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Route-cost-assignment with joint user and operator behavior as a many-to-one stable matching assignment game

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Research Problem

- Increase in options of travelers
- We need to have better understanding of their behavior
- Traveler choices depend on decisions of system provider

Using assignment game we try to take into account the behaviors of both travelers and operators

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Proposed Methodology

Classic Assignment Game Problem (A Cooperative game**):**

$$\max \sum_{i\in P}\sum_{j\in Q} a_{ij}x_{ij}$$

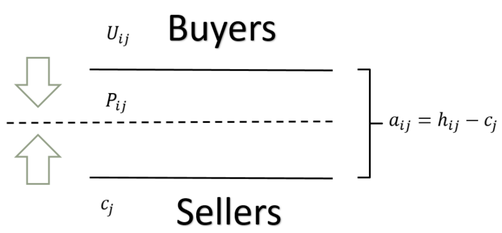
s.t.

$$\sum_{i\in P} x_{ij} \le q_j \qquad \forall j \in Q$$

$$\sum_{j\in Q} x_{ij} \le w_i \qquad \forall i \in P$$

$$x_{ij} \in \{0,1\} \qquad \forall j \in Q \,\&\, \forall i \in P$$

How the cost allocation works



Assignment Game In Transportation Studies

Travelers and operators as two sides of game

$$\max \sum_{s\in S}\sum_{r\in R} a_{sr}x_{sr}$$

s.t.

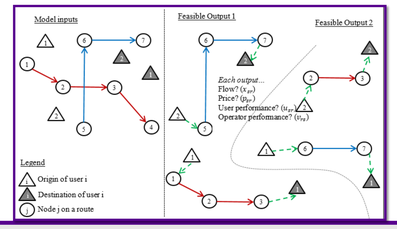
$$\sum_{r\in R} x_{sr} \le q_s \qquad \forall s \in S/\{k\}$$

$$\sum_{s\in S/\{k\}} \delta_{asr}x_{sr} \le w_a \qquad \forall a \in A_r, r \in \mathrm{R}$$

$$\sum_{s\in S/\{k\}} x_{sr} \le M(1-x_{kr}) \qquad \forall r \in R$$

$$x_{sr} \in \mathbb{Z}_+ \qquad \forall s \in S/\{k\}, r \in R$$

$$x_{kr} \in \{0,1\} \qquad r \in R$$



Conclusion and future works

Conclusion

- It is generalized and can be used in several applications. In fact in most of the cases that two sets of supply and demand are working together can be formulated in the proposed model.
- Unlike most of the studies that have strict cost allocation policy or mechanism, in this proposed model any cost allocation policy can be considered.
- This proposed model is very powerful tool for pricing and evaluating cost allocation policies. Unlike conventional studies that just look at one side of supply or demand, this model takes in to account the joint behavior of both users and operators.

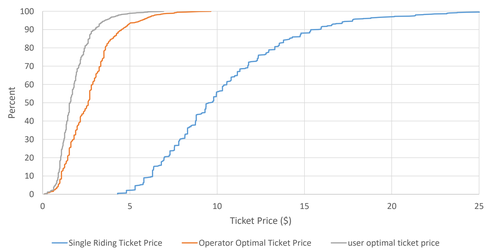
Future Work

- Taking into account the effect of congestion, In such a model, the payoff table ($a_{sr} = U_{sr} - t_{sr}$) would need to treat t_{sr} as a function of flow.
- Consideration of dynamic ridesharing assignment
- stochastic scenarios for risk pooling (cost allocations between operators) in the case of such an events

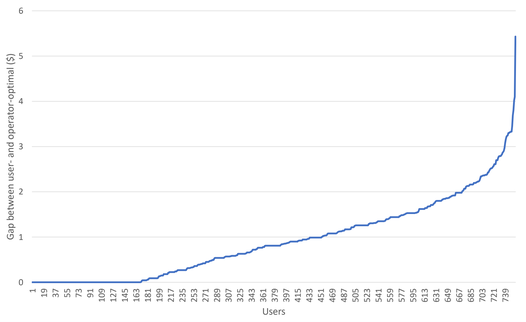
Case Study Results

NYC taxi example

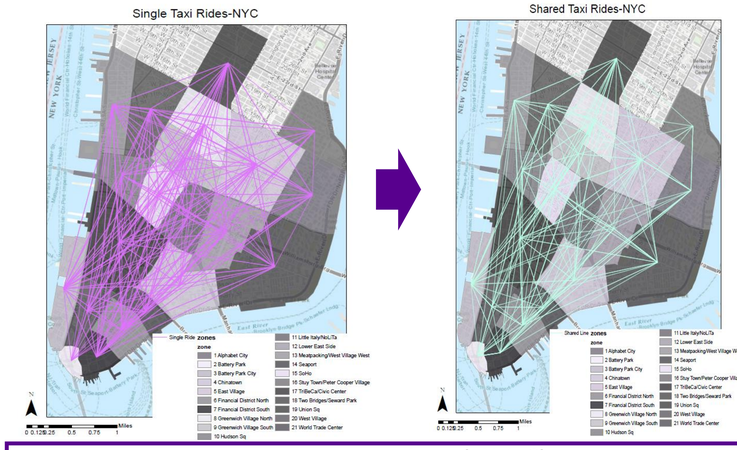
Ticket price percentage of users pay in three different scenario:



Sorted gap between user- and operator-optimal pricing under shared taxi policy



Sharing NYC taxi rides



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