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Social Network Based Recommender System to Enhance Quality of Experience (QoE) and Business Intelligence for Service Providers

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Abstract: Ridesharing service is one of the most excellent urban transport models, where two or more customers share a ride. It mainly helps in reducing the transportation cost and count of vehicles moving, thus enhancing user mobility. Ride Sharing presents advantages like reducing traffic and pollution hence promotes Smart City application. In ride sharing application, the substantial new assessment parameter is quality of experience (QoE) by users. This work proposes recommendation system in ride sharing context using quality of experience which utilizes both the user profile details mined from online social network (OSN) and user preferences. The main purpose of the proposed work is to enhance users' QoE. Based on online social network, the users' profile is constructed for ridesharing that consists of collection of users with similar personality in the same tour, and eliminates customers with conflicting preferences. Initially, subjective tests are conducted to get users' preferences information and their outcomes are evaluated using machine learning algorithms to generate user profiles. The experimental results show that Random Forest classifier has shown accuracy of 94%, precision 90% and recall 95%.

Keywords: *Recommender system, Intelligent Transportation, Online Social Network (OSN), Ridesharing, Machine Learning*

1. Introduction

Presently, transportation service applications developed with smart phones provide mobility innovative direction. They facilitate new and inventive alternatives for the current urban transportation networks. Carpooling service providers such as Uber, Ola Share, sRide, Quick Ride, Cabify allow the online and real-time planning of trips shared with different people. Modern technology like mobile applications and power of communication network assist formation of such novel transport system [1].

These opportunities have sparked modifications to conventional transportation strategies and gradually establishing a market for shared transportation [2], [3]. These services, which are also popularly known as ridesharing, enable travelers with similar itineraries to be grouped together among unidentified users, thus resulting in lower user fees and increased profitability for drivers. This paradigm is suited by the UberPool service [4]. In addition to the currently available shared mobility options for users who are not acquainted, new ones are being suggested.

For instance, framework of Mobility as a Service (MaaS) [5] has introduced shared mobility models powered by autonomous vehicles and a form of autonomous shuttles that enable a bigger number of customers to share vehicles called shared automated vehicle [6] was presented by Navya. As outlined by [7] under the third revolution in urban transport, one of the most promising alternatives for urban transport and lowering CO2 emissions by 2050, is shared mobility. Mobility packages could become consumer segmentation alternatives, allowing customers to have benefits such as select lower or higher values, according to service quality, in parallel to shared mobility solutions [8].

The quality of experience (QoE) in this context is a multifaceted notion found on user perceptions. It represents the reactions—emotional, behavioural, and cognitive—that can be assessed subjectively or scientifically [9]. Users make decisions about a service or product based on personal traits like preferences or past experiences [10].

Therefore, it is advised to establish the user profile for a particular service in order to enhance users' QoE [11]. The abundance of data offered by online social networks (OSN) can be helpful in this regard. It is possible to create user profiles using this information. It is important to note that applications must automatically extract the data and evaluate it using suitable techniques due to the dynamic properties of data, which include context and human variables.

Various machine learning techniques, including Random Forest (RF), Support Vector Machine (SVM), and Artificial Neural Networks (ANN), are used in some ridesharing systems. For tasks like classification, regression, and others, Recommender System (RS) frequently uses these methods [12]. It is crucial to

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remember that only the RS suggested by [13] integrates the fundamental data offered by OSN, notably the friendship connections between users. Information from users' profiles is not taken into account, though. Since customers' profile features and preferences for ridesharing services are taken into account, the primary contribution of this study is the introduction of a novel RS for ridesharing services. Its objective is to show how the suggested framework and user data from OSN are useful for enhancing users' quality of experience.

The suggested approach is shown in Fig. 1, where individuals with comparable preferences for ridesharing services can be grouped. Additionally, when persons with similar preferences organized together, the likelihood of an interest conflict declines [14], potentially improving user quality of experience.

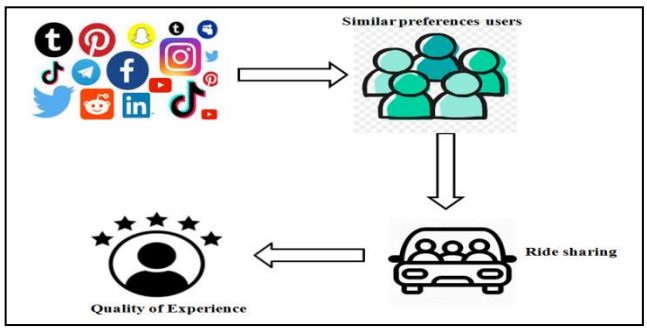

Fig.1. Correlation between Online Social Network, similar user preferences and users' Quality of Experience in Ride sharing application

For the presented work study, subjective tests were conducted to examine the preferences of volunteers who have used ridesharing services while taking into account basic profile information and other pertinent social context topics, including, among others, politics, religion, and sports. As a result, a database was built utilizing these arbitrary test findings. The data from the database was used by several machine learning algorithms to generate a user profile model for ridesharing services. Additionally, the proposed ride sharing RS may pull user profiles from OSN and offer a Web interface where users can respond to questions about their preferences.

The RS obtains a probable passengers list to share a trip from Fig. 1 after the user profile model has been constructed. Model in fig1 describes the connection between OSN, shared preferences of users, and users' quality of experience in the ridesharing context. To rank the people with the most comparable profiles, the proposed RS employs a similarity function. To choose the best solutions, these details are transmitted to the service provider or users. In order to avoid potential matches between passengers who have opposing preferences for a ride, the RS allows for the clustering of passengers with comparable profiles. It is significant to remember that data from OSN is updated continuously due to the incorporation of new users and its non-stationary.

The remaining work in paper is organized as: Section II describes QoE, Online social network, Recommender systems classification and machine learning techniques. Section III explains proposed model working. The results are explained in section IV. Finally, the conclusions are given with pointers to future work.

2. Related Work

This section gives a summary of ridesharing and QoE concepts, recommendation system, machine learning Algorithm are described.

Ridesharing: Advances in technology have made it possible to spread Smart phones with real-time access to digital maps internet, e-commerce platform, communication, payment, and other information. One such technique is alignment with changing consumption patterns, an open space focused on creation, the so-called sharing economy, has emerged. More reachable services, less waste, optimized usage of goods using digital platforms [15] [27]. Share an economy powered by an Internet platform has many advantages, e.g. conversion of temporary use of providers Unused resources [16] [28]. In this regard, some companies offer ride sharing. A car-sharing service decides whether to reward drivers. The principle of these models is to facilitate sharing reduce user nobility and trim down transportation costs.

A few carpooling opportunities were described by [17]. Develop a system with the objective of minimizing the expenses or improve the overall benefit of sharing while hitting a set of restrictions. Examples of costs include travel, CO2 emissions, gas consumption, collection time, downtime, or a weighted combination of the above basic cost functions. Another vehicle issue is addressed by [18]. It's a redirect problem resulting from pick up and drop off additional passengers.

QoE : The QoE field is similar to Consumer Experience (CX) and User Experience (UX). As per this, with the method of [19], the QoE field is type of technology offered to users, also correlated. On the financial side, UX is paid less consideration to the financial dimension. In information systems, QoE is assisting in evaluating how users subjectively perceive application or quality of service [20] such as QoE User-centric and provides a more detailed understanding system determinant.

International Telecommunications Union's definition of QoE is a general acceptance of an application or services subjectively observed by the customers [21]. More recently, the definition of QoE has been extended to: A

person's level of joy or anger at an experience including the resulting application, service, or system satisfying their expectations of usefulness and/or the use and current status of the application or Service User's.

RS: There is a lot of information on the Internet, Users are often overloaded with a lot of unnecessary stuff data. Therefore, RS includes filtering and personalized content for users, automated generation recommendations based on data analysis [22]. RS is generally content-based, collaborative, or combination of both as hybrid. First RS recommends products that are similar to what they used to love in the past. Collaborative filtering consists of suggested articles. People with similar tastes have been favored in the past. Hybrid RS is a combination of his two approaches above.

Machine learning techniques: Machine learning techniques are used in a variety of scenarios and enable accurate classification. Machine learning algorithms [23] are used to better understand how customers of companies that offer scheduled and on-demand transportation services use ridesharing services. The study employs enhancing ensemble trees. The multilayer perceptron, which is one of the regression and classification functions [24] used in ANNs, has a good ability for generalization (MLP). In [25], a deep learning-based method is presented for categorizing passengers' behaviors based on trip features, travel modes, prior trip objectives, individual demographics, and surrounding location classifications at the end of the journey.

Recommender systems strategies were described with content based RS, collaborative filtering and trust based RS [26]. Comparative analysis of these strategies was explained with advantages and disadvantages. User Based Collaborative Filtering recommender system was presented using Bloom Filter with MapReduce framework and significant observed improvement in response time [27]. Content-centric prediction model [28] is proposed for early Autism spectrum Disorder (ASD) screening in patients so therapies, medications can be recommended to patients for healthy lifestyle.

Complete Survey on Recommender Systems algorithms was carried out in detailed in Big Data Analytics with Internet of Things (IoT) Applications with evaluation metrics applications in various domains [29]. A Recommender system using multiple Classifiers was proposed for Early ASD detection [30] along with comprehensive survey of Machine Learning Algorithms used in ASD detection. An intelligent system for secured tele-robotic surgery using fuzzy-based inference engine was described in [31] that optimizes energy efficiency and reduces the work pressure on medical practitioners. A broad survey [32] on exhaled breath (EB) investigation techniques was presented for diseases detection in human body and discussed biomarkers used in diagnosis of the exhaled breath.

3. Proposed Methodology

This part describes method used to represent and execute the proposed Recommender system. Fig 2 depicts proposed methodology. The system receives a list of present and probable passengers from service provider for a particular ride. In order to construct the user profile, user's personal data and some particular topics in ridesharing context are gathered and given as input to machine learning algorithms for ride sharing facility. Then user profiles are examined using similarity function which produces a ranking list of possible passengers who have similar preferences. At the end, this final list is delivered to the service provider or the active passenger.

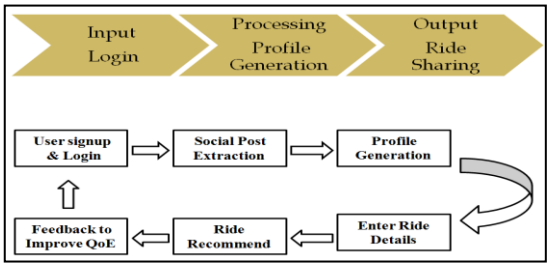

Fig 2.Workflow of proposed Methodology

4. Result and Discussions

Experimentation is performed on a personal computer with a configuration: Intel (R) Core (TM) i5-2450 CPU @ 2.50GHz, 8GB memory, Windows 10, and jdk 1.9. It is dynamic web application for design in Eclipse IDE and execute on Tomcat server 8.0. Following figures show screenshots of web application. Fig2 depicts homepage of web application. User registers in the system by entering required fields shown in fig3. From social network (e.g. Facebook) post, user profile interest (shown in fig5) is constructed by applying text preprocessing steps such as stop word removal, tokenization, stemming etc. and finally prediction as depicted fig6 is generated as user profile. When new user is requesting ride by providing source and destination data, similar users based on found interest are considered for sharing active ride.

The proposed Ride sharing Recommender System has used the Random Forest classifier to categorize user preferences. After this, similarity function algorithm was implemented to find the ranking of potential passengers. The outcomes showed that 94% of users were satisfied with the recommended listing. The ridesharing service provider can incorporate this ranking to collect users with analogous likings or preferences.

Proposed system has used machine learning classifier Random Forest to classify customer preferences. Similarity function is incorporated to identify potential customers

ranking. The results showed that 94% of passengers were satisfied with obtained recommendations. Hence, ride sharing service providers use ranking to cluster passengers with similar liking to overcome users group with conflicting interests. Proposed system results are compared with existing systems. It has been observed that proposed system algorithm with Random Forest machine learning classifier outperforms with accuracy of 94%. Proposed system can be integrated with real ride sharing service provider using a safe and protected connection.

Table1. Performance Metrics of proposed system

Performance metrics	Random Forest
Precision	90%
Recall	95%
Accuracy	94%

Generated recommendations are helpful to users in decision making process. Customer feedback is collected on the scale of 1 to 4 to extract their experience with generated recommendations. It will be useful to service providers to achieve customer satisfaction through quality of service. It will ensure Business Intelligence (BI) for Service Providers too in order to retain and present best facility the customers.

Proposed system is evaluated and compared with existing systems. Fig 3 shows performance metrics for proposed system and Fig 4 show comparison with existed systems.

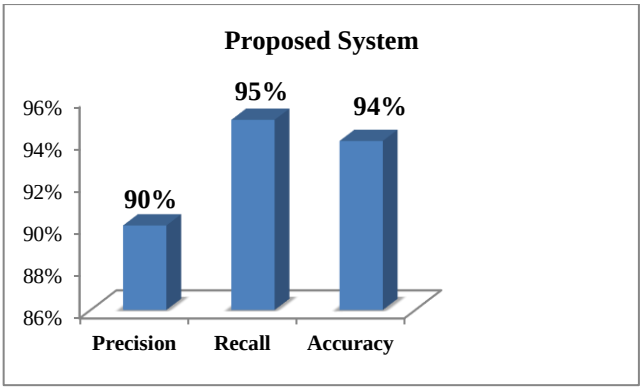

Fig 3. Performance metrics of proposed system

Proposed systems outperforms with accuracy of 94%. Table 2 lists accuracy comparison of proposed system with existing systems.

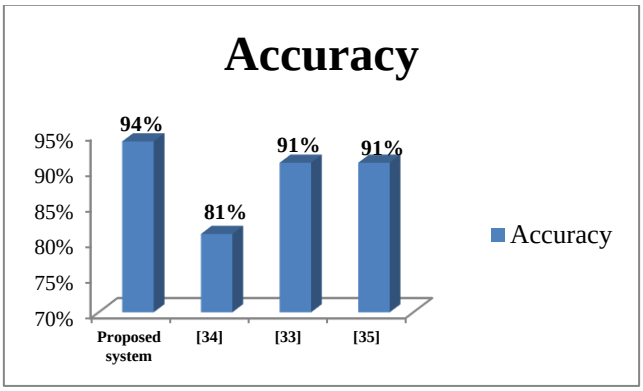

Fig4. Comparison of proposed system with existing systems

Table 2. Comparison with Existing systems

Machine Learning Classifiers	Accuracy
Proposed system	94%
[34]	81%
[33]	91%
[35]	91%

5. Conclusion

These days, ridesharing, in which two or more users share a ride, is one of the most notable new urban transport models. By lowering expenses and the quantity of circulating cars, this transport model increases user mobility. In the context of ridesharing, user quality represents a concrete and innovative assessment factor. As a result, this study addresses the application of quality of experience (QoE) in the context of ridesharing services, and it suggests a recommendation system for ridesharing services using user preferences and profile data from online social networks (OSN). Thus, enhancing users' quality of experience is the primary goal of the proposed recommender system. The proposed recommender system has used Random Forest (RF) algorithm to classify user preferences. The classifier has shown accuracy of 94%, precision 90% and recall 95%. Recommendation application has extracted social network post from OSN to build user profile. Proposed system can be integrated with real time ridesharing service provider to help them in Business Intelligence and in turn Customer satisfaction.

Author contributions

Anita Shinde: Conceptualization, Methodology, Software, Writing-Original draft preparation, Validation, **Dipti Patil:** Visualization, Investigation, Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no conflicts of interest.

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