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Taxi Automation Using Real Time Adaptive Scheduling

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***Abstract*—** the taxi dispatch problem involves assigning taxis to requester waiting at different locations. A dispatch system currently in use by a major cab service provider divides the city (in which the system operates) into regional dispatch areas. Each area has fixed assigned adjacent areas hand-coded by human experts. When a local area does not have bare cabs, the system chooses an adjacent area to search. However, such fixed, hand-coded adjacency of areas cannot be a prudent indicator because it does not take into consideration frequent changes in traffic patterns and road structure. This causes dispatch officials to limit the system by manually enforcing movement on taxis. The proposed system dynamically modifies the adjacency of dispatch areas. The proposed technique will decrease the total waiting time, is less in comparison with the present system and increases taxi utilization in comparison with results of the simulation without self-organization. Interestingly, research work also discovers that human intervention (by either the taxi-dispatch officials or the taxi drivers), to manually overcome the drawbacks of the existing dispatch system can be counterproductive when used with a self-organizing system.

Keywords- *Taxi, adaptive scheduling [1], events, real time.*

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Introduction

In TAS (Taxi Automation System), online dispatch of available taxis to current customer bookings is done with the aid of a satellite-based taxi automation system; the system utilizes a Global Positioning System (GPS) [2] to automatically locate taxis in real-time. In handling current taxi online bookings, the major focus of taxi automation systems has been primarily on reaching individual customers in the shortest time possible to enhance customer satisfaction. However, merely increasing individual customer satisfaction, as is the current practice, is a local endeavor, in that it entails assigning the nearest taxi to a customer prioritized in a first-come, first-served queue, without considering the effects of the assignment on other waiting customers in the request queue. To improve taxi fleet service performance, ideally, we should concurrently and optimally assign taxis to service all customer bookings that are made within the time window. This is an exigent problem confronting current taxi dispatch systems.

Problem definition

The characteristics of this taxi service are as follows:

- Vehicles and drivers have the succeeding attributes: type of vehicle; capability to complete special jobs; driver experience (novice or experienced); place where drivers live; current vehicle location (GPS coordinates); driver status (“unallocated”, “break”, “working”, “free”, “will be free in 5/10 minutes”, “goes home”).
- Uncertain of the traffic congestion in various parts of London causing delays and consequently the interruption of schedules.
- Intermittent no-shows of clients and failure of vehicles.
- Undisciplined, events include: the generation of new orders; modification or cancellations of orders; changes in driver profiles (vehicle type, etc.); changes in driver status or location.
- A number of exceptions to the general requirement to find the best optimal match between a vehicle and a client, including: matching drivers that drive home after finishing their shifts with passengers travelling in the same direction (to reduce drivers’ idle runs) and giving priority to drivers that during a particular day had less work than others (to increase drivers’ satisfaction with working conditions);

Scheduling of vehicles and drivers considering such factors represents an exceedingly complex process, which is not feasible to achieve with any known mathematical method.

Methods

Existing approaches

In general, this problem falls into the group of a classic assignment problem. However benchmark solutions of scheduling and optimization (that are usually being applied

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in transportation logistics and could be considered as a solution for taxi scheduling) have a number of limitations.

1. Theoretical computational complexity of a solution, depending on the chosen algorithm, is between O (n^3) and O (n^4) [3]. Since locations and status of driver's changes every 30 seconds, such dynamics would require everlasting rescheduling. This, combined with the high volume of orders and frequency of disruptive events, makes complexity of taxi management unacceptable.
2. Constraints of taxi management are changing depending on the current situation. For example, to complete an order the driver is usually chosen according to a basic criterion (e.g. distance), but when several drivers are close to the pick-up location, the preference is given to the driver who was idle for a longer time. Similar conditional preferences are taken into account also when a driver is chosen from a queue.

Proposed system

This proposed system is been designed in such a way that will overcome the problem of hand coded elucidation by officials. Proposed solution has an automated adaptive scheduling[1] subsystem and shortest path algorithm which has the ability to match drivers and orders and to change their statuses automatically. This subsystem inspects a set of criteria including distance between vehicle and client locations, driver status and fairness in the orders placement.

Proposed System architecture

Taxi Dispatch System

To calculate the shortest-time path to reach a requested location, we shall assume that a shorter distance path is also a shorter real-time path according to the map. For ex request 1 is initiated before request 2 within a small time window. Under the contemporary practice, requests are allocated different taxis, one request at a time on a customer first-come, first-served basis. So the dispatcher would have to attend to request 1 first. To elaborate, consider a scenario of two available taxis in the proximity of two taxis (service) requests, as depicted in Fig.

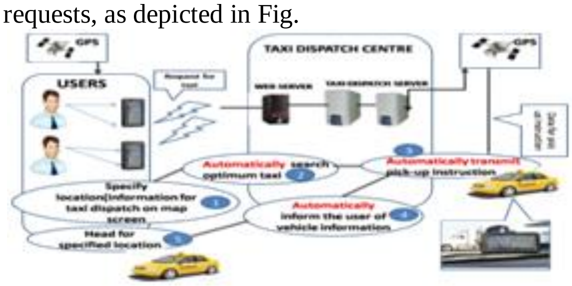

Fig. System Architecture

Basic steps/ scenarios

1. The System always collects information about all vehicles & automatically dispatches a vehicle as soon as a customer calls for a taxi.
2. Once a customer calls for a taxi, the system detects the packets with attribute (Unique User ID, Longitude and Latitude) to identify the customer's location. Then the system references already collected vehicle information to select the closest vehicles (By using Shortest Path Algorithm) & automatically transmit dispatch instruction data to the vehicles one by one and waiting for response from the driver , if response would not come to predefined time then it would request to other second nearest one to the client.
3. The dispatch instruction is displayed as response through android application to a taxi driver.
4. The first acknowledge will be locked and the information of the taxi will be sent back to the customer.
5. Suppose at some scenario if there no taxi is available in scope of client or if no taxi driver willing to respond then server automatically response to the client that "SORRY! No TAXI's available for you".

Algorithm

Haversine Formula

To calculate the distance between two points Haversine formula is used but the system requires time. Analyzing microeconomic data, of the previous trips of taxis following conclusion can be derived:

Scenario 1: normal execution

ET= (HF/ES) + Awt

Where,

ET is Estimated Time
HF is result of Haversine Formula
ES is Estimated Speed
Awt is Average Waiting Time

Scenario 2: in case of failure

ET= [DT/AS] + [(HF-DT)/ES] + Awt + PT

Where,

DT is Distance Travelled
AS is Average Speed
ET is Estimated Time
HF is result of Haversine Formula
ES is Estimated Speed
Awt is Average Waiting Time
PT is Processing Time

Scenario 3: searching allotted taxi nearby the new source

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Adaptive algorithm [1]

While selecting the taxi during the allotment the different microeconomic data that is considered includes the following

- The current status of the taxi.
- The remaining distance of the journey of the already allocated taxi.
- Distance from the destination to the source i.e. from where the new request is generated.

All these constraints are applied on map where the service provider is operational.

Fig.Scenario for adaptive scheduling

Sr = [DT/AS] + [(HF-DT)/ES] + Awt + PT + DDS

Where,

Sr is search result
DT is Distance Travelled
AS is Average Speed
ET is Estimated Time
HF is result of Haversine Formula
ES is Estimated Speed
Awt is Average Waiting Time
DDS is distance from the destination to source

Fig. Scenario after applying adaptive scheduling

Conclusion

A complex problem of efficiently utilizing the resources of taxi service is solved using a new adaptive scheduling method. A considerable economy of resources has been achieved for the client using this strategy. The method is innovative, scalable, compatible with modern trends in optimization and, above all, proven to be effective in a large-scale, practical, commercial application. The use of distributed decision-making and the employment of a variety of interacting self-contained algorithms ensure its applicability to a variety of business problems.

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