Understanding urban dynamics from digital traces

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Context

50% of the globe’s population live in urban areas (just 0.4% of the Earth’s surface) 70% are projected to do so by 2050

The greatest wave of urbanization is yet to come
- Great opportunity for improving people life stiles
- A potential economic, health and environmental disaster
Transportation

Transportation currently accounts for one third of the nation’s energy use.

Personal mobility consumes about two thirds of the total transportation energy use.

Given increasing concerns with energy demand and environmental sustainability, urban transportation faces a grand challenge of:

*providing access to goods, services and opportunities necessary to enable human development while preserving the environment.*

C. Barnhart Transportation @ MIT initiative, 2009
Framework

- Human behavior
- Built environment
- Transportation
- Planning and Management
Framework

- Human behavior
- Environmental Impact
- Built environment
- Transportation
- Planning and Management
My research

Designing and evaluating the impact of intelligent transportation systems in reducing transport demand in cities:

- Understanding human behavior in terms of mobility demand
- Analyzing and predicting transportation needs in short and long terms

Applications
- More efficient planning
- More efficient transportation management
Pervasive technologies datasets
Potentials

- possibility to study micro and macro behaviors
- data is becoming more and more available (mobile technologies increasingly adopted by the population)

Privacy concerns in the use of personal data only partially addressed by the EC (*)

Cyber-physical system

- Human behavior
- Built environment
- Transportation
- Planning and Management

Pervasive technologies datasets
Real time data collection

**Goal:** Extract individual mobility information from telecommunications and transportation networks

Technology used to locate mobile phones engaged in calls

A. Cell ID

B. Angle of Arrival (AOA)

C. Timing Advance (TA)

D. Received Signal Strength (RSS)

Using propagation models and irradiation diagrams, the software engine estimates the mobile phone position finding the point that minimizes the mean square error between measured and estimated mean power received by all base stations.
Modeling urban mobility – special events

**Goal:** Modeling and predicting non-routine additive origin-destination flows in the city

Improving event planning and management, with possible applications for emergency response

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Attendance inference

- Event duration
- User stop
- Overlap time > 70%
- Estimated home location
Origins of attendees

(b) Boston Red Sox vs. Baltimore Orioles at Fenway Park, 2009-9-9
(d) Shakespeare on the Boston Common, 2009-8-13
Event types and attendance origins

<table>
<thead>
<tr>
<th>ZIPCODE</th>
<th>02215</th>
<th>02139</th>
<th>02114</th>
<th>02115</th>
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<tbody>
<tr>
<td>COUNT</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>PERCENT.</td>
<td>7%</td>
<td>5%</td>
<td>7%</td>
<td>11%</td>
<td>9%</td>
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</table>

Multilayer Perceptron Neural Network

Event type

Francesco Calabrese
Event types and attendance origins

<table>
<thead>
<tr>
<th>Features</th>
<th>All attendees</th>
<th>Excl. event zipcode</th>
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<tbody>
<tr>
<td></td>
<td>Precision</td>
<td>Improvement</td>
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<tr>
<td>Fixed baseline</td>
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<tr>
<td>Random baseline</td>
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<tr>
<td>Zipcode</td>
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<td>54.36%</td>
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<tr>
<td>Distance</td>
<td>51.06%</td>
<td>16.06%</td>
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Circles are centroids of zipcode areas
The Smarter Cities Technology Centre merges Collaborative Research & Smarter Cities opportunities

Developing Intelligent Solutions Across a System of Systems
- Optimization
- Predictive Modelling
- Forecasting
- Simulation
- Driving New Economic Models
- Significant Collaborative R&D
- Skills Development & Growth
- Competitive Advantage

Collaboration and Access to Local, Regional & Worldwide Network
- SME’s | MNC’s | Universities | Public Sector | VC Community

Seed Projects
- Real World Insight | Data Sets | Devices

City Fabric
- Energy
- Movement
- Water

Integrated Cross Domain Solutions

Solutions that Sustain Economic Development

Smart City Solutions

Dublin Test Bed

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Thanks
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