Optimizing the Carpool Service Problem with Genetic Algorithm in Service-Based Computing

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Abstract— In today's world due to industrialization number of cars on roadways increased which causes traffic problems and fuel consumption increases. Carpooling System helps to reduce these problems. Carpooling System is based on artificial intelligence and cloud computing .We are going to implement this system for reducing traffic congestion problem. It is also known as BlueNet which consist of two modules Mobile Client Module and Cloud Carpool Service Module. In Mobile Client Module we are using android based phones so users can submit the carpool request through the handheld devices. In Cloud Global Carpool Service module, we are using Genetic Based Carpool Route and Matching Algorithm to match the requests. This Genetic Based Carpool Route and Matching Algorithm require less time to match large number of users as compare to other systems. It operates with less computational complexity therefore required less computing time.

Key words: BlueNet, Carpool Route, Cloud Computing

I. INTRODUCTION

There is public transportation system are available which may be helpful to reduce the traffic but they do not provide degree of comfort liberty and flexibility as do private vehicles, therefore most of the people prefer their own private vehicles. Due to this number of vehicle increases which causes traffic congestion problems.

In Carpooling System, Drivers can share their vehicles with other persons whose destinations are same. It increases the occupancy rate by reducing number of empty seats. Our system has service oriented architecture (SOA) which uses GIS and GPS to create carpool service to operate in real time.

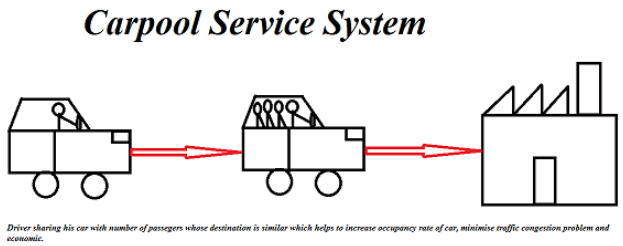

Fig. 1: Overview of Carpool Service System

II. EXISTING SYSTEM

There are some existing systems like CarpoolGlobal and ShareYourRide.

In CarpoolGlobal system, users can search for requests and get the appropriate matching output. But this system cannot work on Geographical Information System (GIS). So it cannot provide real time location.

ShareYourRide uses map based interface to accept requests from user and provide digital GIS support in order to match requests. It doesn't make use of Global Positioning System (GPS) handheld devices due to which it cannot provide instant services to get information regarding user locations.

III. PROPOSED SYSTEM

The proposed system consist two modules such as Mobile Client Module and Cloud Global Carpool Service Module. Both modules communicate with each other through HTTP protocol with the help of Web Services.

A. Mobile Client Module

Users can submit the requests for carpooling and get matching results through Mobile Client Module (MC) at any time and location. This module works on mobile communication network and users personal phone devices which should be Android base. The advantage of this module is it contain GPS technology, it helps to get current location of user. In this way it supports to Intelligent Carpool System.

B. Cloud Global Carpool Service Module

Cloud Global Carpool Service Module (CGCS) takes the information from MC module to match the requests for carpool service. CGCS module consist open GIS system. GIS is Geographical Information System which consist global geographical information include Google Maps, Bing Maps etc. This module work on Genetic Based Carpool Route and Matching algorithm (GCRM) provides optimum solutions in minimum time.

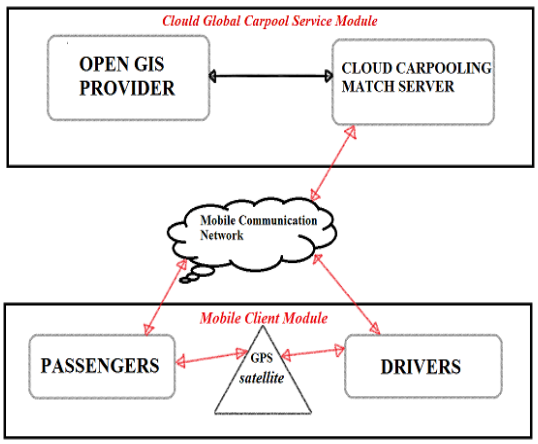

Fig. 2: The Framework of Intelligent Carpool Service System

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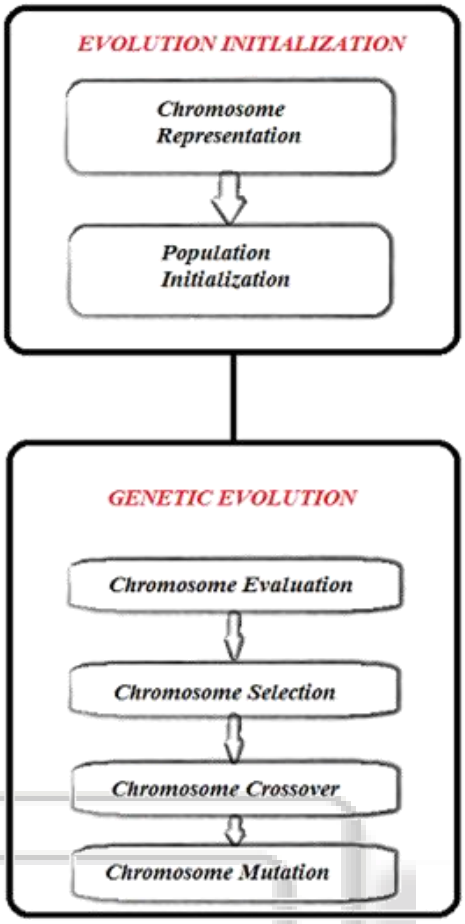

Fig. 5: Genetic Based Carpool Route and Matching Algorithm

In Genetic Based Carpool Route and Matching algorithm, consist of two modules such as:

(1) Evolution Initialization Module (EI)
(2) Genetic Evolution Module (GE)

1) Evolution Initialization Module

It is used to initialise the chromosomes, assigning number of passengers to particular drivers. It consists of two procedures Chromosome Representation and Population Initialization.

a) Chromosome Representation

It provides solution to the Carpool Service Problem (CSP) according to the requirements of drivers and passengers.

b) Population Initialization

It matches the candidates of Initial Population pool feasibly, which are randomly generated.

2) Genetic Evolution Module

This module use to find optimal solution by taking the output of EI module as input. It consists of four procedures such as (1) Chromosome Evaluation (2) Chromosome Selection (3) Chromosome Crossover (4) Chromosome Mutation

Chromosome Evaluation procedure calculates the fitness value to determine the quality of each chromosome. We will find the most efficient route for picking up and dropping off passengers for each corresponding drivers, from that we can calculate fitness value. Chromosome Selection procedure selects chromosome for next generation according to fitness value. Chromosome Crossover is utilized to recombine the chromosomes of selected parents thus generate a more suitable carpool match. Chromosome Mutation is used to maintain population genetic diversity.

a) Chromosome Evaluation:

We need to evaluate the quality of the chromosome in the population, for that fitness function is used to find the travel cost of each driver. The fitness value, let us consider *Fk* of a chromosome is the sum of the fitness values of all segments as follows:

$$Fk = \sum_{i=1}^{m} fi,$$

where ,

Fk is the fitness value of the *k*th chromosome,

fi is the fitness value of each segment in the *k*th chromosome,

and *m* is the number of segments in the *k*th chromosome.

To calculate the fitness value of a segment, we need to find out the most efficient route for picking-up and dropping-off passengers for each corresponding driver. The routing problem in a segment can be viewed as a graph problem:

$$G = (L, A),$$

Where, L = 1, 2. . . 2Si is the index node set, it represents the locations of passengers in the segment, and A = (1, 2). . . (w, x) is the set of arcs in the segment. The constraints is that $w \neq x$, $w \in L$, $x \in L$.

The Cwx is defined as the cost of traveling arc (w, x) between node w and node x. The initial location defined by DL and destination nodes of the driver is defined by DD. According to the above definitions, the fitness function of each segment can be modeled as follows:

$$fi = \sum_{j=1}^{(2Si-1)} (C(j, j+1)) + C(DL,1) + C(2Si,DD),$$

Where, fi is the fitness of each segment, and C(w, x) is the travel cost of the arc(w, x).

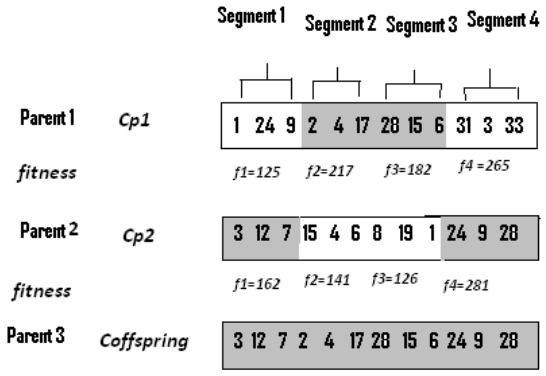

Fig. 3: The Elite-Segment Crossover Procedure

The chromosome evaluation procedure is used to find the shortest route of each segment and subsequently record the routing result in the implicit routing layer of the chromosome. If the fitness value of a chromosome is larger, the routing result is better represented.

b) Chromosome Selection:

After evaluation of initial population, the fitness value can be used as a guide for the chromosome selection procedure.

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For high-quality chromosomes to enter into the next generation and enhance the crossover procedure, we propose a two-phase selection method.

In first phase, sorting the chromosomes into a descending order according to their fitness values is done, and selecting those with the highest values in the population. For that we are using an elitist strategy. This strategy allows for the confinement of chromosomes with the highest fitness values from one generation to the next, as well as ridding the population of low-level chromosomes.

In second phase, the probability value (*Pp*), of each top-tier chromosome (*Cp*) is determined according to the ratio of the fitness value of each top-tier chromosome to the sum of the total fitness values of all top-tier chromosomes. This is shown as follows:

$$Pp = \frac{Fp}{\sum_{k=1}^{en} Fk}$$

where,

Fk is the fitness value of each top-tier chromosome, *en* is the total number of top-tier chromosomes.

Chromosome with a larger fitness value has a larger probability of being selected for the following crossover procedure. We find the top-tier chromosomes by using an elitism-based selection method, for our proposed chromosome selection procedure

3) Chromosome Crossover:

After selection of optimal chromosomes, the chromosome crossover is recombining the chromosomes of selected parents to simulate the natural process of evolution.

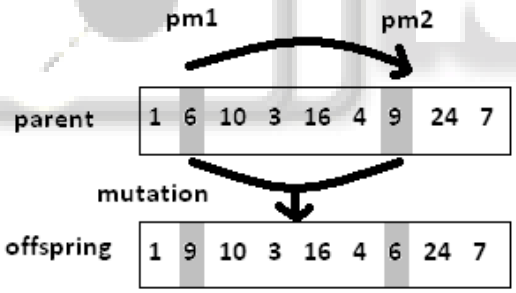

Fig. 4: The Chromosome Mutation Procedure

Generate a more suitable carpool match by capturing the features of elite segments of the parent chromosomes.

Let us consider, two parent chromosomes (*Cp*1 and *Cp*2) are chosen for the crossover procedure from the population of the previous generation.

The first parent chromosome (*Cp*1) is chosen from among the top-tier chromosomes through random selection. The second parent chromosome (*Cp*2) is chosen from the remaining lower-tier chromosomes in the population.

In order to find the best combination of chromosomes from the two chosen parents and produce a high quality offspring, an elite-segment crossover operation is proposed.

The elite-segment crossover operation captures the features of the best segments of the parent chromosomes and passes these features onto a new offspring chromosome (*Coff*).

The elite-segment crossover operation is described as follows:

The two parent *Cp*1 and *Cp*2 are partitioned into m segments. Each segment has a fitness value (*fi*) which are presents the travel cost to the corresponding driver. Where m is the number of segments in the chromosomes,

for $i = 1, \ldots, m$, the *ith* segment of *Coff* inherits the *i*th segment *Cp*1(*i*) of the top-tier parent chromosome and the *ith* segment *Cp*2(*i*) of the lower-tier parent chromosome.

For example, the two parent *Cp*1 and *Cp*2 are divided into four respective segments, as shown in Figure 3. Initially, the proposed elite-segment crossover procedure compares the fitness values of two Segment1 in *Cp*1 and *Cp*2, the procedure is repeated until the entireties of the segments are checked. To improve the quality of the offspring chromosomes, the segment with the better fitness value will be passed to resulting offspring. Segment1 and Segment4 of the offspring then are taken from *Cp*2, and Segment2 and Segment3 of the offspring are taken from *Cp*1.

4) Chromosome Mutation:

To maintain population genetic diversity and thereby lessen the chances of getting stuck in a local optimum, the procedure of chromosome mutation is performed after the crossover procedure and is used to change the allocation of the passengers. Since chromosomes do not contain duplicate passengers, the use of a procedure called swap mutation is proposed. The implement of swap mutation is shown in Figure 4. First, a passenger for the first mutation (*pm*1) is randomly selected.

Then, a passenger for the second mutation (*pm*2) is randomly selected. Finally, the positions of passengers *pm*1 and *pm*2 are exchanged in the chromosome, thus generating a new mutated offspring. After the procedure of chromosome crossover and chromosome mutation, the chromosome may be invalid when the passenger is assigned to more than one driver. Accordingly, it is necessary to repair the chromosome by replacing the invalid gene.

IV. CONCLUSION

We have proposed an intelligent Carpool System which provides an environment, in which user can readily search for and locate carpooling alternatives in any location and at any time. Our proposed intelligent carpool system is divided into two major components: the Machine Client (MC) and Cloud Global Carpool Service (CGCS) modules. Prospective drivers and passengers can use the MC module to interact with the proposed CGCS module and submit carpool requests and receive subsequent matches via the mobile communication network and their personal mobile devices. The CGCS is developed to provide the service-oriented carpool computing, with the help of GPS and GIS technology for increasing the applicability. After receiving the carpool requests of drivers and passengers from the MC, the respective requirements of drivers and passengers in corresponding radial regions will be matched through the carpool route and matching algorithm of the CGCS. Carpooling helps to reduce stress levels as you can escape from driving in high traffic situation.

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