Data Analytics in Smart Cities

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Evolution of cities and urban models

- **NOW**: Data-Intensive Urban Science
- **2000-2010**: Science of Cities
  - Complexity, Social Sciences
- **1990-2000**: Urban Science
  - Internet, Connectivity, Sensors
- **60's**: Computer-Based Urbanism
  - Computers, Cars, ...
- **19th Century**: Urbanism
  - Industrial Revolution
- **19th Century**: City Planning
  - S&T Progress
- **Data-Driven City**: Actionable, Measureable
From measurable to actionable cities

- Standards
  - Reference models
  - Vocabularies/ontologies
  - Common data formats
  - Evaluation framework & indicators
- Scalable middleware to connect data producers with data consumers
- Science-based framework for the analysis and modeling of urban systems
  - System of systems perspective
  - Holistic view
  - Integrated approach
The city as a “system of systems”

- Reference model for Smart Cities
- Common city model to facilitate the exchange of data and best practices
Scalable middleware

- **Information Platform:** Integrates all information flows that move data through the different interconnected and integrated layers of systems and subsystems that form the city anatomy.

- Common interface for developing city applications
- Facilitates the deployment IT-based city services
**Scalable middleware**

- **Information Platform:** Integrates all information flows that move data through the different interconnected and integrated layers of systems and subsystems that form the city anatomy
  - **City Operating System** (City OS)

- **DATA CAPTURE**
  - Cyber-physical systems
  - Other sources

- **DATA MANAGEMENT**
  - Semantics
  - Life-cycle
  - Security
  - Integration & interoperability
  - Storage

- **DATA PROCESSING**
  - Data mining
  - Data analytics
  - ETLs
  - Stream processing

- **APPLICATIONS**
  - CITY SERVICES
    - Mobility, energy, ...

Data Analytics in Smart Cities
Science-based Framework

- Integrates:
  - Data
  - Models
  - Human cognition

- Facilitates decision making
- Makes city data actionable

- Methodologies:
  - Statistics
  - Machine learning
  - Multi-agent systems
  - Physics-based models
  - Non-bayesian data fusion
  - Uncertainty quantification
Multiscale urban systems

- Coupling with built domain components
  - Household analytics (e.g., smart meter)
  - Energy monitoring and optimization in buildings
  - Other scales: block, district, …
  - But also: smart devices (smart bulbs, …)
Framework for city evaluation & analysis

▶ The City Genome

- Evaluation Framework
  - Environment
  - Infrastructures
  - Built Domain
  - Functions
  - Economy
  - Culture
  - Information
  - Society
  - Government

- Interactions

- Comparative analysis
- Analysis across different situations
- Integrated view of all the systems

Cond1  Cond2  Cond3  Cond4

cityA

cityB

cityC

cityD
Coupling of systems
Outlook: Toward Cognitive Cities

Data Analytics in Smart Cities
Thanks

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