AI planning, shared mobility, and sustainability

Eric Horvitz
Microsoft Research

December 2009
Copenhagen meeting

Emissions abatement $\rightarrow$ 450 ppm by 2030 ($\sim 2^\circ$).

(IEA 10/09)
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

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
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)

Kamar and Horvitz, 2009
ABC: Agent-Based Rideshare Project

- Principles of collaboration with varying preferences
- Mechanism design for promoting truthful reporting
- Instant & planned rideshare scenarios

Collaboration with King County Metro, WashDOT MS Facilities, MS Sustainability.

Kamar and Horvitz, 2009
Commutes from Flows and Trips

e.g., Extract AM/PM commutes to/from Microsoft

Kamar and Horvitz, 2009
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

Collaboration with King County Metro, WashDOT MS Facilities, MS Sustainability.
Balancing Diverse & Changing Needs

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

Shared & divergent preferences
Balancing Diverse & Changing Needs

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

Shared & divergent preferences
ABC Rideshare

- Identify rideshares, incentives and truthfulness
- Evaluate on GPS trails from MS employees

Total Cost
+ $735.45

$CO_2$
-231.17 tons per year

$ΔKm$
+ 56.89 km

$ΔMinutes$
- 15.17 mins extra driving
+ 42.58 mins delay
Assignments based on observed trips.

Cost-benefit
- Departure change
- Delayed arrival
- Increased travel
- Savings on effort, fuel, environment
Ideal Coalescence
Plans and Flexibility

- Planned versus “instant” commute
- Owned versus shared cars (e.g., Zipcar)
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
Rideshare queued
Commute request
Rideshare starts
Single rider starts

Videos
ABC rideshare simulator
Microsoft commute data

6am  8am

ΔKm
- $0
0 miles reduction

ΔMinutes
- $0
0 mins extra driving
0 mins delay

Cognitive Cost
- $0

Net Utility
+ $0

ΔCO2
0 tons reduction per year

Waiting List

Kamar and Horvitz, 2009
Videos

ABC rideshare simulator
Microsoft commute data

Commute request

Rideshare queued

Rideshare starts

Single rider starts
New user (<30min)

Original Route
Rideshare

Cost-benefit Analysis

Queue
Trip Activity
- Green: share
- Red: single

Queue

Current Time: 08:55 AM

Activity
- trip ended: goodall (3)
- trip ended: dbrock (1)

$\Delta K_m$
- + $0$
0 km reduction

$\Delta \text{Minutes}$
- - $0$
0 mins extra driving
0 mins delay

Cognitive Cost
- + $0$
0 drivers less

Net Utility
- + $0$

$\Delta \text{CO}_2$
0 tons reduction per year

Waiting List
2: rojas_luisax, 09:01 AM
2: illey_35, unknown3:GPS14, 09:04 AM
1: vagner_09:10 AM
1: a-djeliow:09:14 AM
1: tammy09:14 AM
2: egilbabt-benkom2: 09:11 AM
Results

Normal commute

Computed rideshares
**Computation Models and Insights**

"What If?" Studies

System Efficiency

<table>
<thead>
<tr>
<th>Number of agents</th>
<th>Efficiency on number of commutes</th>
<th>Efficiency on total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>860</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Number of participants ➔*

*Kamar and Horvitz, 2009*
Computation Models and Insights
"What If?" Studies

Kamar and Horvitz, 2009

Fuel Cost ➔
Computation Models and Insights
"What If?" Studies

Cost of time ➔

Kamar and Horvitz, 2009
Computational Models and Design

Best Park & Ride Locations?
Computational Models and Design

Best Park & Ride Locations?
Aceptance, Trust, and Ridesharing

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)
Integrating Preferences about People

- Constraints
- Preferences

Optimization allows for smooth insertion of:

\[ U(p_i, p_j) = d(a_i, a_j) \]

\[ = f(d(a_{i1}, a_{j1}), \ldots, d(a_{in}, a_{jn})) \]

\[ = \sum_k k_i d(a_{il}, a_{jl}) \]
Distances and Relationships

Wall
Info Photos Boxes +

What’s on your mind?

Eric + Friends Just Eric Just Friends

RECENT ACTIVITY

Eric and Carl L Murphy are now friends. Comment Like

Eric and Rob Miller are now friends. Comment Like

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. Comment Like

Eric and Lori Horvitz are now friends. Comment Like

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...
Distances and Relationships
Directions

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
Computational Futures

- Autonomous vehicles? ...Yes.
- But...preferences, incentives, optimization!
  ➢ Direction: Public microtransit
Publications, videos


Additional detail:


Videos:

ABC Rideshare Simulator at 6am, 8am.