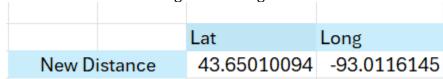# Module 12 – Location Graph

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

	Lat	Long
New Distance	43.65010094	-93.0116145

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    - We have chosen to use this as the new coordinates for our new location as it is in a good placement in between out others drop off locations, and allows for a minimized distance. This will allow for there to be a closer DC to the shipping points that are far away, and the previous one will service those which it is closest too.

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.

Constraints: none, possible Variable cells > 0
Objective function: Sum(Distances)
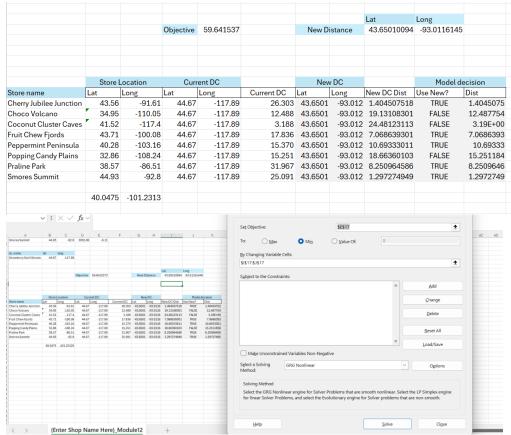**Decision Variables:** Lat and Long starting with 0
Minimized function: MIN "SUM(distance)" / "IF ("use new?", "New DC dist.", "Current DC dist.")"

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)*

					Lat	Long
Objective	59.641537		New Distance		43.65010094	-93.0116145

Store name	Store Location		Current DC		Current DC	New DC			Model decision	
	Lat	Long	Lat	Long		Lat	Long	New DC Dist	Use New?	Dist
Cherry Jubilee Junction	43.56	-91.61	44.67	-117.89	26.303	43.6501	-93.012	1.404507518	TRUE	1.4045075
Choco Volcano	34.95	-110.05	44.67	-117.89	12.488	43.6501	-93.012	19.13108301	FALSE	12.487754
Coconut Cluster Caves	41.52	-117.4	44.67	-117.89	3.188	43.6501	-93.012	24.48123113	FALSE	3.19E+00
Fruit Chew Fjords	43.71	-100.08	44.67	-117.89	17.836	43.6501	-93.012	7.068639301	TRUE	7.0686393
Peppermint Peninsula	40.28	-103.16	44.67	-117.89	15.370	43.6501	-93.012	10.69333011	TRUE	10.69333
Popping Candy Plains	32.86	-108.24	44.67	-117.89	15.251	43.6501	-93.012	18.66360103	FALSE	15.251184
Praline Park	38.57	-86.51	44.67	-117.89	31.967	43.6501	-93.012	8.250964586	TRUE	8.2509646
Smores Summit	44.93	-92.8	44.67	-117.89	25.091	43.6501	-93.012	1.297274949	TRUE	1.2972749

40.0475	-101.2313

- *A text explanation of what your model is recommending*
  The model is recommending that we place a new DC at (43.65,-93.01)
- *Update your graph from the EDA section by adding in your new DC and add indicators of which Stores are serviced by which DC*

Store name	Store Location		Current DC		Current DC	New DC			Model decision	
	Lat	Long	Lat	Long		Lat	Long	New DC Dist	Use New?	Dist
Cherry Jubilee Junction	43.56	-91.61	44.67	-117.89	26.303	43.6501	-93.012	1.404507518	TRUE	1.4045075
Choco Volcano	34.95	-110.05	44.67	-117.89	12.488	43.6501	-93.012	19.13108301	FALSE	12.487754
Coconut Cluster Caves	41.52	-117.4	44.67	-117.89	3.188	43.6501	-93.012	24.48123113	FALSE	3.19E+00
Fruit Chew Fjords	43.71	-100.08	44.67	-117.89	17.836	43.6501	-93.012	7.068639301	TRUE	7.0686393
Peppermint Peninsula	40.28	-103.16	44.67	-117.89	15.370	43.6501	-93.012	10.69333011	TRUE	10.69333
Popping Candy Plains	32.86	-108.24	44.67	-117.89	15.251	43.6501	-93.012	18.66360103	FALSE	15.251184
Praline Park	38.57	-86.51	44.67	-117.89	31.967	43.6501	-93.012	8.250964586	TRUE	8.2509646
Smores Summit	44.93	-92.8	44.67	-117.89	25.091	43.6501	-93.012	1.297274949	TRUE	1.2972749

40.0475	-101.2313

Model with Stipulation

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

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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.*

							Lat	Long				
		Objective	87386.667			New Distance	44.12487957	-93.06229				

| Store name | Store Location | | Current DC | | | New DC | | | Model decision | | | |
	Lat	Long	Lat	Long	Current DC	Lat	Long	New DC Dist	Use New?	Dist	DEMAND	DEMAND STIP
Cherry Jubilee Junction	43.56	-91.61	44.67	-117.89	26.303	44.1249	-93.062	1.558279545	TRUE	1.5582795	1578.57	2459.85
Choco Volcano	34.95	-110.05	44.67	-117.89	12.488	44.1249	-93.062	19.30701185	FALSE	12.487754	1618.92	20216.7
Coconut Cluster Caves	41.52	-117.4	44.67	-117.89	3.188	44.1249	-93.062	24.47671396	FALSE	3.19E+00	1237.84	3946.09
Fruit Chew Fjords	43.71	-100.08	44.67	-117.89	17.836	44.1249	-93.062	7.029962934	TRUE	7.0299629	1692.52	11898.4
Peppermint Peninsula	40.28	-103.16	44.67	-117.89	15.370	44.1249	-93.062	10.80494546	TRUE	10.804945	1425.23	15399.5
Popping Candy Plains	32.86	-108.24	44.67	-117.89	15.251	44.1249	-93.062	18.9013331	FALSE	15.251184	1405.41	21434.2
Praline Park	38.57	-86.51	44.67	-117.89	31.967	44.1249	-93.062	8.590063512	TRUE	8.5900635	1198.11	10291.8
Smores Summit	44.93	-92.8	44.67	-117.89	25.091	44.1249	-93.062	0.84676735	TRUE	0.8467674	2055.06	1740.16
	40.0475	-101.2313										

I completed option A, in this I added 2 additional columns to multiple the demand by the distance. I then re ran the solver and summed this distance instead to make the demand distance smaller. This did not change the cooridnates very much, only by meer tenths of points.