Algorithms 4110
Project Assignment 2
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Note: time taken is skewed because all pairs shortest path for each city is serialized to a file
Note: All pairs shortest path was too large for my laptop, and I was unable to compute median/centers
    without running out of memory.

Cities used: Lethbridge, Alberta – Cochrane, Alberta

Solutions for p = 1 and p = 2

P-median

P = 1
place: Lethbridge
cost = 87725
time taken: 5.791866s
nodes:
    id: 88224127
    address: Crowsnest Trail, West Lethbridge, Lethbridge, City of Lethbridge, Alberta,
            T1J 4L3, Canada
    lat: 49.7063388
    lon: -112.8566988

P = 1
place: Cochrane
cost = 10248
time taken: 3.3224s
nodes:
    id: 786871152: {
    address: Bow Valley Trail, West Valley, Cochrane, Town of
            Cochrane, Alberta, T4C 2K8, Canada

     lat: 51.1984194
     lon: -114.4862267

P = 2
place: Lethbridge
cost = 178059
time taken: 15.451487s
nodes:
    id: 188224127:
    address: Crowsnest Trail, West Lethbridge, Lethbridge, City of
            Lethbridge, Alberta, T1J 4L3, Canada
    lat: 49.7063388,

lon': -112.8566988

id: 188226045:
address: Tim Hortons, Scenic Drive S, Downtown, West
          Lethbridge, Lethbridge, City of Lethbridge, Alberta,
          T1J 4L3, Canada
    lat: 49.6933384,
    lon: -112.845508424358

P-center

P = 1
Place: Lethbridge
cost = 65
time taken: 5.613962s
nodes:
    id: 4831027202:
    address: Park Meadows Boulevard N, Park Meadows, Lethbridge,
            City of Lethbridge, Alberta, T1H 5E9, Canada
    lat: 49.722395
    lon: -112.8022259

P = 1
Place: Cochrane
cost = 41
time taken: 3.3419s
nodes:
    id: 3555307523:
    address: The Willows of River Heights, Cochrane, Town of Cochrane
    lat: 51.1642649
    lon: -114.462013262378

P = 2
Place: Lethbridge
cost = 115
time taken: 17.351259s
nodes:
    188227587:
    address: 9 Avenue S, Victoria Park, Lethbridge, City of
            Lethbridge, Alberta, T1J 1W5, Canada
     lat: 49.6866368,
     lon: -112.8146255

    id: 4831027202:
    address: Park Meadows Boulevard N, Park Meadows, Lethbridge,
            City of Lethbridge, Alberta, T1H 5E9, Canada
     lat: 49.722395,
     lon: -112.8022259

Maximum solution:
I was able to compute up to p = 5 before the computations started to become too slow.

Algorithm:

The algorithm for p-center and p-median is a variation on the local search algorithm described here http://mauricio.resende.info/talks/pmedianls.pdf.

Firstly, the shortest path between all pairs was pre-computed and serialized to save time. An aggregate hashmap is created from these shortest paths, for p-center, we use the maximum distance between a node and some other node, and for p-median, we use the summed distance between a node and every other node.

We reduce the usable nodes to only those that have a distance or maximum > 0, then we assign our first solution to be the first p nodes of the graph. Then, for each node in the solution, we iterate every other node in graph, replacing one solution node and checking if the solution improves. This iteration ends when no node swaps improve the solution for the graph.