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

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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

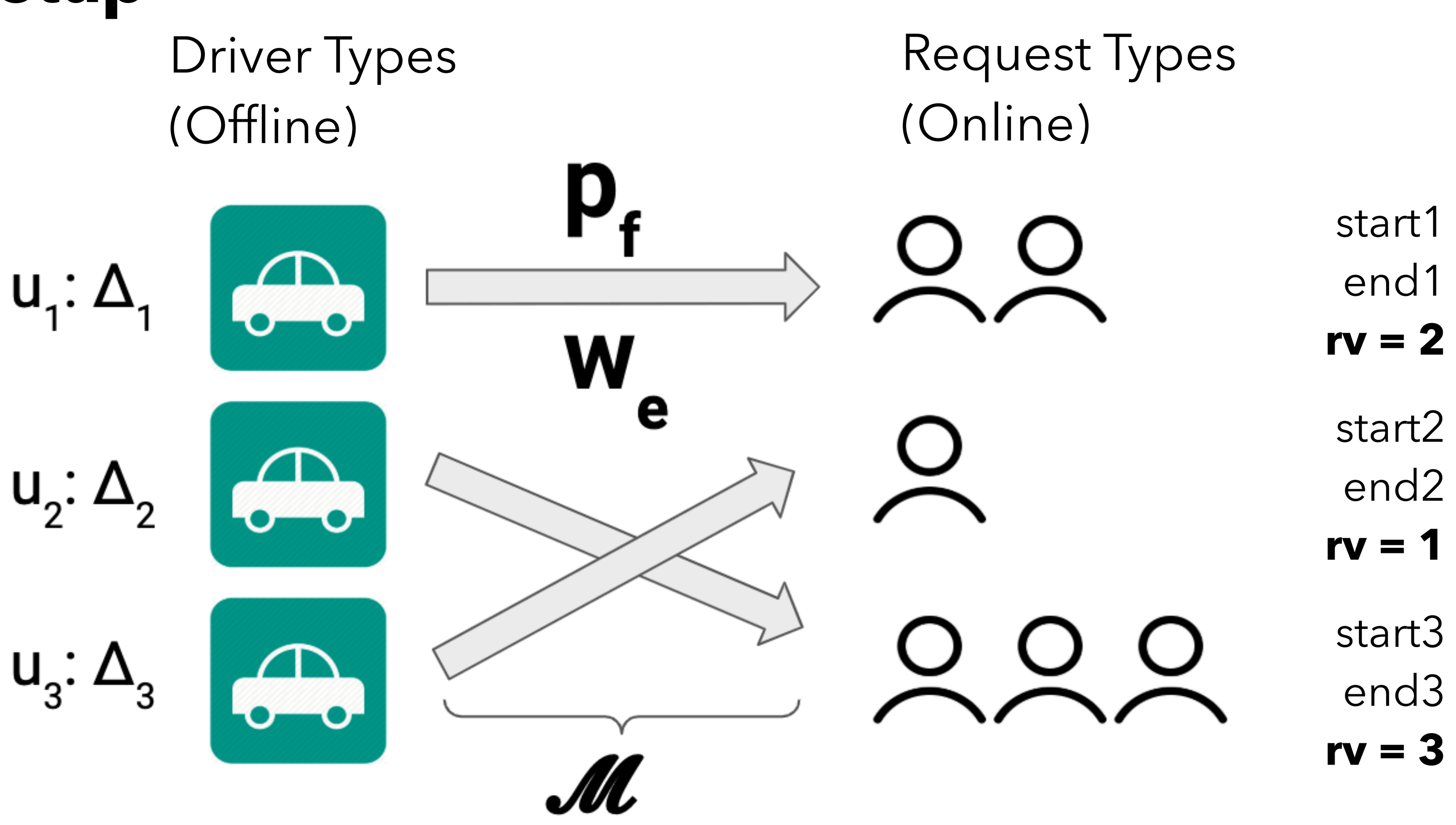
- Riders’ photo and destination are hidden from the driver until they accept/reject the request
  - Uber recently removed this safeguard
- Penalty is imposed if drivers cancel a certain number of trips after initially accepting them

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

Setup



Fairness: $$\min_{v \in V} \frac{\mathbb{E}[|\mathcal{M}_v|]}{r_v}$$

Profit: $$\mathbb{E}\left[\sum_{e \in \mathcal{M}} w_e\right]$$

Optimal Solution

$$\max \sum_f w_f x_f p_f \tag{1}$$

$$\max \min_{v \in V} \frac{\sum_{f \in E_v} x_f p_f}{r_v} \tag{2}$$

$$\text{s.t.} \sum_{f \in E_u} x_f p_f \le 1 \quad \forall u \in U \tag{3}$$

$$\sum_{f \in E_u} x_f \le \Delta_u \quad \forall u \in U \tag{4}$$

$$\sum_{f \in E_v} x_f \le r_v \quad \forall v \in V \tag{5}$$

$$0 \le x_f \quad \forall f \in E \tag{6}$$

- Solve these LPs to get x* (profit) and y* (fairness)

Proposed Algorithm: NAdap (α, β)

- 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 $\alpha + \beta \le 1$)
- No (non-adaptive) algorithm can achieve (α, β) competitive ratio simultaneously on the profit and fairness objectives for $\alpha + \beta > 1 - 1/e$

Evaluation