coRide: Data-driven Ridesharing Service for Large-Scale Vehicle Networks

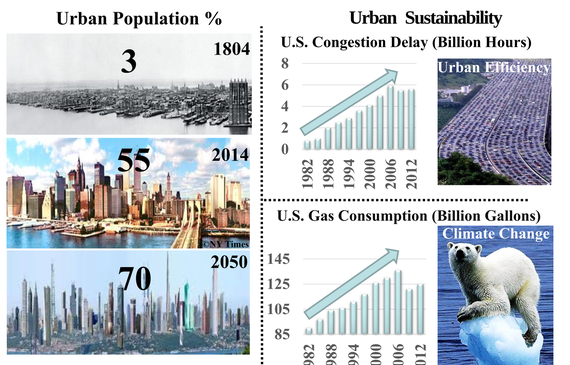
Desheng Zhang & Tian He

Department of Computer Science and Engineering, University of Minnesota

Acknowledgements
NSF CNS-1446640

Introduction

Motivation



High-Level Goals

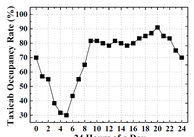
Reduce Traffic Congestion

= 20 ×

Taxi as Example

Reduce Gas Consumption

Challenge & Opportunity

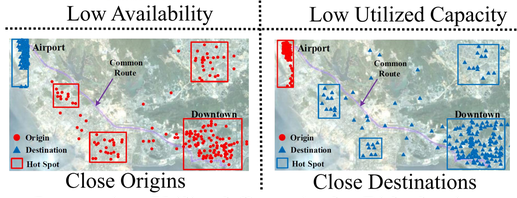


Low Availability

Passenger Per Trip

70% Wasted

1.3 in NYC & **1.4** in Shenzhen
Low Utilized Capacity



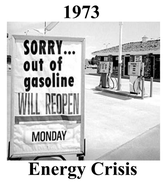
Increasing Utilized Capacity by Ridesharing

Related Work

1942

World War II

1973



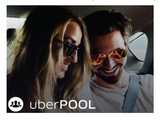
Energy Crisis

2011

Sustainability

T-Share (TDKE'14)

UberPool (2014.12)



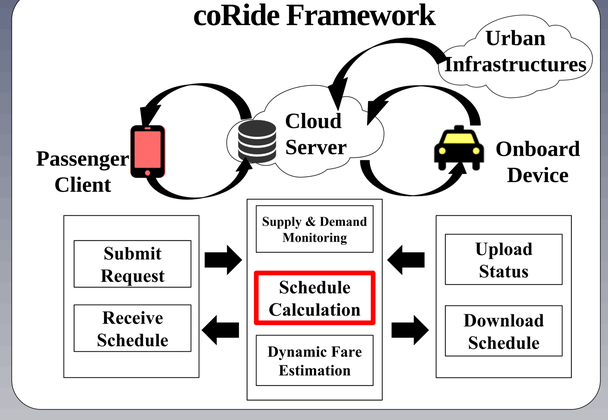
- No Infrastructure Support
- Heuristic Matching
- Lacking Generalization

Contributions

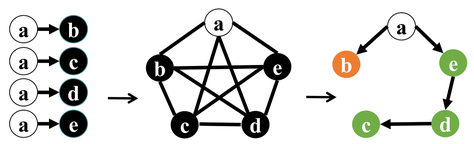
- Infrastructure Support
- A Set of Solutions
  - Optimal
  - Approximation
  - Online
  - Practical Constraints
- Real-world Implementation
- Extensive Evaluations
- Generalization to Broader Logistics

Design

coRide Framework



Schedule Calculation



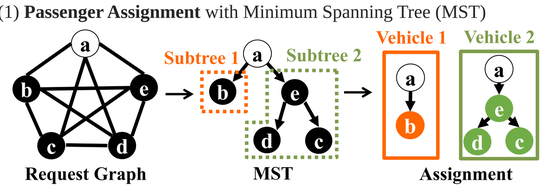
(1) Passenger Requests **(2) Request Graph** **(3) Delivery Graph** Connected Spoke Structure

Minimum Branches (Congestion) or **Weight** (Gas Consumption)

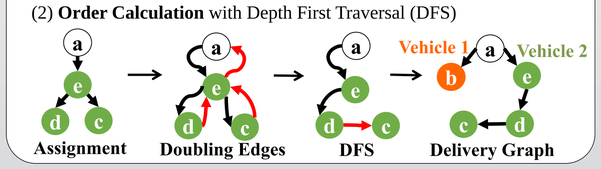
- Constraints
  - Vehicle Count
  - Vehicle Capacity
  - Travel Period & Tolerated Delay
- NP Hard: Traveling Salesmen (TSP)
  - Optimal
  - **2-Approximation**
  - Online

Approximation Algorithm

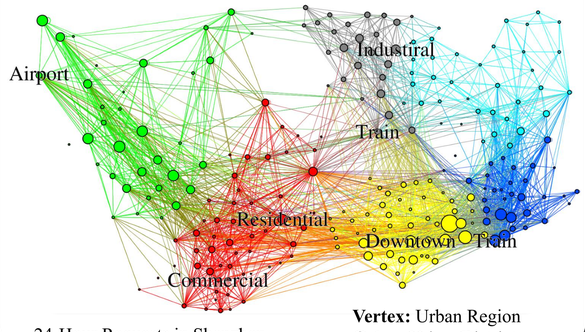
(1) **Passenger Assignment** with Minimum Spanning Tree (MST)



(2) **Order Calculation** with Depth First Traversal (DFS)



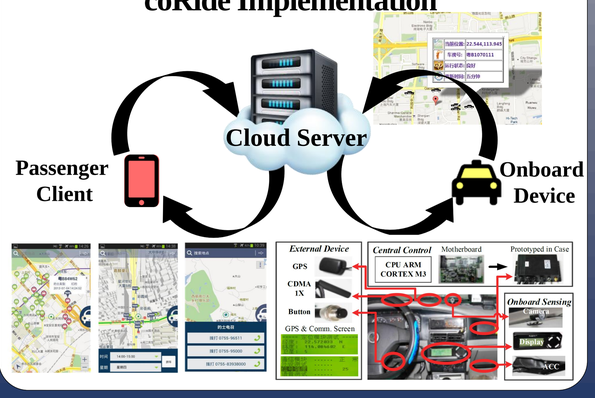
Delivery Graph Example



24-Hour Requests in Shenzhen

Vertex: Urban Region
Color: Urban District

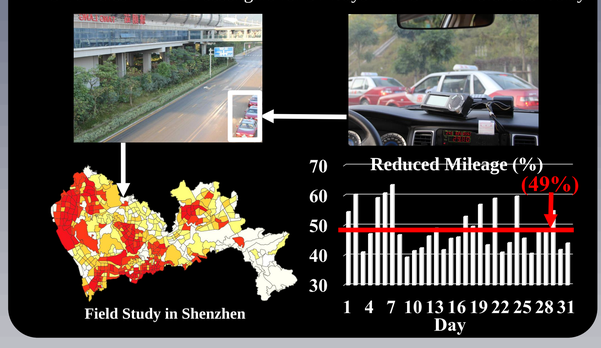
coRide Implementation



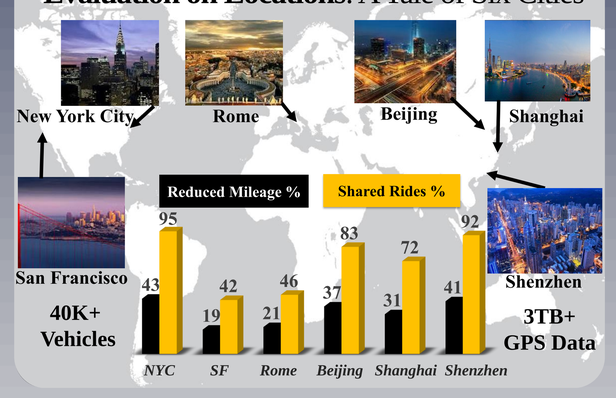
Evaluation

Evaluation on Scales (1/3): Regional

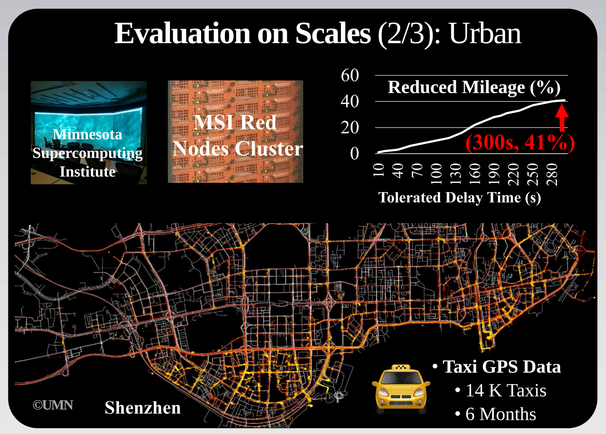
3 Vehicles with 12 Passengers for 31 Days with 5 Mins Tolerated Delay

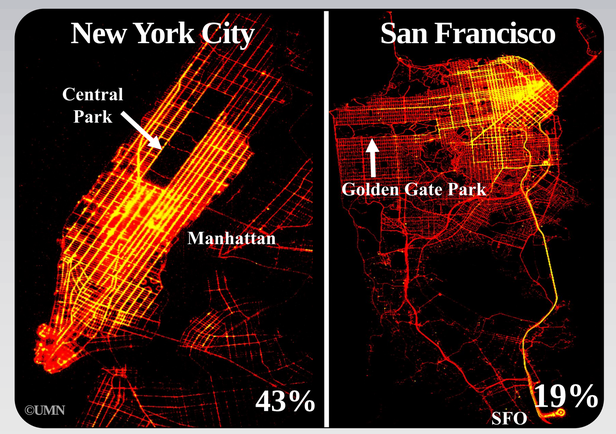


Evaluation on Locations: A Tale of Six Cities

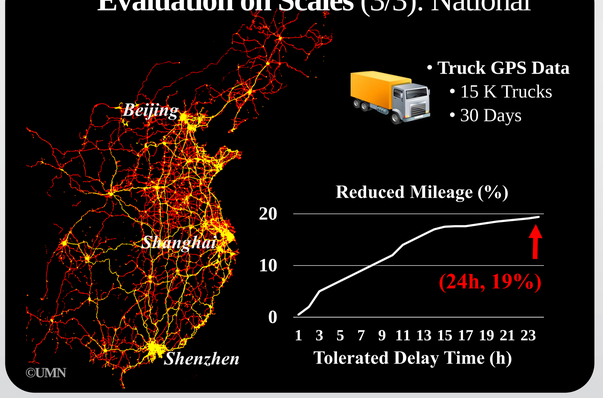


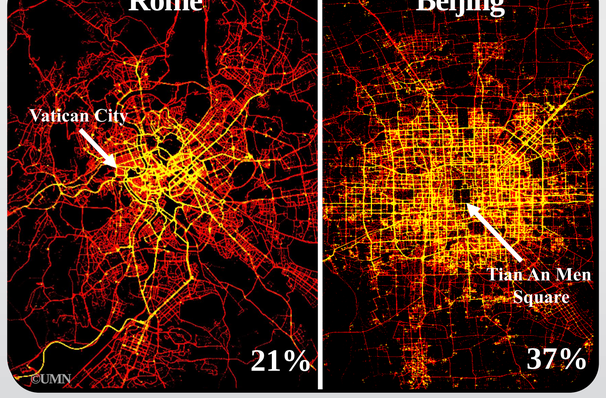
Evaluation on Scales (2/3): Urban



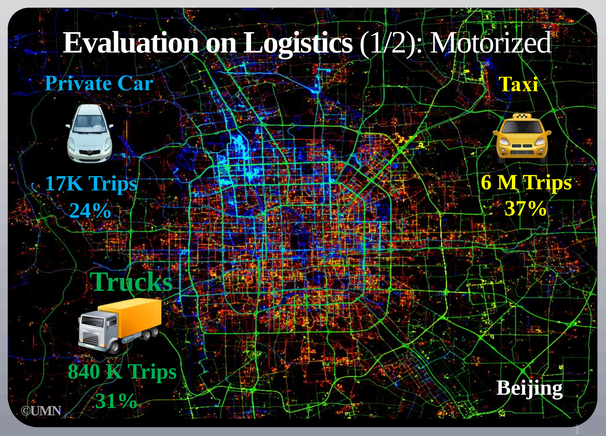


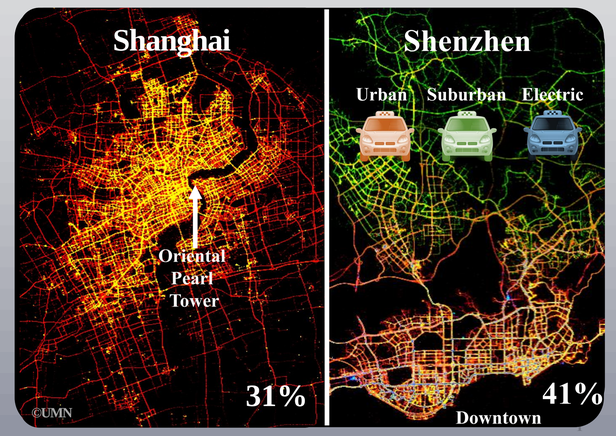
Evaluation on Scales (3/3): National



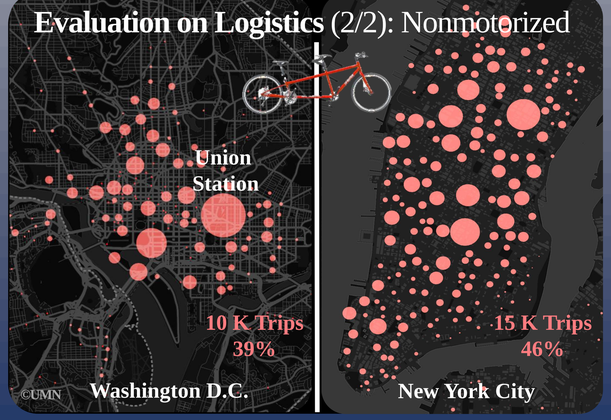


Evaluation on Logistics (1/2): Motorized





Evaluation on Logistics (2/2): Nonmotorized



Conclusion & Future Work

- Reducing Gas Consumptions & Congestions by Ridesharing
- Groundwork for Sharing Economy in Logistics Systems
- Magnifying Benefits by Linking Various Urban Infrastructures