**Homework #5**

**MLDS Program, Fall 2023**

**Optimization**

**Due: At the start of class on Wed 11/01/23**

1. Extend the VRP with flow formulations model in the Notebook:
   1. Assume you can't drive faster than 20 miles/hr. How the model changes if you need to finish your tour in maximum one hour? What about 45 minutes? What about half an hour?
   2. Assume you don't need to return to the depot (node 0) after finishing your route. How do you adjust the model to account for that (this is called Open VRP or OVRP)? Solve the original model with this new assumption.
   3. Solve part (a) with OVRP.
   4. In all of the models above, adjust the maximum number of stops and report the effects on objective value and run time.
   5. In all of the models above, adjust the number of vehicles and report the effect on the objective value and run time. What do you need to do in your model if you don't have a restriction on number of vehicles (i.e., assume you have an infinite number of vehicles)?
2. We use the data in “manhattan\_customers20.csv” file.

The following assumptions hold for all the parts below:

* Since this is Manhattan data, it’s only appropriate for you to use Manhattan distances!
* Assume you have maximum 4 drops (or if you count depot, you have maximum 5 stops)
  1. Solve the problem using Clarke-Wright algorithm.

Now for all the following parts, assume that you are solving an Open VRP (so, no return to the depot at the end of your tour). With changing some parameter and functions, you can have the answer to this part using the Set Partitioning formulation in the Notebook. Let’s call that **“SP” solution**.

* 1. Solve the problem using Nearest neighbor (NN) heuristic.
  2. Compare the result of your NN heuristic with **“SP” solution**. If they are not the same (hopefully your “SP” solution is not worse!), then improve the solution in part (b). You have several options here. Choose one and explain your choice:
* Use another heuristic that you learned in the class (or was discussed in the class)
* Use a new heuristic (you can even use your own heuristic)
* Use improvement heuristic(s) on the solution of part (b). Note that meta-heuristics are also considered improvement heuristics.