FW-HTF-RM: A Trustworthy Data-Driven Management Framework for Location-based Online-to-offline Commerce Platforms in an Open Environment

Overview: Location-based Online-to-offline (LBO2O) Commerce is a business strategy that draws potential customers from an online platform to make purchases or request services in physical world with a focus on locations, e.g., Uber for Ridesharing and DoorDash for Food Delivery. The ultimate goal of LBO2O to create sustainable profits and values for itself and for all its participates, e.g., producers, couriers, consumers. The rise of Artificial Intelligence (e.g., Machine Learning Driven Decision Making) has significant impacts on the future LBO2O and work created by it, given the fact that the most, if not all, major decisions in LBO2O will be made driven by data and algorithms in an expeditious real-time fashion. Researchers have accumulated abundant knowledge on how to optimize on these LBO2O platforms from technical, social, or economic aspects, but the studied setting is in a rather *closed environment*, e.g., Uber with fully vetted professional drivers. However, with flexibility as their strength, many future LBO2O platforms will be in an *open environment* where new, diverse or maybe untrusted producers, couriers, and consumers may join, leave, or even game a platform in dynamic fashions. Given such an open environment, it is challenging to consider various real-world *technical, social, and economic factors* beyond the basic profits including fairness, bias, loyalty, experiences, attitudes, and even some conflicting factors, e.g., the privacy for workers but the transparency for decision-making process. Due to complex interactions of four entities (i.e., a platform, producers, couriers, consumers), underlying expected or unexpected social and physical couplings among these factors are under-explored, which lead to both technical and societal challenges in future LBO2O. Developing a trustworthy management framework for LBO2O is essential for ensuring social inclusion and equity of future O2O workers in the era of AI because the impacts of biased decisions are likely to be concentrated in some sub-communities of workers, leading to the social inequality.

Intellectual Merits: Our key merit is to produce new knowledge by the development of a *Trustworthy Data-Driven Management Framework* and its deployment for LBO2O Platforms with three components:

- How to trustworthily *predict* status and behaviors of platform participates without violating their privacy, and then adequately explain prediction results in terms understandable to platform operators: a social diversity aware Machine Learning approach that utilizes data from platform, interviews, and surveys, along with data-driven economic and behavioral models;
- How to trustworthily *decide* consumers' order assignment among various producers and carriers without exhibiting socially harmful biases: a fair multi-objective yet equity-centric scheduling that accounts for socially acceptable trade-offs with Game Theory and Deep Reinforcement Learning;
- How to *disseminate* results and technology to empower community of platform workers from a convergent perspective: a social intervention approach based on professional training and education outreach including impacts of Machine Learning on workers, labor market and dynamics, etc.

Our real-world implementation of this framework by working with our partners in Amazon will show its effectiveness. Its *novelty* is that it is first grounded in Social Science results where new insights were drawn from LBO2O data collection to better understand workers' diversity, inclusion, and equity. It is then materialized with a set of sequential socially-informed technological merits for behavior prediction and order scheduling, and is further evaluated with both technological and social experiments. It finally creates societal impacts through social interventions (e.g., training session, educational outreach, etc.) to *inclusively* and *equitably* benefit a *diverse* set of workers as stakeholders from platform operators, producers, couriers, and consumers.

Broader Impacts: (1) Technology transfer into the Amazon with Microsoft Research for their Location-based Services; (2) An comprehensive education plan well-integrated with the proposed research including training and technology dissemination for diverse LBO2O workers; integrating our research results with various courses, e.g., Rutgers CS § 554 Data Science for Location-based Services and § 672 Computational Economy; reaching out to K12, Undergraduate, Female, Minority; (3) Conducting various community activities: Workshops, Tutorial Video, Open Platform Data; (4) Strong Outreach to Minorities: Working with NJ Chapter of Black Data Processing Associates (the largest professional technology nonprofit for U.S. African Americans); (5) The theory and deployment we proposed have potential impact beyond LBO2O Management to address the fundamental AI Trustworthy issues considering uncertain human behaviors in multi-stakeholder open environments. As a result, its potential impact goes beyond the Work of Future including smart city, smart agriculture, and smart health.