Balancing the Tradeoff between Profit and Fairness in Rideshare Platforms During High-Demand Hours

Vedant Nanda, Pan Xu, Karthik A. Sankararaman, John P. Dickerson, Aravind Srinivasan
University of Maryland, Max Planck Institute for Software Systems, New Jersey Institute of Technology, Facebook
vedant@cs.umd.edu

Issues in Rideshare
› Rideshare platforms can allow drivers to reject requests up to a predefined number - exacerbating biases!
› Drivers can choose to reject rides based, e.g., on trip length and starting/ending location
› Can disadvantage those going to “unpopular” destinations
› UCLA Study (Brown, 2018): Black riders had to wait 1 minute and 43 seconds longer than their white counterparts for rides and were 4 percent more likely to have drivers cancel on them

Current Mitigation Strategies
› Riders’ photo and destination are hidden from the driver until they accept/reject the request
   ‣ Uber recently removed this safeguard
› Penalty is imposed if drivers cancel a certain number of trips after initially accepting them

Not Enough!

Our Contributions
› We formalize a fairness metric relevant in this setting
› We present a provably efficient online matching algorithm
   ‣ Performs better than a reasonable lower bound on both profit and fairness objectives
   ‣ Includes driver’s preference for rides
› We evaluate the proposed algorithm on real-world rideshare data

Optimal Solution
\[
\begin{align*}
\max_{x,y} & \sum_{v \in V} w_x y_x p_v \\
\max_{y \in V} & \min_{v \in V} \frac{\sum_{v \in E_v} x_{v} y_{v} p_{f}}{r_{v}} \\
\text{s.t.} & \sum_{f \in E_v} x_{v} p_{f} \leq 1 \ \forall u \in U \\
& \sum_{f \in E_u} y_{v} \leq \Delta_{u} \ \forall u \in U \\
& \sum_{f \in E_v} y_{v} \leq r_{v} \ \forall v \in V \\
& 0 \leq x_{v} \ \forall v \in V \\
\end{align*}
\]

› Solve these LPs to get \( x^* \) (profit) and \( y^* \) (fairness)

Proposed Algorithm: NAdap \((\alpha, \beta)\)
› For an incoming request \( v \):
   ‣ Out of all possible edges \((u, v)\), sample an edge \( f \) with probability \( \alpha x^* + \beta y^* \)
   ‣ Assign, \( v \) to \( u \).
   ‣ \( v \) may then choose to accept/reject the ride based on \( p_f \)
   ‣ With probability \( 1 - \alpha - \beta \) reject the request

Guarantees
› NAdap achieves a competitive ratio of at least \( \frac{\alpha}{e} \) for profit and at least \( \frac{\beta}{e} \) for fairness (for \( \alpha + \beta \leq 1 \))
› No (non-adaptive) algorithm can achieve \((\alpha, \beta)\) competitive ratio simultaneously on the profit and fairness for \( \alpha + \beta > 1 - 1/e \)

Evaluation