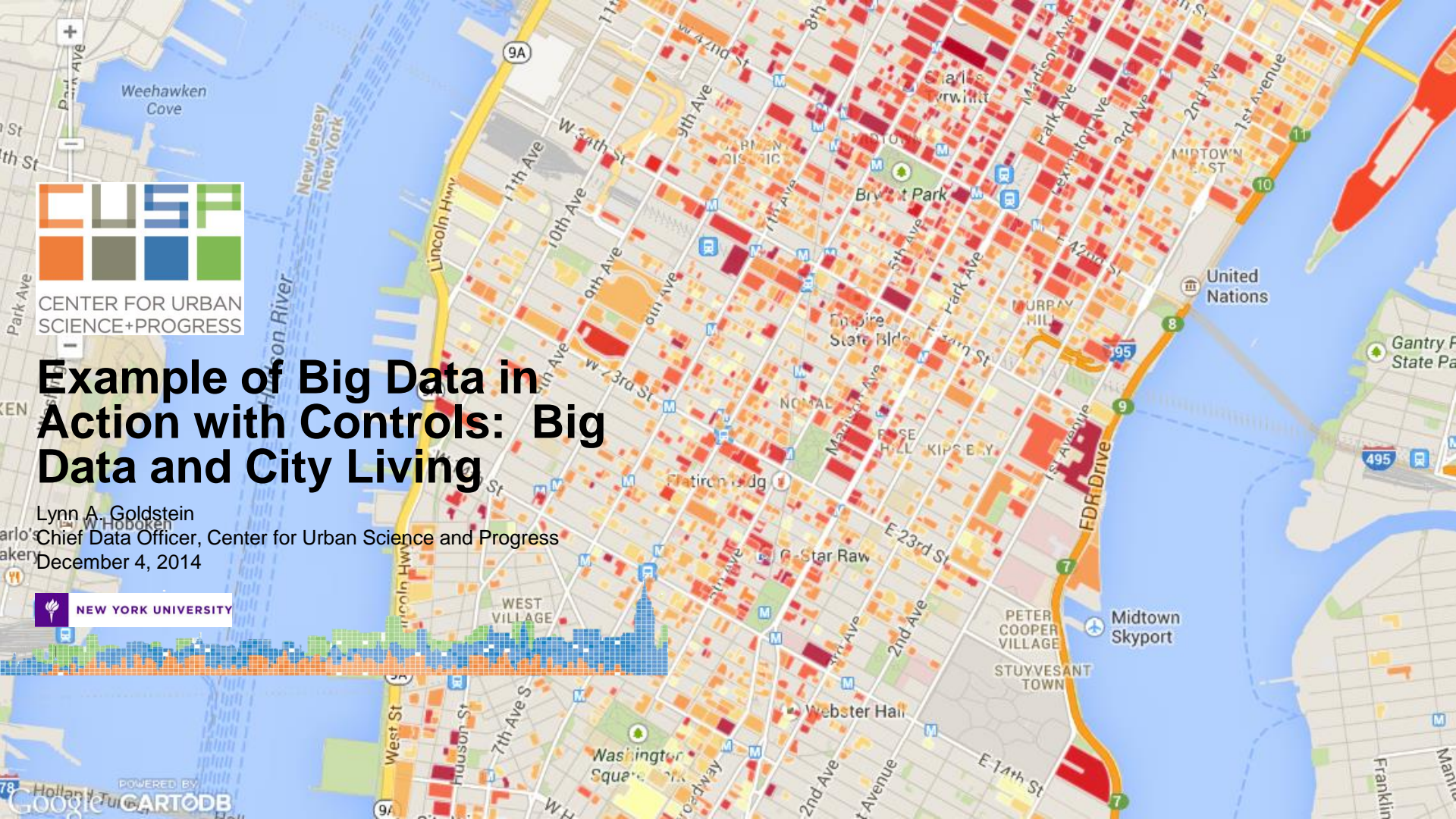




Example of Big Data in Action with Controls: Big Data and City Living

Lynn A. Goldstein
Chief Data Officer, Center for Urban Science and Progress
December 4, 2014



Applied Sciences NYC

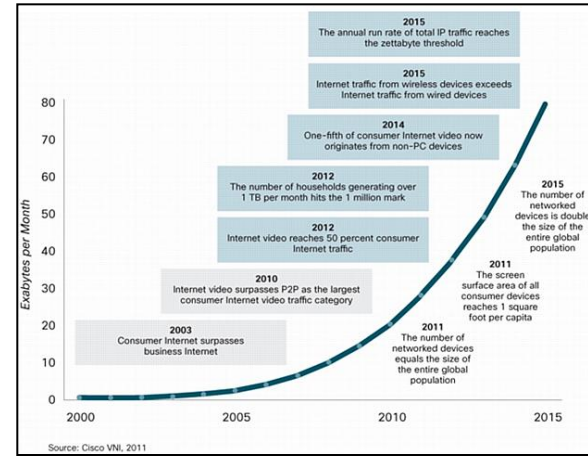
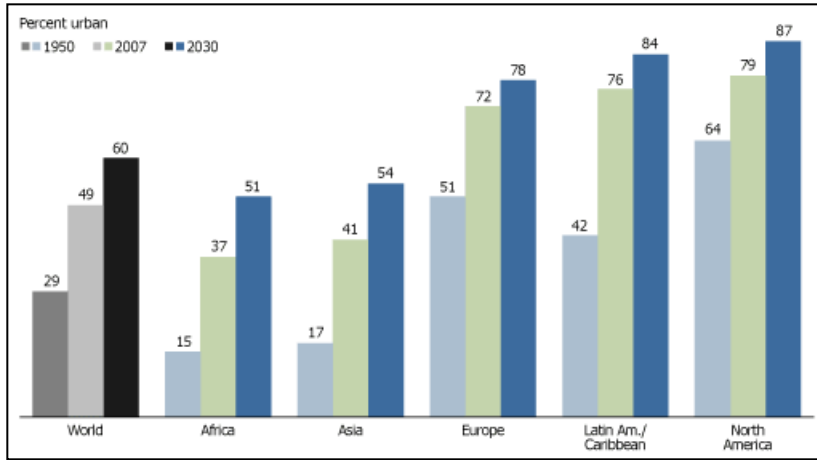
“Applied Sciences NYC is the City’s unparalleled opportunity to build or expand world-class applied sciences and engineering campuses in New York City. We are seeking to dramatically expand our capacity in the applied sciences to maintain our global competitiveness and create jobs. These campuses would not only enrich the City’s existing research capabilities, but also lead to innovative ideas that can be commercialized, catalyzing hundreds of spinoff companies and increasing the probability that the next high growth company – a Google, Amazon, or Facebook – will emerge in New York City.”

New York City Economic Development Corporation

The NYU-led Center for Urban Science and Progress, a multi-sector research and education collaborative, was announced on April 23, 2012.

INVESTING IN INNOVATION
FOR A
STRONGER ECONOMY

Big Cities + Big Data



- The world is urbanizing
- Cities are the loci of consumption, economic activity, and innovation

Cities are the cause of our problems and the source of the solutions

- Global network traffic, 30% CAGR
- Informatics capabilities are exploding
 - Storage, transmission, analysis
- Proliferation of static and mobile sensors
- Internet of things

What can cities do with the data?

- **Optimize operations**
 - traffic flow, utility loads, services delivery, ...
- **Monitor infrastructure conditions**
 - bridges, potholes, leaks, ...
- **Infrastructure planning**
 - zoning, public transit, utilities
- **Improve regulatory compliance** (“nudges”, efficient enforcement)
- **Public health**
 - Nutrition, epidemiology, environmental impacts
- **Abnormal conditions**
 - Hazard detection, emergency management
- **Data-driven formulation of data-driven policies and investments**
 - Low-Income Home Energy Assistance Program, road pricing and congestion charging, ...
- **Better inform the citizenry**
- **Enhance economic performance and competitiveness**

New York City as a Living Lab

The Center for Urban Science and Progress (CUSP) is a unique public-private research center that uses New York City as its laboratory and classroom to help cities around the world become more productive, livable, equitable, and resilient. CUSP observes, analyzes, and models cities to optimize outcomes, prototype new solutions, formalize new tools and processes, and develop new expertise/experts. These activities will make CUSP the world's leading authority in the emerging field of "Urban Informatics."

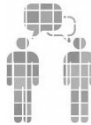


The CUSP Partnership



University Partners

- NYU (*multiple schools*)
- The City University of New York
- Carnegie Mellon University
- University of Toronto (*Canada*)
- University of Warwick (*UK*)
- IIT-Bombay (*India*)



Industrial Partners

- IBM
- Microsoft
- Xerox
- Cisco, Con Edison, Lutron, National Grid, Siemens
- AECOM, Arup, IDEO



National Laboratories

- Brookhaven
- Lawrence Livermore
- Los Alamos
- Sandia

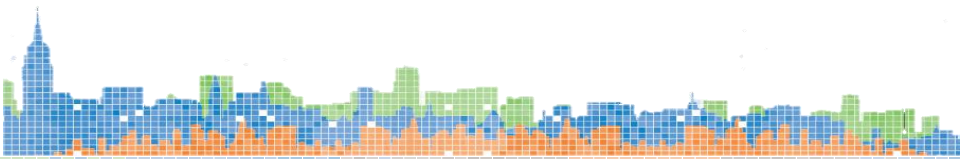


City & State Agency Partners

- The City of New York
 - Buildings
 - City Planning
 - Citywide Administrative Services
 - Design and Construction
 - Economic Development
 - Environmental Protection
 - Finance
 - Fire Department
 - Health and Mental Hygiene
 - Information Technology and Telecommunications
 - Parks and Recreation
 - Police Department
 - Sanitation
 - Transportation
- Metropolitan Transportation Authority
- Port Authority of NY & NJ

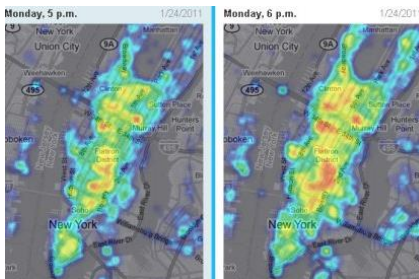
Research

Urban Science & Actionable Insight



Urban Data Sources: Acquire, Integrate, Use

Organic Data Flows



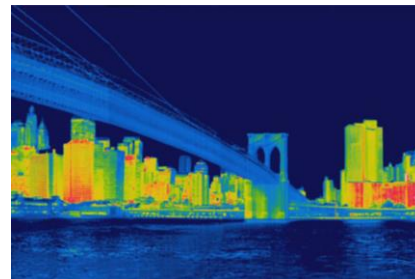
- Administrative records (census, permits, ...)
- Transactions (sales, communications, ...)
- Operational (traffic, transit, utilities, health system, ...)
- Social media (Twitter, Facebook, blogs, ...)

Sensors



- Personal (location, activity, physiological)
- Fixed *in situ* sensors
- Crowd sourcing (mobile phones, ...)
- Choke points (people, vehicles)

Novel Technologies



- Visible, infrared and spectral imagery
- RADAR, LIDAR
- Gravity and magnetic
- Seismic, acoustic
- Ionizing radiation, biological, chemical
- ...

- Buildings
- Sanitation
- Planning
- Parks



- Police
- Fire
- Emergency Management

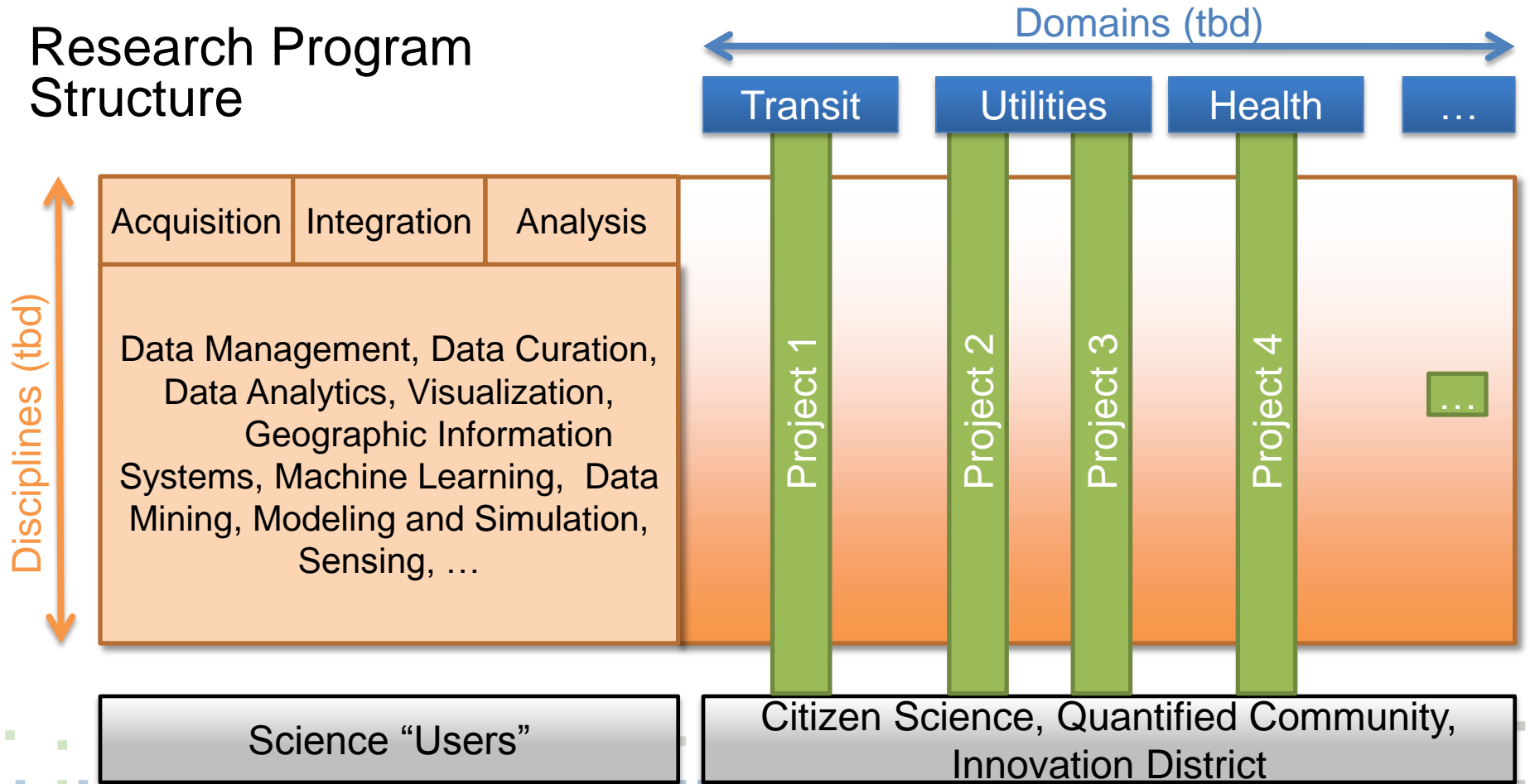
Core City Services Include...



- 311
- Business Assistance
- Quality of Life

- Social Services
- Health
- Education
- Youth

Research Program Structure



Partnership with NYC Agencies

Meeting with NYC Agency Commissioners, 2012 – 2013

- Identify priorities and challenges

3-hour meetings at Agencies 2013 - ongoing

- Establish lines of communication at staff level
- Introduce CUSP
- Better understand agency structure, available data, needs

Agency Collaborators (**bold** indicates meetings that have already occurred)

Department of Buildings

Department of City Planning

Department of Citywide Administrative Services

Department of Design and Construction

Department of Environmental Protection

Department of Finance

Department of Health and Mental Hygiene

Office of Long-Term Planning and Sustainability

Department of Parks and Recreation

Department of Transportation

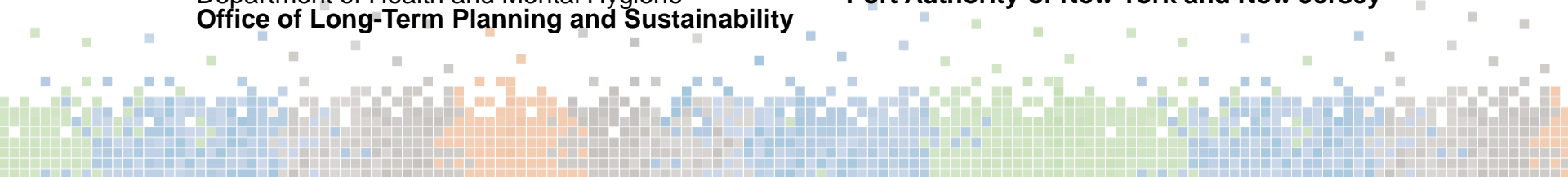
New York City Fire Department

New York City Housing Authority

New York City Police Department

Taxi and Limousine Commission

Port Authority of New York and New Jersey



2013-2014 Research Workshops

COMPLETED

- **Mobile Sensing** (March)
- **Ethical, Legal & Social Implications (ELSI)** (March 2013)
- **Persistent Synoptic Phenomenology** (April 2013)
- **Urban Observatory** (April 2013)
- **Neuroeconomics** (April 2013)
- **Noise** (April 2013)
- **MTA New York City Transit** (April 2013)
- **Building Energy Efficiency** (May 2013)
- **Simulation & Modeling** (May 2013)
- **Citizen Science I** (May 2013)
- **MTA Long Island Railroad** (June 2013)
- **Social Media & Peer Networks** (July 2013)

- **Quantified Community** (July 2013)
- **Citizen Science II** (July 2013)
- **Bio Sensing** (September 2013)
- **Commercialization** (November 2013)
- **Data Warehouse** (February 2014)

UPCOMING

- **MTA Metro North** (May)
- **Citizen Science III** (May)
- **Urban Sustainability**

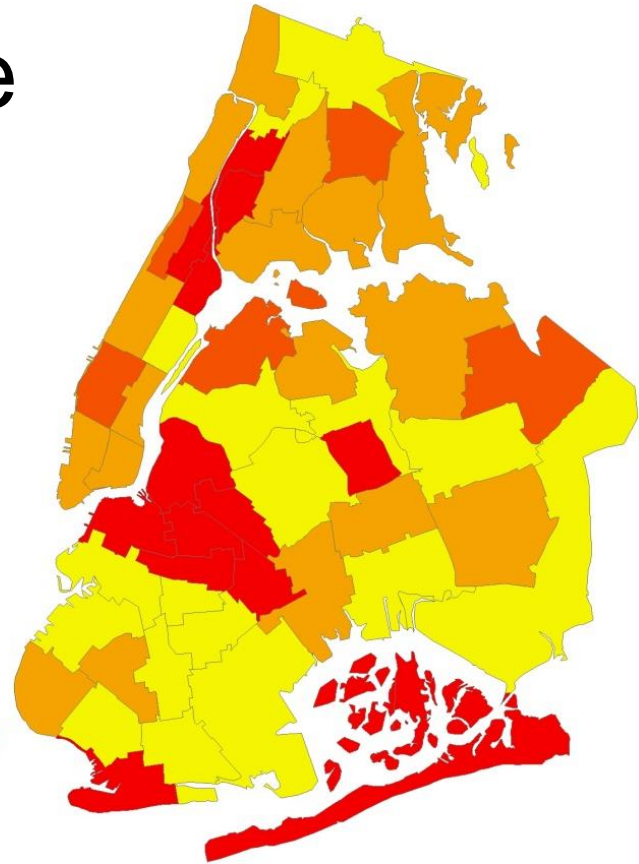
POTENTIAL

- **Data Analysis & Visualization**
- **Urban GIS**

CUSP Infrastructure
Agency-Specific
Major Project

Projects for the City & State

- Economic Mapping
- Greener Greater Buildings Plan
- MTA Bus Driver Optimization
- MTA Origin/Destination Study
- New York City Police Department
- Parks Attendance & Utilization
- Parks Tree Census
- Property Ownership Records Assessment
- Public Health
- School Property Use Assessment
- Taxi Visualization
- Transit Operations
- and more





Analysis of Massive Taxi GPS Data

Overview

- Data from yellow cabs 2009-2013 is almost 800 million trips; nearly impossible to manage, explore, visualize, and analyze with existing tools

Objective & Goal

- Build scalable, usable tools that can be used by experts and non-experts
- Work with relevant city agencies on development & deployment of the technology

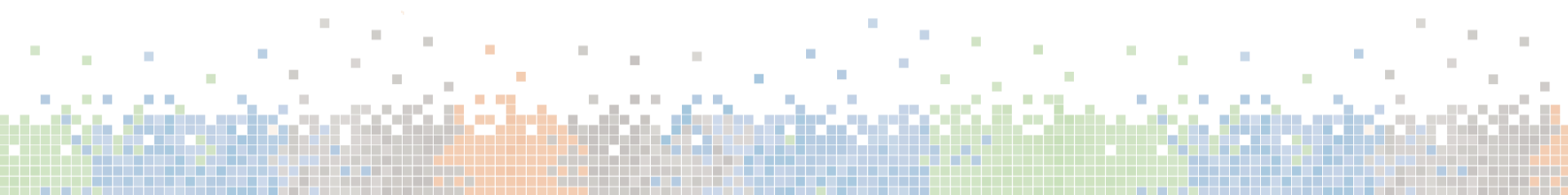
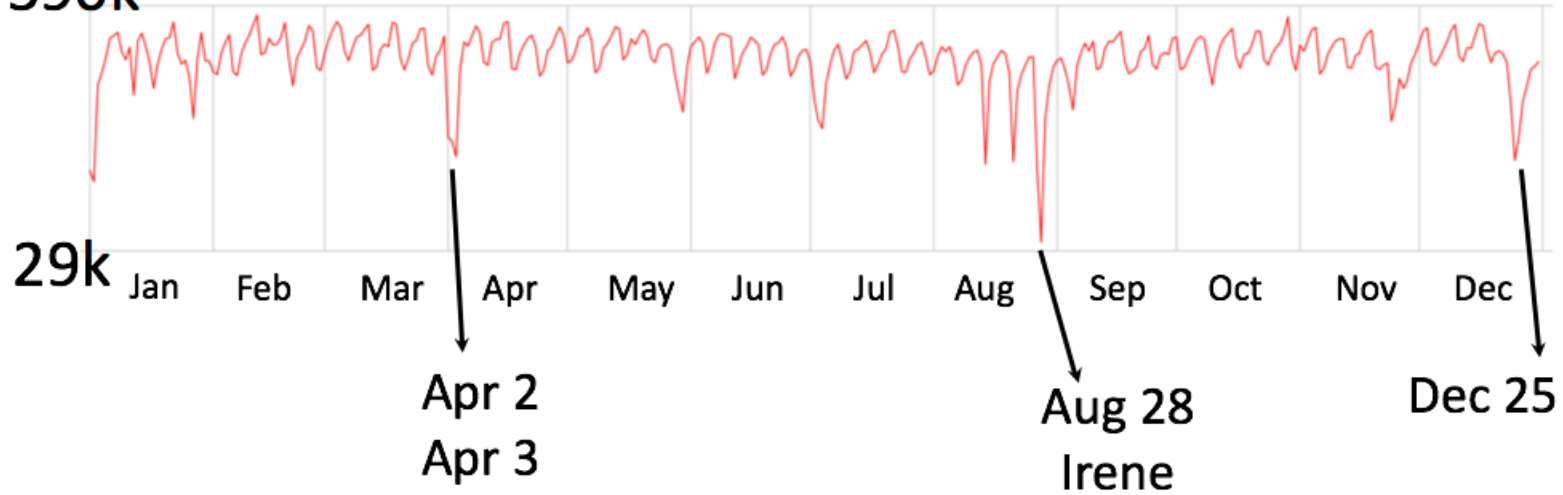
Status

- Initial deployment of TaxiVis at NYC Taxi & Limousine Commission and Department of Transportation

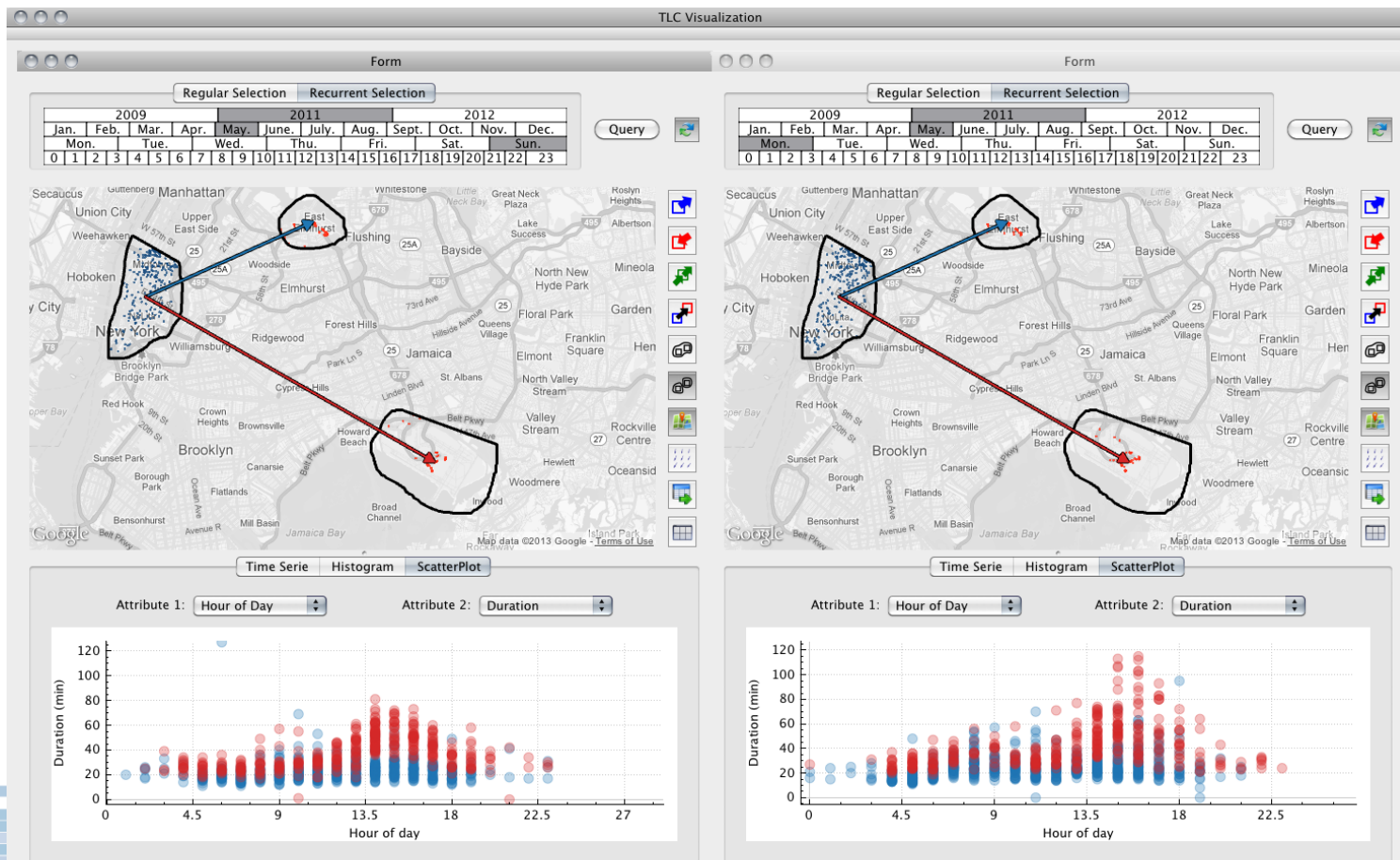
Taxis as City Sensors

NYC Taxi Rides by Day in 2011

590k



TaxiVis: Interactive Visual Exploration of NYC Taxi Records




CUSP Research Facilities

IN EXPANSION

- **CUSP Data Warehouse:** data management & science
- **CUSP Urban Observatory**
- **CUSP Quantified Community**

IN DEVELOPMENT

- **Modeling and Simulation**
 - **Citizen Science:** crowdsourced data and community engagement in urban science
 - **#Social Cities:** urban social media
- 

Data Warehouse Facility

Overview

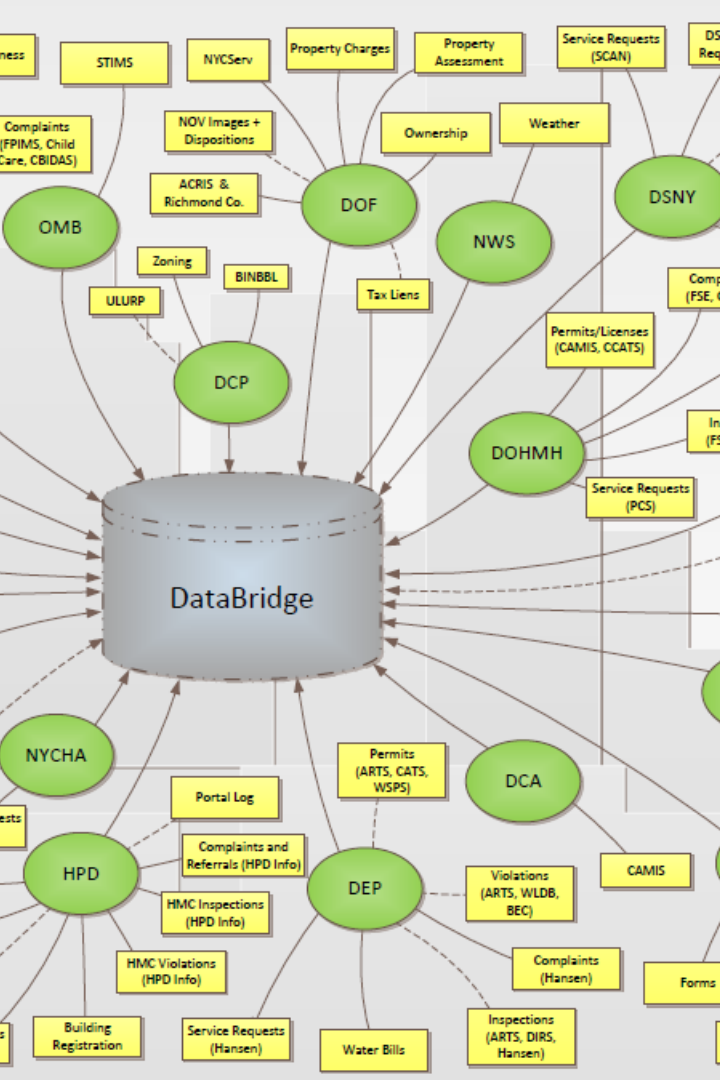
- Omnivorous ingestion to a repository for NYC-related data for urban science and informatics

Objective and Goals

- Make data interoperable, with proper multi-layered access protocols

Data

- Data from City agencies on operations, schedules, maps, etc., including NYC Open Data
- Will include proprietary data, social media data, CUSP-generated data
- Working with the NYC Mayor's Office of Analytics
- CUSP Chief Data Officer will oversee ethical, legal, and social issues



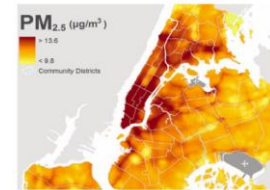
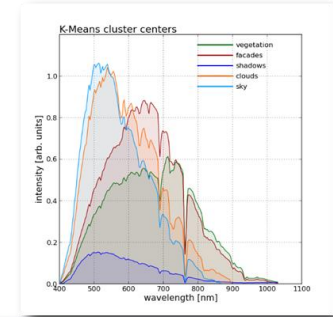
An aerial night view of a city skyline, likely New York City, with a semi-transparent text overlay. The Empire State Building is prominent on the left. The text 'Urban Observatory' is centered in a large, black, sans-serif font. Below it, the subtitle 'PERSISTENT and SYNOPTIC ANALYTICS for URBAN SCIENCE' is displayed in a smaller, black, sans-serif font. The background shows a dense urban landscape with numerous lit-up buildings and streets.

Urban Observatory

PERSISTENT and SYNOPTIC ANALYTICS for URBAN SCIENCE

The CUSP Urban Observatory

- unique user facility for persistent and synoptic observations of cities with detailed analysis
- seek high impact science and applications to enhance public well-being, city operations, and future urban design
- instrumentation to include both broad band and hyper-spectral from visible to infrared wavelengths
- combine correlative data including administrative records, in situ measurements, topography, etc.



Natural Systems
(health of environment)

Human Systems
(patterns and behaviors)

City Lights Project

OBJECTIVES

- Develop a fundamentally new modality for studying the city “from a distance”
- Identify aggregate patterns of light in the time-dependent brightnesses of city lights
- Leverage these patterns into foundational contributions to urban science and urban functioning



IMPACT

Urban Science

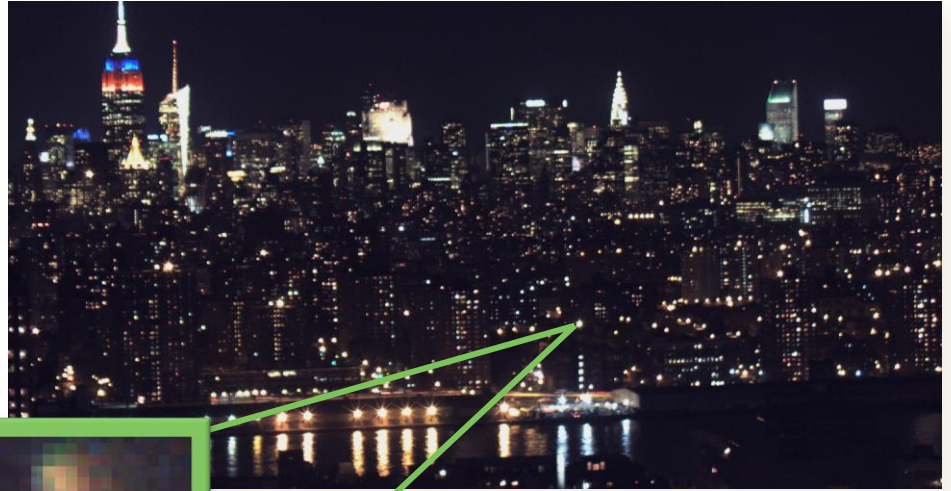
- Determine the underlying drivers of the “pulse of the city”
- Understand the effects of perturbations


City Life

- Monitor energy consumption by proxy using light patterns as a measure of building occupancy
- Evaluate the effects of disturbances (e.g., light/noise pollution) on public health

Privacy Protections

- Institutional Review Board approval of all projects involving non-open data
- Close oversight by CUSP Chief Data Officer, Lynn Goldstein
- Limited # of pixels per window (but atmosphere/instrument effects typically dominate)
- Aggregate and de-identified analysis only



An aerial photograph of Lower Manhattan, New York City, showing a dense cluster of skyscrapers and buildings along the waterfront. The water in the foreground is dark blue, with several boats and a white wake visible. A semi-transparent white horizontal band is overlaid across the middle of the image, containing the title and subtitle text.

Quantified Community

PERSISTENT and SYNOPTIC ANALYTICS for URBAN SCIENCE

Quantified Community Overview



- A fully instrumented urban neighborhood that uses an **integrated, expandable sensor network and citizen engagement** to support the measurement, integration, and analysis of neighborhood conditions.
- Through an **informatics overlay**, data on physical and environmental conditions and use patterns will be processed in real-time to **maximize operational efficiencies, improve quality of life for residents and visitors, and drive evidence-based planning.**

What will the CUSP Quantified Community measure?

Infrastructure

Solid waste, storm-water management, power generation/distribution

Safety and Security

Network Security, Situational Awareness, Emergency Management Integration, Event Forecasting

Environment

carbon emissions; air pollution and particulates; noise; climate

Buildings

Resource consumption; indoor air quality; productivity, health measures

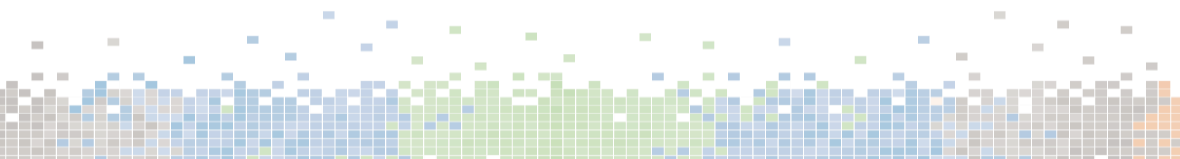
People

Behavior; mobility; health; activity; social networks, metagenomics



CUSP-Initiated Projects

- Building Informatics
- Sound
- City Lights
- Transportation Research
- Etc.



Building Informatics Program

Objectives & Goals

- Understand and model patterns and flows of energy use and carbon emissions within and across cities, across spatial and temporal scales
- Study the relationship between the urban built environment, urban development, and resource efficiency, particularly focusing on issues of socioeconomic and demographic disparities
- Provide policymakers, community organizations, and the real estate community with actionable insight to support strategies to reduce resource consumption and carbon emission in cities

Data

Currently hold one of the largest databases of heterogeneous, non-self-selected building energy and water and building attribute data available, sources include:

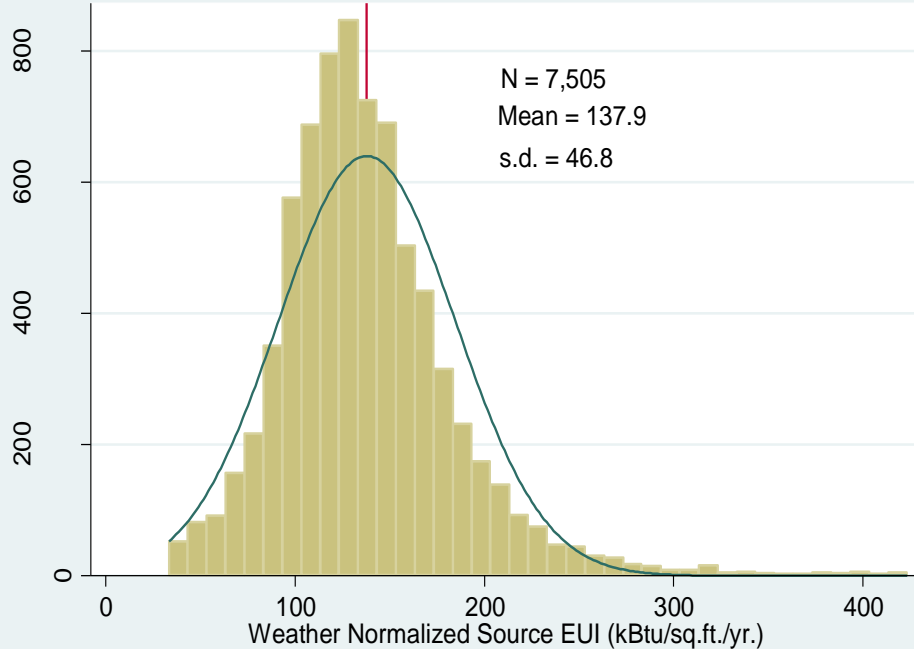
- NYC Local Law 84 – approx 20,000 buildings over three years
- Urban Land Institute – approx. 6,000 buildings across 46 cities over five years



Building Energy Efficiency (NYC Local Law 84)

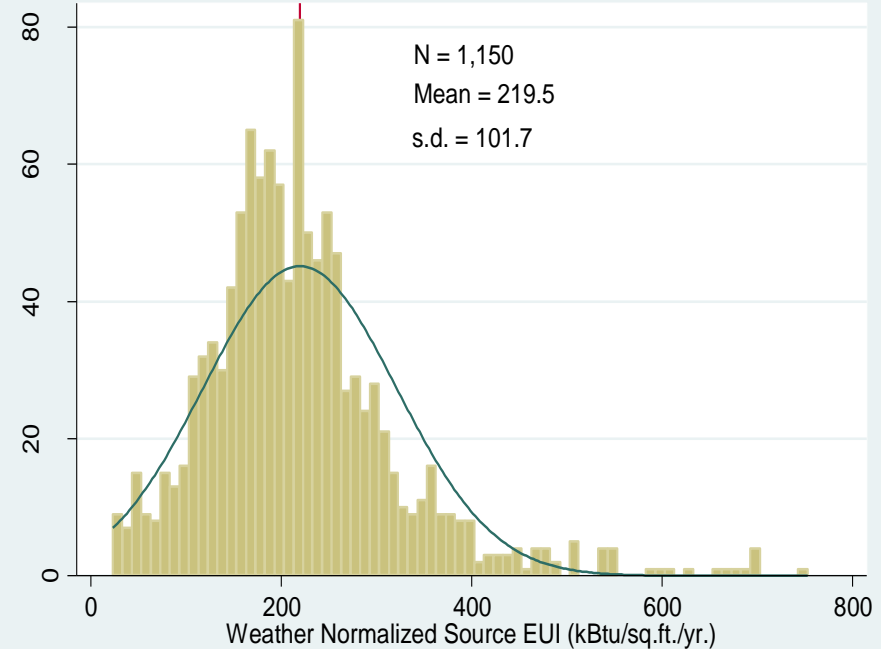
Source Energy Use Intensity, Multi-Family Buildings, New York City

Source: Local Law 84 Energy Disclosure Data, Kontokosta 2013



Source Energy Use Intensity, Office Buildings, New York City

Source: Local Law 84 Disclosure Data, Kontokosta 2013



Source: Kontokosta 2013

Sound Project

Overview

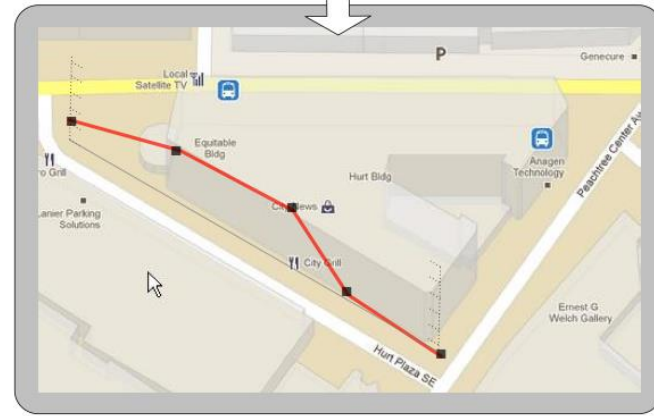
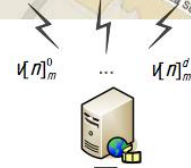
- Noise the biggest 311 complaint
- Significant public health issue
- Noise code enforcement is difficult

Objective and Goals

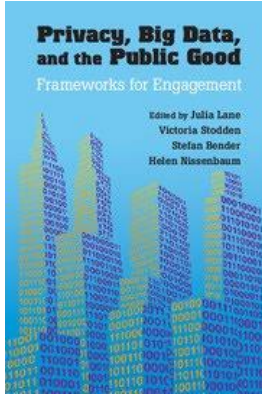
- Characterize the “soundscape” of the City
- Inform policy makers
- Build an archive of sound around the city that can be used for research

Project Plan: initial phases underway

- Audio measurements throughout the City via phones or fixed microphones
- Panel on ethical, legal, and social implications will be convened and led by CUSP Chief Data Officer



Privacy, Big Data, and the Public Good: Frameworks for Engagement



The book will identify ways in which vast new sets of data on human beings can be collected, integrated, and analyzed to improve urban systems and quality of life while protecting confidentiality. Sponsored by CUSP, the American Statistical Association, its Privacy and Confidentiality subcommittee, and the Research Data Centre of the German Federal Employment Agency.

Editors: Julia Lane, American Institutes for Research; Victoria Stodden, Columbia; Stefan Bender, The German Federal Employment Agency; Helen Nissenbaum, NYU

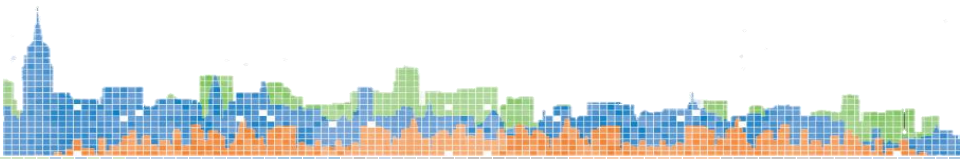
Chapter Authors

Steve Koonin, CUSP; Frauke Kreuter, U-MD and Richard Peng, Johns Hopkins; Alessandro Acquisti, Carnegie Mellon University; Robert Goerge, UChicago; Helen Nissenbaum, NYU; Kathy Strandberg, NYU; Paul Ohm, Colorado; Victoria Stodden, Columbia; Alan Karr, National Institute of Statistical Sciences and Jerry Reiter, Duke University; John Wilbanks, Sage Bionetworks/Kauffman Foundation; Cynthia Dwork, Microsoft; Alexander Pentland, et al., MIT; Carl Landwehr, George Washington University; Peter Elias, University of Warwick



CENTER FOR URBAN
SCIENCE+PROGRESS

Education Urban Science & Informatics




CUSP Educational Programs

Train professionals who will understand how cities function and the potential of urban informatics.

CURRENT

- Master of Science in Applied Urban Science & Informatics
- Advanced Certificate in Applied Urban Science & Informatics
- Executive education, “Boot Camps” for City and other professionals

FUTURE

- PhD in Urban Informatics
 - Global Executive M.S. in Urban Analytics and Innovation
 - Dual/joint degrees (NYU & Academic Partners)
 - Distance and online learning modules
- 

M.S. in Applied Urban Science and Informatics

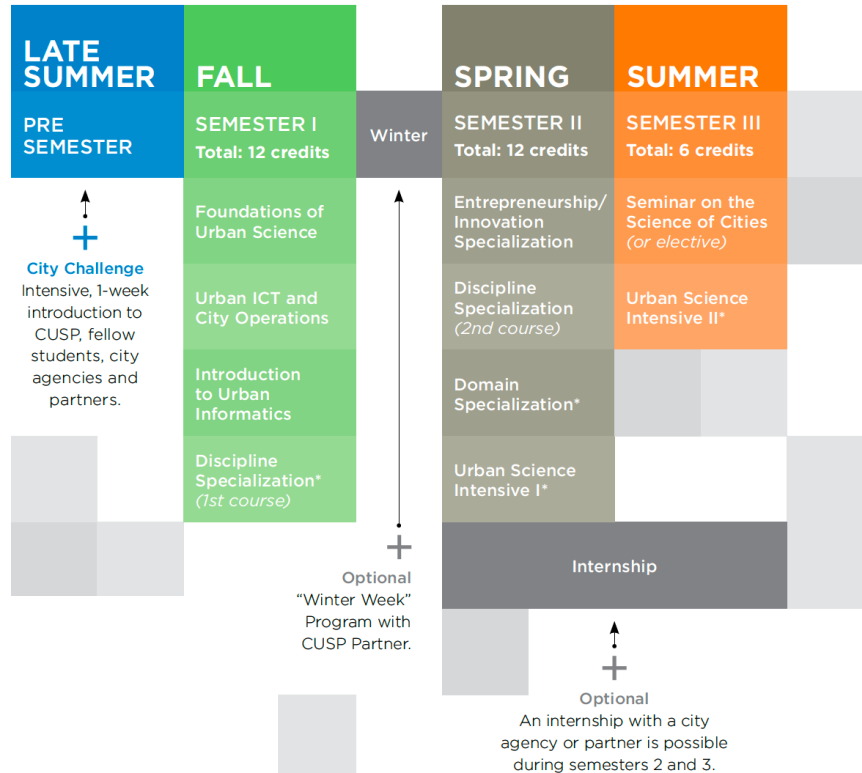
CURRICULUM (1 YEAR) →

DEGREE
Master of Science

LENGTH
One Year, 3-semester
(Full-time)

CLASS SIZE
23 / 1

TERM
August - July



Admissions Summary, Class of 2014

Cycle Dates: December 18, 2012 through June 30, 2013 (~6months)

24

Inaugural Class
(including 1 Adv. Cert.)

21%

Selectivity

27

Years
Average Age

36%

Female

3.5

Average Undergraduate GPA



20

Undergraduate Disciplines

48%

International

9

Countries Represented

4

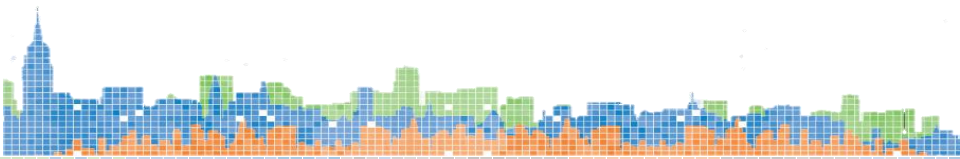
Years Average
Work Experience

28%

With Graduate Degree

In 5-10 years,
CUSP will be a
major center for
research and
education in Urban
Informatics

- Defined practice of Urban Science and Informatics
- Projects that impact the City and its Citizens
- New tools for the social sciences
- Global Reach
- 50 senior researchers, 30 Postdocs, ~500 students (M.S., PhD, Certificate)
- Several hundred new experts trained
- Commercialization and new services development





CENTER FOR URBAN
SCIENCE+PROGRESS

THANK YOU

lynn.goldstein@nyu.edu

cusp.nyu.edu

*Privacy, Big Data, and
the Public Good:
Frameworks For Engagement*

**Join us on June 16, 2014 in New
York City for a preview event**

<http://www.dataprivacybook.org/>

[http://cusp.nyu.edu/event-
registration/?ee=44](http://cusp.nyu.edu/event-registration/?ee=44)

