




# Integrating Multi-Source Big Data to Sense Urban Dynamics

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CONTENTS

- 1/ **Big Geo-data: Definition and Examples**
- 2/ **Social Sensing: From Human Behavior Patterns to Geographical Characteristics**
- 3/ **Sensing Urban Diversity and Dynamics**
- 4/ **Concluding Remarks**

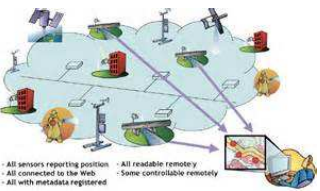
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## 1. Big Data


- With the development of ICT, we have entered the **BIG DATA** era




Mobile Devices



Sensor web




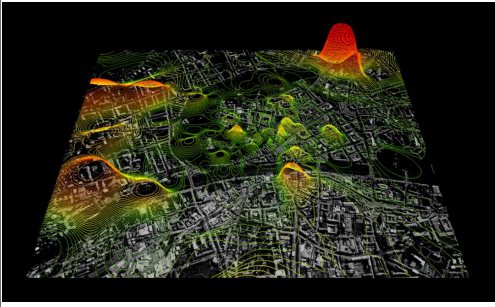
GPS-enabled vehicles

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## Big Geo-Data

- Properties of Big Geo-Data
  - Besides 4Vs (Volume, Velocity, Variety, Variability)
    - Spatio-temporal tags
    - Associated with individuals
  - Including:
    - Location based social media data, Mobile phone data, Taxi data, Metra card data...


 **北京大学** / **Examples of Big Geo-data (1)**




Population distribution: estimated using mobile phone data





PRE-SANDY CHECK-INS SATURDAY, 10/27      POST-SANDY CHECK-INS WEDNESDAY, 10/31



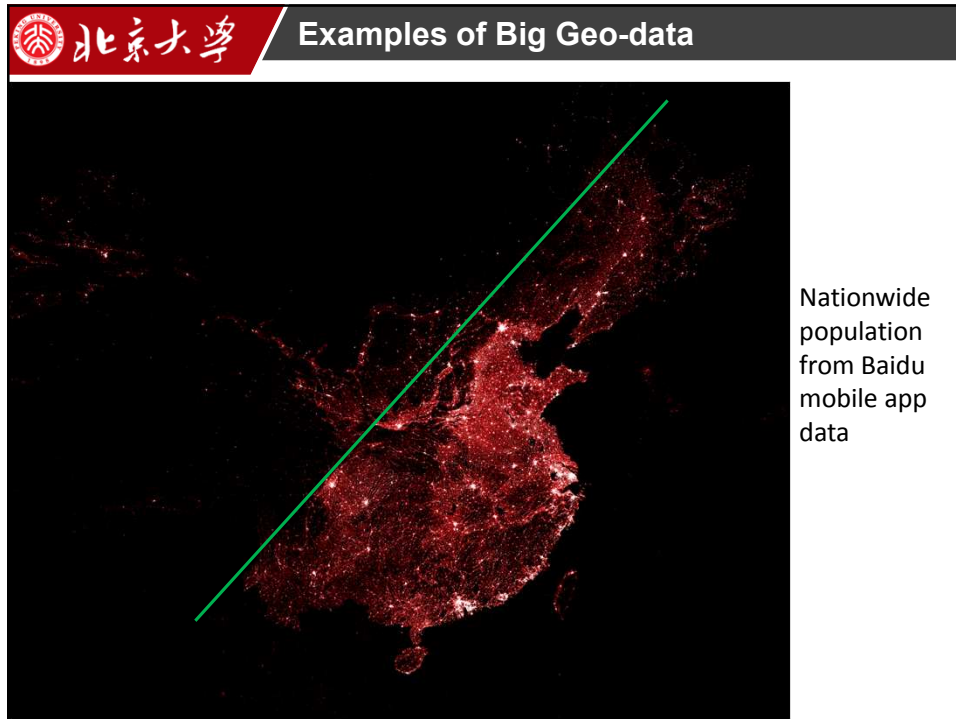


Population distribution before and after Hurricane Sandy: estimated using Foursquare check-in data

 **北京大学** / **Examples of Big Geo-data**

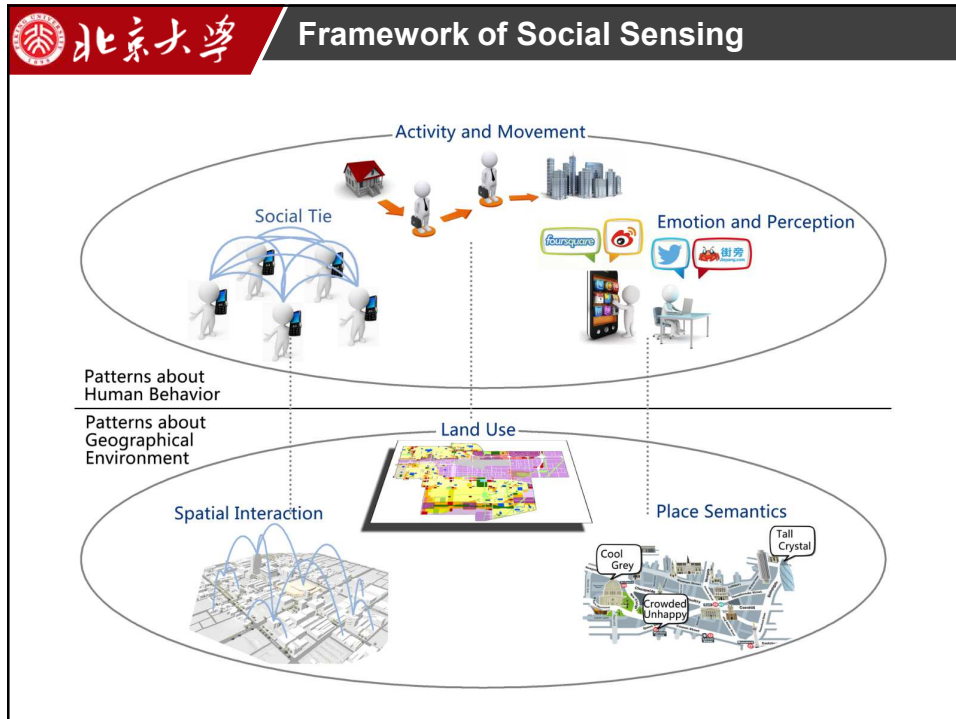



Taxi data of NYC



2. Social Sensing

- Individual-based geospatial big data can be viewed as an analogue of remote sensing data in social science research
- While **remote sensing** data have been widely and successfully used to map physical features, social sensing data can capture human behaviors and consequently reveal socio-economic features
- Why the term “Sensing”
  - Analogue of remote sensing
  - Each individual plays the role of a sensor




 北京大學 **3. Urban Diversity and Dynamics**

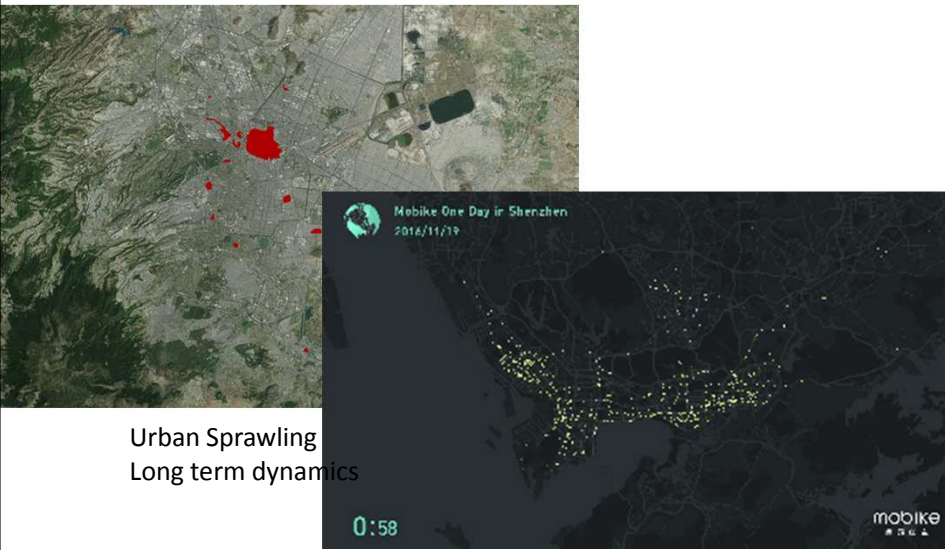
- Landscape diversity and dynamics are two most attractive properties of cities.
  - Diversity of physical landscape + Diversity of human landscape
  - Dynamics of physical features + Dynamics of human features
    - Urban land use sprawl vs. Commute of urban residents
- Understanding urban diversity and dynamics, from both physical and human aspects, is essential to smart cities.
- Multi source big geo-data provide an unprecedented opportunity to observe and measure urban diversity and dynamics
- →and thus, well support constructing smart cities.



 **北京大学** / An Ant Tribe Village in Beijing



 **北京大学** / Urban Dynamics



Urban Sprawling  
Long term dynamics

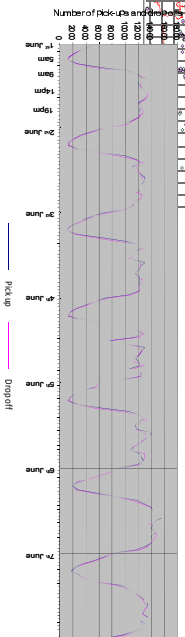
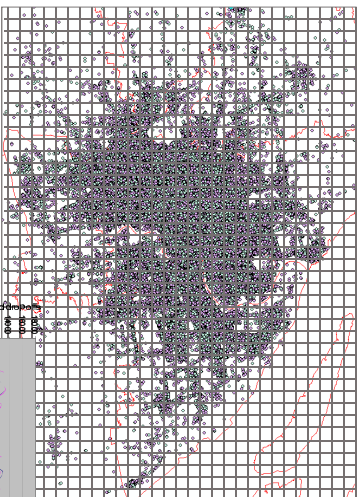
Mobike One Day in Shenzhen  
2016/11/19  
0:58  
mobike

Intra-urban movement  
Short term dynamics



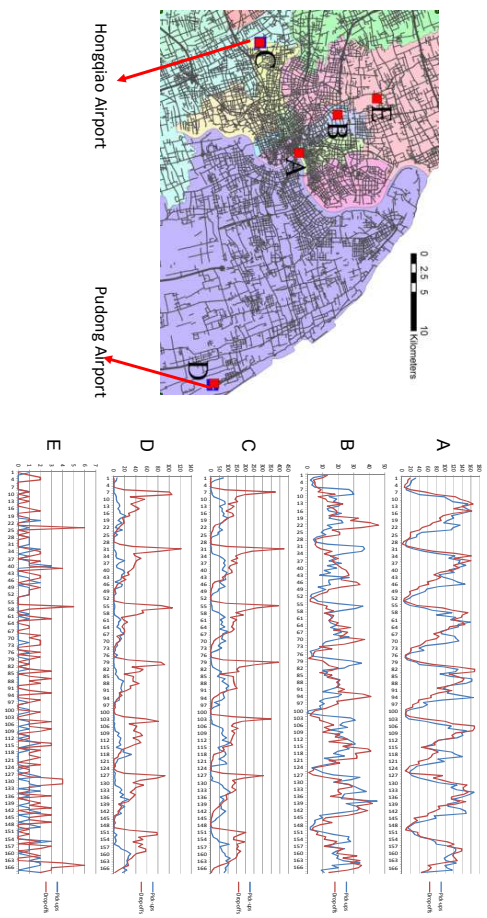
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### Temporal Rhythm of Shanghai Taxi Trips



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### Local Temporal Signatures



**北京大学** Linking Temporal Signatures with Land Uses

Given that different urban land uses are associated with different temporal signatures of human activities, which can be captured by various big geo-data, we can infer land use categories from the observed temporal signatures.

**A 居住区**

**B 办公区**

**C 商业区**

**北京大学** Case study: Shanghai

(a)

(b)

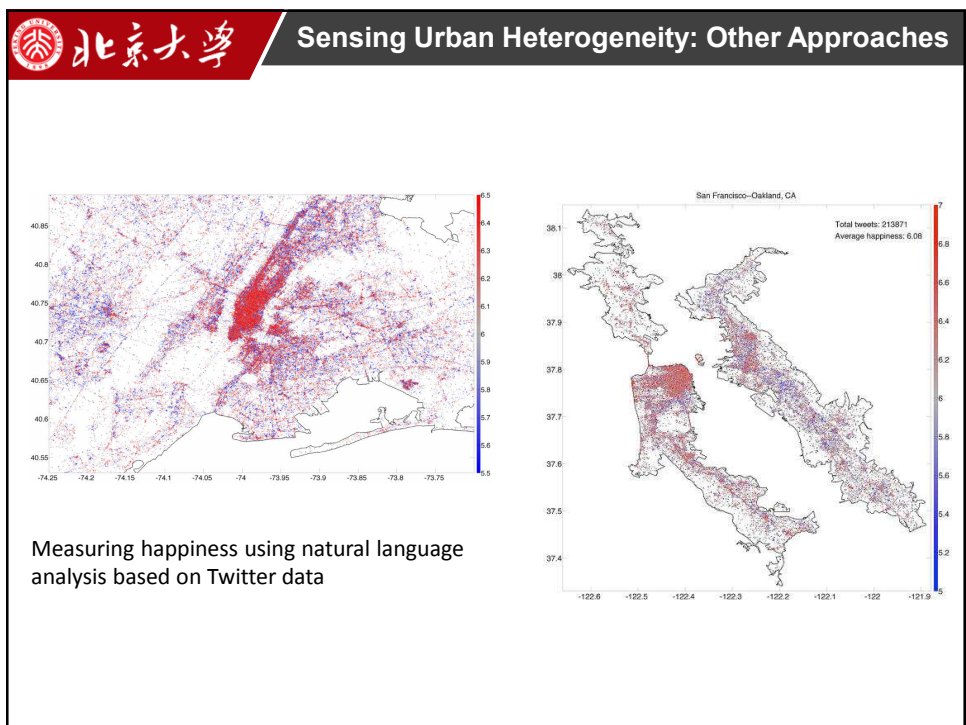
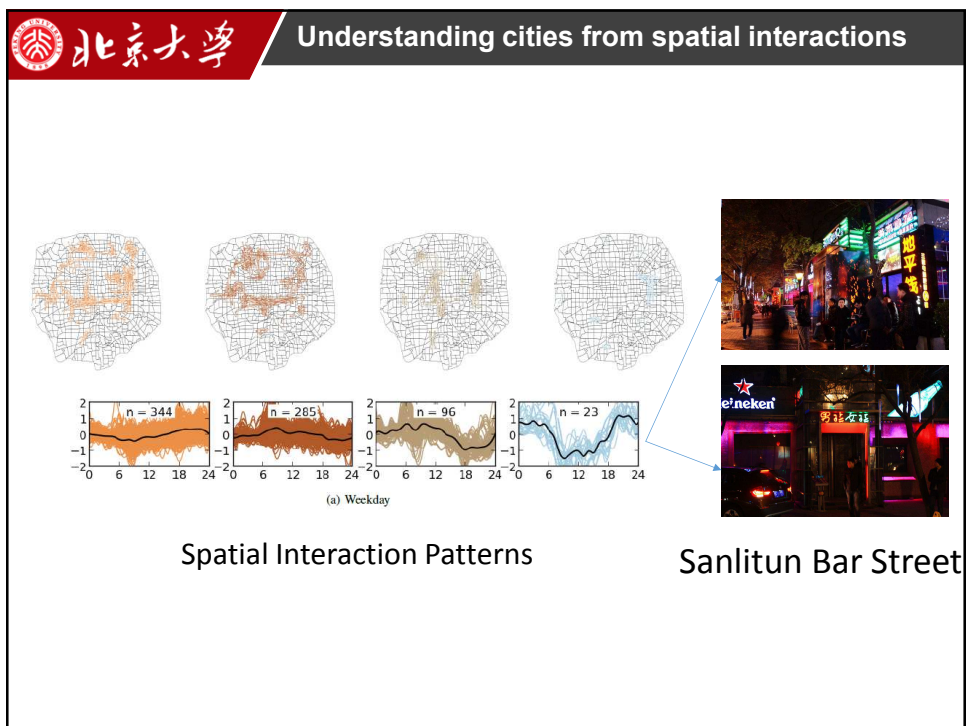
**混合度**

- 0.00 - .27
- .27 - .70
- .70 - .90
- .90 - 1.02
- 1.02 - 1.11
- 1.11 - 1.19
- 1.19 - 1.25
- 1.25 - 1.29
- 1.29 - 1.33
- 1.33 - 1.38

0 1.5 3 6 9 12 km

Reveal the concentric ring urban structure from taxi data and social media data, using unsupervised classification





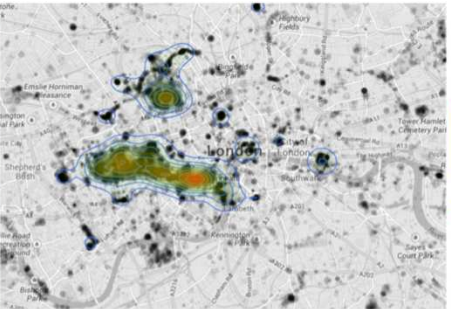


 **北京大学** Sensing Urban Heterogeneity: Other Approaches

			
"little girl is eating piece of cake."	"baseball player is throwing ball in game."	"woman is holding bunch of bananas."	"black cat is sitting on top of suitcase."
			
"a young boy is holding a baseball bat."	"a cat is sitting on a couch with a remote control."	"a woman holding a teddy bear in front of a mirror."	"a horse is standing in the middle of a road."


**Image content Analysis**

 **北京大学** Sensing Urban Heterogeneity: Other Approaches

level  
800  
600  
400  
200

47886 Vars  
0.5  
1.0



**Measuring greenness using crowdsourcing images**

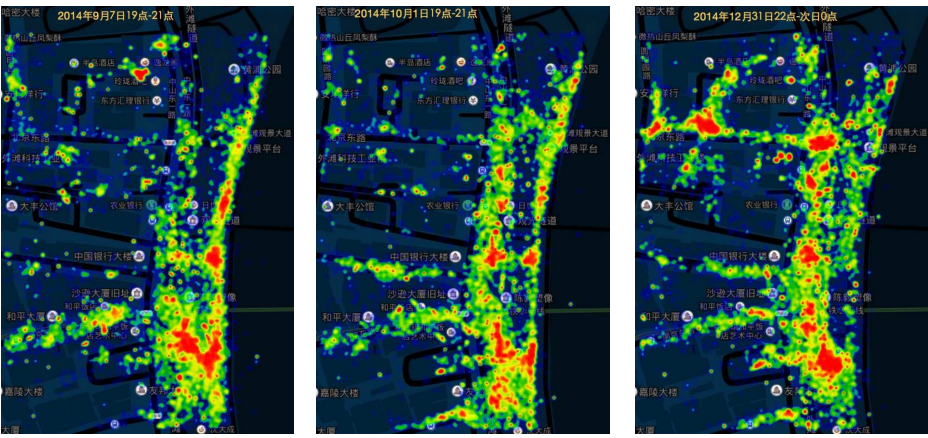
**北京大學** Applications: 2014 Shanghai Stampede



On December 31, 2014, a deadly stampede occurred in Shanghai, on the Bund (Waitan), where around 300,000 people had gathered for the new year celebration. 36 people were killed and there were 49 injured,

**北京大學** Applications: 2014 Shanghai Stampede

Population distributions in three periods



Sep. 7th                      Oct. 1st                      Dec. 31<sup>st</sup>



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Applications: Under-occupied Property



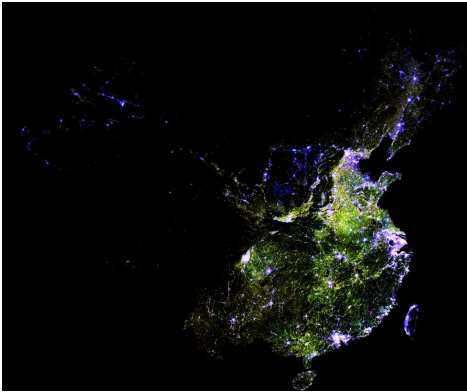
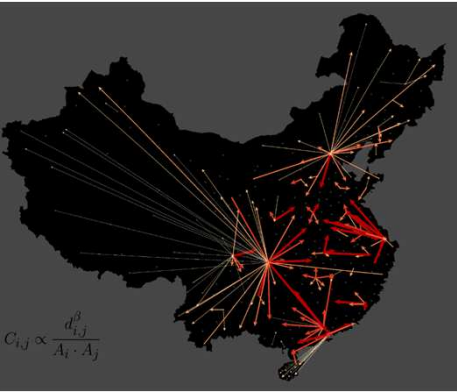
**MIT Technology Review**

Emerging Technology Photo by arXiv  
January 5, 2016

**Best of 2015: Data Mining Reveals the Extent of China's Ghost Cities**



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Applications: Nationwide Migration

Using the individuals' location data that cover the spring festival, we can compare the spatial distributions in two periods (before and during the holiday) and identify labor export areas (such as Henan and Hunan) and labor import areas (such as Shanghai and Shenzhen)



- **Multi-source big geo-data provide an unprecedented opportunity to capture large volumes of individuals' behavior patterns.**
- **With regard to the spatial diversity and dynamics of cities, big geo-data can reveal both from human and geographical perspectives.**
- **Big geo-data (or social sensing data) will become an important component of geo-spatial information infrastructure, and are essential to the construction of smart cities.**



**Thanks. Comments?**