Emergency Vehicle Dispatching System

IMPLEMENTED USING PYTHON

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Githublink: https://github.com/Sonjongkook/Group4-Emergency-Vehicle-Dispatching-System-Project-

Assumptions

1. Requests are processed by order of their ID. Once a vehicle is assigned to a request, it becomes unavailable for use in later requests.
2. When building the graph, edges are assumed to be undirected.
3. The number of vehicles available is greater than the number of vehicles requested.
4. If the distance is the same for multiple vehicles, we make the selection based on ID number in ascending order (if there are two vehicles equidistance from a request zip code, we would send vehicle with ID 1 over vehicle with ID 2).

Project Workflow

1. Make json data according to Project guidelines
2. Process the information from the Json file
3. Find shortest path from request zip code to zip code with available vehicle of the correct type using Dijkstra's Shortest Path Algorithm
4. Dispatch most suitable vehicle to the request and set it to unavailable

Step 1: Creating a Json file

As described in the project guidelines, we have created data for three tables: vehicles, requests, and distances. This is shown in the Json file.

The first section in the Json file is for vehicles. Each vehicle listed has an ID, type, and zip code. The vehicles are in ascending order by their IDs. Vehicles types are in accordance with the project description – (1) Ambulance, (2) Firetruck, and (3) Police Car.

The second section is for requests. Each request has an ID, type of vehicles, and zip code. The requests are also ordered by ascending ID.

The last section, distances, contains zip code 1, zip code 2, and the distance between the two. This data will be used to construct the graph.

We can manually input all of this information or use a Json generator in the source code.

Step 2: Process information from Json file

Iterate through all of the vehicles and set their availability to "available".

We also need the construct the graph using the Graph class and the "distances" section of the Json file. Vertices will be formed from the "zip code 1" and "zip code 2" data, and edges will be weighted with the distances between them.

Step 3: Finding shortest path using Dijkstra's Shortest Path Algorithm

In order to implement an efficient algorithm, we have used Dijkstra's algorithm, which provides the minimum shortest path without leaving any vertex behind.

For each request, reset the graph so all vertices are initialized back to their starting state.

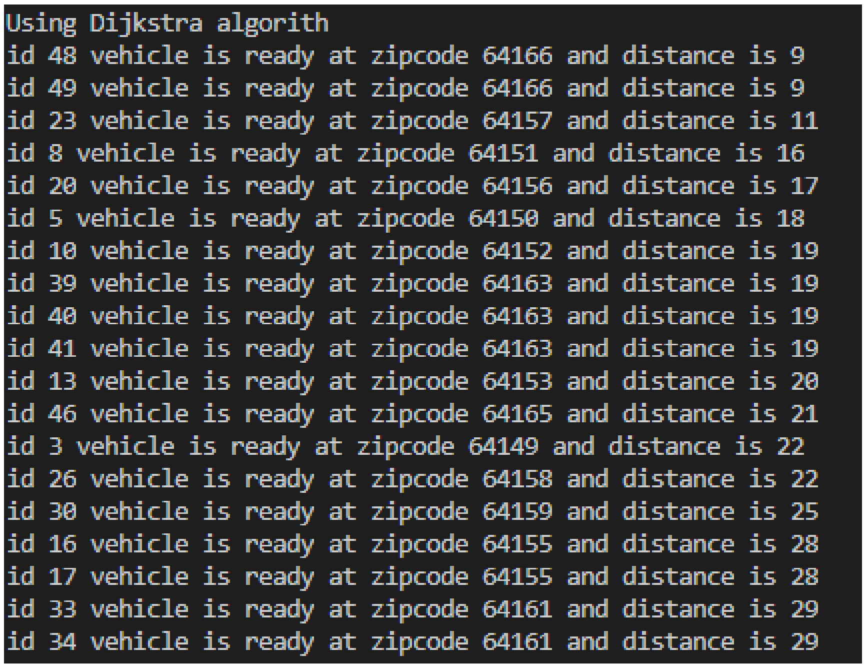
We create a list to hold available vehicles and populate it by iterating over each vehicle and adding it only if the type matches the request type and if the vehicle is set to available.

We then run Dijkstra's algorithm with the request node as the starting point. The algorithm will find the distance from the starting node to each vertex in the graph.

Step 4: Dispatch most suitable vehicle to the request

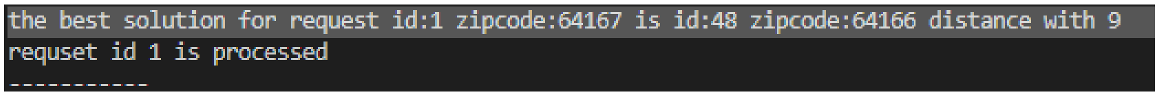
We order the list of available vehicles by their distances found in the Dijkstra function.

We can then print this list to the console:



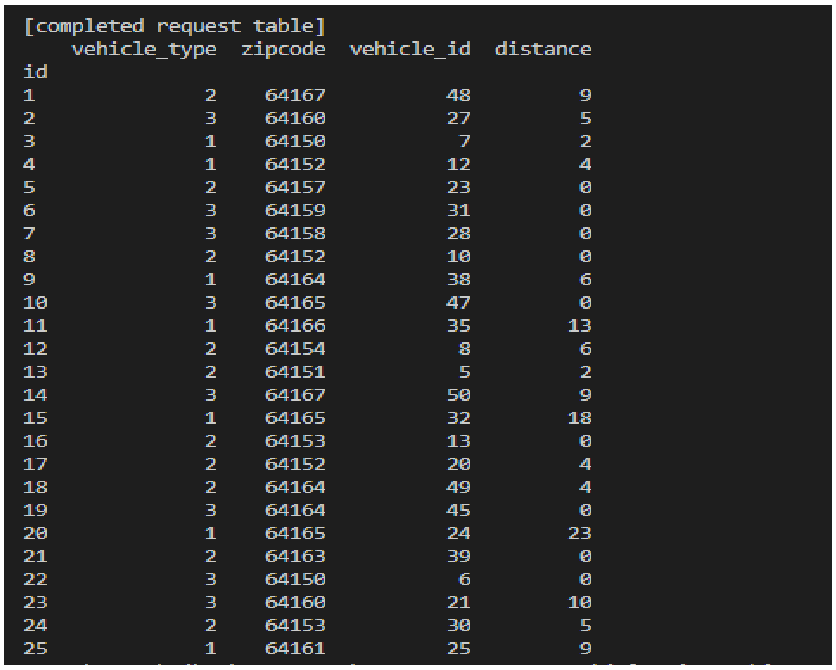
```
Using Dijkstra algorith
id 48 vehicle is ready at zipcode 64166 and distance is 9
id 49 vehicle is ready at zipcode 64166 and distance is 9
id 23 vehicle is ready at zipcode 64157 and distance is 11
id 8 vehicle is ready at zipcode 64151 and distance is 16
id 20 vehicle is ready at zipcode 64156 and distance is 17
id 5 vehicle is ready at zipcode 64150 and distance is 18
id 10 vehicle is ready at zipcode 64152 and distance is 19
id 39 vehicle is ready at zipcode 64163 and distance is 19
id 40 vehicle is ready at zipcode 64163 and distance is 19
id 41 vehicle is ready at zipcode 64163 and distance is 19
id 13 vehicle is ready at zipcode 64153 and distance is 20
id 46 vehicle is ready at zipcode 64165 and distance is 21
id 3 vehicle is ready at zipcode 64149 and distance is 22
id 26 vehicle is ready at zipcode 64158 and distance is 22
id 30 vehicle is ready at zipcode 64159 and distance is 25
id 16 vehicle is ready at zipcode 64155 and distance is 28
id 17 vehicle is ready at zipcode 64155 and distance is 28
id 33 vehicle is ready at zipcode 64161 and distance is 29
id 34 vehicle is ready at zipcode 64161 and distance is 29
```

Lastly, we will assign the vehicle at the list index '0' to the request, set this vehicle's availability to 'False', and print the solution to the console:



```
the best solution for request id:1 zipcode:64167 is id:48 zipcode:64166 distance with 9
requset id 1 is processed
-----------
```

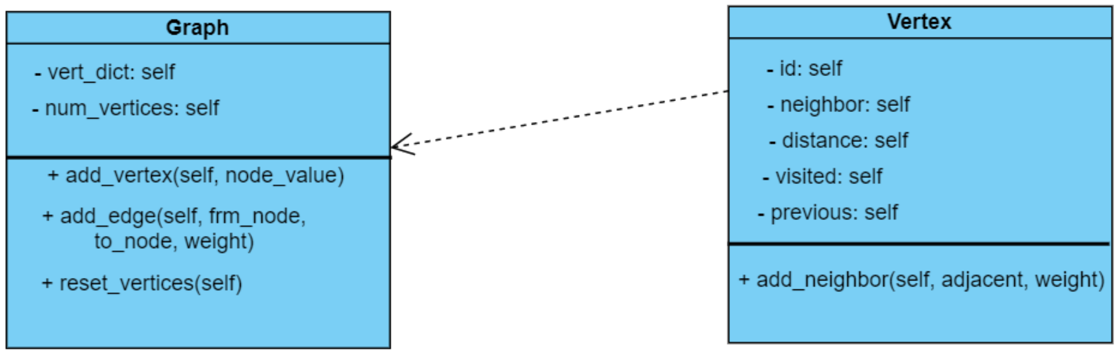
This process will repeat for all requests until none are remaining, at which point the program will print “all requests have been processed” to the console and completed request table is printed on console to clarify the result of request then our code is quit.



```
[completed request table]
    vehicle_type  zipcode  vehicle_id  distance
id
1              2    64167          48         9
2              3    64160          27         5
3              1    64150           7         2
4              1    64152          12         4
5              2    64157          23         0
6              3    64159          31         0
7              3    64158          28         0
8              2    64152          10         0
9              1    64164          38         6
10             3    64165          47         0
11             1    64166          35        13
12             2    64154           8         6
13             2    64151           5         2
14             3    64167          50         9
15             1    64165          32        18
16             2    64153          13         0
17             2    64152          20         4
18             2    64164          49         4
19             3    64164          45         0
20             1    64165          24        23
21             2    64163          39         0
22             3    64150           6         0
23             3    64160          21        10
24             2    64153          30         5
25             1    64161          25         9
```

Diagrams

Classes:

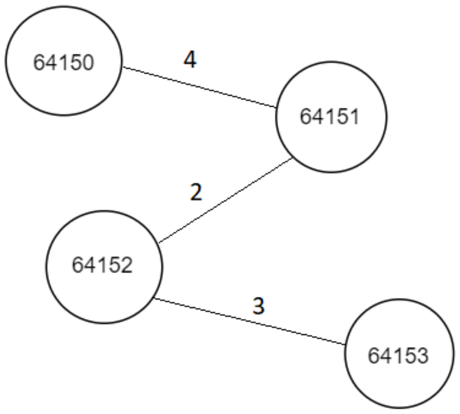


Graph Example:

Taking this table from the project description:

ID	VehicleType	ZipCode	VehicleID	Distance
1	1	64151	1	2
2	2	64149	15	1
3	1	51234	20	3
…	…	…	…	…

The graph we would create in “main” using the “Graph” class is:



If a request was entered for zip code 64150 and there were two available vehicles at 64152 and 64153, the dijkstra function would find a distance of 6 for the vehicle at zip code 64152, and a distance of 9 for the vehicle at zip code 64153. The program would then dispatch the vehicle at 64152.

Big-O of Significant Functions

The heapsort function used to sort the list of available vehicles has a time complexity of O(n).

The time complexity of dijkstra for ‘v’ vertices, is $O(n*v^2)$, because there are two nested while-loops, and “heapify” is also used in this function as well.

References

https://stackoverflow.com/questions/23110383/how-to-dynamically-build-a-json-object-with-python

https://www.youtube.com/watch?v=XB4MIexjvY0 (Dijkstra algorithm)

https://docs.python.org/3/library/heapq.html (heapq library) https://www.bogotobogo.com/python/python_Dijkstras_Shortest_Path_Algorithm.php (implement Dijkstra)

https://stackoverflow.com/questions/53554199/heapq-push-typeerror-not-supported-between-instances (to implement heapify successfully)

https://www.datacamp.com/community/tutorials/json-data-python (how to deal with Json in python)