Session 2 Big Data, Transportation Data Analysis

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The Public Bikes

Integrating information technology for a self-regulated PBS

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Why the hype?

• From 1870’s development of the “bicycle” machine.

• Famous bicycle playing cards introduced to motivate use as vehicles.

• Transportation alternative for individuals.

• Mass production from 1890’s.

• II World War: shortage of petrol, ubiquitous in all cities in Europe.

• Women, children and minorities are statistically the most prominent users.
Back to the Future?

- > 50% world population lives in cities
- By 2050 population > 9 billion
- New twist in bike hype: a sustainable alternative for public transportation
- Well suited to inner city travel
- Healthier, energy efficient, … and fun!

Bikes are good for sustainable cities.
## Comparison

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Distance</th>
<th>Space required</th>
<th>Negative Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>car</td>
<td>drop off point to destination</td>
<td>Space inefficient</td>
<td>Environmentally unfriendly</td>
</tr>
<tr>
<td>bus</td>
<td>Surface traffic slows it down</td>
<td>Space efficient</td>
<td>Additional wait time, have to share with others, Since it is public, less contro</td>
</tr>
<tr>
<td>subway</td>
<td>Often not close to either at either end</td>
<td>Space efficient</td>
<td>Additional wait time</td>
</tr>
<tr>
<td>Bicycle rental</td>
<td>Needs return at origin</td>
<td>Space efficient</td>
<td>Not good in wet weather</td>
</tr>
<tr>
<td>taxi</td>
<td>Close</td>
<td>Expensive, space inefficient</td>
<td>Additional wait time</td>
</tr>
<tr>
<td>skateboard</td>
<td>can be carried to the office</td>
<td>space efficient</td>
<td>accident prone, only good for a few</td>
</tr>
</tbody>
</table>
Brief History of PBS

- 1\textsuperscript{st} Gen (1965) Amsterdam White Bikes, many to follow.
  - Vandalism
  - Misuse
  - Theft
- 2\textsuperscript{nd} Gen (1995) Copenhagen “bike library”: borrow with a deposit, many to follow
  - Users are not registered, so not accountable
  - Theft, misuse
- 3\textsuperscript{rd} Gen (1998) Rennes, Lyons: use of “smart card” technology
  - User identification
  - Information, monitoring, etc
2007: the “vélib” comes to Paris
It impacts the rest of the world.

The tipping point
In early 2014, some 600 cities in 52 countries host advanced bike-sharing programs, with a combined fleet of more than 570,000 bicycles.

Spain leads the world with 132 separate bike-share programs. Italy has 104, and Germany, 43. The world’s largest bike-sharing program is in Wuhan, China’s sixth largest city, with 9 million people and 90,000 shared bikes. In 2013, China was home to 82 bike-sharing programs, with a whopping combined fleet of some 380,000 bicycles.

The United States hosts 36 modern bike-sharing programs. With a number of new programs in the works and planned expansions of existing programs, the U.S. fleet is set to nearly double to over 37,000 publicly shared bicycles by the end of 2014.
Transportation not recreation

Public asset for sharing

Public Bike Share

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How did Paris achieve this goal?

• Short distance, shared bikes
• Any time, anywhere, for “free”
• Discourage “recreation” trips

• Access fee:
  • Annual memberships
  • Short term memberships

• Usage fees:
  • Above 30-45 minute ride
  • Geometric progression: $7, $14, etc, $441 for three hours!

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Is it working?
The time limit

Unlimited number of rides, but each with a time limit,

Why do this?

• People learn: find a dock, park and get another bike
• Drivers may rush to park in time, and risk accidents
• Today 33% revenue in US PBS comes from usage fees

Significant revenue at Risk

Negative Impact on Safety

Negative Impact on Availability

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Our Vision of the Future for the 4th Gen PBS

Availability. Failures if no bikes or no docks when needed. We model customer behavior.

Satisfaction. People become anxious facing uncertainty. Confirmation bias: tendency to blow up perceived confirmation and to overlook information disagreeing with our expectations

Solution 1: Software based changes only

Solution 2: Pricing alternative

Pilot simulations show feasibility, on-going study.

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**Solution 1:** Integration of information about the ride, probabilistic model for prediction, monitoring rides to trigger warning alarms. Optimization algorithms.

- Reduced distance traveled (no waste finding docks)
- Reduced maintenance costs
- Increased availability
- Reduced uncertainty and anxiety for customers
- Increased safety in riding
**Solution 2:** Economic model for pricing alternatives.

**Simplified schematic dynamics.**

**Ongoing:** stochastic analysis of dynamic system with feedback for optimal balance (economic equilibrium)

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Our Vision for the 4th Gen PBS

- Integration of data analytics (GPS, customer classes, preferences, patterns, multimodal transport)
- Humans as users but also as sensors/agents
- Incentivize redistribution by reward systems
- Allow reservations

**Self-regulation:** use information for
- Dock/bike dynamic reallocation
- Maintenance, expansion
- Dynamic yield management

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System Overview

PBS Model

Central Agent

Bikes

Simulator

Computer simulation
Real-world testing

Evaluation

Human Participants Tests

Bike Docks

App

Fine-tuning

controls

communicates with

use

results feed into

Evaluation

results feed into
Research Team

- **Felisa Vázquez-Abad**: stochastic optimization, probability theory, mathematical models.
- **Ted Brown**: simulations, data gathering, apps development.
- **Carlsten Kessler**: Geo-positioning expertise, analysis of geographical data.
- **Jason Young**: behavioral psychology, modeling human reactions and behavior

Open to establish public/private collaborations in NYC.
Thank you!