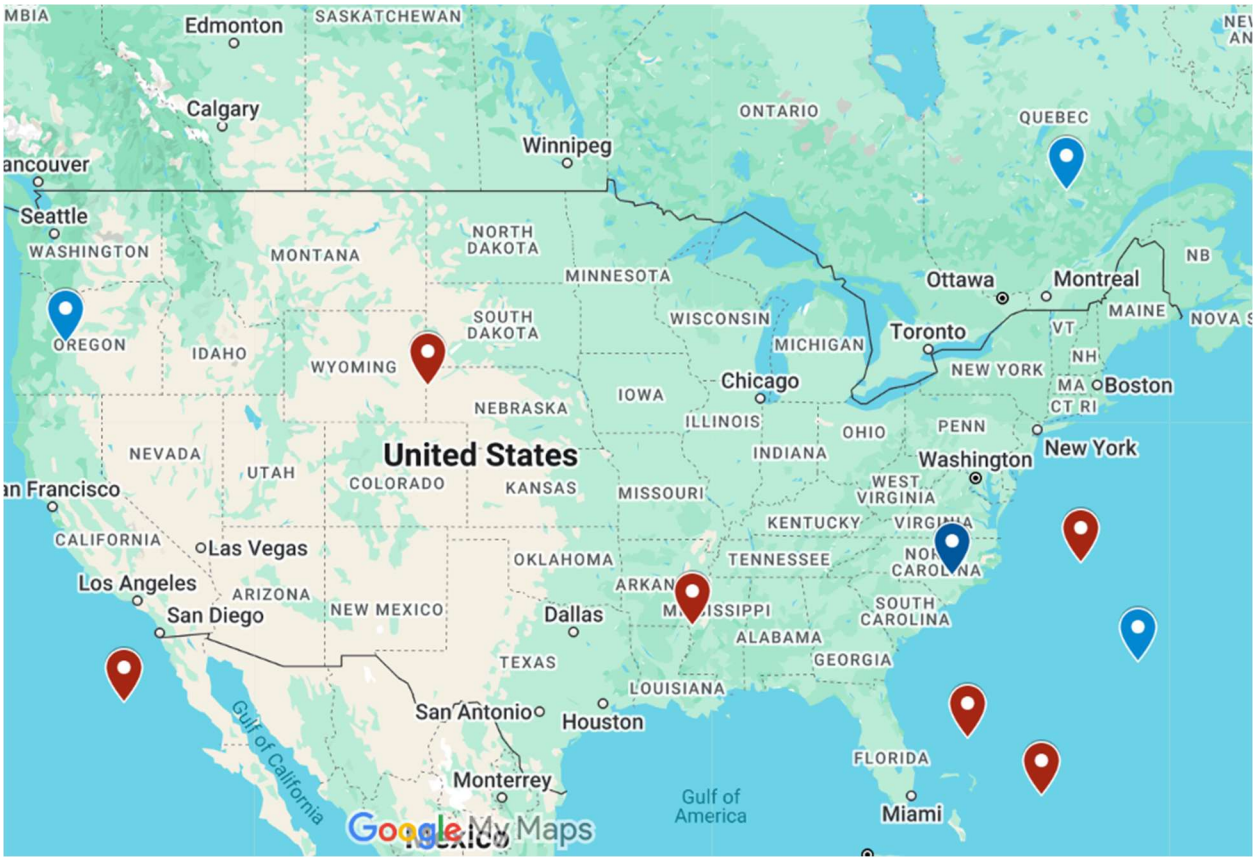
Module 09 – Fixed Charge Problem

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



Red: Distribution Center
Blue: Warehouses

Model Formulation

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.

Min:
6.73*X11 + 7.61*X12 + 13.68*X13 + 14.82*X14 + 46.05*X15 + 33.02*X16+6.88*X21 + 11.64*X22 + 10.55*X23 + 23.39*X24 + 51.62*X25 + 45.75*X26+14.16*X31 + 25.54*X32 +

$24.45*X33 + 34.29*X34 + 65.52*X35 + 38.07*X36+58.27 * X41 + 60.03 * X42 + 66.1 * X43 + 41.76 * X44 + 17.01 * X45 + 19.4 * X46 + 2489Y_1 + 2768Y_2+2268Y_3+2063Y_3$

$1: X_{11} + X_{21} + X_{31} + X_{41} \geq 617$
$2: X_{12} + X_{22} + X_{32} + X_{42} \geq 600$
$3: X_{13} + X_{23} + X_{33} + X_{43} \geq 918$
$4: X_{14} + X_{24} + X_{34} + X_{44} \geq 740$
$5: X_{15} + X_{25} + X_{35} + X_{45} \geq 679$
$6: X_{16} + X_{26} + X_{36} + X_{46} \geq 931$

Linking Constraints:

$X_1 + 15Y_1 \geq 0$
$X_2 + 14Y_2 \geq 0$
$X_3 + 11Y_3 \geq 0$
$X_4 + 10Y_4 \geq 0$

Model Optimized for Min Costs to Supply DCs

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)*

		Distribution Center					
	WH v DC	1	2	3	4	5	6
Warehouse	1	6.73	7.61	13.68	14.82	46.05	33.02
	2	6.88	11.64	10.55	23.39	51.62	45.75
	3	14.16	25.54	24.45	34.29	65.52	38.07
	4	58.27	60.03	66.1	41.76	17.01	19.4

Objective Function:	$ 66,406.64

Sum of Demand	4485
Transportation cost	$61,854.64
Setup Cost	$ 4,552.00
Max Number of Warehouses	2

		Distribution Center					
	WH v DC	1	2	3	4	5	6
Warehouse	1	617	600	918	740	0	0
	2	0	0	0	0	0	0
	3	0	0	0	0	0	0
	4	0	0	0	0	679	931
	Units Sent	617	600	918	740	679	931
	Total DC Demand	617	600	918	740	679	931

WH Sum Set		Binary	Linking	Set up Costs	
1	2875	1	-1610	2489	2489
2	0	0	0	2768	0
3	0	0	0	2268	0
4	1610	1	-2875	2063	2063

- *A text explanation of what your model is recommending*
    - My model is recommending that the company should open 2 warehouses, warehouse 1 and warehouse 4. To minimize the cost, my model is suggesting that we do not send more materials than what is demanded. Warehouse 1 would receive the demand form distribution center 1, 2, 3, and 4. Warehouse 2 would receive the demand form distribution center's 5 and 6.

Model with Stipulation

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

Please perform 2 out of the 3 scenarios below with a short text description on what changed:

1. *Instead of only being able to open 2 warehouses, what happens to our objective function when we only can open 1 warehouse?*
    - Originally, our costs would be $66,406.64. When we only allow one Warehouse to be opened the costs increase to $96,742.02. This could be because the distance from one warehouse to all the DCs is so much that it would be cheaper to open a second warehouse. 2 warehouses cuts down on transportation costs.

2. *Right now, we have $1 per unit shipped over the distance between the warehouse and the DC. What happens to our objective function when we increase this to $30? Does your DC assignment change at all?*
    - My objective function gets really high. It goes from $66,406.64 to]$1,855,191.20. This is a huge increase. This happens because now the cost for the distance is $29 more than it used to be, which increases the transportation costs by a large margin.

3. *For distance between each location, we used Manhattan distance but what happens to our model if we use Euclidean distance instead? Did the change impact the model at all? Do you feel this is a better distance metric to use in this scenario?*