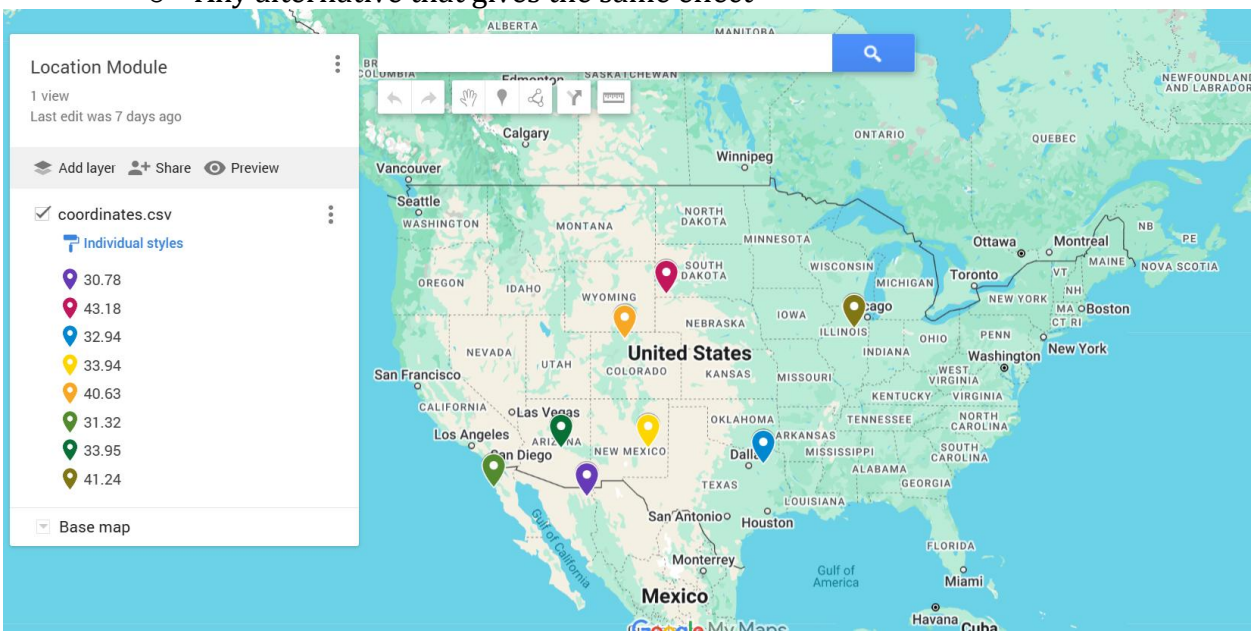
Valeria Santoni

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?**
- Average Latitude = 35.9975
- Average Longitude= -104.5625

This method gives a "middle" point that's balanced among the stores, but may not account for store demand

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.

$$\sqrt{(30.78 - X1^2) \pm (109.4 - Y1)^2} + \sqrt{(43.18 - X1)^2 + (-103.3 - Y1^2)} +$$
$$\sqrt{(32.94 - X1)^2 + (-95.79 - Y1^2)} + \sqrt{(33.94 - X1)^2 + (-104.7 - Y1^2)} +$$
$$\sqrt{(40.63 - X1)^2 + (-106.5 - Y1^2)} + \sqrt{(31.32 - X1)^2 + (-116.6 - Y1^2)} ++$$
$$\sqrt{(33.95 - X1)^2 + (-111.4 - Y1^2)} + \sqrt{(41.24 - X1)^2 + (-88.81 - Y1^2)}$$

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$\sqrt{(30.78 - X1^2) \pm 109.4 - Y1^2} \leq 5.8$ **(Butter Pecan Bluff)**
$\sqrt{(43.18 - X1^2 \pm 103.3 - Y1^2)} \leq 8.1$ **(Candyfloss Countryside)**
$\sqrt{(32.94 - X1^2 \pm 95.79 - Y1^2)} \leq 11.95$ **(Caramel Cascades)**
$\sqrt{(33.94 - X1^2 \pm 104.7 - Y1^2)} \leq 3.4$ **(Coconut Cream Cove)**
$\sqrt{(40.63 - X1^2 \pm 106.5 - Y1^2)} \leq 4.5$ **(Frosted Fluff Fields)**
$\sqrt{(31.32 - X1^2 \pm 116.6 - Y1^2)} \leq 10.5$ **(Hazelnut Haven)**
$\sqrt{(33.95 - X1^2 \pm 111.4 - Y1^2)} \leq 4.7$ **(Licorice Labyrinth)**
$\sqrt{(41.24 - X1^2 \pm 88.81 - Y1^2)} \leq 19.2$ **(Malted Milk Manor)**

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)***

Current DC	lat	long					Lat	Long
Peppermint Peninsula	36.18	-107.3				New DC	34.14817989	-94.774

	Store Location			New DC			Model Decision	
Stores	Lat	Long	Current DC Dist	lat	long	New DC list	Use new?	Dist
Butter Pecan Bluff	30.78	-109.42	5.802498731	30.78	-109.42	15.02834	1	5.802499
Candyfloss Countryside	43.18	-103.29	8.066051652	43.18	-103.29	12.413567	1	8.066052
Caramel Cascades	32.94	-95.79	11.95769441	32.94	-95.79	1.5786156	2	1.578616
Coconut Cream Cove	33.94	-104.68	3.447905719	33.94	-104.68	9.908223	1	3.447906
Frosted Fluff Fields	40.63	-106.49	4.52178934	40.63	-106.49	13.389529	1	4.521789
Hazelnut Haven	31.32	-116.59	10.48507666	31.32	-116.59	21.998591	1	10.48508
Licorice Labyrinth	33.95	-111.43	4.694233359	33.95	-111.43	16.657215	1	4.694233
Malted Milk Manor	41.24	-88.81	19.16950784	41.24	-88.81	9.2662173	2	9.266217
							Total Distance	47.86239

A text explanation of what your model is recommending? The model has chosen the new DC for most stores, and it has minimized the Total Distance to 47.86239 by selecting the new DC for the majority of the stores. The model suggests that, overall, the new DC location provides a more efficient distribution network compared to the current DC.

Update your graph from the EDA section by adding in your new DC and add indicators of which Stores are serviced by which DC

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Model with Stipulation

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.*

Current DC	lat	long								Lat	Long			
Peppermint Peninsula	36.18	-107.3							New DC	32.94000878	-95.79			
	Store Location					New DC			Model Decision					
Stores	Lat	Long	Current DC Dist	Demand	Dist*Demand	lat	long	New DC list	Use new?	Dist	Demand	Dist*Distance		
Butter Pecan Bluff	30.78	-109.42	5.802498731	1898.001	11013.14839	30.78	-109.42	13.800098	1	11013.15	1898.001	26192.60055		
Candyfloss Countryside	43.18	-103.29	8.066051652	1910.9952	15414.18599	43.18	-103.29	12.692814	1	15414.19	1910.995	24255.90592		
Caramel Cascades	32.94	-95.79	11.95769441	1919.0022	22946.84188	32.94	-95.79	1.094E-05	2	0.020989	1919.002	0.02098928		
Coconut Cream Cove	33.94	-104.68	3.447905719	1914.996	6602.72566	33.94	-104.68	8.9460717	1	6602.726	1914.996	17131.69146		
Frosted Fluff Fields	40.63	-106.49	4.52178934	1845.998	8347.214078	40.63	-106.49	13.176726	1	8347.214	1845.998	24324.20958		
Hazelnut Haven	31.32	-116.59	10.48507666	1827.9972	19166.69077	31.32	-116.59	20.862998	1	19166.69	1827.997	38137.50254		
Licorice Labyrinth	33.95	-111.43	4.694233359	1939.9956	9106.792062	33.95	-111.43	15.672584	1	9106.792	1939.996	30404.74381		
Malted Milk Manor	41.24	-88.81	19.16950784	1791	34332.58854	41.24	-88.81	10.844822	2	19423.08	1791	19423.07612		
									Total Distance	89073.85				

2. ***Provide a text explanation on what your model is recommending now with this change.*** In this updated model, the distances to both the current DC and new DC are now multiplied by the demand for each store . With the implementation of the demand-weighted distance calculation, the model now factors in not just the geographical distance between the stores and the distribution centers (DC), but also the demand of each store. This helps to ensure that the distance is weighted by how much demand each store generates, making the distribution strategy more efficient by considering not just the physical proximity but also the volume of goods each store requires.

Explain the changes to your Solver/Model.