Fair and Transparent Algorithmic Solutions in E-commerce and Gig Economies

Abstract

Digital platforms, including e-commerce, social commerce, and gig-based services, are reshaping the global economy, offering unprecedented opportunities while raising critical challenges related to fairness, transparency, and personalization. In gig economy platforms, particularly food delivery services, workers face income instability and opaque task allocation mechanisms, leading to economic disparities. Social commerce platforms empower local sellers and re-sellers but lack fair exposure mechanisms, often concentrating earnings among a small subset of users. Meanwhile, e-commerce platforms struggle with accurately identifying user personas, which is crucial for delivering personalized recommendations while ensuring diverse and equitable representation.

This thesis advances fairness and transparency in digital marketplaces by developing data-driven, algorithmic solutions across three domains: (1) fair income distribution for gig workers in food delivery platforms, (2) fair earning allocation in social commerce, and (3) persona identification in e-commerce. For gig workers, this research formulates fair income distribution as a constrained optimization problem, proposing novel allocation algorithms that balance wage equity with platform efficiency. In social commerce, a fair division model is introduced to ensure equitable exposure and revenue opportunities for re-sellers, leveraging fairness concepts such as Nash social welfare and envy-freeness. In e-commerce, this thesis presents a persona identification framework using Graph Neural Networks (GNNs), modeling user behaviors and interactions in a heterogeneous graph structure.

All methodologies developed in this thesis have been rigorously tested on real-world datasets and formulated in collaboration with industry partners, ensuring practical relevance and applicability. By integrating algorithmic fairness, machine learning, and real-world constraints, this research contributes to building more equitable, transparent, and user-centric digital marketplaces.