

# Demand-Supply Oriented Taxi Suggestion System for Vehicular Social Networks with Real Time Charging Advisor: Survey

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**Abstract** - Data mining depends on large-scale taxi traces is an important research concepts. A vital direction for analyzing taxi GPS dataset is to suggest cruising areas for taxi drivers. Most of the existing researches merely focus on how to maximize drivers' profits while overlooking the profit of passengers. This difference makes the prevailing solutions don't work well during a real-world setting. This paper constructs a recommendation system by jointly considering the profits of both drivers and passengers. The work first investigates the real-time demand-supply level for taxis, and then makes an adaptive tradeoff between the utilities of drivers and passengers for different hotspots. At last, the qualified candidates are suggested to drivers based on analysis. Results indicate that constructed suggestion system achieves a remarkable improvement on the global utility and make equilibrium between the utilities of drivers and passengers at the same time. It also considers a driver's utility with four factors, i.e, expected revenue, searching time for next passenger, travel distance and preference. The work also provides a real-time charging station recommendation system for EV taxis via large-scale GPS data mining. In addition, the proposed system providing the solutions and recommendation for the minimal time as well as for the minimal recharging cost for the Electronic Vehicle taxi drivers.

**Keywords** - Vehicular Social Networks, Hotspot location, Trajectory data mining, Supply-demand level.

## I. INTRODUCTION

A social networking service (SNS) may be a platform to create social networks or social relations among people that share similar interests, activities, backgrounds or real-life connections. A social network service consists of an illustration of every user usually a profile, his or her social links, and a spread of extra services. Social network sites area unit web-based services that enable people to make a public profile produce a listing of users with whom to share connections, and think about and cross the connections among the system. The Most social network services area unit web-based and supply suggests that for users to act over the net, like e-mail and instant electronic messaging. Social network sites area unit varied and that they incorporate new info and communication tools like mobile property, photo, video sharing. The web community services area unit generally thought of a social network service, although in an exceedingly broader sense, social network service sometimes suggests that associate degree individual-centered service whereas on-line community services area unit group-centered. Social networking sites enable users to share ideas, pictures, posts, activities, events and interests with folks in their network.

Social Networking has become the subsequent feature, Social networking area unit the popular trend in trendy days. With its huge quality, little business homes have additionally started victimization social networking websites for whole promotion. Today's age is associate age of advanced technology. With boon of net reaching nearly each corner of the planet, there has been associate huge transformation in every field. Be it putting in an improved platform of communication or connecting the world beneath a typical network, net has actually contributed in creating world a lot of a smaller place to measure in. From video chats to Video conferencing, from on-line promoting to meeting via social media, net has actually and certainly blessing for the worldwide societies. Social media promoting is (SMM) remarked outline bound websites that facilitate inter-personal communication through bound websites wherever in folks will produce their own profile page and communicate with friends and associates through on-line messages or scraps. A user will produce a network of friends, produce a gaggle, initiate or participate in an exceedingly word. These Social Media websites became a tool that paved the manner for advanced mode of communication between all the networks and net users.

The social media sites not solely remained a platform to initiate informal dialogues and a supporter of live messages, however became associate integral a part of promoting ways of the many a business homes. the appliance of those sites has unfold to business homes that started victimization the Social Networking sites as a platform to market their services and build whole awareness. Social Networking shortly became how for whole promoting and promotion on social sphere, whereby, the enterprises started victimization these on-line communities or websites for developing contacts and driving traffic to their several websites. These social networking websites kind the most tool of social media promoting. The foremost ordinarily used websites Twitter and Face book. Facebook may be a Social Networking web site that helps friends and colleagues to share dialogues with one another through Wall Posts, Messages and Comments.

Social Networking web site, Facebook has quite 350 million members and still investigating. This web site experiences quite 2 million clicks per day. Statistics state that users pay a mean of 20minutes per day in Facebook. Facebook is one in all the fatal tools in SMM and SMO. Twitter may be a social media platform wherever the users 'tweet' to stay connected with friends and his 'followers' at intervals his/her circle. Twitter permits posting "tweets" to any or all the individuals in their on-line network. Twitter conjointly became a tool for social media selling, the business posting a Tweet button on each post on its diary, makes it straightforward for anyone UN agency reads the post to Tweet it to their followers. This helps channelize the data to unfold from one finish to a different, making correct whole awareness. Joined In may be a skilled social media web site wherever a stream of skilled gets the prospect to review and act with their counterparts. Joined In offers a solid platform for establishing new business relationships. Joined in by facilitating a lot of a private communication between the business professionals will facilitate the business. My house conjointly a colossal impact within the social networking world, once registered with MySpace, a user cannot only inform the complete networking circle about their likes and dislikes but may also submit videos. Social Media networking Sites isn't solely contributed to require inter-personal communication to a distinct level, however conjointly an excellent selling tool for the little businesses. Planned approach to social media selling. This can be the feature in social media selling The main objectives of the Taxi Recommendation square measure

- To specialize in a way to maximize drivers' profits whereas high the profit of passengers.
- To value 2 completely different levels of Demand offer that square measure appropriate for busy (peak) days and traditional operating days
- To provides a time period charging station recommendation system for taxis.
- To calculate waiting time beside the gap for the recharging stations.

## II. RELATED WORKS

### A. Vehicular Social Networks: Enabling Smart Mobility

In this article stressed the importance of high- potency and reliable transmissions in VSNs for sensible cities. Significantly, we tend to study a case on traffic anomaly detection for VSNs by mechanical phenomenon knowledge analysis. Though VSNs will be considered the mixing of social networks and IoVs to enhance the standard of life for voters, the avenues of VSN studies aren't flat, and plenty of open problems are still ahead. They believed that VSNs can draw in depth attentions and analysis efforts within the close to future because the integrations of data technology and social network services become additional compacted.

### B. Vehicular Social Networks: A Survey

Considered social networking in an exceedingly transport environment; the authors investigated the possible applications of VSNs and communication design. VSNs enjoy the social behaviors and quality of nodes to develop novel recommendation systems and route coming up with. They bestowed a progressive literature review on socially-aware applications of VSNs, information dissemination, and quality modeling. Further, they gave an outline of various recommendation systems and path coming up with protocols supported crowd sourcing and cloud-computing with future analysis directions. Further, they mentioned the various communication protocols style and information dissemination techniques to deal with the present gap between VSNs and ancient ad-hoc networks that is that the terribly 1st issue to be thought-about by the analysis community to understand the construct of VSNs in public accepted. Finally, they bestowed some open analysis issue for future direction. From the intensive literature review, they terminated that VSNs area unit still in their infancy level. However, various vary of novel applications, coming together transport networks, exploiting quality pattern, socially aware recommendation systems on the roads area unit a number of the factors towards whom the analysis community has shown concrete interest.

#### C. Temporal, Functional and Spatial Big Data Computing Framework for Large-Scale Smart Grid

In this paper, they need designed a completely unique temporal, useful and abstraction huge knowledge computing framework for a large-scale sensible grid. In abstraction dimension, a completely unique heuristic has been planned to position the smallest amount range of PNs during a set of candidate locations that have high computing resources. Once deciding the ultimate location of PNs, in useful dimension, a classic K-means matrix bunch algorithmic program has been utilized to divide each dataset into many smaller teams, every of that is named as information. Thus, one sub-group of knowledge things rather than a dataset (chunk) is switched out from the present PN to a selected DN, resulting in the development of computing potency in temporal dimension. Simulation results have incontestable that: 1) a promising computing potency has been on the brink of the bound with ninety five % convergence quantitative relation; 2) the development ratio of saving the in-path information measure has been eighty one percent; 3) the shift practicality between chunk and information has been achieved with a fast response. In summary, the planned huge knowledge computing framework is effective on raising the computing potency and saving the in-path information measure, particularly for the large-scale sensible grid that features plentiful datasets. Within the future work, they'd any measure the effectiveness of their temporal, useful and abstraction huge knowledge computing framework during a lot of realistic setting.

#### D. Energy-Latency Trade-Off for Energy-Aware Offloading in Mobile Edge Computing Networks

In this paper, single and multi-cell MEC network eventualities are thought-about at an equivalent time. The residual energy of good devices' battery is introduced into the definition of the coefficient issue of energy consumption and latency. In terms of the mixed number nonlinear drawback (MINLP) for computation offloading and resource allocation, we tend to propose AN reiterative search rule combining interior penalty operate with D.C. (the distinction of 2 convex functions/sets) programming (IPDC) to search out the optimum resolution. Numerical results show that the projected rule will get lower total price (i.e., the weighted add of energy consumption and execution latency) examination with the baseline algorithms and also the energy-aware coefficient issue is of nice significance to keep up the life of good mobile devices.

#### E. Vehicular Fog Computing: Enabling Real-Time Traffic Management for Smart Cities

In this paper, the authors declared that Fog computing extends the ability of cloud computing from the middle to edge networks. though fog computing has the benefits of location awareness and low latency, the rising needs of omnipresent property and ultra-low latency challenge the traffic management for good cities. As associate degree integration of fog computing and transport networks, transport Fog Computing (VFC) is promising to attain real-time and location-aware network responses. Since the conception and use case of VFC area unit within the initial part, this text 1st created a three-layer VFC model for distributed traffic management, so as to attenuate the time interval of wide events collected and reported by vehicles.

### III. METHODOLOGY

The proposed work makes a trade-off between a driver's utility and a passenger's waiting time. The score expression of each hotspot is given for recommendation. In this way, high utilities for drivers can be achieved and save a mass of waiting time for passengers meanwhile. This work constructs an adaptive recommendation system based on the supply-demand level, by which a tradeoff is made between the utilities of drivers and passengers. Then the hotspot with the highest score is recommended to available taxis. It considers a passenger's utility with the waiting time for vacant taxis, which is predicted by mining the pick-up events.

First pick-up points for each time segment from the taxi trajectory are extracted. Then an adaptive Density-based Spatial Clustering of Applications with Noise algorithm (I-DBSCAN) for clustering is utilized. The essential knowledge of each hotspot is calculated for online recommendation. Passengers' expected waiting time is predicted based on the information of different hotspots. For the online part, we retrieve hotspots within certain limits for the correct time segment according to the time and location of available taxis. Then the driver's utility can be calculated based on the knowledge. After evaluating the real-time demand-supply level of the whole area, we can make a tradeoff between the driver's and passengers' utilities. The recommendation score is defined according to the abovementioned idea. Finally, the hotspot with the highest value is recommended to the driver.

#### A. Demand Hotspots Scanning by Clustering

By clustering the pick-up points, information from taxi trajectory can be extracted to identify candidate demand hotspots. Traditional DBSCAN algorithm is a kind of density-based clustering methods, which can discover arbitrary clusters and deal with noise or outliers effectively. However, the parameter, Eps is required to be input manually. First, the distance distribution matrix is calculated, denoted by Dist  $nxn$ .

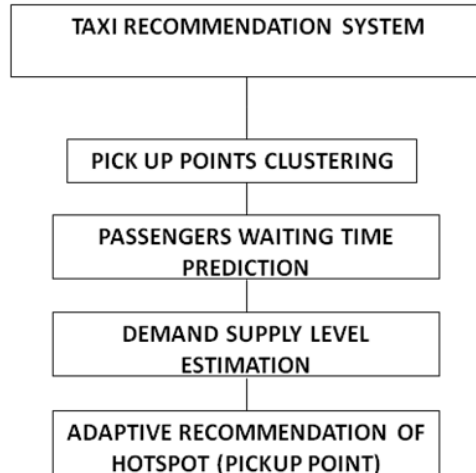


Fig. 1 Taxi recommendation system

$$Dist_{n \times n} = \{dist(i, j) | 1 \leq i \leq n, 1 \leq j \leq n\}$$

where  $n$  is the number of pick-up points we extract, and  $dist(i, j)$  is the Manhattan distance between GPS point  $p_i$  and  $p_j$ . The value of each element is obtained before sorting them in an ascending order line by line. When the value of  $i$  increases, the number of clusters and noise both decrease. When they reach the convergence, the corresponding  $epsi$  is the optimal estimation of parameter  $Eps$ . Following shows the algorithm for DBSCAN Clustering.

**Input:** The pick-up points dataset to be clustered  $P$

**Output:** The final set of clusters  $C$

- 1: for  $p_i, p_j$  in  $P$  do
- 2:  $Dist[i][j] \leftarrow getManhattandis(p_i, p_j)$ ;
- 3: end for
- 4: Sort  $Dist$  in an ascending order line by line;
- 5: for the  $i$ -th column vector in  $Dist$  do
- 6: get average value as  $epsi$ ;
- 7: end for
- 8: DBSCAN ( $epsi$ , fixed  $MinPts$ );
- 9: Select optimal  $Eps$  by the number of cluster and noise;
- 10:  $N \leftarrow 0$ ;
- 11: for  $p$  in  $P$  do
- 12:  $N + getEpsNeighbourNum(p)$ ;
- 13: end for
- 14:  $MinPts \leftarrow N/|P|$ ;
- 15: Perform DBSCAN with optimal  $Eps$  and  $MinPts$ ;
- 16: return clustering results  $C$ .

#### B. Passenger's Waiting Time Prediction

The arrival times of passenger for a particular vehicle and actual vehicle arrival time is taken. Then the average values of waiting times are calculated and thus the passenger waiting time is predicted. The following algorithm is used to predict the waiting time. With the input of pick up events time stamp sequences, the waiting time is calculated.

**Input:** The pick-up events timestamp sequence

$T_p = \{pe_1, pe_2, \dots, pe_n\}$

**Output:** The estimated waiting time  $w$  for the hotspot

- 1:  $\lambda \leftarrow n-1 \cdot pe_n - pe_1$ ;
- 2: Initiaize the passenger arrival events timetamp sequence  $T_a = \{ae_1, ae_2, \dots, ae_n\}$ ;
- 3: for  $i = 1$  to  $n$  do
- 4: if  $i = 1$  then
- 5:  $ae_i = random(0, pe_i)$ ;
- 6: // Uniform distribution
- 7: else

```

8:  $aei = aei-1 + \text{random}(0, pei - aei-1)$ ;
9: // Truncated exponential distribution with  $\lambda$ 
10: end if
11: end for
12:  $w \leftarrow 0$ ;
13: for  $i = 1$  to  $n$  do
14:  $w + (pei - aei)$ ;
15: end for
16:  $w \leftarrow w/n$ ;
17: return expected waiting time  $w$ .

```

### C. Demand-Supply Level Evaluation

The following algorithm is used for demand supply level evaluation. Total time intervals among the trajectories and total free/busy counts are calculated and  $\alpha$  value is found out.

**Input:** Record of trajectory points for the taxi  $R = \{r1, r2, \dots, rn\}$

**Output:** The real-time demand-supply level  $\alpha$

```

1:  $S \leftarrow \emptyset$ ;
2: for each  $R$  do
3: for  $r$  in  $R$  do
4: if  $r$ .location in area and  $r$ .state was FREE then
5: get  $r$ .timestamp as  $ta$ ;
6: while FREE IN THIS AREA do
7: get next record;
8: end while
9: get  $r$ .timestamp as  $tb$ ;
10: get  $r$ .state as  $m$ ;
11:  $\Delta t \leftarrow (tb - ta + 1 - m)$ ;
12:  $S \cup (\Delta t, m)$ ;
13: end if
14: end for
15: end for
16:  $sum1 \leftarrow 0, sum2 \leftarrow 0$ ;
17: for  $(\Delta ti, mi)$  in  $S$  do
18:  $sum1 + \Delta ti$ ;
19:  $sum2 + mi$ ;
20: end for
21:  $\alpha \leftarrow sum2 / (sum1 + sum2)$ ;
22: return real-time demand-supply level  $\alpha$ .

```

### D. Adaptive Recommendation

The following Algorithm is carried out in which Input is Available taxi's current time curtime and location curloc, candidate hotspots set H and Output is the recommended hotspot. Tracing trajectory and computing the driver's recent spent time on each hotspot is found out. Real-time demand-supply level  $\alpha$  is taken from previous algorithm. Max Score is found out based on revenue in various pick up points. Hotspot with max score is recommended.

**Input:** Available taxi's current time curtime and location curloc, candidate hotspots set H

**Output:** The recommended hotspot

```

1:  $MaxScore \leftarrow 0, MaxId \leftarrow 0$ ;
2:  $U \leftarrow \emptyset, w \leftarrow \emptyset$ ;
3: Tracing trajectory and computing the driver's recent spent time on each hotspots  $ST = \{st1, st2, \dots, stn\}$ ;
4: for  $hi$  in  $H$  do
5:  $d \leftarrow \text{getManhattandis}(curloc, hi.core)$ ;
6:  $V \leftarrow (hi.revenue - \beta hi.searchingtime - \gamma d)$ ;
7:  $\epsilon \leftarrow sti \sum k stk$ ;
8:  $U \cup (V + \epsilon)$ ;
9:  $wUhi.waitingtime$ ;
10: end for
11: Evaluate real-time demand-supply level  $\alpha$  based on curtime using previousAlgorithm
12: for  $U * i, w * i$  corresponding to each hotspot do

```

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14: score  $\leftarrow (1-\alpha)U * i + \alpha w * i$ ;
15: if score > MaxScore then
16: MaxScore  $\leftarrow$  score;
17: MaxId  $\leftarrow$  i;
18: end if
19: end for
20: return recommended hotspot hMaxId.

```

#### IV. CONCLUSION

In this paper, proposed a framework for adaptive recommendation system. The work constructs an adaptive recommendation system by jointly considering the benefits of drivers and passengers. First, a spatio-temporal clustering method named I-DBSCAN is leveraged to group pick-up locations into different clusters. Second, to improve the drivers' utility, kinds of metrics including expected revenue, driving distance, searching time and preference are taken into consideration. By mining the taxi trajectory data, drivers' utility calculation and passengers' waiting time prediction can be fulfilled. Then, the real-time demand-supply level for the whole area is evaluated, and a tradeoff between drivers' and passengers' utilities is made off, by which the score function of each hotspot can be calculated. The hotspot with the highest value is recommended to the driver. At last, the experiment is conducted in two different areas based on real-world taxi trajectory data. The future work, we plan to consider more metrics. For drivers, they may pick up a passenger halfway. Thus, the influence of middle source cannot be ignored. For passengers, tolerance threshold of waiting time deserves to be considered. In addition, some external metrics, such as road network and traffic controlling, are important. For the second phase work, real time charging system of vehicles is to be carried out.

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