Improving effeciency of NightRide

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***Abstract*—This paper describes implementation of optimization process of dynamic car sharing, specially designed for NightRide (University of Cincinnati drop home service). A new method for car assignment has been developed which uses Genetic Algorithm to produce best solution.**

Keywords-NightRide, Dynamic ride sharing, Genetic Algorithm

I. INTRODUCTION

This paper is based on improving efficiency of NightRide. NightRide is an on-demand transportation service program within University of Cincinnati's Public service department. This service is available for students, staff and faculty which can be accessed using the app to pick up and drop off within one-mile radius of the University for hours of night.

The current trend followed is queue method, which assigns request to the car with less number of passengers. This method has drawbacks as high wait time and high overall service time. This paper simulates the present queue method and new method for car assignment and compares results for different number of passenger counts per night.

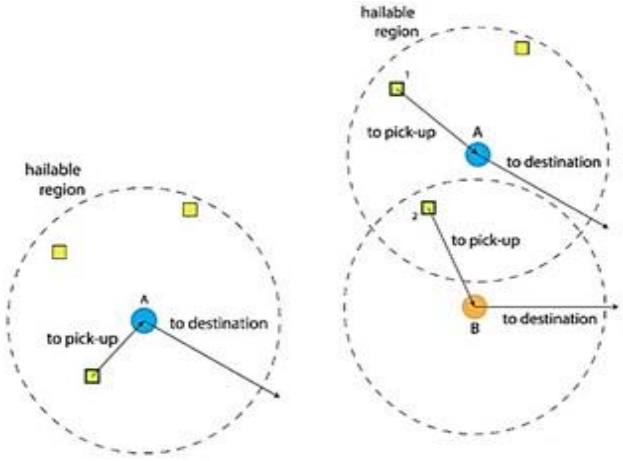
A. The Problem

Present process follows queue method. So, if new pickup is requested then it is assigned to car with minimum number of passengers irrespective of pick-up and drop-off locations. There are limited number of cars operating each night. This process takes more time for dropping passengers, as car does not follow optimum path for dropping passengers. It is based on first come-first serve process. This increases travel time of each passenger and wait time of upcoming passengers.

II.EXISTING MODELS

With increase in commute the ways have been developed to make travel easy, from increase in the number of vehicles to development of various kind of vehicles and by developing ways of effective travelling e.g. dynamic ride sharing. Cab services like Uber, Ola, Lyft have started providing Uber pool, Ola share, Lyft line which provides cheaper travelling options as compared to booking a personal cab. Current approach of shared cabs is different from the traditional method of carpooling. In this there is no specific time decided or you do not have to know the person driving or accompanying to share the cab, and you can call for a shared taxi any time. This method decreases the cost of travelling. To implement dynamic ride sharing, simulations were done. The scheme used by Uber pool, Lyft line allows pick up and drop off to be combined in an existing route and not changing the in-progress ride.

Allocating a cab to the rider is based on different factors, like a cab with the least number of passenger would be allocated the new passenger not considering the distance or the route to be followed. Other approach is assigning the cab to the person in a hail able radius. The cabs will be shared around a map and when a request pops up system will search for the cab in specified radius.



(Quantifying the Potential for Dynamic Ride-Sharing
of New York City's Taxicabs by Suraj Bhat-Princeton University-June 2016)

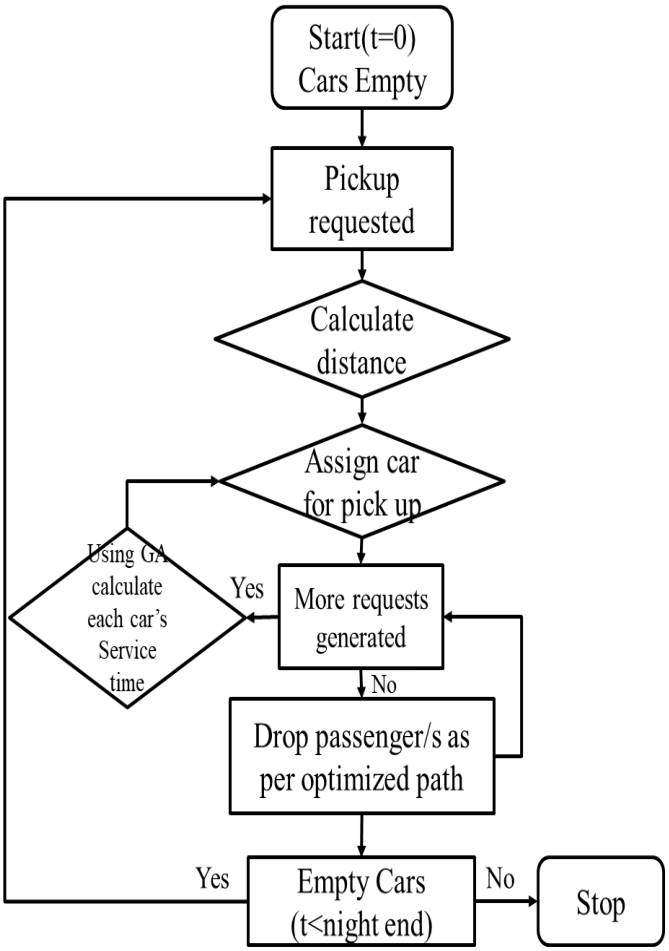
Figure: -The yellow squares in the circle represents taxis and the blue circle represents passenger A's pick-up location, and orange circle represents passenger B's pick location.

As described in paper the concept of hail able region for, pick up arranges for a cab nearest to the pickup location of the person in its hail able region. When a simultaneous request pops up in nearer area of person A, by passenger B the simulation runs and searches for the cab in B's region. As seen in the figure there is only one available car in B's radius which is also the nearest one to A. In this kind of situation this car is assigned to B and because there are other cars available in A's region nearer one will be assigned to A. This approach of assigning cabs in nearest region is used in this paper. Though the numbers of cars are not as high as in normal cab services hence there is less possibilities of car availability in the pickup location. Hence the notion of hail able region will not be a feasible solution for optimizing NightRide's route. An

approach has been developed keeping in mind to assign cab in the nearest distance of the pickup location.

III. NEW MODEL

A. Flow Chart



B. The Process

For improvising the efficiency, the process is followed as shown in the flowchart. Initializing the process when time t=0 and the cars will be empty without any passengers in it. When a random pick up is requested the calculations begins. The location of pick up is marked and compared with the initial location of the cars. The one at least distance from the pickup location will be assigned the car and it will leave to pick up and drop off the person at the destination. Meanwhile when any other request is generated the second car is assigned.

This case is for the initial ride requests, during the ongoing ride there will be other requests generated. The pickup location of request generated is marked and a car is assigned. For assignment of car to the person, a different approach is applied because of its ongoing drive. Wait time of each car to the person and total travel time is compared of both the cars. The one with least service time is assigned the person. This model allows another person to be picked up and dropped off before a passenger already in the car if the journey time is optimized. This optimizing process is done using Genetic Algorithm. Details of which are discussed.

On completing this loop, when both the cars get empty that means no passenger is in the car and there is no ongoing process, cars wait for the new requests. When a request is generated the loop goes to initial type of process of calculating the distance and assigning the car with minimum distance. This course goes on till the drop off is done of each person in the cab. When the time ends no more requests will be considered and cars will get empty and the loop of this procedure ends.

C. Car assignment logic

At any point of time suppose car1 is having n1 passengers and car2 is having n2 passengers. Let W11, W12, …., W1n1 be wait time for passengers in car 1. Similarly, W21, W22, …., W2n2 be wait time of passengers in car 2 at that moment. T11, T12, …, T1n1 is estimated travel time obtained from GA for all the passengers in car1. Similarly, T21, T22, …., Tn2 is estimated travel time for passengers in car2.

Optimum path is found by keeping position of car as first city and drop-off location of passengers as other cities and by applying similar concept of travel sales man problem using Genetic Algorithm. In this paper henceforth, "Genetic Algorithm" will be termed as GA. GA is used because of its fast results with less amount of time. Which suits best for this case as new requests are generated at random time and we need fast optimization tool to get optimum results. In GA PMX(partially-mapped crossover operator) is used for cross over and mutations with probability of 0.2 is carried out. The Total number of population is taken constant as it is needed for faster converging results. Average passenger count per night is 150, as per data given by University of Cincinnati, IT Department. Genetic Algorithm is tested for 200 passengers and it gives promising results.

C is car position and D_1, D_2, …, Dn be drop-off location of passenger present inside city. Optimum path is found by calculating route starting from C and passing through D1, D2, …, Dn.

$$C \longrightarrow [D_1, D_2, \ldots, Dn]$$

By this, Travel time(T) of each passenger is decided as we are considering constant average speed of car.

S is estimated service time of all the passengers in car present at moment. Service time of each passenger can be calculated as addition of his wait time and travel time. As passenger is presently inside the car W, wait time cannot be changed.

$$S1=W11+T11+W12+T12+\ldots\ldots. +W1n1+T1n1.$$

$$S2=W21+T21+W22+T22+\ldots\ldots. +W2n2+T2n2.$$

If new passenger requests for the car, then car1 and car 2 will check the increased S value if they accommodate new passenger in their car. For new service time only travel time of passengers, who are already in car changes as wait time is constant.

$$NS1=W11+NT11+W12+NT12+\ldots +W1n1+NT1n1+W1p+T1p$$

$$NS2=W21+NT21+W22+NT22+ \ldots. +W2n2+NT1n2+W2p+T2p$$

If difference in service time of car1 (NS1-S1) is less than difference in service time of car2 (NS2-S2) then the new passenger will be assigned to car1. Then NS1 will replace S1 and S2 will remain the same.

GA is used for Calculation of NS1. But in calculation of optimum path, pick-up location of new passenger should be ahead of drop-off location. For this, firstly optimum path is calculated for all drop-off location starting from car to [D1, D2, D3, …Dn, Dp] including the new passengers drop-off location.

C ⟶ [D_1, D_2, …, Dn, Dp]

Then new pick-up location is added in between each drop-off location and check for least total distance. New optimum path is the path with least distance obtained from above method.

IV. Results

MATLAB is used to simulate the above model. In Workspace of X (0,100) and Y (0,100) random requests were generated at random time with random pick-up and drop-off locations. Two cars are allotted for simulation simplicity. Simulations are run with changing number of passengers per night and another set of simulations were run using queue method which is being used presently.

Data for total simulation time			
Number of pickups	**Total distance travelled by cars**	**Total distance travelled by cars(Queue)**	**% decrease**
20	1999	2185	8.51
30	2262	2769	18.31
40	2707	4175	35.16
50	2474	3959	37.51
60	3600	6042	40.42
70	4102	7241	43.35

Table: - Simulation Results

(* assumed each car goes at constant speed. Distance ∝ Time)

Simulation is done for two conditions, the present mode of queue and the new optimized method of using GA. Number of passengers travelling are varied to compare the results which optimum number of passengers per night to number of cars ratio.

From the results as the number of passengers travelled per night increases the total distance travelled by cars decreases as compared to the queue method.

V. Challenges

a) Obtaining fitness function for GA. Objective function used to guide the simulation could produce good results for minimising distance. Formulating the algorithm in MATLAB to minimise total path proved tough.

b) Using GA to calculate modified S1 and S2 assigning pick up point before dropping point. To get optimum path in GA the pickup point need to be ahead of the drop of point for a person, while in normal GA path is optimised only for the drop off locations. Hence, finding way for formulating the logic for GA was an issue.

c)Updating position values of both the cars simultaneously. When a new request is generated the pickup location is assigned to a car and similarly other car also gets a pickup request during the ongoing ride. The new values of pick up needs to be calculated and optimised not only for single car but both the cars at same time. Generating a loop which updates the position values for both the cars at same time came up as a big challenge.

VI. Conclusion

New model was developed which best suits for present situation of Nightride UC. GA optimization technique is used for obtaining optimum path for all passengers at any moment. New model involves each car calculating its total service time when a person requests for the cab and cab will be assigned to cab with least effected service time. This condition is simulated in MATLAB. Outputs of simulation shows that for less number of cabs both models gives results with almost equal efficiency. But when number of passengers increased per night efficiency of new model is high compared to present running queue model. Considering average passenger count per night new model gives good results.

Acknowledgment

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