A3. Description of the solution

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Bus-Route Optimization

The creation of a good routing for buses is important for a working public transportation system, since it determines the amount of buses that are needed to meet the demand as well as how much time it will take to travel from one place to another, resulting in less waiting time and better customer satisfaction. The total length of the route has direct impact on how much money will be spent on gasoline and maintenance, which also contribute to the impact on the environment. The *city of Gotham* could benefit for our consultation in order to create the best solution for implementing a bus network for the city.

Bus-routing problem consists of an objective function and constraints. The objective function is usually formulated as transportation cost function, which can include the monetary cost to operate the system and the time to serve the customers. Constraints are applied to bus route optimization in order to avoid solutions that have undesirable properties and can be formulated as positive transportation cost. The parameters in bus-routing problem can be estimated from real life data, such as population distribution in the city and common travel routes used by the people. These parameters can be the estimate of the demand and best locations for the bus stops ("Route Optimization Algorithm.."), ("Vehicle Routing Problem - Wikipedia"). Widely used option to obtains solution to bus-routing problem is to use genetic algorithm, which is optimization technique that borrows its working principles from the process of evolution. The main steps of this algorithm are: Initializing a *population* which is set of possible routing candidates, computing the *fitness* of each of the individual routings in the population which measure how good each routing is, and selecting a percentage of the best performing individuals and using them to *reproduce* new individuals using some rule. We also apply a random mutation on randomly selected individuals. This process creates a new population for which we can use the process again ("Genetic Algorithm - Wikipedia"). Another option is to use optimization software such as ("Gurobi Optimization - the State-of-the-Art Mathematical Programming Solver").

Using mathematical optimization to obtain bus-routing solution can significantly increase efficiency of the network and decrease the operating costs. Waiting times between buses will be shorter and the customer will be served more effectively. Good bus-routing will also decrease pollution since people will be more inclined to use the bus network instead private transportation.

References

"Genetic Algorithm - Wikipedia." https://en.wikipedia.org/wiki/Genetic_algorithm.

"Gurobi Optimization - the State-of-the-Art Mathematical Programming Solver." http://www.gurobi.com/.

"Route Optimization Algorithm.." https://www.slideshare.net/Mazhar_Nazik/route-optimization-algorithm-57634160.

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