Reinventing Mobility with Artificial Intelligence

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Outline

- Motivation
  - Technology enablers
  - Case Study
  - On Demand Multimodal Public Transportation
The Importance of Mobility

- Car ownership in the US
  - best predictor of upwards social mobility

The relationship between transportation and social mobility is stronger than that between mobility and several other factors, like crime, elementary-school test scores or the percentage of two-parent families in a community

Nathaniel Hendren, Harvard University

The Importance of Mobility

- Transportation and health care

Many low-income people in urban and suburban areas struggle to find reliable transportation. The result is missed appointments and poor illness management, even when care is readily available.


- 3.6 Millions do not obtain medical care because of a lack of transportation in a given year

- Access to Health Care and Nonemergency Medical Transportation Two Missing Links. By Wallace & al, 2005
The Importance of Mobility

- Transportation and Healthy Food
  - Accessing healthy food is a challenge for many Americans—particularly those living in low-income neighborhoods
    - The Grocery Gap, 2010

- Lack of supermarkets
  - 23 millions have no supermarket within a mile
  - predominance of convenience stores

- Lack of transportation access to stores
  - residents in many urban areas have few transportation options to reach supermarkets
The Importance of Mobility

▶ Transportation and Healthy Food

EVERYDAY MONEY GROCERIES

This Grocery Store Will Give You a Free Uber Ride Home if You Spend $50

Brad Tuttle @bradrtuttle | Sept. 17, 2015

Coupons are great, but free Uber rides are better.

If you don’t have a car, it’s difficult to stock up at the supermarket. No one wants to walk or ride the bus home lugging more than a bag or two of groceries.
The Challenge

On Demand Transportation as a Public Service
Outline

- Evidence-Based Optimization
- Technology Enablers
- Case Study
- On Demand Multimodal Public Transportation
Automated Vehicles
Progress in Analytics

Prescriptive Analytics
What should I do?

Diagnostic Analytics
Why did it happen?

Predictive Analytics
What will happen?

Descriptive Analytics
What has happened?

Analytics Focus
Past  Present  Future

Human input to decision
Data
Insight
Decision
Business value

Source: http://ibm.co/1gJyfl3
Progress in Analytics

- Progress in data-mining and machine learning
  - activity-based model of mobility
  - demand forecasting

- Large-scale optimization
  - network design
  - dynamic routing

- Online stochastic optimization
  - combining predictive and prescriptive models

- Pricing
  - different levels of services
Outline

- Evidence-Based Optimization
- Progress in Optimization
- Case Study
- On Demand Multimodal Public Transportation
Canberra
Planned City

- Garden city
  - Walter Griffin

- Design principle
  - self-contained communities
  - greenbelt
  - “bush capital”

- Many towns
  - city centers
  - infrastructure

- Started in 1913
Public Transportation in Canberra

- The problem: off-peak bus service
  - long routes
  - 1-hour frequency
  - buses running almost empty
  - buses are expensive
On-Demand Public Transportation

- The Solution: Hub and Shuttle Network
  - buses only run routes between hubs
On-Demand Public Transportation

- The Solution
  - Passengers travel to/from hubs in multi-hire taxis
On-Demand Public Transportation

- The Solution
  - one ticket booked online
On-Demand Public Transportation
Cost and Quality of Service

<table>
<thead>
<tr>
<th>Day</th>
<th>BusPlus</th>
<th>Action</th>
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<tbody>
<tr>
<td></td>
<td>Buses ($)</td>
<td>Cost ($)</td>
</tr>
<tr>
<td>Monday</td>
<td>45728.57</td>
<td>369420.37</td>
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<tr>
<td>Tuesday</td>
<td>45728.57</td>
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<td>Friday</td>
<td>43893.83</td>
<td>350709.85</td>
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Table 5: Time and Cost Comparison Between BusPlus and Action.
Live Trial in 2016
Outline

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Mobility in Ann Arbor
On Demand Multimodal Public Transportation

- Fleets of connected and automated vehicles
  - synchronized with light rail and high-frequency buses
  - fleet sizing

- On demand public transportation
  - First/Last mile
    - small automated and connected vehicles
  - economy of scale
    - high-frequency buses and light rail

- Mode and mobility changes
  - how does this system affect transportation modes?
  - how does this system affect mobility?
  - how does this system affect parking and congestion?
UM Parking and Transportation

- Some figures
  - 50,000 commuting trips a day
  - 7.4 millions a year
  - 75% capacity utilization
  - increasing congestion issues
Northwood Commuter
Massive Data Sets

- UM Parking and Transportation Services
  - ridership, bus routes, bus schedules …

- UMTRI
  - safety pilot program
  - 2,000 cars fully tracked

- UM
  - mobility data from students (TBC)

- And more
  - Ann Arbor, SE Michigan, …
Conclusion

- Bringing public transportation into the 21st century
  - first/last mile
  - mobility as a public service
  - congestion

- Technology enablers
  - connectivity
  - data science (machine learning and optimization)
  - automated vehicles

- Case studies
  - preliminary evidence of benefits
    - quality of service, costs, emission

- Many more opportunities
  - electrical vehicles, holistic infrastructure optimization