BIG-DATA AND URBAN METABOLISM

Cases in China

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About Us

BEIJING TSINGHUA TONGHENG URBAN PLANNING & DESIGN INSTITUTE

Large State-owned Planning and Design institute

- In 1993, Beijing Tsinghua Urban Planning and Design Institute was established, attached to Tsinghua University.
- In Aug. 2012, from the ownership by the whole people to limited liability company, the overall company transferred to Tsinghua Holdings, officially renamed Beijing Tsinghua Tongheng Urban Planning and Design Institute.
- In Mar. 2013, Tsinghua Tongheng and several companies have undergone strategic reorganization, integrated into Tsinghua Holdings Human Settlement Group.
- The only company in industrial groups of Tsinghua University specialized in research and practice on urban planning and design.

comprehensive solution to whole industry chain and Cross-disciplinary collaboration

Tsinghua Tongheng provides comprehensive technical service of whole industry chain from strategy, planning and design to implementation and operation, and forms servic mode of cross-disciplinary collaboration covering town and country planning, landscape architecture, architectural design, municipal traffic as well as science and technolog media. Combining advanced concept and technology support with local characteristics, Tsinghua Tongheng offers customized service to government at all levels, such a national ministry, province, municipality, county (district and city), street, town and village, provincial and municipal departments, and park management committee as well a large enterprises (urban construction investment and operation company, and industrial operation company, etc.)

- Class A qualification in town and country planning
- Class A qualification in national tourism planning and design
- Class A qualification in survey and design on cultural relic protection project
- Class A qualification in special design on landscape architecture
- Class A qualification in construction industry (architecture)
- Class B qualification in land planning
- Certified by ISO9001:2008 quality management system.

Transforming planning, design and research results into the driving force to supporting urban and rural development, Tsinghua Tongheng persists on paying back through planning and technology, and actively devotes to public welfare, volunteering to take on industrial mission and social responsibility.

Innovation Center for Technology

Established by Tsinghua Tongheng Planning and Design Institute in 2014

- The first department in domestic planning and design companies to set up Big Data R&D department
- Rooted in profound academic accumulation of Tsinghua University, and Tsinghua Tongheng's deep understanding of city, utilizing multi-source data to develop urban innovative think tank business
- Provide emerging service model and technique product in the field of urban planning and management
- ~50 professionals from multiple displines

Tsinghua Tongheng Urban Planning & Design Institute
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Innovation Center for Technology
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北京清华同衡规划设计研究院
BEIJING TSINGHUA TONGHENG URBAN PLANNING & DESIGN INSTITUTE

About Us

Core Businesses

Providing chains of solutions for urban planning, operation, management and services in the context of big data.

Big Data Consulting

Planning and design such as smart city, smart urban management and smart scenic spots;
Consultation service such as population, industry, transportation, housing and urban governance.

Urban Monitoring

Fine monitoring on urban operation condition based on data, including urban facility, career, residence and travel.

Policy Implementation Evaluation

Sophisticated index system, advanced model algorithm, as well as intuitive visual platform, providing a scientific evaluation on policy implementation

Data Fusion Analysis

Possessing practical ability of multidimensional urban data analysis, including population, transportation, industry, facility and housing.

Urban Dynamic Diagnosis

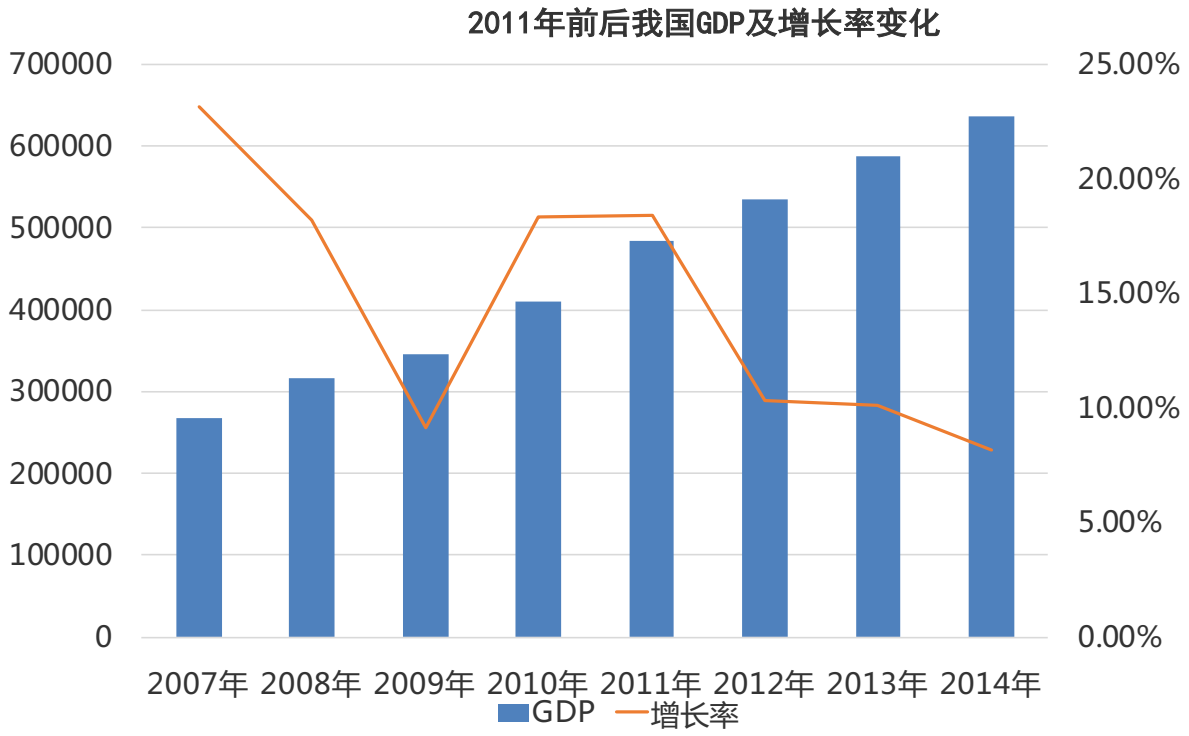
Integrating real-time data and professional urban spatial analysis method, making dynamic and comprehensive analysis on urban problems.

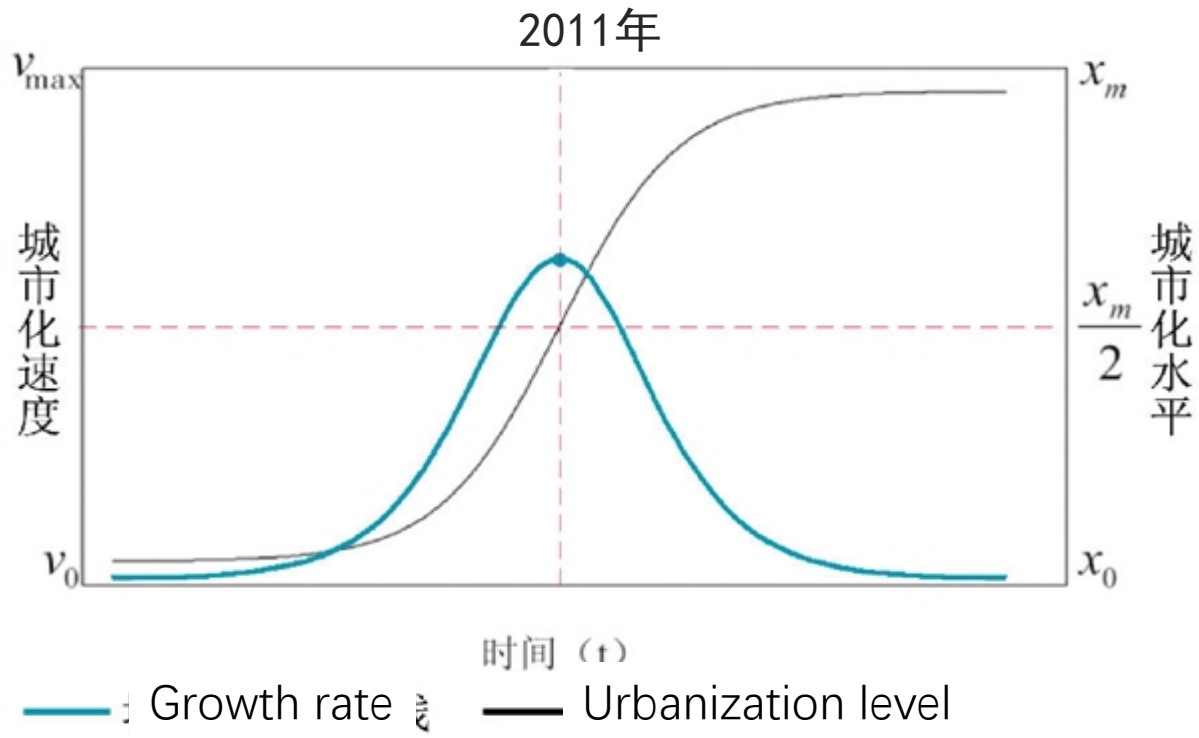
Big Data Platform for Cities

Multiple systems and platforms, such as industrial operation, population evaluation, traffic operation and decision-making support.

Social-economic and urbanization trends in China

- Decreasing growth rates of economy and urbanization since 2011





Forwarding a better city life

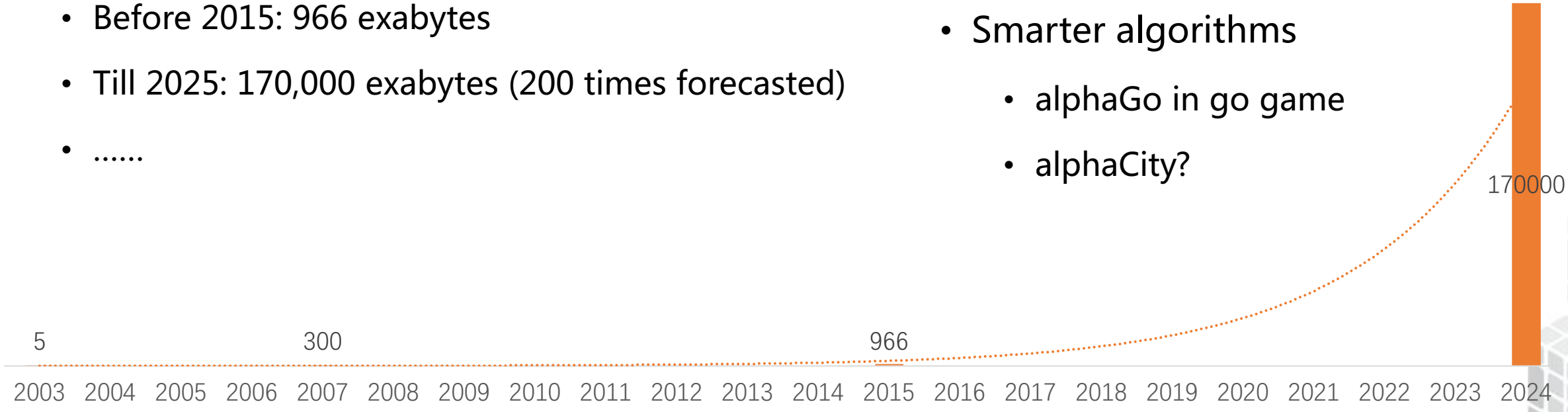
From urban sprawls to urban quality: Traffic congestion, housing difficulties, environmental degradation, resource constraints and so on "big city disorders" is becoming more and more serious

From simple growth to a more balanced one

A starting big-data era: data, computing and algorithms

- More than 3 billion people and 170 billion devices are connected to the net
  - The total amount of data before 2003: 5 exabytes
  - Before 2007: 300 exabytes
  - Before 2015: 966 exabytes
  - Till 2025: 170,000 exabytes (200 times forecasted)
  - ……

- Powerful devices / computing capability
  - Mobile phones now vs. PCs 10 years ago
  - cloud computing
- Smarter algorithms
  - alphaGo in go game
  - alphaCity?



Big-data analytics matters in urban governance

Higher frequency, finer granularity and richer property

- In terms of time, space, subject, attribute, relationships and so on

New-type data

手机信令　企业注册信息　互联网房价　互联网 LBS　健身APP　大众点评　携程网　POI设施　……

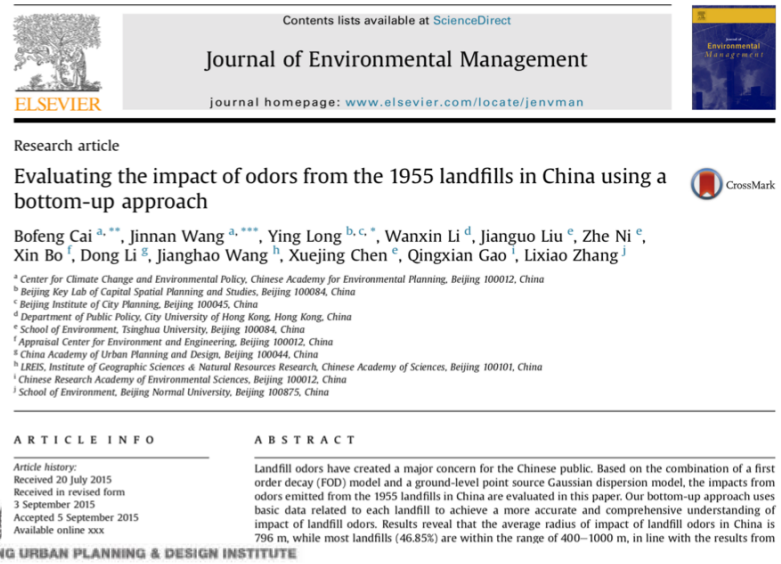
一卡通　滴滴出行　摩拜单车数据　路网矢量　出租车GPS

Traditional data

统计数据　普查数据　抽样数据　调查数据　……

Case 1: Landfills and social media

Landfill odors have created a major concern for the Chinese public. Based on the combination of a first order decay (FOD) model and a ground-level point source Gaussian dispersion model, the impacts from **odors** emitted from the 1955 landfills in China are evaluated in this paper. Our bottom-up approach uses basic data related to each landfill to achieve a more accurate and comprehensive understanding of impact of landfill odors. Results reveal that the average radius of impact of landfill odors in China is 796 m, while most landfills (46.85%) are within the range of 400~1000 m, in line with the results from previous studies. The total land area impacted by odors has reached 837,476 ha, accounting for 0.09% of China's land territory. Guangdong and Sichuan provinces have the largest land areas impacted by odors, while Tibet Autonomous Region and Tianjin Municipality have the smallest. According to the **CALPUFF** (California Puff) model and an analysis of **social big data**, the overall uncertainty of our calculation of the range of odor impacts is roughly 32.88% to 32.67%. This type of study is essential for gaining an accurate and detailed estimation of the affected human population and will prove valuable for addressing the current **Not In My Back Yard (NIMBY)** challenge in China.



Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Evaluating the impact of odors from the 1955 landfills in China using a bottom-up approach

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ARTICLE INFO

Article history:
Received 20 July 2015
Received in revised form
3 September 2015
Accepted 5 September 2015
Available online xxx

ABSTRACT

Landfill odors have created a major concern for the Chinese public. Based on the combination of a first order decay (FOD) model and a ground-level point source Gaussian dispersion model, the impacts from odors emitted from the 1955 landfills in China are evaluated in this paper. Our bottom-up approach uses basic data related to each landfill to achieve a more accurate and comprehensive understanding of impact of landfill odors. Results reveal that the average radius of impact of landfill odors in China is 796 m, while most landfills (46.85%) are within the range of 400–1000 m, in line with the results from

中国垃圾填埋场恶臭影响人口和人群活动研究*

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摘要: 恶臭是垃圾填埋场邻避效应的主要原因。解决垃圾填埋场邻避问题的基础性工作是较全面和准确地评估受其恶臭影响的人口和人群活动。利用 LandScan 1 km 人口空间数据、单位机构点源 GIS 数据和微博大数据等,基于中国每个垃圾填埋场基础信息和恶臭影响范围,以"自下而上"的研究模式较彻底地评估了中国受垃圾填埋场恶臭影响的人口、敏感单位和人群活动。研究结论表明: 受影响人口为 1 227.52 万人,占全国总人口的 0.90%,其中儿童 164 万,老人 100 万,即敏感人群(儿童+老人)人口总数达到 264 万。广东、湖南、四川受恶臭影响人口最多,天津、海南、西藏受恶臭影响人口最少。受影响敏感单位共计 7 818 个,其中学校 3 143 个,医院 4 675 个。研究特色在于保证了微观层面数据的准确性和可靠性,即以每个垃圾填埋场自身数据为计算依据,不做太多参数平均化假设,同时又能较完整地覆盖全国所有垃圾填埋场,从而较为准确和全面地评估了中国垃圾填埋场恶臭的影响情况。试探性地使用了微博大数据表征人群活动强度,提供了此前难以或者无法获取的微观层面的人群活动信息,对于研究垃圾填埋场恶臭的影响具有重要意义。

关键词: 垃圾填埋场; 恶臭; 影响人口; 人群活动
DOI: 10.13205/j.hjgc.201602002

Case 1: Landfills and social media

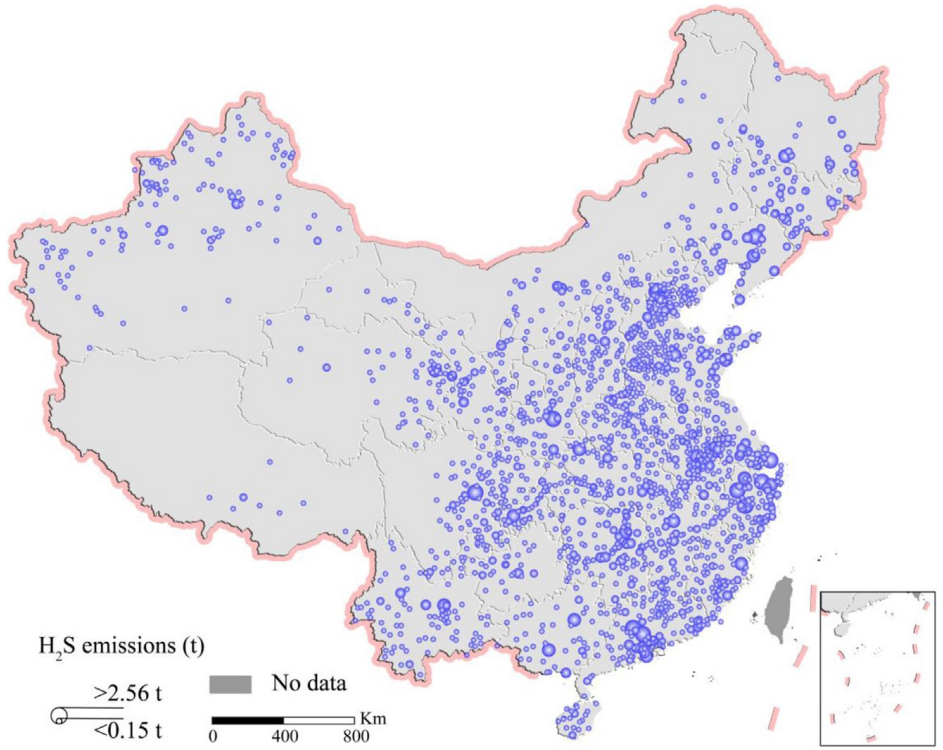
- H_2S emission estimation
- landfill odor diffusion
  - Gaussian dispersion model
  - CALPUFF model
- **Geo-tagged Social media data**
  - **Locations and contents**

First, we identified all the microblogs with geographical coordinates and selected those containing the words "landfill" and "odors." The selected microblogs were then assessed individually to make sure they actually reflected landfill odor impacts. The distance from where the microblog was submitted to the nearest landfill was set as the odor impact range of that landfill. For data from news reports, we selected those containing the specific odor impact distance and specific landfill. These data from social media and news reports were then compared with the results from our physical models.

It should be noted that the distance determined by this method might be smaller than the actual affected range of landfill odor, so the data could underestimate the actual influence range of landfill odors to a certain extent.

Case 1: Landfills and social media

Results reveal that the average radius of impact of landfill odors in China is 796 m, while most landfills (46.85%) are within the range of 400~1000 m, in line with the results from previous studies. The total land area impacted by odors has reached 837,476 ha, accounting for 0.09% of China's land territory. Guangdong and Sichuan provinces have the largest land areas impacted by odors, while Tibet has the smallest.

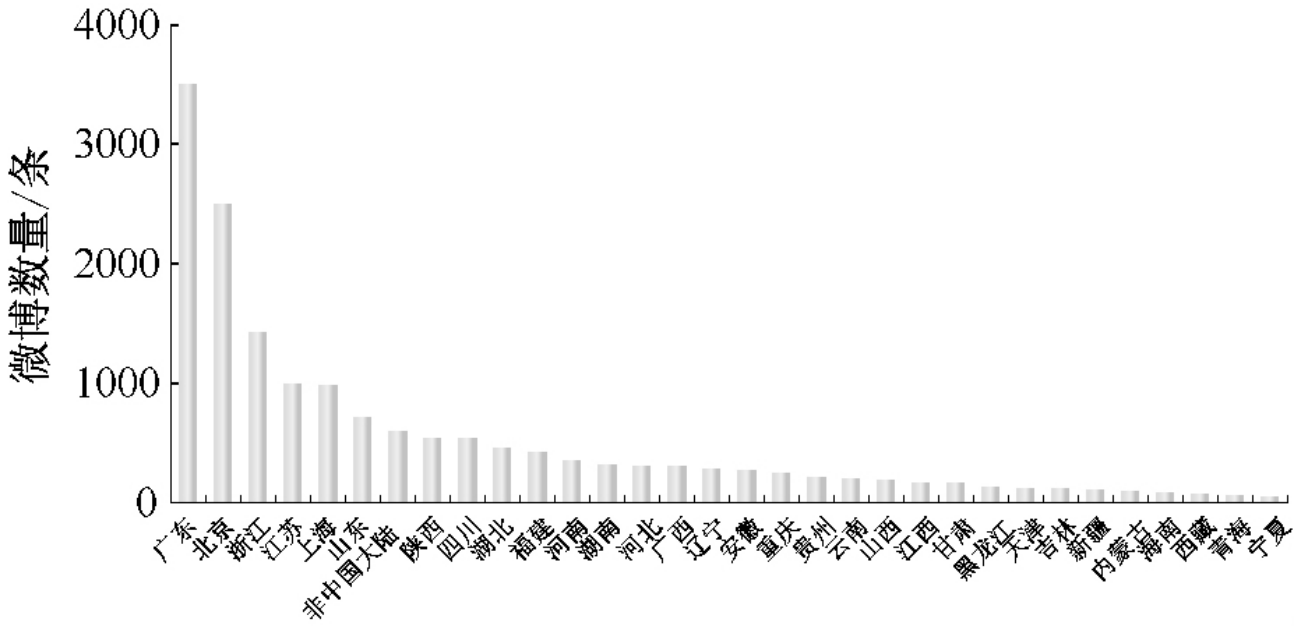


H2S emissions from each landfill in China

Table 2
Landfill odor emissions and ranges of impacts in each provinces of China.

Provinces	H_2S emissions (kg)	Range of impacts (ha)
Beijing	8537	14391
Tianjin	2425	1410
Hebei	6961	28055
Shanxi	4944	12733
Inner Mongolia	5259	5646
Liaoning	10353	21735
Jilin	6757	17464
Heilongjiang	5513	6546
Shanghai	11164	45086
Jiangsu	10543	21964
Zhejiang	19901	61268
Anhui	8726	19227
Fujian	4689	15465
Jiangxi	8170	41356
Shandong	11602	6962
Henan	7166	25983
Hubei	7094	48234
Hunan	10650	58136
Guangdong	27749	112203
Guangxi	4909	14934
Hainan	849	3337
Chongqing	4816	30963
Sichuan	8929	78245
Guizhou	3158	14529
Yunnan	5565	23344
Tibet	347	1634
Shaanxi	6404	47321
Gansu	3523	27379
Qinghai	2334	5575
Ningxia	1328	7712
Xinjiang	6258	18639
Total	226623	837476

Case 1: Landfills and social media



Social media relevant to landfills per province

字体大小代表词频的高低; “垃圾填埋场” 不作为关键词进行分析。
垃圾填埋场微博语义和关键词分析结果

Case 1: Landfills and social media

According to the **CALPUFF** (California Puff) model and an analysis of **social big data**, the overall uncertainty of our calculation of the range of odor impacts is roughly 32.88% to 32.67%.

CALPUFF

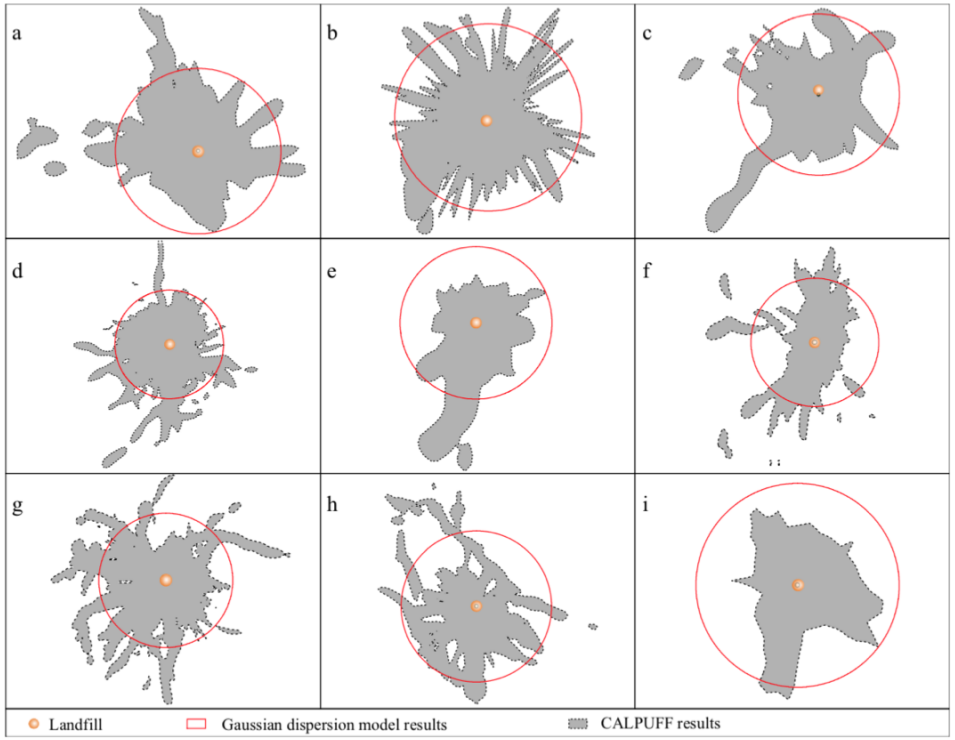
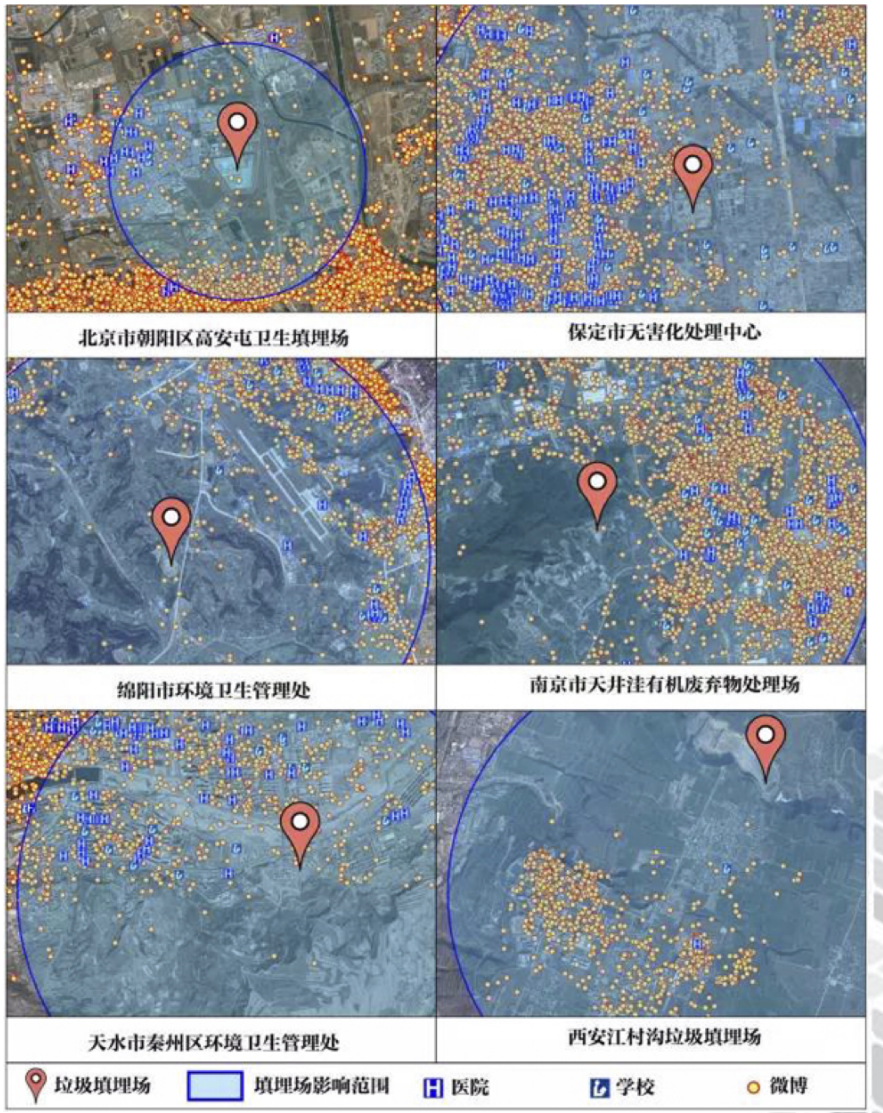


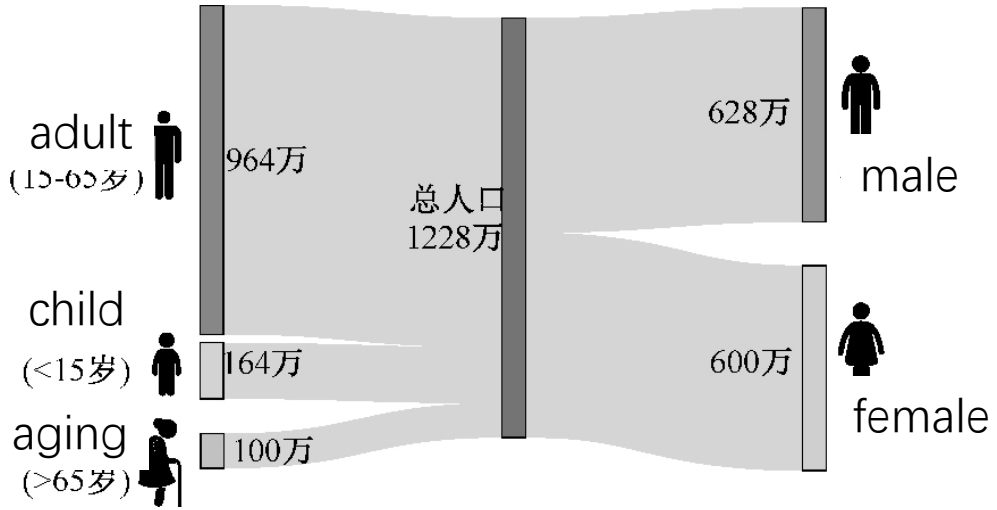
Fig. 5. Comparison of the simulated results between the CALPUFF and Gaussian dispersion models. Landfill names (and locations): (a) Liulitun (Beijing); (b) Laogang (Shanghai); (c) Maiyuan (Nanchang); (d) Xingfeng (Guangzhou); (e) Xiaping (Shenzhen); (f) Changshengqiao (Chongqing); (g) Chengdu (Chengdu); (h) Jiangcungou (Xi'an); (i) Shenjiagou (Xining).

Geo tagged social media: yellow dots

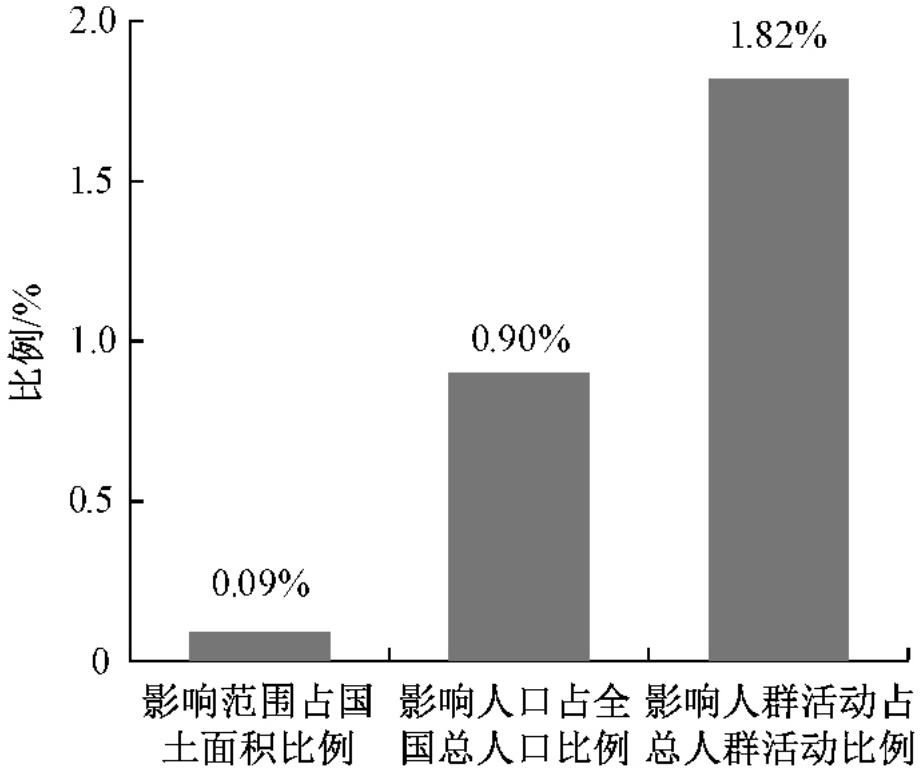


Case 1: Landfills and social media

12,280,000 ppl in total (landscan)



Demographic structure relevant to landfills (landscan)



Land covering

Population affected
Static (landscan)

Population affected
dynamic (social media)

Case 1: Landfills and social media

Study of Facility Distribution Indicators of Typical Landfills Based on a Distance-density Relationship

10 环 境 工 程
Environmental Engineering

基于距离－密度关系的典型垃圾处理设施布局指数研究

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摘要: 基于较高空间分辨率的人口分布(LandScan)和人口活动(Weibo)数据,结合全国垃圾处理设施信息,构建了距离－密度关系曲线,并据此提出了垃圾处理设施布局指数。通过距离－密度关系曲线可分析处理设施潜在环境影响暴露水平的分布情况,而布局指数则从空间覆盖的角度定量测定其影响水平的大小,形成了一种可开展跨地区、跨类型设施布局影响对比研究的手段。基于此方法,以北京、上海为例,对两市共计32座垃圾处理设施的影响水平进行分析和比较。

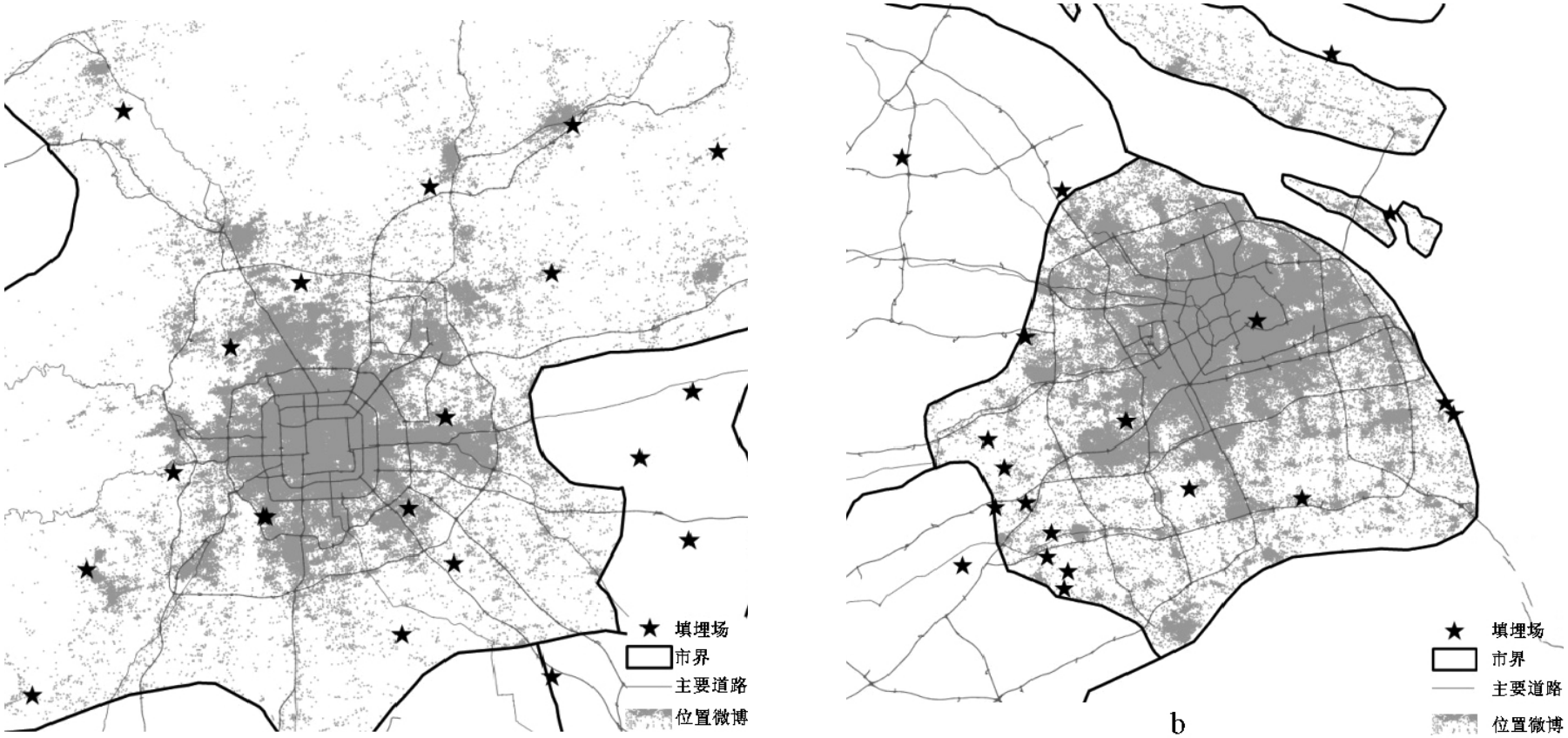
关键词: 垃圾处理设施; 距离－密度关系; 设施布局指数
DOI: 10.13205/j.hjgc.201602003

Issues for planning and management:
to better evaluate the location of landfills based on a higher resolution and dynamic dataset of population

- Data: LandScan (static) vs. geo-tagged Social media (dynamic)
- for overall pattern in a city and for specific facilities
- Comparing different cities within same dataset and framework

Case 1: Landfills and social media

Geo tagged social media: grey dots



Landfills and geo-tagged social media in Beijing and Shanghai

Case 1: Landfills and social media

IDW: inverse distance weighted

$$P_i = \frac{S_{id} \times (d_{\max} - d)}{\sum_d S_{id}}$$

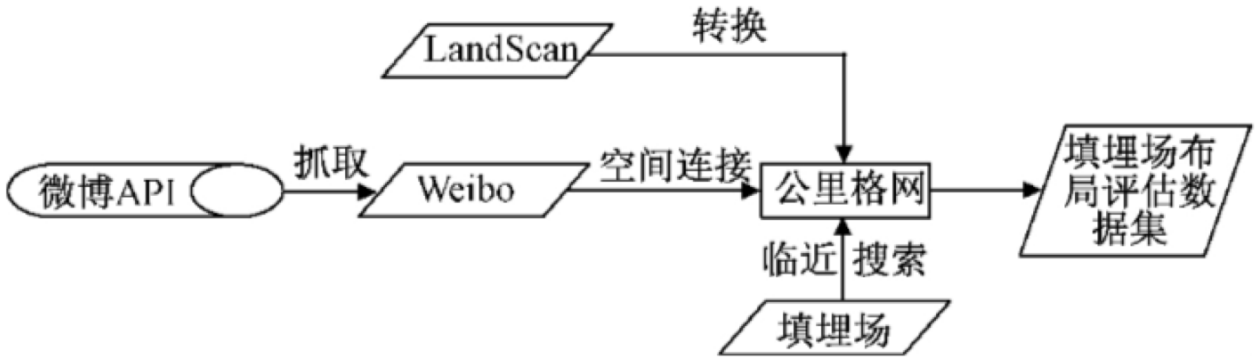
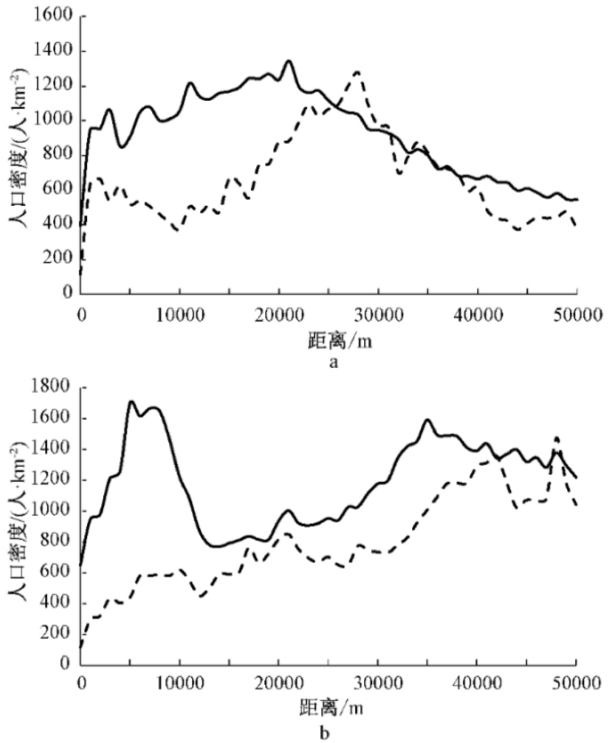


图2　数据获取与处理整体流程

Fig. 2　Framework of data acquisition and processing

Case 1: Landfills and social media

LandScan



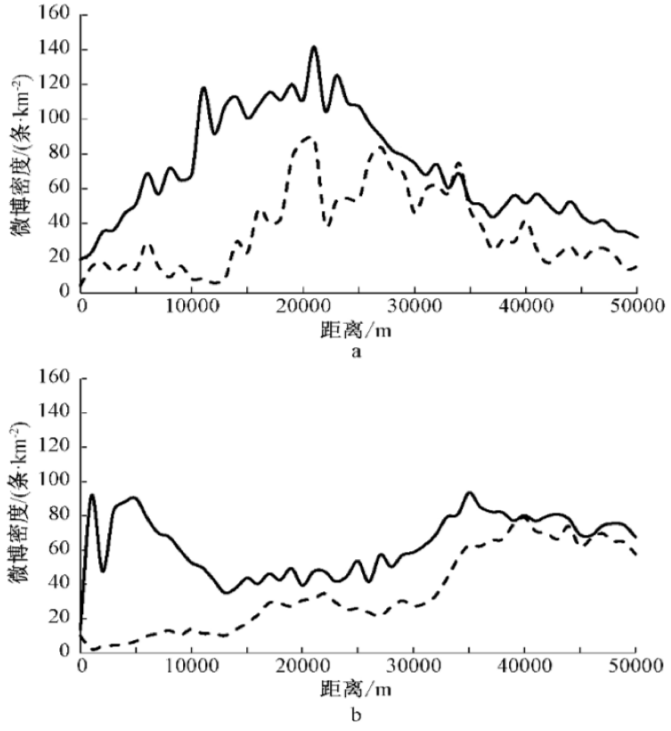
a—北京；b—上海。

——平均值；——中值。

图 3　基于 LandScan 数据的处理设施密度－距离特征曲线

ig. 3　The curve of density-distances of landfills based on LandScan da

Geo-tagged social media



a—北京；b—上海。

——中值；——平均值。

图 4　基于 Weibo 数据的处理设施密度－距离特征曲线

ig. 4　The curve of density-distances of landfills based on Weibo data

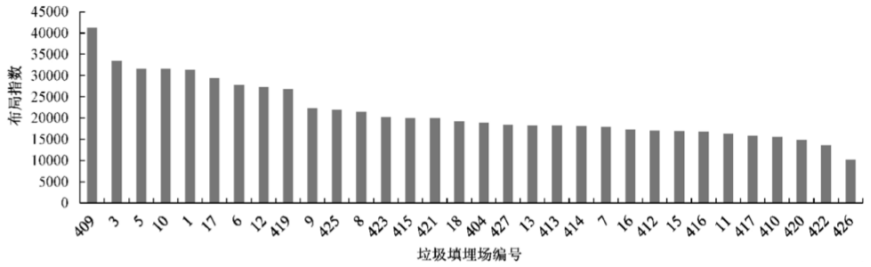


图 6　北京(编号 1～18) 、上海(编号 404～427) 垃圾处理设施布局指数比较

Fig. 6　The facility distribution indicators comparison of landfills in Beijing (No. 1～18) and Shanghai (No. 404～427)

上海老港(浦东) (编号 409) 布局 指数 P 最高，潜在的环境影响暴露水平最大，其次是 北京丰台垃圾场(编号 3) 、北京六里屯(编号 5) 等处 理设施，而上海崇明(编号 426) 布局指数 P 最低

Case 2: City GHG grid management platform

Competition proposal for Wuhan Urban Simulation Lab

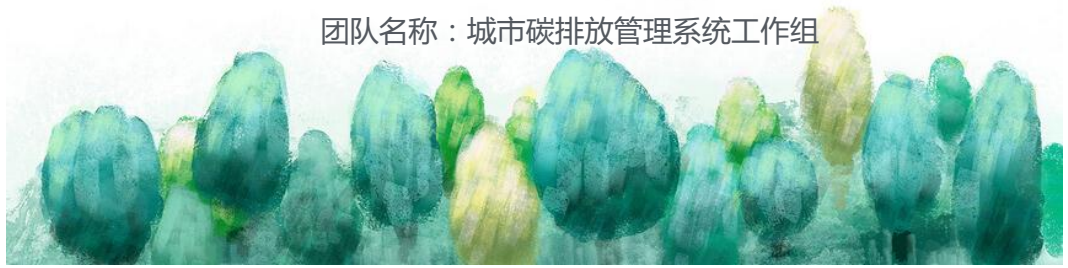
- state-of-art GHG inventory for cities
- Quality control of data results
- Finer granularity GHG grid in Wuhan: spatial (1km) and time (every month)
- Management system with a modern and easy interface: analyzing and visualizing

武汉城市仿真实验室

碳排放模块

团队编号：02

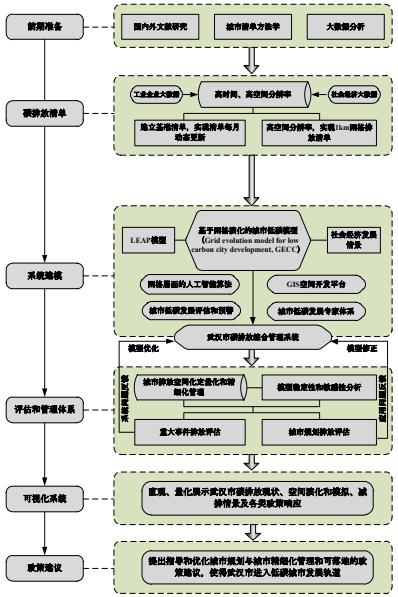
团队名称：城市碳排放管理系统工作组



研究思路

目标和技术路线

- **建立武汉市高空间（1 km）、高时间（1月）分辨率二氧化碳排放清单体系；**
- **建立武汉市基于网格的城市低碳管理综合模型；**
- **建立武汉城市低碳评估可视化决策、分析系统。**



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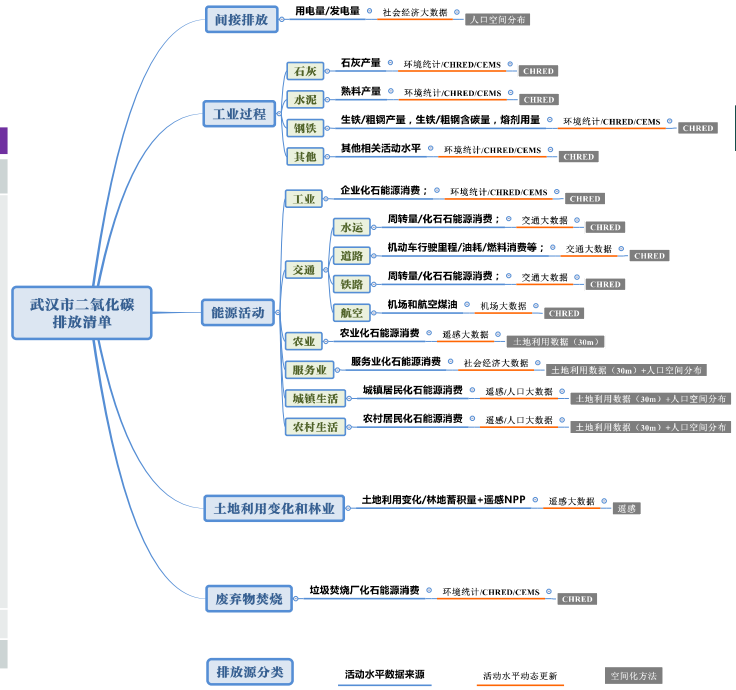
碳排放清单—结构

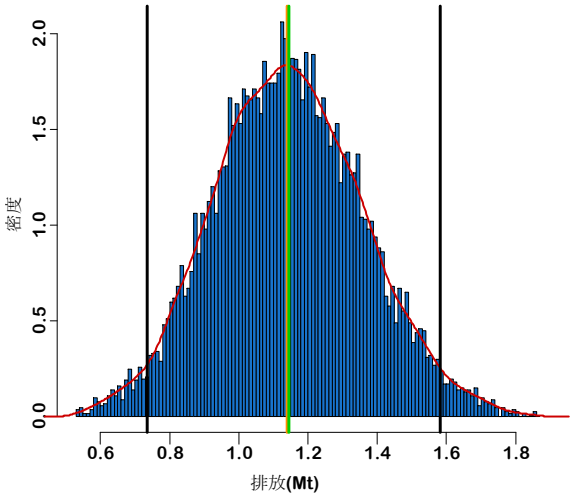
WRI/C40/ICLEI		武汉市对应部门	
范围1	范围2	范围1	范围2
居民建筑	电力使用	城镇生活+农村生活	外调电力排放
商业建筑	电力使用	服务业	
制造业	电力使用	工业（不包括电力生产）	
发电上网		火电	
农林业	电力使用	农业	
能源开采逃逸	电力使用	煤矿开采	
交通（道路、铁路、水运、航空和非道路）	电力使用	交通（道路、铁路、水运和航空）	
废弃物处理（生物处理、垃圾焚烧、垃圾填埋和废水处理）	电力使用	废弃物处理（垃圾填埋、废水处理）	
工业过程和产品使用		工业过程和产品使用	
畜禽养殖		畜禽养殖	
林业和土地利用		林业和土地利用	
农业其他		水稻种植	
BASIC（绿色部分）		无	
BASIC+（绿色部分+蓝色部分）		基本相当于总排放（范围1+范围2）	



碳排放清单—质量控制

主要步骤

- **活动水平质量控制和典型企业第三方核查；**
- **排放因子精度控制和抽样校对；**
- **基于蒙特卡罗方法的不确定性分析。**

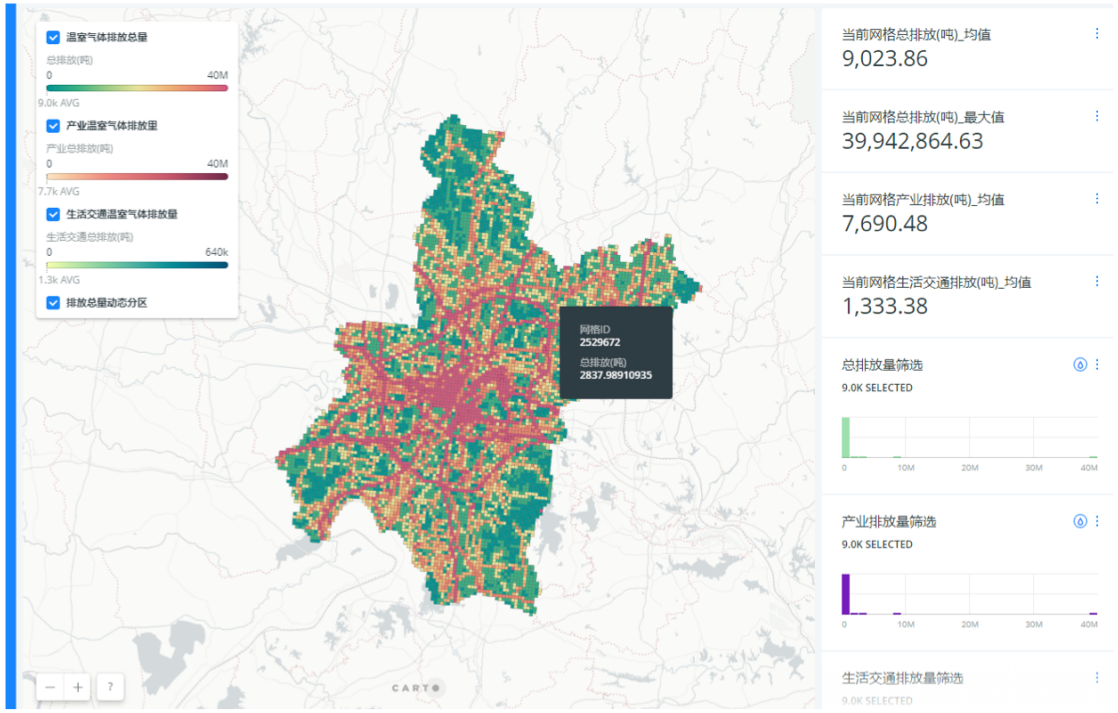


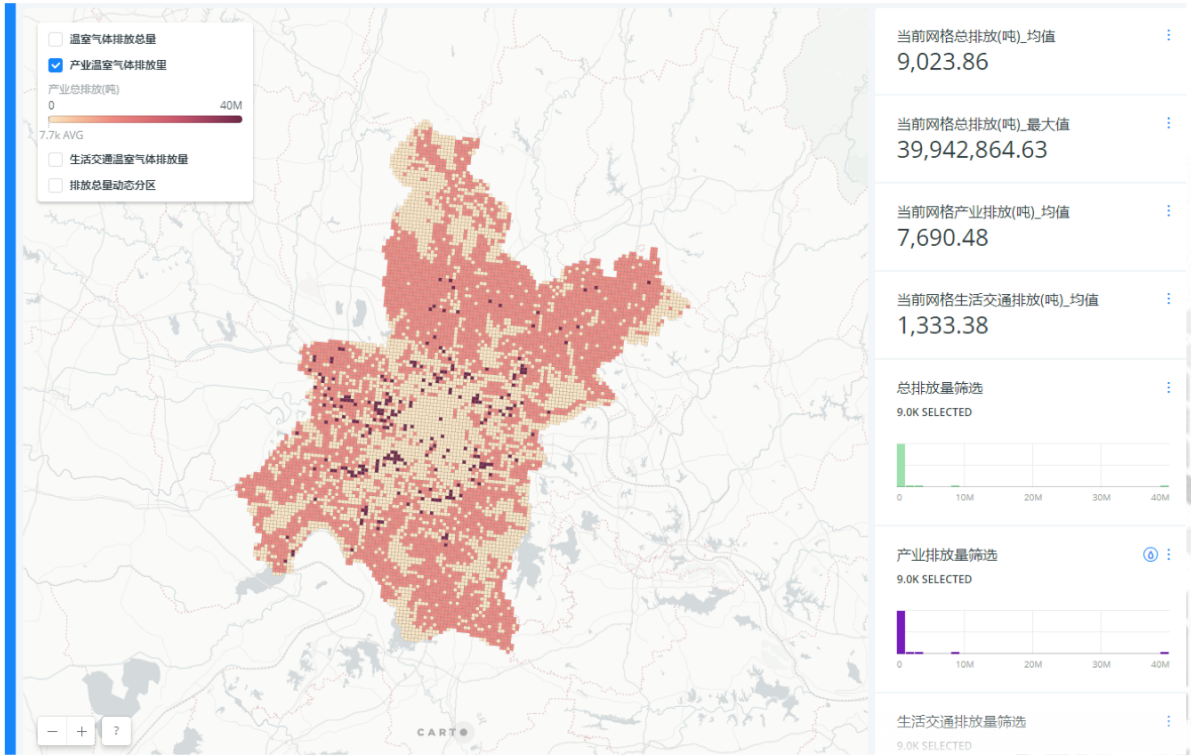
考虑关键排放源、验证成本、准确性、验证方案和实施的复杂性、数据可获得性等。

Case 2: City GHG grid management platform

Competition proposal for Wuhan Urban Simulation Lab

- state-of-art GHG inventory for cities
- Quality control of data results
- Finer granularity GHG grid in Wuhan: spatial (1km) and time (every month)
- Management system with a modern and easy interface: analyzing and visualizing





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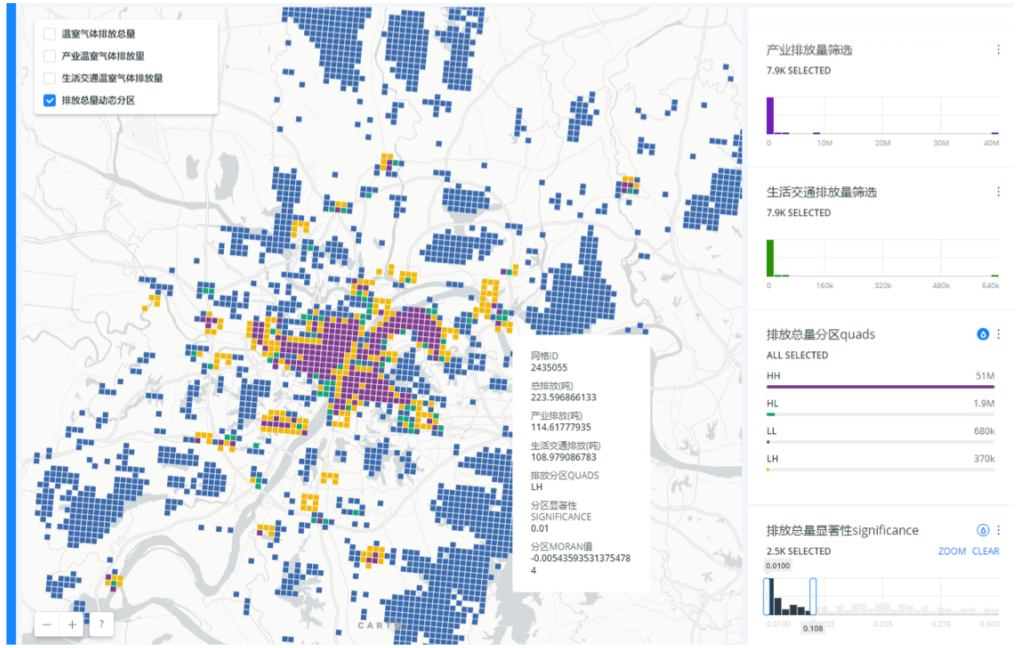
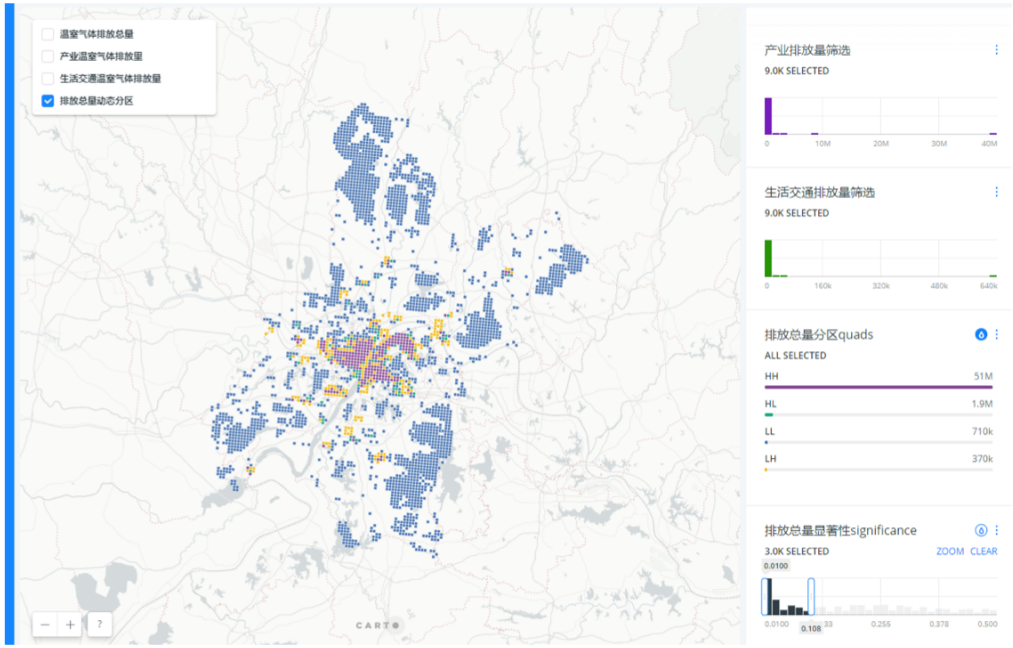


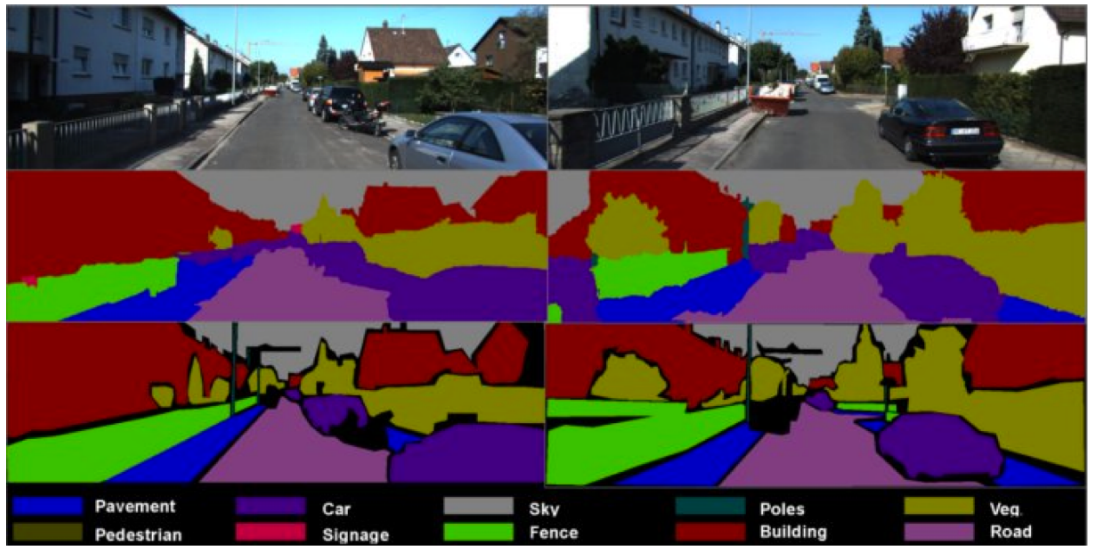
Ad-hoc and interactive online analysis:
hot-cold area of GHG emissions



other cases

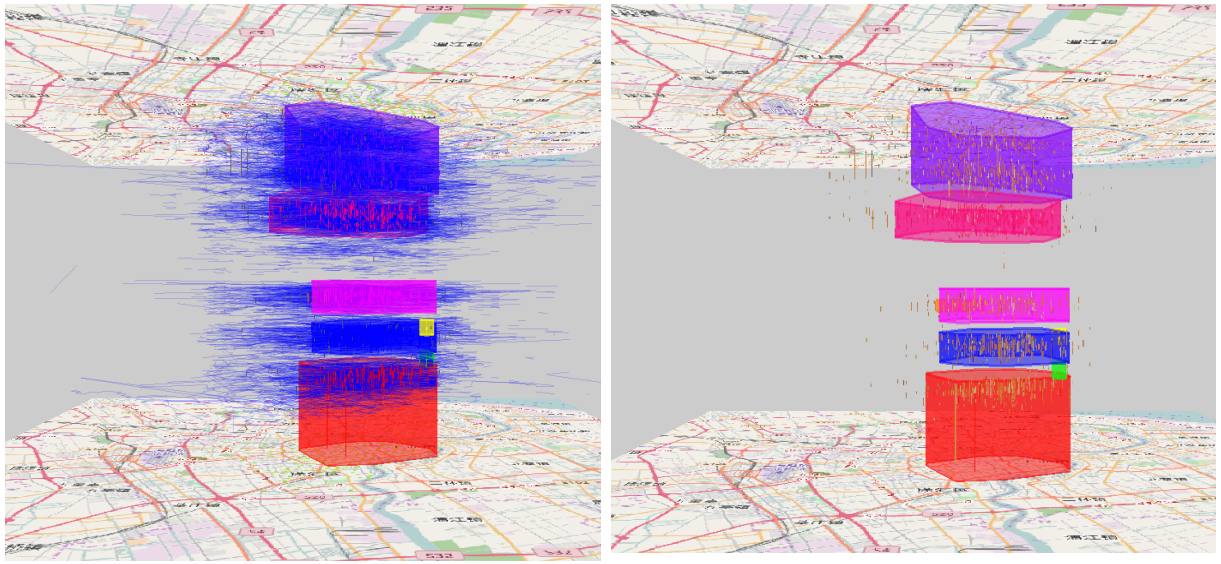
Data Fusion Analysis: for Public Services and healthy cities

Internet street View



Computer vision analysis of Street View image segmentation

Dock-less floating bike usages



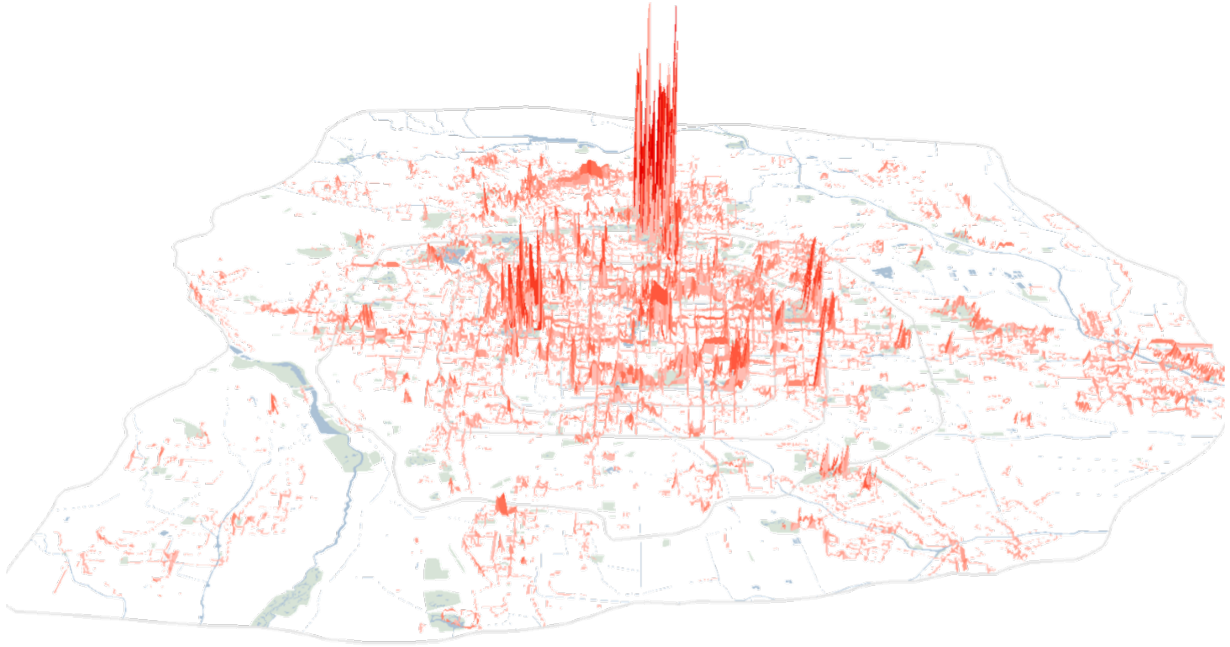
Space-time analysis of bicycle riding trajectory hotspot

other cases

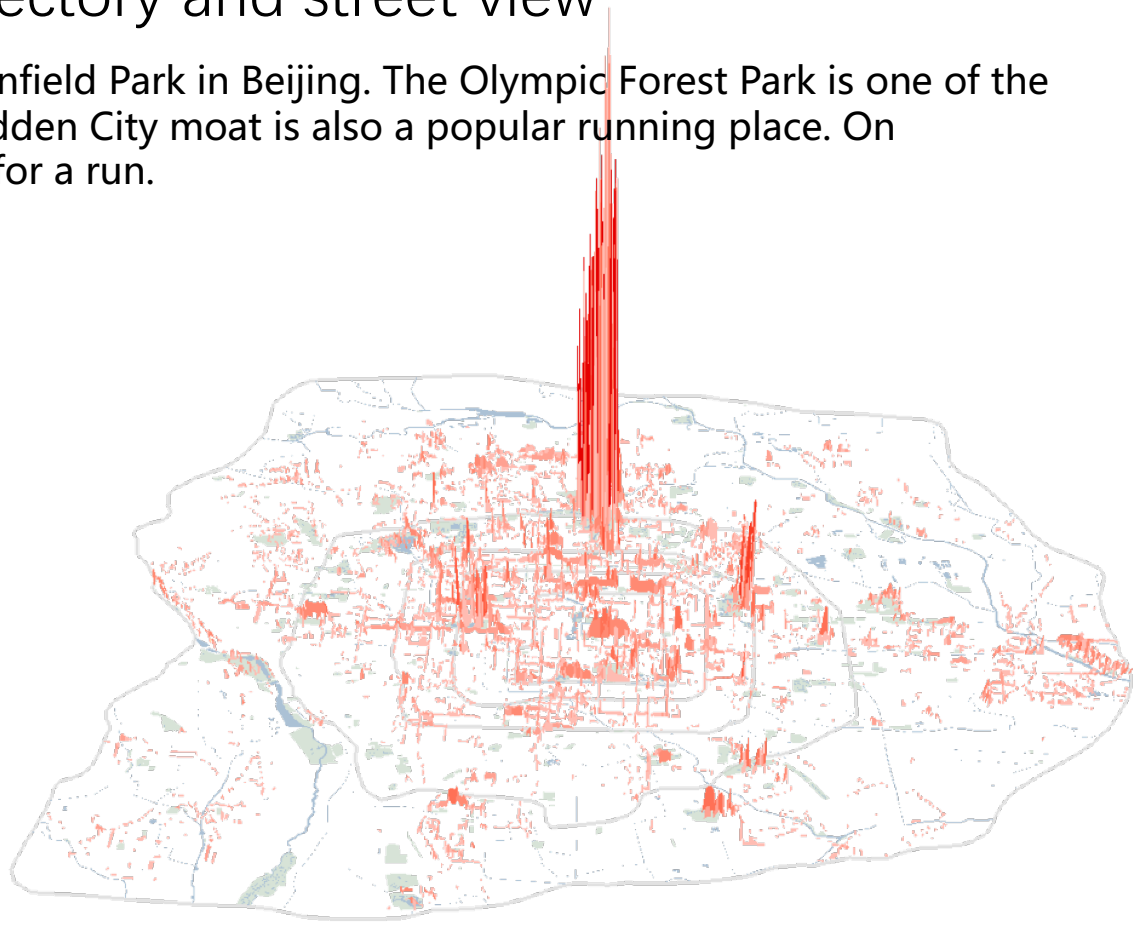
Data Fusion Analysis: for Public Services and healthy cities

Data-driven Healthy cities: the movement trajectory and street view

The running trajectory is very significantly distributed around the Greenfield Park in Beijing. The Olympic Forest Park is one of the most popular places to run. Yuyuantan Park, Chaoyang Park, the Forbidden City moat is also a popular running place. On weekends, the above popular places will attract more people to come for a run.



Running track of weekday and distribution of green space in Beijing



The trajectory of weekend running and the distribution of green space in Beijing

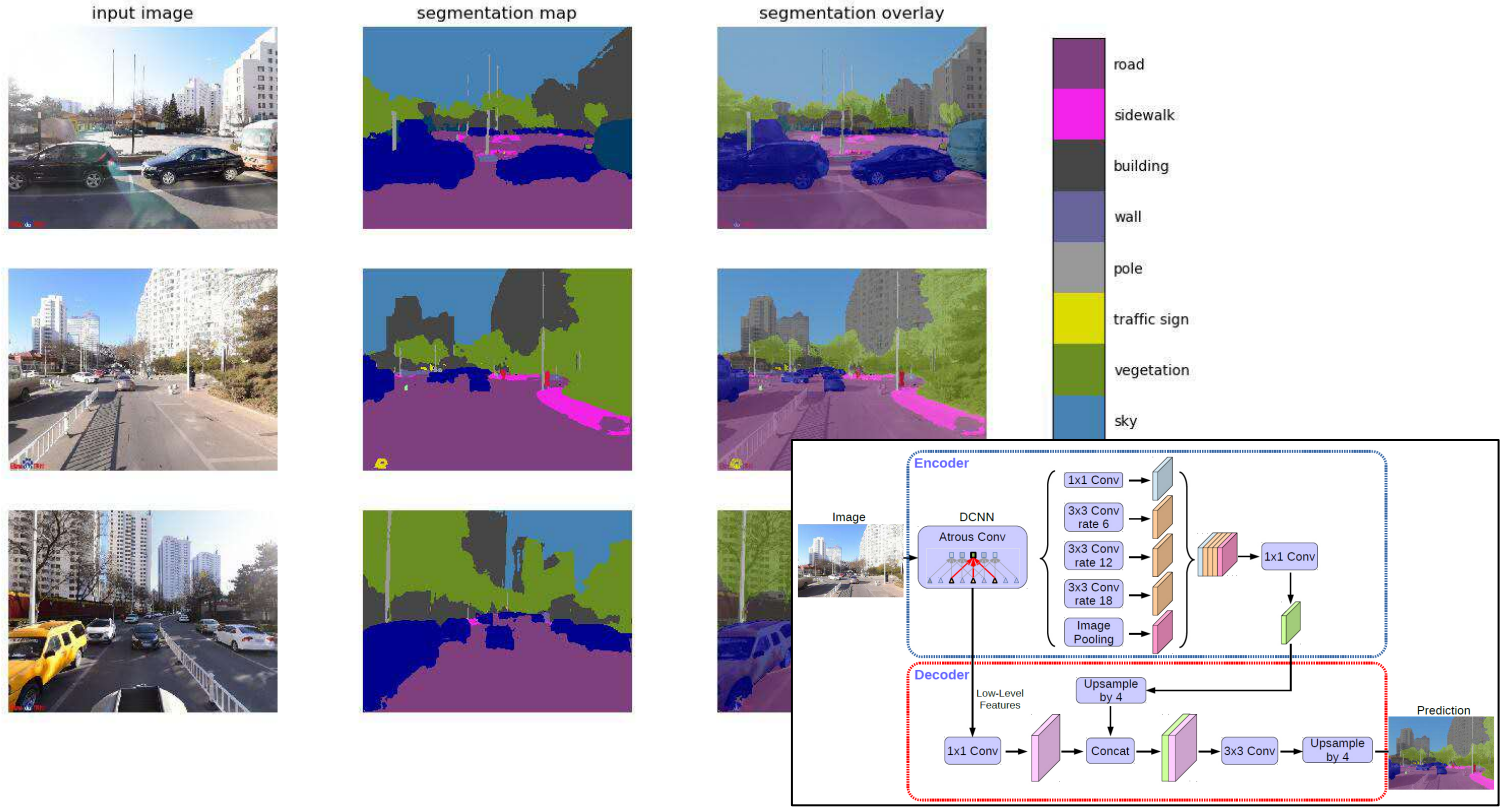
other cases

Data Fusion Analysis: for Public Services and healthy cities

Data-driven Healthy cities: the movement trajectory and street view

- Sports Fitness Big Data
- Street View Map Big Data

Collect more than 1.6 million Street View data in Beijing six ring, use deep learning computer vision algorithm, semantic segmentation of streetscape image



TRAINING

Keep

User sample approx. 30,000
More than 200,000 behavior records

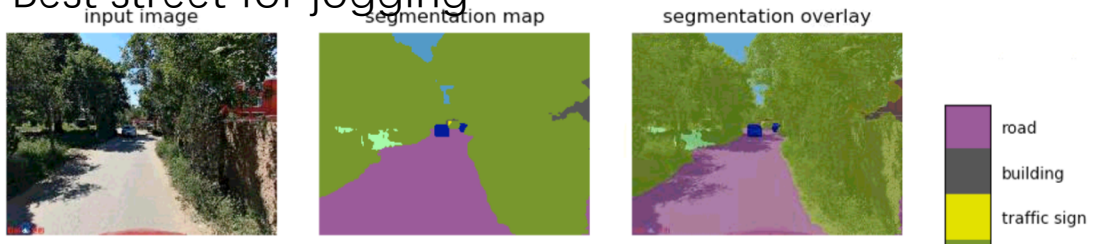
other cases

Data Fusion Analysis: for Public Services and healthy cities

Data-driven Healthy cities: the movement trajectory and street view

Geo-detector: a statistical method for detecting spatial differentiation and revealing the driving force behind indicators, the degree to which a factor X is identified by using the geo-factor detection method explains the spatial separation level of attribute Y.

Best street for jogging



Worst street for jogging

	Running	Biking	Greening	Sky	Vehicles
Best street	**7856**	**5**	44.88%	6.15%	1.92%
Worst street	**2**	**3**	18.70%	36.79%	0.63%

Factors that significantly affect the amount of trajectory (descending):

- **Proportion of the sky**
- **Distance from green space**
- Distance from a settlement
- Road density
- Proportion of roads
- Nearby area of green space within 100 meters
- Proportion of buildings
- Percentage of cars
- Number of residential areas within 100 meters of the vicinity

other cases

Data Fusion Analysis: for Public Services and healthy cities

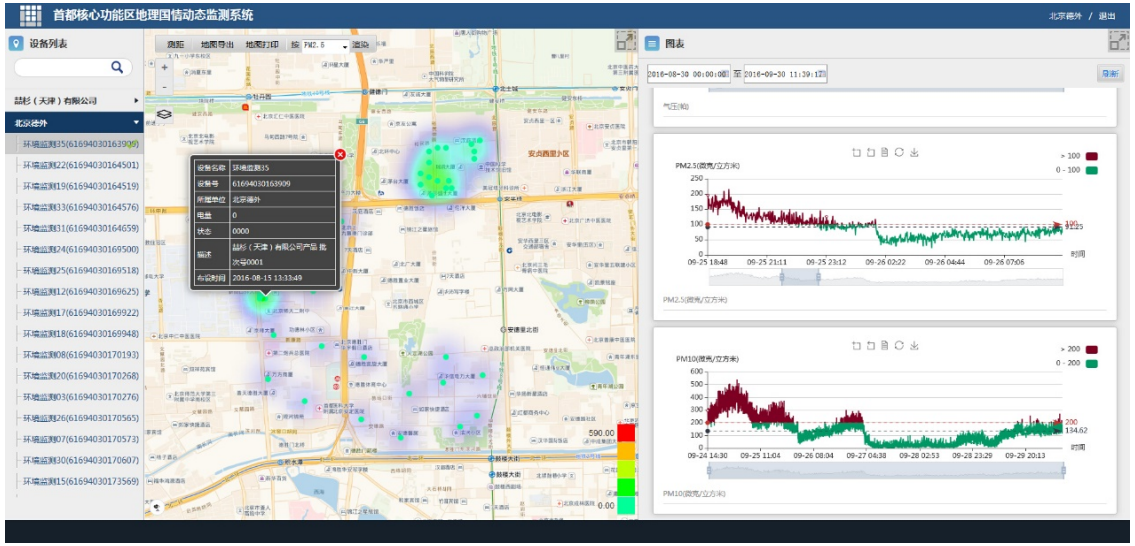
- **Dynamic operation monitoring of the functional core district of Beijing**

  - Outdoor environment sensors, human and traffic flow monitoring sensors were installed in the streets.
  - Analysis of spatial and temporal characteristics, human and traffic flow characteristics, job-housing characteristics based on data collection by the monitors.
  - More detailed understanding of urban operation, as well as scientific basis for further environment improvement.

Outdoor environment sensor

human and traffic flow monitoring sensor

Real-time visualization and analysis of monitoring data



other cases

Big Data Platform for Cities

■ National Urbanization Governance Decision Support System

Institute for China Sustainable Urbanization of Tsinghua University was co-established by **National Development and Reform Commission and Tsinghua University** in March 2016. Targeted at the theme of new urbanization, the Institute provides theoretical, intellectual and technical support for the new urbanization construction with Chinese characteristics. A comprehensive quality assessment system for the new urbanization construction is being developed. The Institute also researches on key engineering technologies and standards in the new urbanization field, and takes parts in a number of relevant evaluation systems and standards. Through the system based on multi-dimensional big data, the researchers are able to reveal the operational characteristics, trends and problems of urban agglomerations, and provide quantitative analysis support for the new urbanization research.

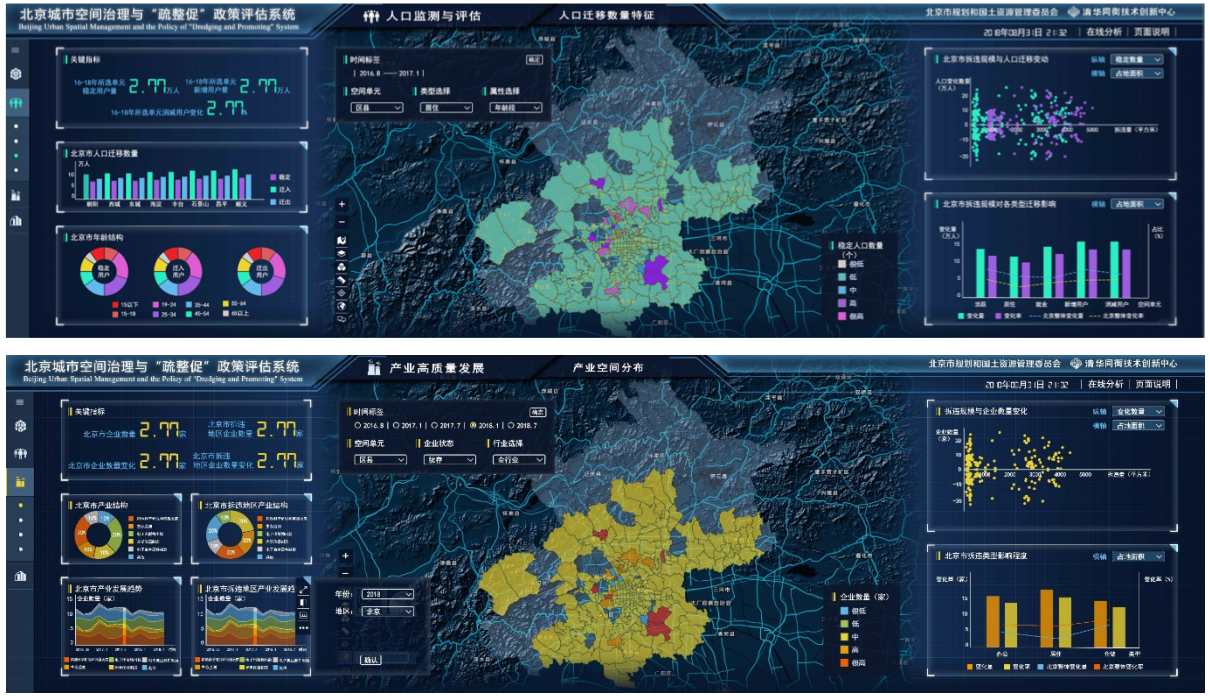
other cases

Big Data Platform for Cities

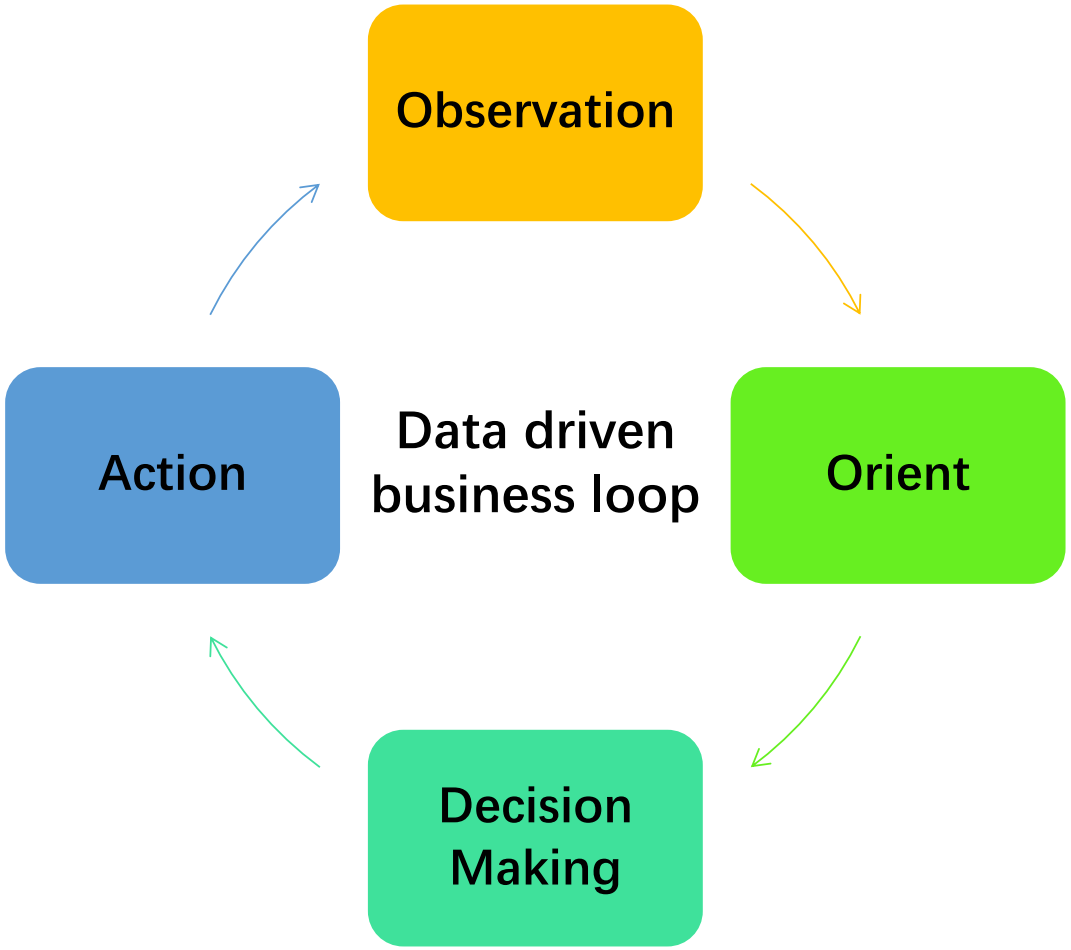
- **Next generation platform in Beijing**

  Forthcoming in 2019, *hopefully*

1. **Principal Method Framework of Urban Policy Evaluation**
2. **An Intelligent Platform of Urban Spatial Governance and Policy Evaluation for Beijing**
   - Involving Space, Population, Industry and Civic Life.

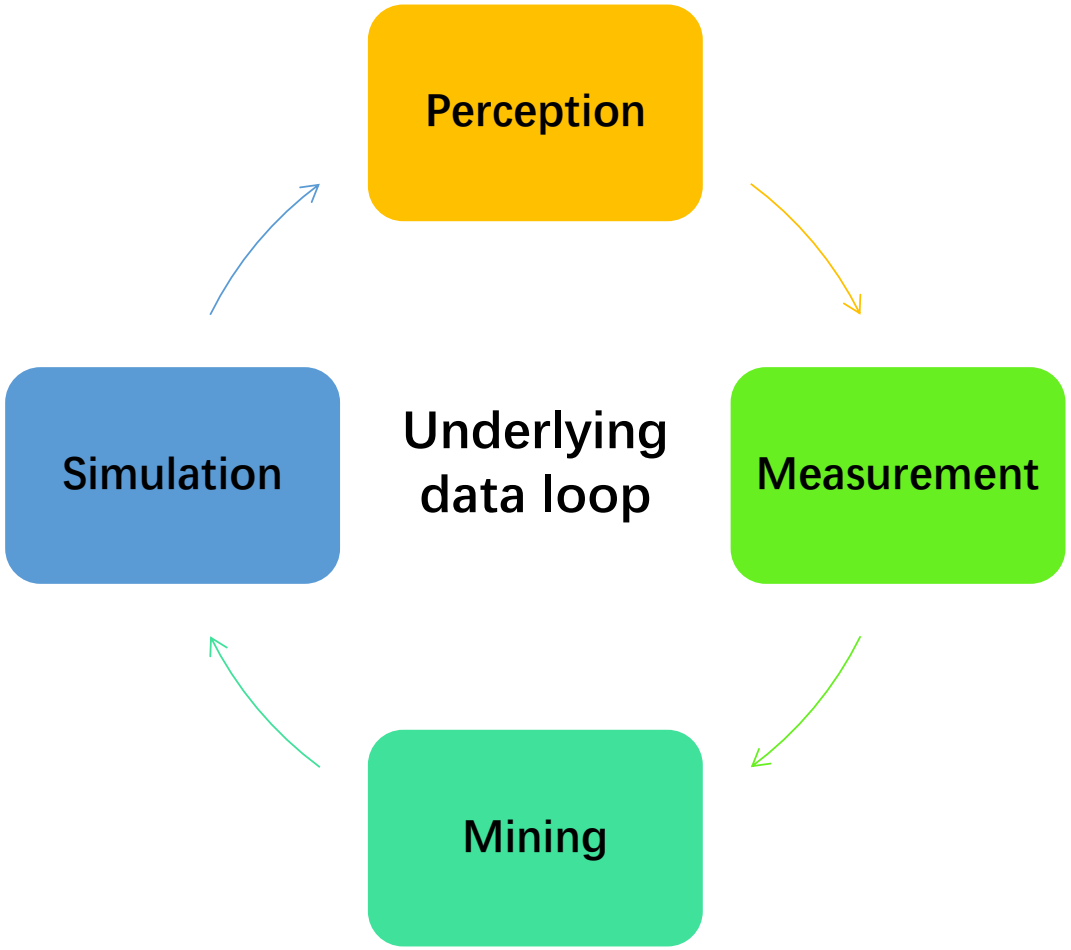


Loop 1: The business loop



- **Observation**: is the organization and interpretation of external sensory information by the human brain. Includes access to sensory information, understanding of information, screening of information, and organization of information.
- **Orient**: in psychology refers to the process of acquiring knowledge by forming psychological activities such as concept, perception, judgment or imagination, that is, the psychological function of individual thinking to information processing.
- **Decision Making**: is a cognitive process, after which individuals can decide to act on the basis of their personal beliefs or the reasoning of a combination of factors in a variety of options. Each decision-making process aims to produce a final decision and choose the final choice. And the form of these choices can be an action or a selection of opinions.
- **Action**: refers to the way an organism behaves, as well as a reaction to the environment in which it is located and other organisms or objects.

Loop 2: The data loop (workflow)

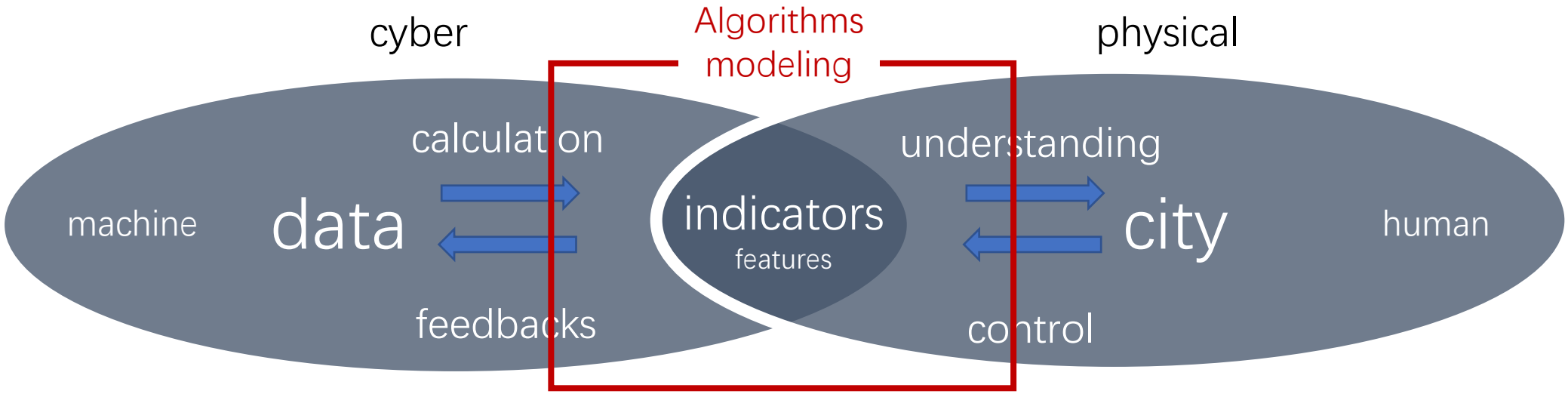


- **Data Perception**: the collection of data is cleaned, and the reality is more refined
- **Data Measurement**: The analysis and evaluation of the data makes it more reasonable to judge the situation
- **Data Mining**: a comprehensive interpretation of the data, understanding the reasons more deeply
- **Data Simulation**: Deduction, extension and application of data mining rules

Remarks 1: CPS - bridging between virtual and reality

Cyber-Physical System

Border closure, clear mechanism **Open border, fuzzy mechanism**



Remarks 2: IT and DT are different

- IT（Information Technology）Information technology, is a technology based on computer and internet to enhance people's information dissemination ability

- DT（Data Technology）Data technology, the essence of data technology is the "processing" of data technology
  - The essence of data technology is also the technology of "cognition", the Technology of "thinking" and the technology of "decision making", which eventually forms the equipment of "artificial intelligence".

Remarks 3: data, and AI, is not Almighty

DARPA's perspective on AI: three waves

That can be clustered into three waves of AI development that may be described as - *handcrafted knowledge, statistical learning and contextual adaptation*

AI Wave	① Handcrafted Knowledge	② Statistical learning	③ Contextual Adaptation
	Systems that have established sets of rules to represent knowledge in well-defined domains • **Examples**: logistics program scheduling, game-playing programs • **Features:** Enables reasoning over narrowly defined problems. No learning capability and poor handling of uncertainty • **Challenges:** The structure of the knowledge is defined by humans. The specifics are explored by the machine. Failure of the autonomous cars in the DARPA Grand Challenge	Systems based on statistical models developed to address specific challenges and trained using big data • **Examples:** voice recognition, face recognition • **Features:** Nuanced classification and prediction capabilities. No contextual capability and minimal reasoning ability • **Challenges:** statistically impressive but individually unreliable, inherent flaws can be exploited, skewed training data creates maladaptation, "blackbox"	• Systems that construct ***contextual explanatory models*** for classes of real world phenomena • **Examples**: Image recognition • **Features:** Ability to perceive, learn, abstract and reason • Models that generate explanations of how an object might have been created to ***explain and drive decisions***
Perceiving Learning Abstracting Reasoning			

X Artificial intelligence

√ **Augmented intelligence**

Thank you!

Looking forward to future cooperation

清华同衡规划播报

同衡创新