indicate whether or not the original or the new DC would be used for each store based on the new value, considering distance and demand. Finally adding the Weight Chosen column with an IF statement to indicate the lower of the two distances, selecting from Current/New DC Weight. Interestingly enough, the New DC we found with simple averages was more beneficial than the current DC. Then the NEWER DC we found using Solver proved to be even more efficient. Now, with weights considered, we see that the stores that are designated to use the NEWER DC were the same as the New DC without weights. This indicates that this should be a rather simple decision process for implementing this new DC. That is, with the given information in this scenario, this model points to concrete examples of what DC should service which stores.