Computation & Crowds: Models for Dynamic Ridesharing

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Article:
People, Crowds, and Services

- Computation at center of opportunistic planning & coordination among people
- Principles for weaving together collaborations in light of related goals and preferences
- *Rideshare as theoretical & practical example*
Multiple sources

- GPS, cell tower, wifi
- Direction requests to routing services

> e.g., MS Multiperson Location Survey
Data on location, trips, destinations

Multiple sources - GPS, cell tower, wifi

Direction requests to routing services > e.g., MS

Multiperson Location Survey
Data on location, trips, destinations

*e.g.* Predestination algorithm

Assign probabilities to each cell as trip progresses

![Map](image)

- Trip starts
- Inference as trip progresses
- Narrowing of destination possibilities

- Median error 2 kilometers at trip’s halfway point

with John Krumm
Learning from Data on Flows & Trips

- 5 yrs of GPS trails
- ~500,000 km
- Multiple projects
  - Clearflow (now in 72 cities)
  - Community sensing
Commutes from Flows and Trips

e.g., Extract AM/PM commutes to/from Microsoft
Toward Effective Rideshare Systems

- Ongoing computation in support of collaboration
- Changing needs & preferences
- Acceptance, trust, convenience, cost
- Range of scenarios
  - Spectrum across immediacy vs. planned
  - General vs. special situation
  - Owned car vs. shared vehicle (e.g., Zipcar style)
Balancing Diverse & Changing Needs

Cost-benefit
- Earlier departure
- Delayed arrival
- Increased travel
- Savings on effort
- Fuel, environment

![Graph showing changes in start time and trip duration](image-url)
Balancing Diverse and Changing Needs

Cost-benefit
- Earlier departure
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Agent-Based Carpool (ABC) System

- Instant & planned rideshare scenarios
- Methods for promoting fairness in reporting needs
- Social relationships, comfort, communication
- Prototype for running system & analytical bench

*Optimize for individuals and across a population*
ABC Rideshare

- Cost-benefit methods to find ideal rideshares
- Evaluated on GPS trails from MS employees

with Ece Kamar
Assignments based on observed trips.

Cost-benefit
- Departure change
- Delayed arrival
- Increased travel
- Savings on effort, fuel, environment
Planned vs. Instant Commuting

Planned commute
→ ABC notified of AM/PM needs day in advance

Instant: Commute requests on the fly
→ ABC notified 15 minutes before trip start time
Execution with Real-World Workload
New user (<30min)

- Original Route

- Activity
  - driver added: gerryb for bradley (1)

- $\Delta K_m$
  - +$1.72$
  - 13.96 km reduction

- $\Delta M_inutes$
  - -$0.19$
  - -5.53 mins extra driving
  - 17.37 mins delay

- Cognitive Cost
  - +$1$
  - 1 drivers less

- Net Utility
  - +$2.53$

- $\Delta CO_2$
  - 0.98 tons reduction per year

Waiting List
1. pfgo rty 06:33 AM
2. Bradey 06:31 AM
3. gerryb 06:28 AM
Rideshare

Cost-benefit Analysis

Queue

Current Time: 06:09 AM
Activity
driver added: gerryb for bradleys (1)

Δ Km
- + $1.72
13.96 km reduction

Δ Minutes
- $0.19
-5.53 mins extra driving
17.37 mins delay

Cognitive Cost
- + $1
1 drivers less

Net Utility
- + $2.53

Δ CO₂
0.98 tons reduction per year

Waiting List
2: gerryb, bradleys 06:28 AM
1: phil, gentry 06:23 AM
Trip Activity
- Green: share
- Red: single
AM Commute
Beyond Real-Time: "What If?" Studies

Number of agents

Efficiency on number of commutes
Efficiency on total cost

System Efficiency

Number of participants →
Beyond Real-Time: "What If?" Studies

Fuel Cost ➔
Beyond Real-Time: "What If?" Studies

Cost of time ➔
Challenge: Understanding acceptance, perceptions, social considerations

- Address concerns, leverage opportunities
- Trusted organizations
- Referral, reputation
  - e.g., existing online social networks (e.g., link distance bounds)
Optimization allows for smooth insertion of:

- Constraints
- Preferences

\[ U(p_i, p_j) = d(a_i, a_j) = f(d(a_{i1}, a_{j1}), \ldots, d(a_{in}, a_{jn})) = \sum_l k_l d(a_{il}, a_{jl}) \]
Distances and Relationships

Eric Horvitz's Home:
Facebook | Eric...

Wall | Info | Photos | Boxes |

What's on your mind?

Eric + Friends | Just Eric | Just Friends

Settings

Recent Activity

Eric and Carl L Murphy are now friends.
Eric and Rob Miller are now friends.
2 more similar stories

Nuria Oliver
Eric!!! how are you?? thanks for your post on IJCAI!! I am so happy!! are you going to CHI? I'll be there. Would be great to catch up during a coffee break!!
I hope that all is going well in Seattle!

March 31 at 10:22pm · Comment · Like · See Wall-to-Wall

Recent Activity

Eric and Christian Borgs are now friends.
Eric and Lori Horvitz are now friends.
7 more similar stories

Sarah Revi Sterling
nice NPR slot!!

March 21 at 8:50am · Comment · Like · See Wall-to-Wall

Prasun Dewan
Eric, Just heard your NPR Interview! In fact, when Lee saved my career from working on the web. I am so thankful for that.
Distances and Relationships
Studies of preferences & acceptability
  ➢ Flexibility, acceptance, and ease of use

Implementation directions
  ➢ Shuttle overlay, instant carpool, AM/PM commute
  ➢ Outlook add-in, web service
    - Encode preferences, needs, commitments

Collaboration with MS Real Estate & Facilities, MS Sustainability, King County Metro
Identified methods that harness computing for coordination among people

Computing services integrate data about know-how, availability, location, ad goals.

Other location-centric coordination
Related work: Creating meshes of people for emergency assistance