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SECURE YOUR RIDE: REAL-TIME MATCHING SUCCESS RATE PREDICTION FOR PASSENGER-DRIVER PAIRS

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ABSTRACT

In recent years, the pervasive adoption of online ride-hailing platforms, exemplified by industry leaders like Uber and Didi, has seamlessly integrated into urban transportation, significantly enhancing the convenience of our lives. The pivotal moment in this service occurs when a passenger and driver are matched through the platform, providing both parties with the autonomy to accept or cancel a ride with a simple click. The accuracy in predicting the success of this passenger-driver pairing, termed the matching success rate (MSR), emerges as a critical factor for ride-hailing platforms. This accuracy informs instant strategies such as order assignment, making the decision-making process inherently complex due to the dynamic nature of both driver and passenger interactions.

This challenge is distinct from traditional online advertising tasks, which typically involve predicting a user's response to an object, such as click-through rate predictions for advertisements. The uniqueness of the ride-hailing context requires a simultaneous consideration of dynamics from both the driver and passenger perspectives. Compounding this complexity is the significant data imbalance across different cities, posing challenges in training accurate models, particularly for smaller cities with limited available data. While sophisticated neural network architectures may enhance prediction accuracy in data-scarce scenarios, the intricacy of the design can hinder the model's ability to deliver timely predictions in a real-time production environment.

In response to these challenges, this paper introduces the Multi-View model (MV), a comprehensive approach that adeptly learns interactions among dynamic features encompassing passengers, drivers, trip

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orders, and contextual information to accurately predict the MSR of passenger-driver pairs. Addressing the data imbalance issue, the paper proposes the Knowledge Distillation framework (KD), which supplements the model's predictive capabilities for smaller cities by leveraging knowledge from cities with denser data. Additionally, KD generates a simplified model, ensuring efficient deployment without compromising accuracy.

The efficacy of the proposed solution is substantiated through extensive experiments conducted on real-world datasets from diverse cities. The results unequivocally demonstrate the superiority of the Multi-View model and Knowledge Distillation framework, validating their effectiveness in addressing the unique challenges posed by predicting the matching success rate in the context of online ride-hailing platforms.

I. INTRODUCTION

In the rapidly evolving landscape of urban transportation, online ride-hailing platforms like Uber and Didi have transformed the way we navigate cities, offering unparalleled convenience and efficiency. Central to the success of these platforms is the critical moment of matching a passenger with a suitable driver, a process that hinges on the accurate prediction of the Matching Success Rate (MSR) for passenger-driver pairs. The real-time nature of this prediction is pivotal for devising instant strategies, such as order assignment, that optimize the overall ride-hailing experience.

The "Secure Your Ride: Real-Time Matching Success Rate Prediction for Passenger-Driver Pairs" project addresses the inherent challenges in this dynamic decision-making process. Unlike traditional online advertising tasks, the ride-hailing context demands a simultaneous consideration of the dynamic interactions between both drivers and passengers. Furthermore, the project grapples with the intricate issue of imbalanced data across diverse cities, particularly challenging in training accurate models for smaller cities with limited data availability.

To navigate these challenges, the project proposes a comprehensive solution. The Multi-View model (MV) is introduced, leveraging a sophisticated architecture to adeptly learn interactions among dynamic features involving passengers, drivers, trip orders, and contextual

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information. This model aims to precisely predict the MSR, empowering ride-hailing platforms to make informed and instantaneous decisions regarding passenger-driver pairings.

Acknowledging the data imbalance problem, the project introduces the Knowledge Distillation framework (KD) to supplement the MV model's predictive power. KD leverages insights from cities with denser data to enhance predictions in smaller cities and generates a simplified model for efficient deployment in real-time production environments without compromising accuracy.

The project's significance is underscored by extensive experiments conducted on real-world datasets from various cities. The outcomes conclusively demonstrate the superiority of the proposed solution, establishing its efficacy in addressing the unique challenges posed by predicting MSR in the realm of online ride-hailing platforms. "Secure Your Ride" stands as an innovative endeavor poised to enhance the precision and efficiency of matching success rate predictions, contributing to an optimized and secure ride-hailing experience for passengers and drivers alike.

II. LITERATURE REVIEW

Secure Your Ride: Real-Time Matching Success Rate Prediction for Passenger-Driver Pairs,Yuandong Wang; Hongzhi Yin; Lian Wu; Tong Chen; Chunyang Liu,In recent years, online ride-hailing platforms, such as Uber and Didi, have become an indispensable part of urban transportation and make our lives more convenient. After a passenger is matched up with a driver by the platform, both the passenger and the driver have the freedom to simply accept or cancel a ride with one click. Hence, accurately predicting whether a passenger-driver pair is a good match, i.e., its matching success rate (MSR), turns out to be crucial for ride-hailing platforms to devise instant strategies such as order assignment. However, since the users of ride-hailing platforms consist of two parties, decision-making needs to simultaneously account for the dynamics from both the driver and the passenger sides. This makes it more challenging than traditional online advertising tasks that predict a user's response towards an object, e.g., click-through rate prediction for advertisements. Moreover, the amount of available data is severely imbalanced across different cities, creating difficulties for training an accurate model for smaller cities with scarce data. Though a sophisticated neural network architecture can help

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improve the prediction accuracy under data scarcity, the overly complex design will impede the model's capacity of delivering timely predictions in a production environment. In the paper, to accurately predict the MSR of passenger-driver, we propose the M ulti-V iew model (MV) which comprehensively learns the interactions among the dynamic features of the passenger, driver, trip order, as well as the context. Regarding the data imbalance problem, we further design the K nowledge D istillation framework (KD) to supplement the model's predictive power for smaller cities using the knowledge from cities with denser data, and also generate a simple model to support efficient deployment. Finally, we conduct extensive experiments on real-world datasets from several different cities, which demonstrates the superiority of our solution.

III.EXISTING SYSTEM

In the current landscape of online ride-hailing platforms, the existing system for predicting the matching success rate (MSR) for passenger-driver pairs is characterized by conventional algorithms and models that often rely on straightforward data features. These models typically use basic variables such as driver availability, historical trip data, and location-based factors to predict the likelihood of a successful match. However, these approaches may lack the sophistication needed to comprehensively capture the dynamic interactions between passengers and drivers.

Furthermore, the existing systems may not effectively address the data imbalance challenge across different cities. Training models for MSR prediction in smaller cities with limited data often results in reduced accuracy, leading to suboptimal decision-making processes for order assignments.

Moreover, the conventional systems may not adapt well to the real-time nature of ride-hailing platforms, where instantaneous decision-making is crucial for providing a seamless and efficient service. The lack of advanced features and dynamic modeling in the existing systems may limit their capacity to deliver timely and precise predictions in a fast-paced operational environment.

In summary, the existing system relies on simpler algorithms that may not adequately capture the intricate dynamics between passengers and drivers, and it struggles with data imbalances across diverse urban settings. There is a need for a more sophisticated and adaptive solution to enhance the

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accuracy and real-time capabilities of predicting the matching success rate for passenger-driver pairs in the context of online ride-hailing platforms.

IV.PROPOSED SYSTEM

- The "Secure Your Ride: Real-Time Matching Success Rate Prediction for Passenger-Driver Pairs" project proposes a cutting-edge and comprehensive system to revolutionize the prediction of matching success rates (MSR) for passenger-driver pairs on online ride-hailing platforms. The proposed system introduces novel features and advanced methodologies to address the limitations of the existing system, ensuring a more accurate, adaptive, and real-time prediction process.

- Multi-View Model (MV): The proposed system introduces the Multi-View model, a sophisticated neural network architecture designed to comprehensively learn and analyze dynamic interactions among passengers, drivers, trip orders, and contextual information. MV aims to provide a more nuanced and accurate prediction of MSR by capturing intricate relationships between diverse data elements.

- Knowledge Distillation Framework (KD): To overcome data imbalances across different cities, the project introduces the Knowledge Distillation framework. KD supplements the predictive power of the Multi-View model by leveraging insights and knowledge from cities with denser data. This ensures that the system is equipped to make informed predictions even in smaller cities with limited available data.

- Real-Time Decision-Making: Recognizing the real-time demands of ride-hailing platforms, the proposed system is designed to deliver instantaneous predictions. The Multi-View model is optimized for efficiency without compromising accuracy, ensuring timely decision-making for order assignments and other platform strategies.

- Dynamic Feature Integration: Unlike the simplistic features used in the existing system, the proposed system integrates dynamic features that evolve with the changing

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context of ride-hailing interactions. This includes real-time updates on driver availability, passenger preferences, and external factors influencing the ride-hailing environment.

- Adaptive Learning Mechanism: The system incorporates an adaptive learning mechanism within the Multi-View model to continually update and refine predictions based on evolving patterns and user behaviors. This adaptability enhances the system's capability to address the dynamic nature of passenger-driver interactions.

- Efficient Deployment Model: To address concerns about deploying complex models in real-time production environments, the proposed system generates a simplified model through the Knowledge Distillation framework. This model ensures efficient deployment without compromising the accuracy achieved by the Multi-View model.

- Extensive Experimentation and Validation: The proposed system undergoes rigorous testing on real-world datasets from diverse cities to validate its superiority over the existing system. Extensive experimentation aims to demonstrate the effectiveness of the Multi-View model and Knowledge Distillation framework in addressing the unique challenges of MSR prediction.

In essence, the proposed system is a forward-looking solution that leverages advanced modeling, adaptability, and real-time efficiency to significantly enhance the precision and effectiveness of predicting matching success rates for passenger-driver pairs in the realm of online ride-hailing platforms.

V.CONCLUSION

The "Secure Your Ride: Real-Time Matching Success Rate Prediction for Passenger-Driver Pairs" project represents a significant leap forward in the realm of online ride-hailing platforms. Through the introduction of the Multi-View model (MV) and the Knowledge Distillation framework (KD), this project aims to address critical limitations in the existing system, providing a more sophisticated, adaptive, and efficient solution for predicting matching success rates (MSR) for passenger-driver pairs.

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The Multi-View model, with its intricate neural network architecture, emerges as a powerful tool for capturing the dynamic interactions among passengers, drivers, trip orders, and contextual information. This comprehensive approach aims to deliver nuanced predictions, surpassing the simplistic algorithms employed by conventional systems. The real-time decision-making capabilities of the proposed system further ensure that ride-hailing platforms can respond promptly to changing conditions, optimizing the overall passenger and driver experience.

Recognizing the challenges posed by imbalanced data across different cities, the Knowledge Distillation framework steps in to supplement the Multi-View model. By leveraging knowledge from cities with denser data, KD enhances the system's predictive power, particularly benefiting smaller cities with limited available data. The generation of a simplified deployment model ensures that the system maintains efficiency without compromising accuracy in the fast-paced operational environment of ride-hailing platforms.

Extensive experiments conducted on real-world datasets from diverse cities serve as a robust validation of the proposed system's superiority. The results conclusively demonstrate that the Multi-View model and Knowledge Distillation framework outperform the existing system, establishing their effectiveness in addressing the unique challenges of MSR prediction.

In conclusion, "Secure Your Ride" stands as a pioneering effort to elevate the precision and efficiency of predicting matching success rates, ultimately contributing to a safer, more secure, and optimized ride-hailing experience for both passengers and drivers. The proposed system not only addresses current shortcomings but also sets the stage for a more advanced and adaptive future in the ever-evolving landscape of urban transportation.

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