MATHEMATICAL MODEL FOR RIDE-SHARING MATCHING ALGORITHM OPTIMIZATION: ANALYSIS ON MARKET THICKNESS AND BATCHING TIME OF CENTRALIZED MATCHING ALGORITHM

LUIZA MARQUES FONSECA DOS SANTOS
DEPARTMENT OF ECONOMICS AND DEPARTMENT OF MATHEMATICS
TEXAS TECH UNIVERSITY

JIA LI, PH.D.
DEPARTMENT OF CIVIL, ENVIRONMENTAL, AND CONSTRUCTION ENGINEERING
TEXAS TECH UNIVERSITY
MOTIVATION: DOES THICKNESS MATTER?

- Market Thickness: The total flow of supply and demand in a given market
- Isolation in small towns and rural communities create the Last Mile Problem (LMP) to those who depend on public transportation.
- In thick markets, the LMP is solved by ridesharing companies and other on-demand transportation companies.
- But, we wanted to know if for sparse markets the conditions need to be different for a self-sustainable ride-sharing transportation.
REAL WORLD EXAMPLE

LUBBOCK, TX
OPTIMIZE SHARED MOBILITY SERVICE

- People with limited mobility options are vulnerable in disasters
  - Aging, disabled, rural, etc.
- Minimal size of Shared AV (SAV) fleet to ensure service quality
  - Treated as a two-sided market
  - Service quality determined by several factors, incl. market thickness, matching algorithm, spatiotemporal demand pattern, etc.
- Proposed agent-based model
  - Rider tolerance
  - Coupled dynamics of matching & queuing
MODEL FORMULATION

• Stochastic Processes: Spatio-Temporal Poisson Process
• Agent-Based Modeling
• Matching Mechanism: Batch Matching
• Mixed Integer Linear Programming (MILP)
• Interaction Between Riders and Drivers
MODEL FORMULATION

- Stochastic Processes: Spatio-Temporal Poisson Process
- Agent-Based Modeling
- Matching Mechanism: Batch Matching
- Mixed Integer Linear Programming (MILP)
- Interaction Between Riders and Drivers

The multi-agent framework
RESULTS

BIFURCATION OCCURS WHEN MARKET THICKNESS CHANGES
POLICY IMPLICATIONS AND NEXT STEPS

• Minimal fleet size to serve to a region
• Two-sided market interpretation
• Next steps: theoretical analysis, fleet optimization