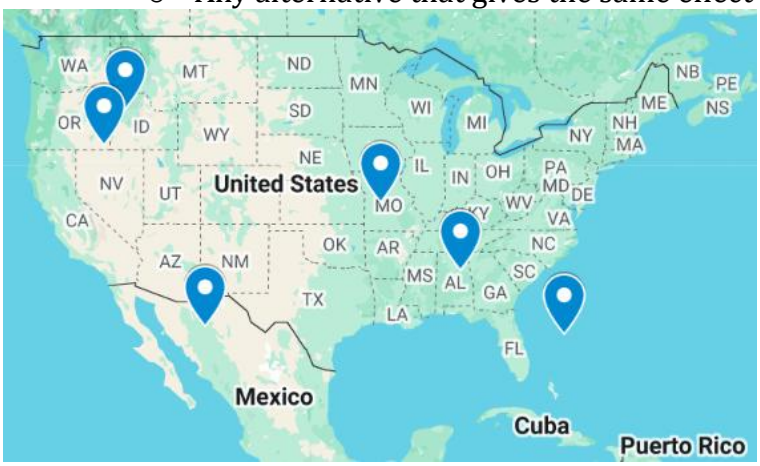
Module 09 – Fixed Charge Problem

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



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: 43.71X11 + 12.6X12 + 17.15X13 + 22.35X14 + 51.06X15 + 50.71X16 + 22.01X21 + 17.78X22 + 4.55X23 + 7.99X24 + 36.7X25 + 36.35X26 + 10.77X31 + 24.1X32 + 15.79X33 + 13.57X34 + 30.38X35 + 30.03X36 + 38.69X41 + 7.58X42 + 19.11X43 + 30.97X44 + 59.68X45

WH V DC > #1 43.71X11+12.6X12 +17.15X13 +22.35X14+51.06X15+50.71X16 <= 620

WH V DC > #2 22.01X21+ 17.78X22+4.55X23+ 7.99X24 +36.7X25+36.35X26 <=960

WH V DC> #3 10.77X31+24.1X32+ 15.79X33+ 13.57X34+ 30.38X35+30.03X36 <=820

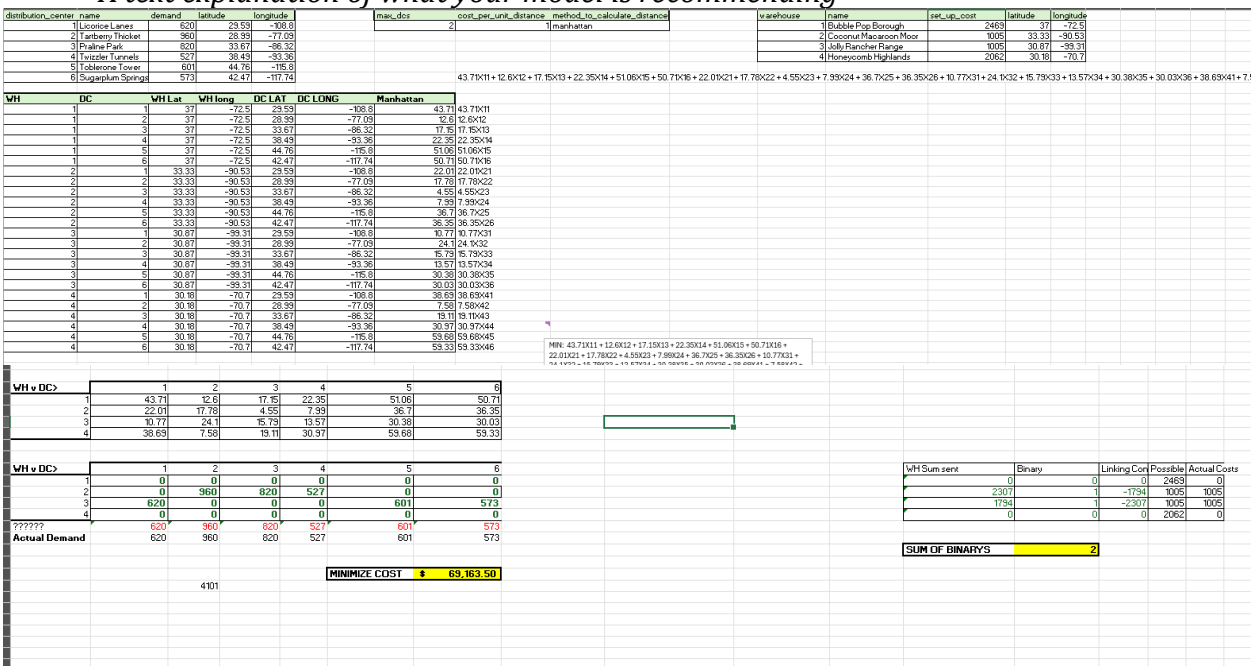
WH V DC > #4 38.69X41 7.58X42 19.11X43 30.97X44 59.68X45 59.33X46 <=527

Linking Constraints
X11+ X12+X13+X14+X15+X16- 4101Y1<=0
X21+X22+X23+X24+X25+X26-4101Y2<=0
X31+X32+X33+X34+X35+X36-4101Y3<=0
X41+X42+X43+X44+X45+X46-4101Y4<=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)*
- *A text explanation of what your model is recommending*



distribution_center	name	demand	latitude	longitude
1	Licorice Lanes	620	29.59	-108.8
2	Tartberry Thicket	960	28.99	-77.09
3	Praline Park	820	33.67	-86.32
4	Twizzler Tunnels	527	38.49	-93.36
5	Toblerone Tower	601	44.76	-115.8
6	Sugarplum Springs	573	42.47	-117.74

max_dcs	cost_per_unit_distance	method_to_calculate_distance
2	1	manhattan

warehouse	name	set_up_cost	latitude	longitude
1	Bubble Pop Borough	2469	37	-72.5
2	Coconut Macaroon Moor	1005	33.33	-90.53
3	Jolly Rancher Range	1005	30.87	-99.31
4	Honeycomb Highlands	2062	30.18	-70.7

43.71X11 + 12.6X12 + 17.15X13 + 22.35X14 + 51.06X15 + 50.71X16 + 22.01X21 + 17.78X22 + 4.55X23 + 7.99X24 + 36.7X25 + 36.35X26 + 10.77X31 + 24.1X32 + 15.79X33 + 13.57X34 + 30.38X35 + 30.03X36 + 38.69X41 + 7.

WH	DC	WH Lat	WH long	DC LAT	DC LONG	Manhattan	
1	1	37	-72.5	29.59	-108.8	43.71	43.71X11
1	2	37	-72.5	28.99	-77.09	12.6	12.6X12
1	3	37	-72.5	33.67	-86.32	17.15	17.15X13
1	4	37	-72.5	38.49	-93.36	22.35	22.35X14
1	5	37	-72.5	44.76	-115.8	51.06	51.06X15
1	6	37	-72.5	42.47	-117.74	50.71	50.71X16
2	1	33.33	-90.53	29.59	-108.8	22.01	22.01X21
2	2	33.33	-90.53	28.99	-77.09	17.78	17.78X22
2	3	33.33	-90.53	33.67	-86.32	4.55	4.55X23
2	4	33.33	-90.53	38.49	-93.36	7.99	7.99X24
2	5	33.33	-90.53	44.76	-115.8	36.7	36.7X25
2	6	33.33	-90.53	42.47	-117.74	36.35	36.35X26
3	1	30.87	-99.31	29.59	-108.8	10.77	10.77X31
3	2	30.87	-99.31	28.99	-77.09	24.1	24.1X32
3	3	30.87	-99.31	33.67	-86.32	15.79	15.79X33
3	4	30.87	-99.31	38.49	-93.36	13.57	13.57X34
3	5	30.87	-99.31	44.76	-115.8	30.38	30.38X35
3	6	30.87	-99.31	42.47	-117.74	30.03	30.03X36
4	1	30.18	-70.7	29.59	-108.8	38.69	38.69X41
4	2	30.18	-70.7	28.99	-77.09	7.58	7.58X42
4	3	30.18	-70.7	33.67	-86.32	19.11	19.11X43
4	4	30.18	-70.7	38.49	-93.36	30.97	30.97X44
4	5	30.18	-70.7	44.76	-115.8	53.68	53.68X45
4	6	30.18	-70.7	42.47	-117.74	53.33	53.33X46

MIN: 43.71X11 + 12.6X12 + 17.15X13 + 22.35X14 + 51.06X15 + 50.71X16 + 22.01X21 + 17.78X22 + 4.55X23 + 7.99X24 + 36.7X25 + 36.35X26 + 10.77X31 +

WH v DC>	1	2	3	4	5	6
1	43.71	12.6	17.15	22.35	51.06	50.71
2	22.01	17.78	4.55	7.99	36.7	36.35
3	10.77	24.1	15.79	13.57	30.38	30.03
4	38.69	7.58	19.11	30.97	53.68	53.33

WH v DC>	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	960	820	527	0	0
3	620	0	0	0	601	573
4	0	0	0	0	0	0
??????	620	960	820	527	601	573
Actual Demand	620	960	820	527	601	573

MINIMIZE COST	$ 69,163.50

4101

WH Sum sent	Binary	Linking Con	Possible	Actual Costs
0	0	0	2469	0
2307	1	-1794	1005	1005
1794	1	-2307	1005	1005
0	0	0	2062	0

SUM OF BINARYS	2

To minimize cost, these are the decision variables needed.

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:

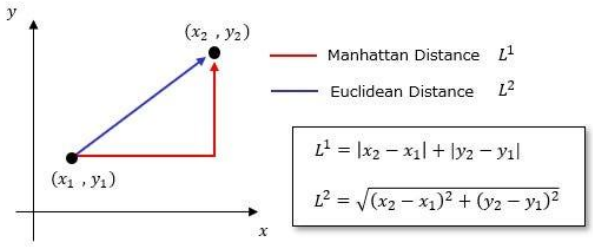
1. *Instead of only being able to open 2 warehouses, what happens to our objective function when we only can open 1 warehouse?*

When we reduce warehouses, our objective function is minimizing cost increases

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?*

   No because during the model formulation, cost per unit was nowhere utilized when inputting it into solver.

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?*


y
$(x_2\ ,\ y_2)$
$(x_1\ ,\ y_1)$
x
Manhattan Distance L^1
Euclidean Distance L^2
$L^1 = |x_2 - x_1| + |y_2 - y_1|$
$L^2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$