

Cartographic Frontiers in the Era of Big Data

Bo Zhao

Assistant Professor in
Cartography and Geovisual Analytics

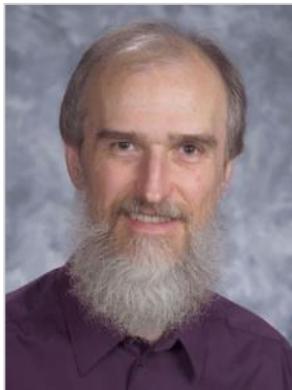


College of Earth, Ocean, and Atmospheric Sciences

Voices

“Has GIS killed Cartography?” A special session at AAG Annual

Meeting in 1996, organized by the then-president Judy Olson, who is a cartographer.



Alan MacEachren
Cartographer

*No, GIS has not killed
cartography; cartography
committed suicide
instead!*



Michael Goodchild
GIScientist

*No, GIS has not killed
cartography; they got
married!*



Eric Sheppard
Human Geographer

*Yes, GIS may have killed
cartography—but the
jury will never convict!*

Dead?

A New Phase?

[PDF] Is Cartography Dead? - Department of Geography

www.geography.wisc.edu/.../Roth_20... ▾ University of Wisconsin-Madison ▾
Feb 10, 2006 - Introduction. Wood, Denis. 2003. Cartography is Dead. (Thank God!).
Cartographic Perspectives. 45: p4-7. Primary Impetus. Olson, Judy M.

[PDF] Cartography is Dead (Thank God!) - Making Maps

makingmaps.owu.edu/mm/cartographydead.pdf ▾
by D Wood - Cited by 54 - Related articles
4. Number 45, Spring 2003 cartographic perspectives. Cartography is Dead (Thank God!) Denis Wood. Independent Scholar. Cartography Is Dead (Thank God!).

[PDF] Chapter 5: Counter-Mapping and the Death of Cartography.

www.quiqui.org/wp-content/.../WOOD-2010-Death-of-Cartography.pdf ▾
These examples imply that counter-mapping is played out over long stretches of time —the counter-mapping that led to the creation of Nunavut began in the ...

Cartography is dead, long live the map makers | - edparsons

www.edparsons.com/.../cartography-is-dead-long-live-the-map-makers/ ▾
Sep 1, 2008 - Cartography is dead, long live the map makers. Seems like only last year, ah yes it was last year, that the bored press hits upon it annual "shock ...

The Death of Cartography and the Rise of the Machines ...

www.gogeomatics.ca/.../the-death-of-cartography-and-the-rise-of-the-ma... ▾
Apr 22, 2013 - This article explores how technology has influenced map making, how cartography requirements have changed, and what skill sets one needs ...

Is Cartography Dead? No!... - The British Cartographic Society

<https://www.facebook.com/bcsweb/posts/520973277938615> ▾

Cartography is not dead, but its survival requires thoughtful redefinition. Right now, many of us are not quite sure what cartography involves anymore, and plenty ...



Is there a need for **neo-cartography**?

[MJ Kraak](#) - Cartography and Geographic Information Science, 2011 - Taylor & Francis
These days more and more maps are being produced and used by more people than ever before. This seems to be a very positive development for those who are in favor of maps. The increase can be witnessed both in a professional environment (eg, geoscientists). Cited by 18 Related articles Cite Save

Crowdsourced **cartography**: mapping experience and knowledge

[M Dodge, R Kitchin](#) - Environment and Planning A, 2013 - eprints.maynoothuniversity.ie
... We then go on to discuss the changing nature of **cartography** in the Web 2.0 era with respect to authorship, ontology, representation, and temporality. Keywords: **cartography**, crowdsourcing, 'prosumers', Web 2.0, authorship, ontology, representation, temporality ... Cited by 48 Related articles All 11 versions Cite Save

[PDF] Cartography 2.0: For people who make interactive maps

[M Harrower, AC Robinson...](#) - Cartographic ..., 2009 - cartographicperspectives.org
Cartography 2.0 (<http://Cartography2.org>) is a free online knowledge base and e-textbook for students and professionals interested in interactive and animated maps. I (Mark) proposed the idea of doing an 'online textbook' to my co-authors because I knew that, as teachers ... Cited by 1 Related articles All 11 versions Cite Save More

[CITATION] Perspectives on the **new cartography**

[MF Goodchild](#) - Environment and Planning A, 2015 - epn.sagepub.com
Whether we recognize it as 'un-cartography', 're-cartography', 'cartography 2.0', 'cybercartography', or whatever we choose to call it, the papers in this collection give a compelling sense of the very exciting changes that are occurring in what has in many ways ... Cited by 1 Related articles All 4 versions Cite Save

Map?

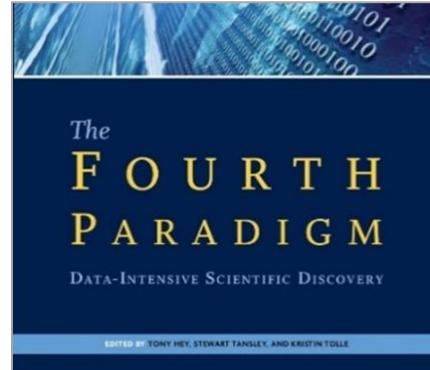
Paradigms	Research Focus	
	Map Construction	Map use
Map as Images (The communicative/cognitive tradition)	Visual symbol design, color use, graphical hierarchy, and figure/ground	Reading, visualizing, communicating, and metaphor
Map as Model (The analytical tradition)	Data structure design, and algorithm development	Analytical modelling, hypothesis testing, and simulation
Maps as Intent/Social Construction (The critical tradition)	Distortion/biases built-in, power relationship, ethical consideration	Power and control, governance, propaganda tool, counter-surveillance

Background

New way of doing science?

Paradigm	Nature	Form	When
First	Experimental Science	Empiricism; Describing natural phenomena	Pre-Renaissance
Second	Theoretical Science	Modelling and generalization	Pre-computers
Third	Computational Science	Simulation of complex phenomena	Pre-Big Data
Fourth	Exploratory Science	Data-intensive; statistical exploration and data mining	Now

Complied from Hey et al. (2009)



Office of Science and Technology Policy
Executive Office of the President
New Executive Office Building
Washington, DC 20502

FOR IMMEDIATE RELEASE
March 29, 2012

Contact: Rick Weiss 202 456-6037 pweiss@ostp.eop.gov
Lisa-Joy Zgorski 703 292-8311 lisajoy@nsf.gov

OBAMA ADMINISTRATION UNVEILS "BIG DATA" INITIATIVE:
ANNOUNCES \$200 MILLION IN NEW R&D INVESTMENTS

In addition to its funding of the Big Data solicitation, NSF is also:

- Encouraging research universities to develop interdisciplinary graduate programs to prepare the next generation of data scientists and engineers;
- Funding a \$10 million project based at the University of California, Berkeley, that will integrate three powerful approaches for turning data into information - machine learning, cloud computing, and crowd sourcing;
- Providing the first round of grants to support "EarthCube" - a system that will allow geoscientists to access, analyze and share information about our planet;
- Issuing a \$2 million award for a research training group to support training for undergraduates to use graphical and visualization techniques for complex data.
- Providing \$1.4 million in support for a focused research group of statisticians and biologists to tell us about protein structures and biological pathways.
- Convening researchers across disciplines to determine how Big Data can transform teaching and learning.

A Session on Emerging Topics in **Data-Driven Geography** at 2015 Annual Meeting of the Association of American Geographers

Co-chairs

- Linna Li, California State University
- Bo Zhao, The Ohio State University

Discussants

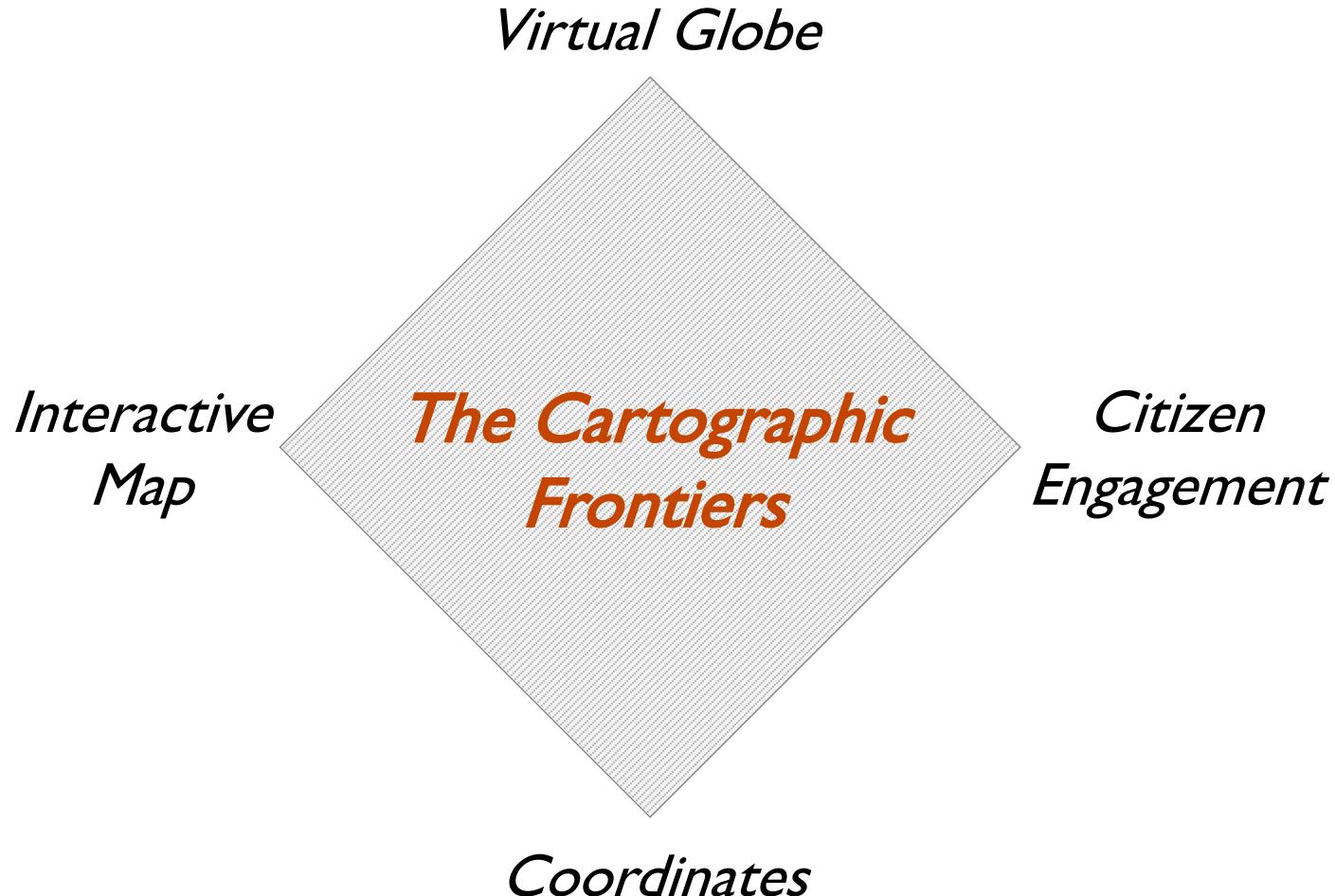
- Daniel Sui
- Harvey Miller
- Michael Goodchild



Outline

- An emerging phase of cartography?
- The cartographic frontiers
 - Overview of my research and teaching
 - Discussion and implications
- Conclusion

Perspectives on the Frontiers

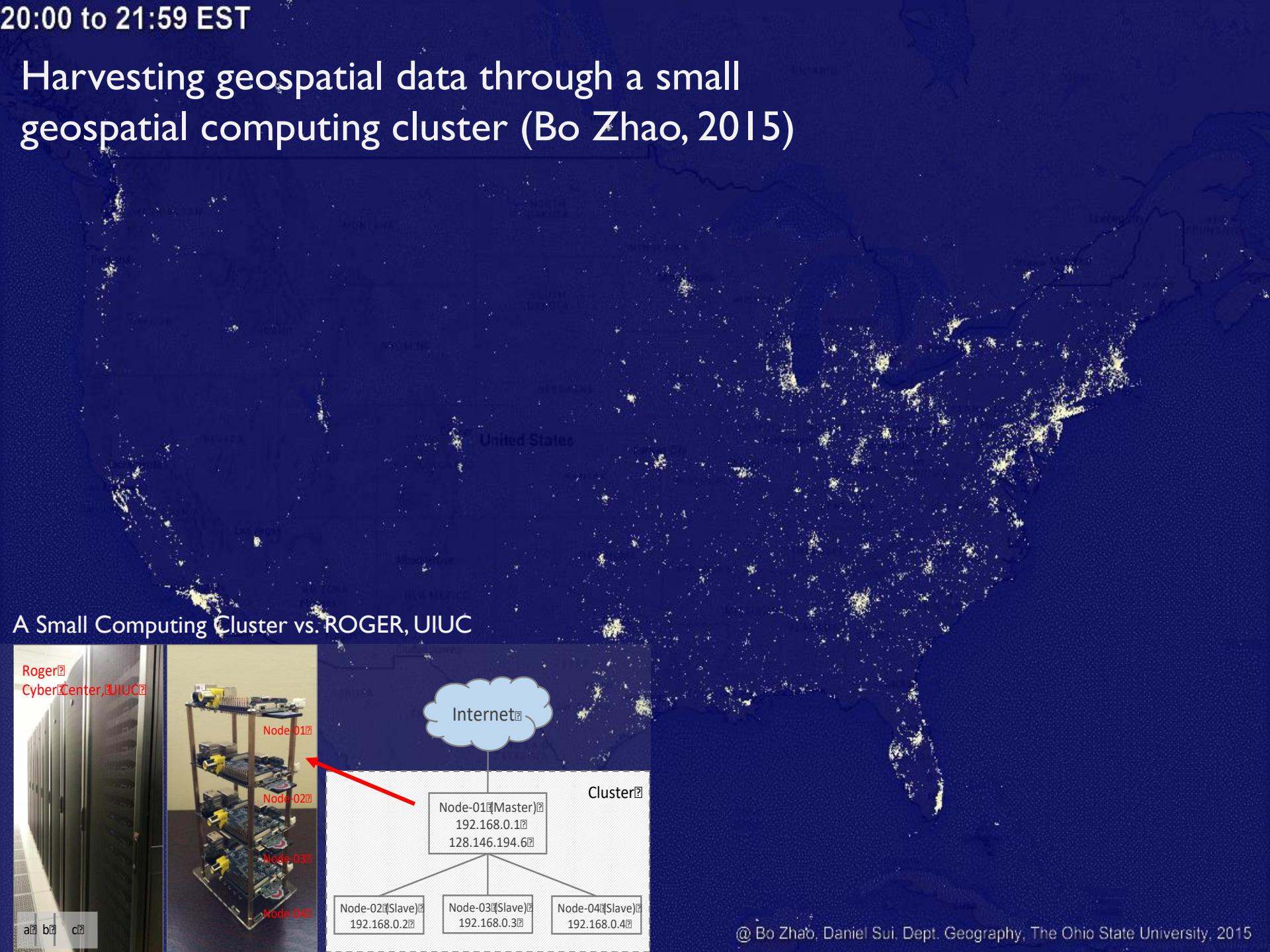


I. Virtual Globe

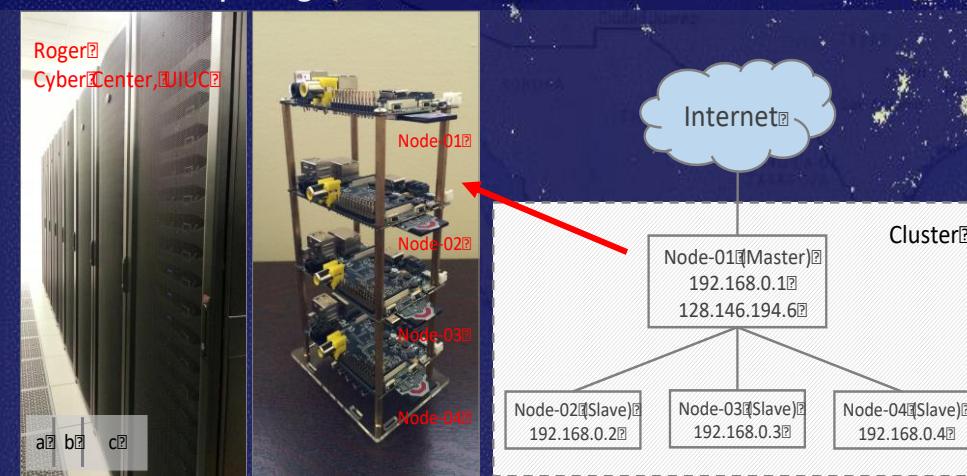
- Digital Earth:
 - Google Earth
 - ArcGlobe by ESRI
- Program for Virtual Globe:
 - United States: EarthCube
 - Europe Union: ENVRI (Environmental Research Infrastructure)
 - China: Tianditu
- Infrastructure:
 - Amazon Web Services
 - ROGER (Resourcing Open Geospatial Education and Research), an NSF funded Cyber GIS infrastructure (Wang, 2015)



Harvesting geospatial data through a small geospatial computing cluster (Bo Zhao, 2015)

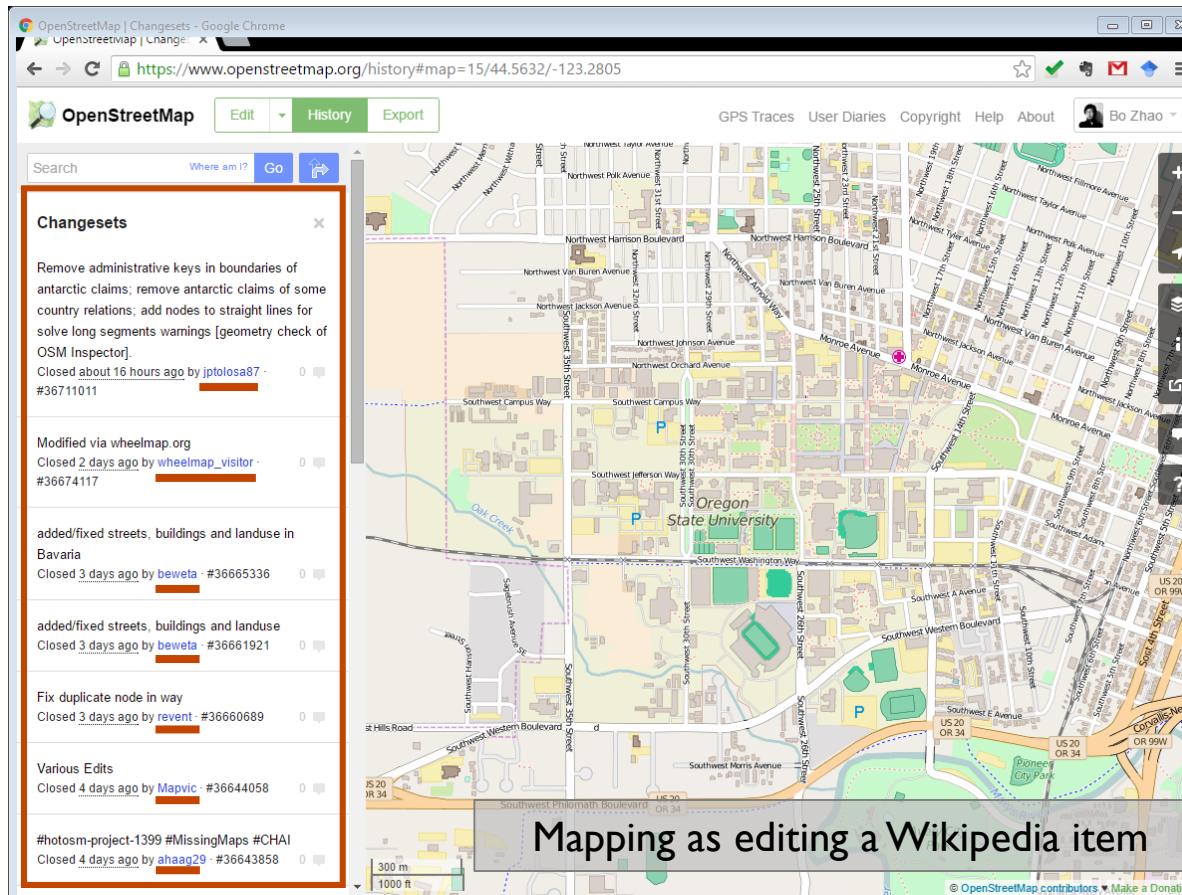


A Small Computing Cluster vs. ROGER, UIUC



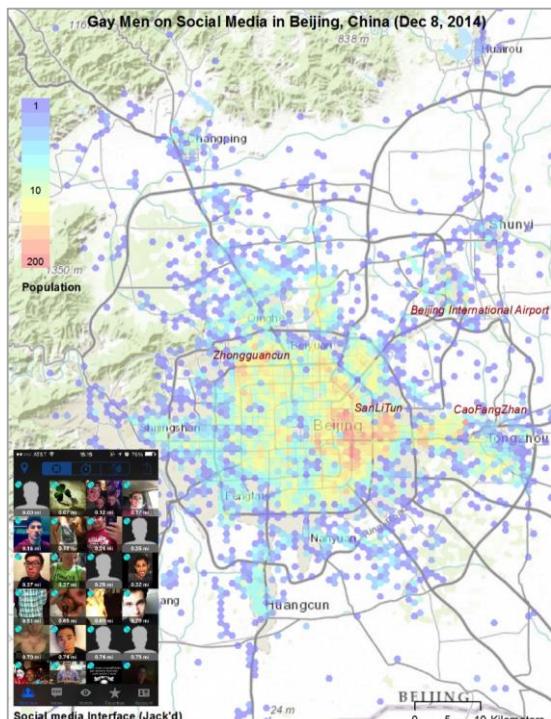
II. Citizen Engagement

- Citizen Science, Crowdsourcing
- VGI: Open street map

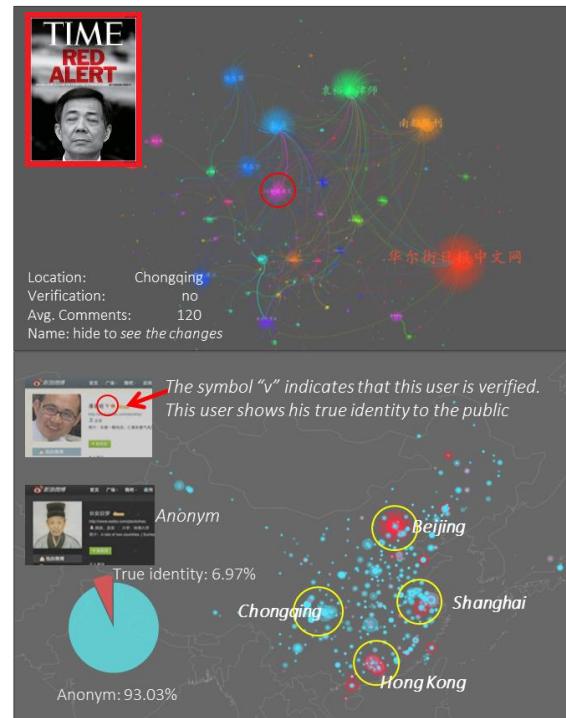


II. Citizen Engagement: Applications

- Forest Fire (Longueville et al, 2009)
- Flood Hazard (Poser et al, 2010)
- Climate Change (Kirilenko, 2014; Williams, 2015)



LGBT Community
(Zhao, 2014)



A Political Scandal
(Zhao, 2012)



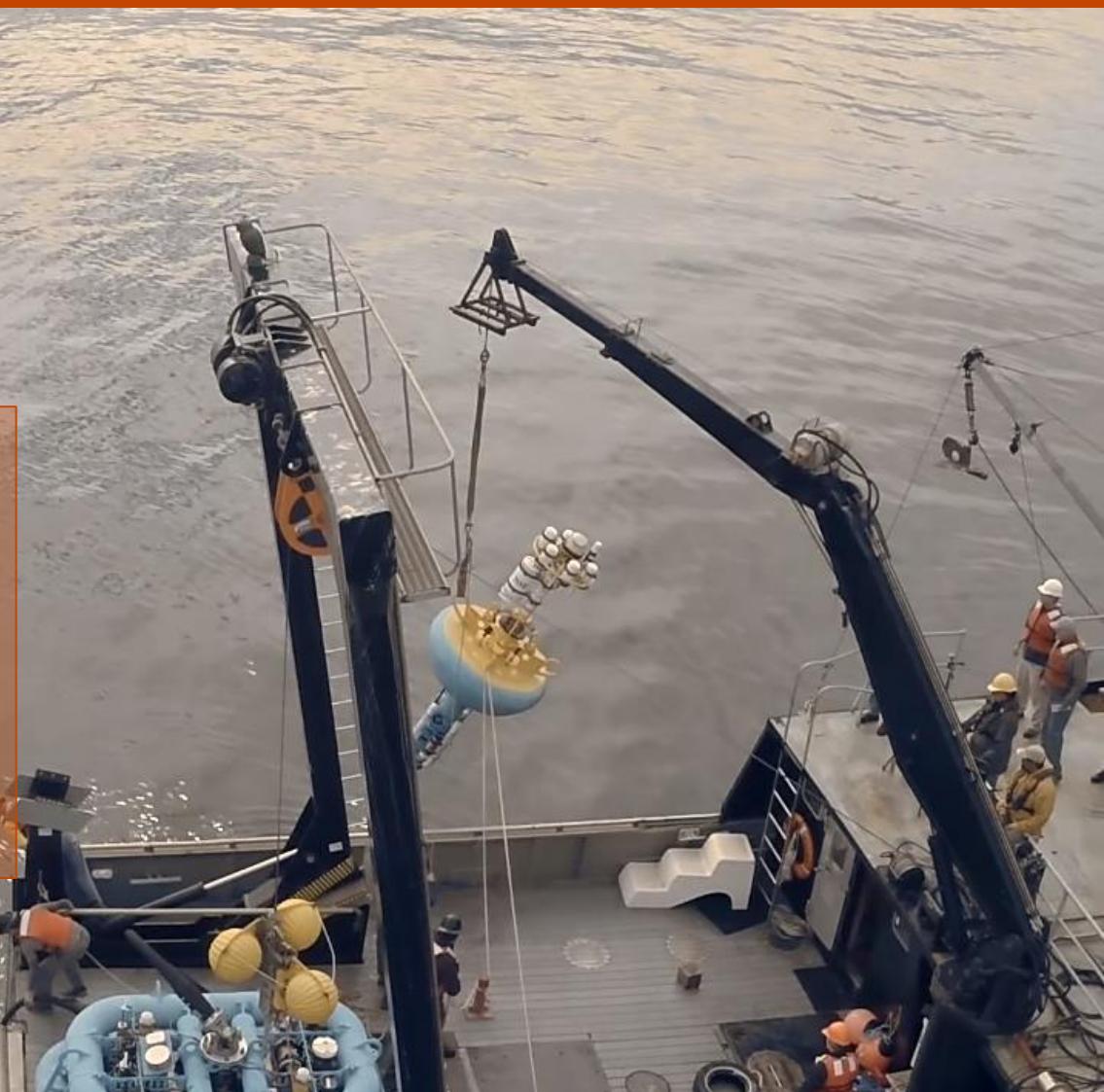
Child Street Beggars
(Zhao, 2011)

III. Coordinates

It will provide continuous, real-time data on ocean conditions in a way never possible before.

On June 3rd, 2015, a team of scientists from CEOAS at Oregon State University deployed research buoys off of Newport, Oregon.

It is the largest marine sciences initiative in the history of the NSF.



III. Coordinates



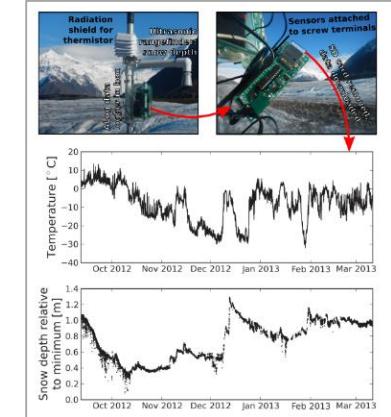
CJRSLRB® 16pcs/lots Raspberry pi 2 B+ sensor module Board package
16 kinds of sensor Set kit
by CJRSLRB
★★★☆☆ 5 customer reviews
#1 New Release in Laptop Barebones
Price: \$27.99 Prime
In stock on January 13, 2016.
Order it now.
Sold by Vidianna and Fulfilled by Amazon. Gift-wrap available.
This item has no Manual. If you mind, please order cautiously.
2 new from \$27.99

Click to open expanded view

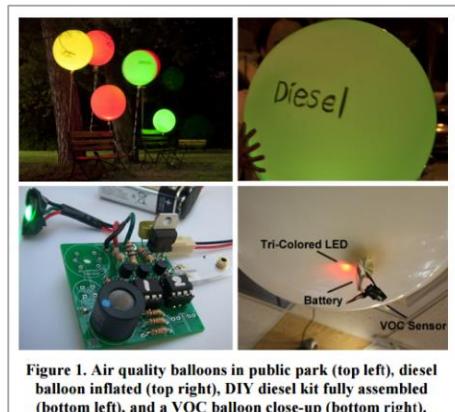
Open Source hardware on Amazon
(Kuznetsov, 2011)



Ocean drifter
(Ganderton, 2014)



Temperature and snow depth sensor
(Wickert, 2014)



Air quality sensor carried by balloons
(Kuznetsov, 2011)



An infant monitor *unfinished*
(Zhao, 2016)

IV. Interactive Maps

Storytelling with Maps



An iPhone App for Historical Sites
(Zhao et al, 2010)

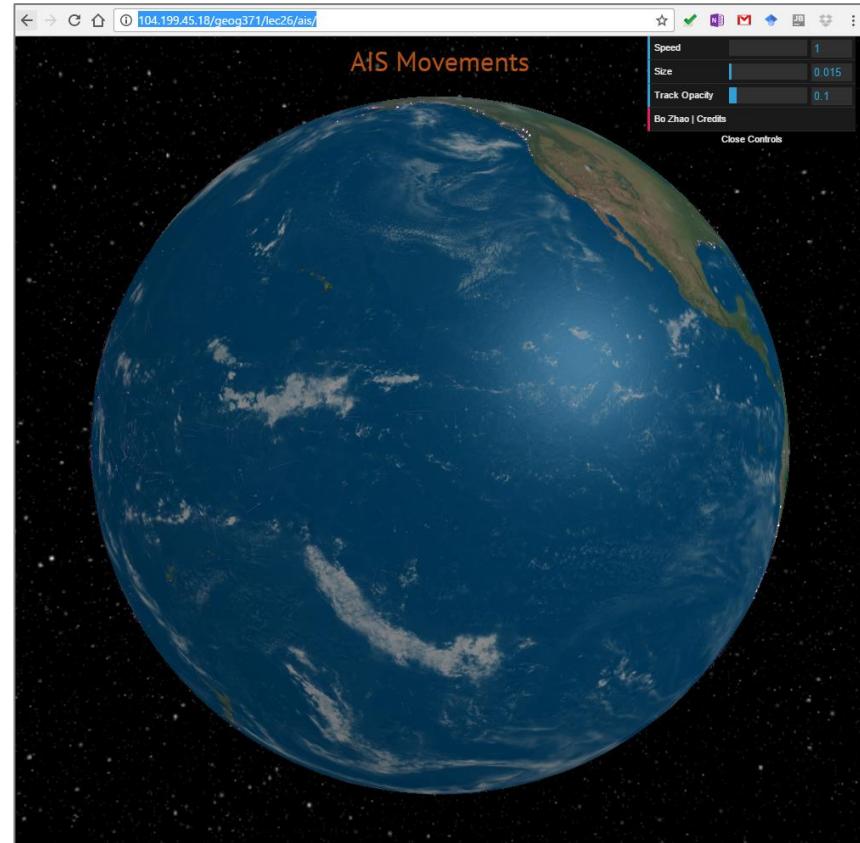
A River Reborn

Salmon return to Washington's Elwha River after the removal of two century-old dams

A Story Map by The Esri Story Maps team

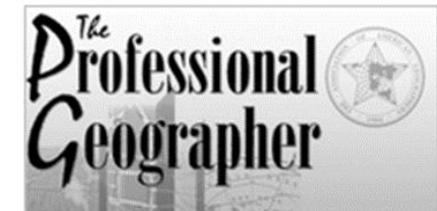
A River Reborn (ESRI, 201X)

WT 2017: GEOG 371 Web Mapping



Can Social Media Clear the Air? A Case Study of the Air Pollution Problem in Chinese Cities

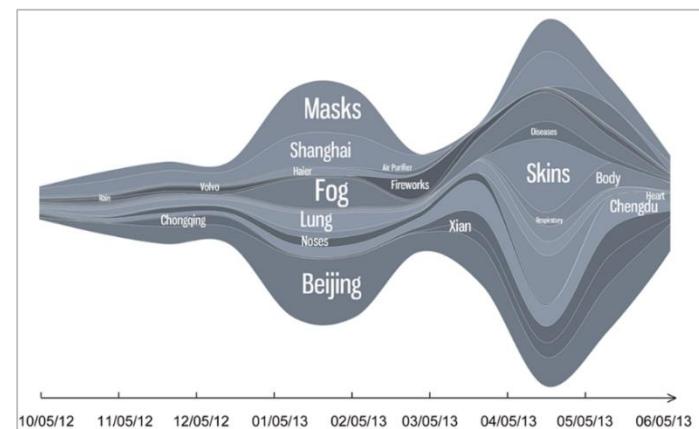
Samuel Kay, Bo Zhao, and Daniel Sui
The Ohio State University



Since the U.S. Embassy in Beijing placed an air quality sensor on its roof and began publishing the results on Twitter in 2008, air quality has gained widespread attention on Chinese microblogs. When the Chinese government introduced new air quality standards in 2012, some hailed this as a victory for Chinese microbloggers, signifying the emergence of social media as a democratizing force leading to greater citizen power. Using a representative sample of microblog posts collected from October 2012 to June 2013 on the topic of air pollution, as well as contextual information from a variety of sources, we examine how the government, companies, nongovernmental organizations, and individuals approach the Chinese social media landscape. We find that although microblogs are capable of empowering citizens to advance an environmental cause, social media have also been increasingly employed by the government as a tool for social monitoring and control and by companies as a platform for profiting from air pollution. **Key Words:** air pollution, Chinese cities, social media, urban political ecology.

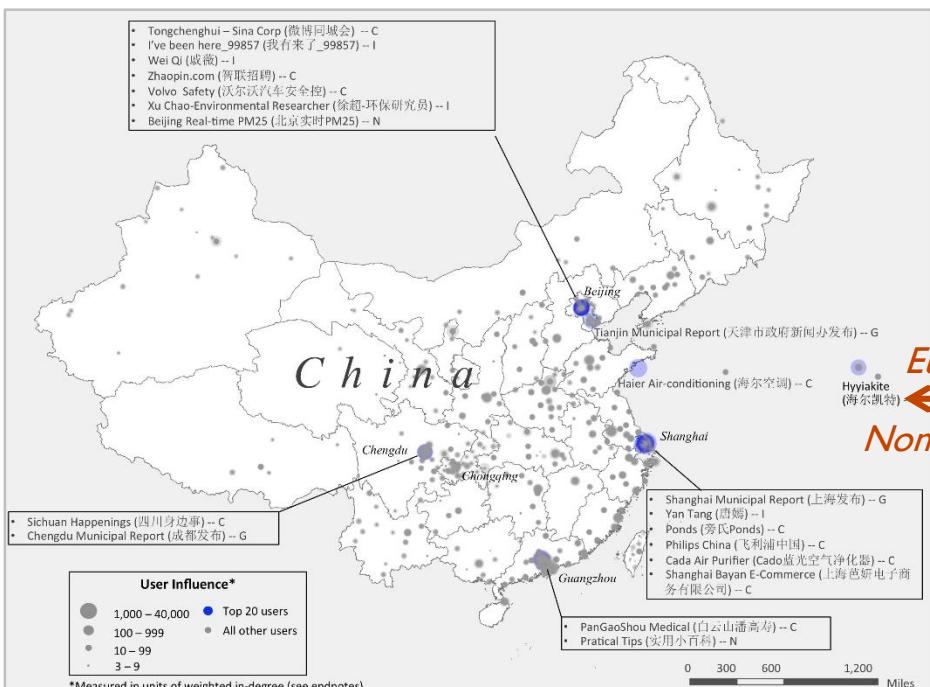


A word cloud of the high-frequency terms in the debate

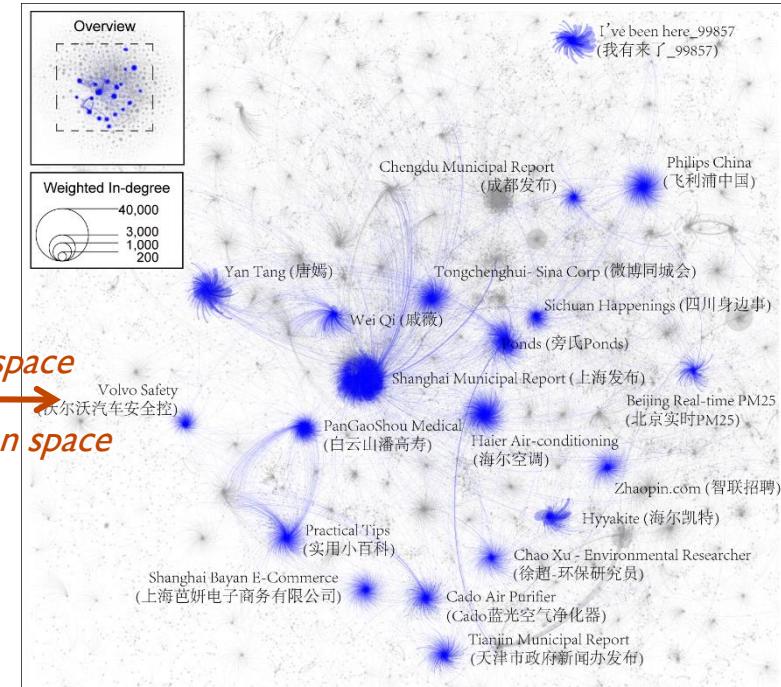


A time stream of the high-frequency terms

Opinion Leaders of the Debate

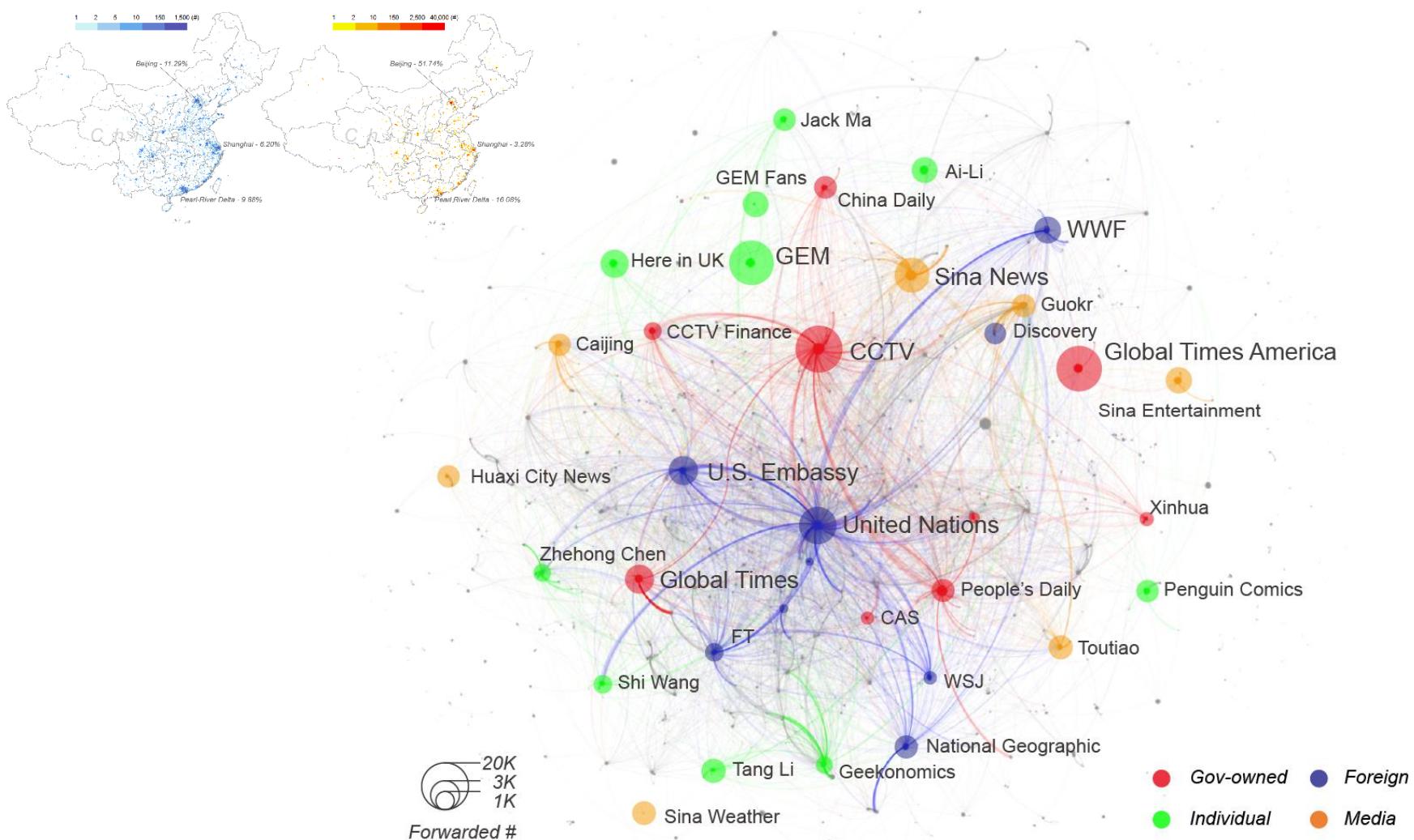


The spatial distribution of the opinion leaders



The social network of the opinion leaders

Who Speaks for Climate Change in China? Evidence from Weibo



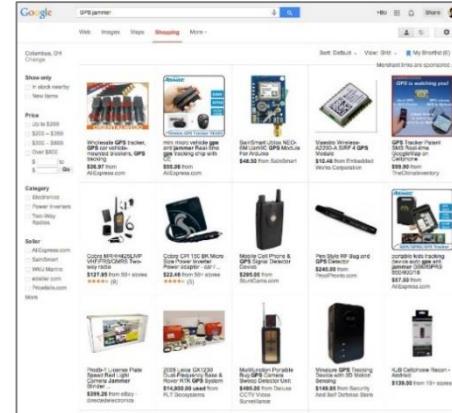
Outline

- An emerging phase of cartography?
- The cartographic frontiers
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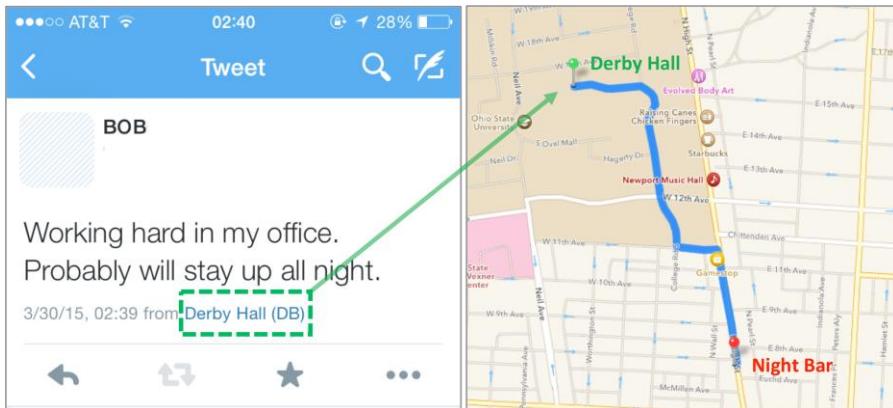
Discussion: Location Spoofing



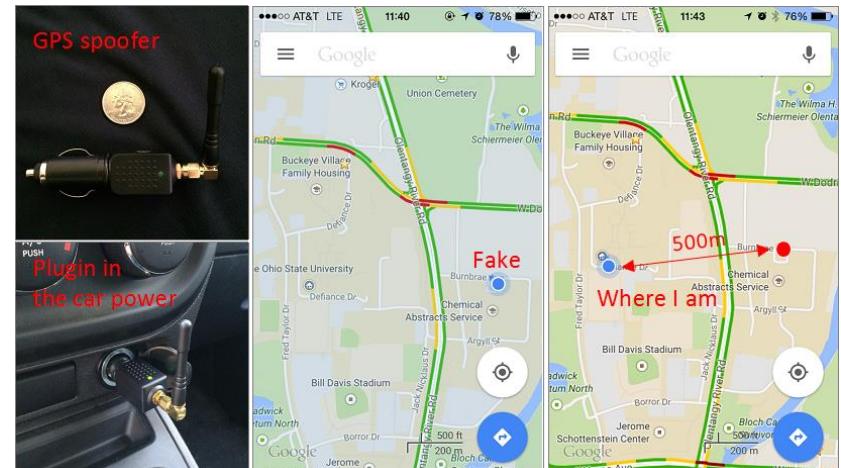
Location Spoofing Apps



GPS spoofers From Google Shopping

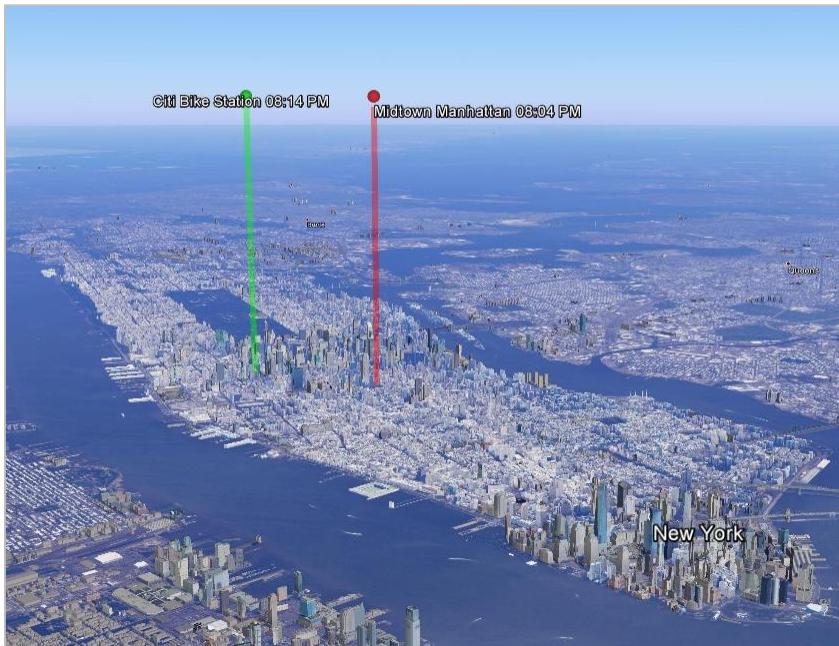


Location spoofing via an app

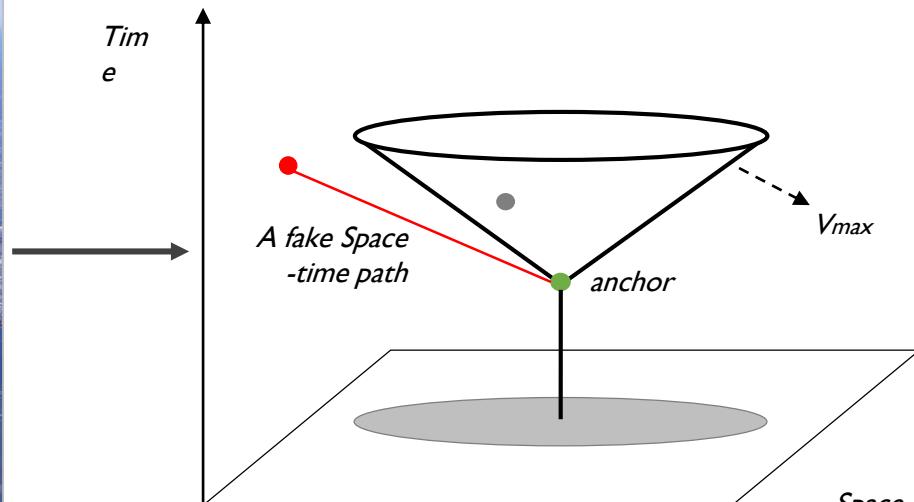


Location spoofing via a mobile GPS spoofer

Detecting location spoofing based on a Bayesian time geographic approach (Zhao, 2015)

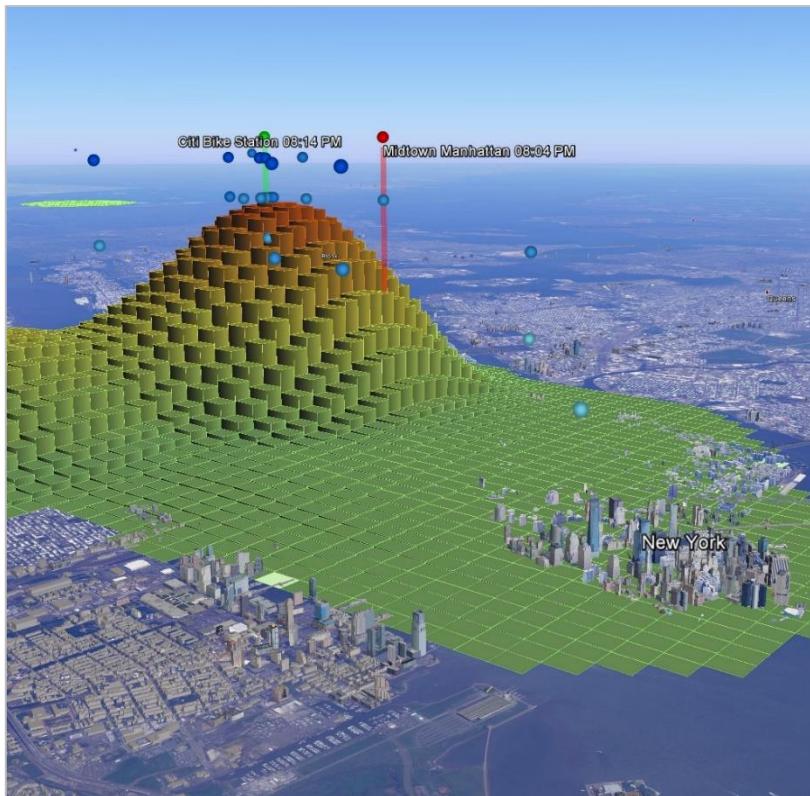


A candidate and its consecutive location



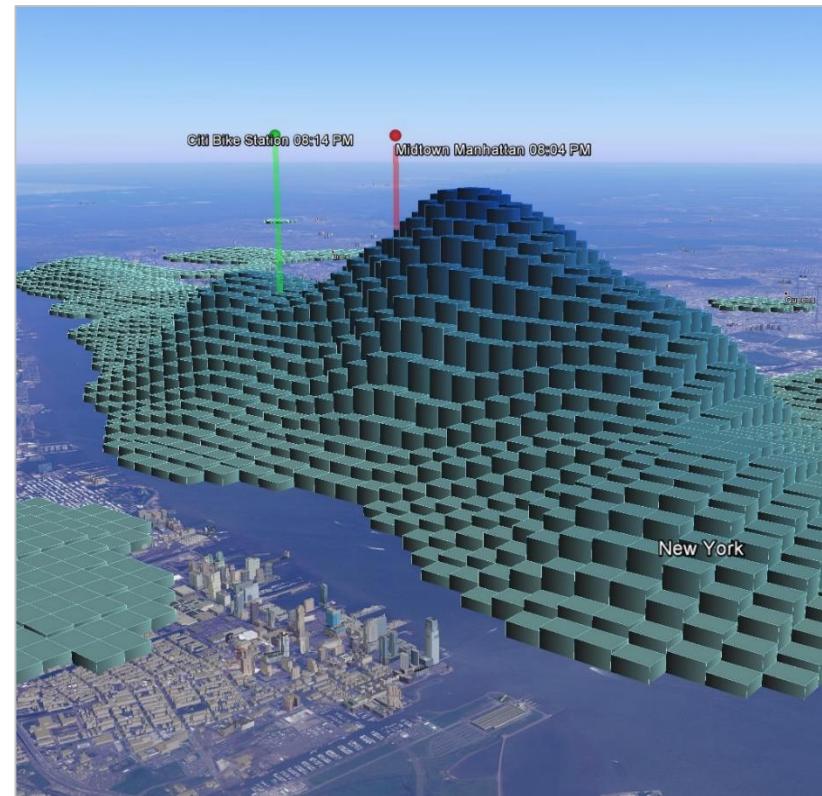
A space-time cone

Detecting location spoofing based on a Bayesian time geographic approach (Zhao, 2015)



Individual Activity Probability $P(A)$

$$P_l(A) = \frac{1}{(N-1)[t(1, N) \cdot v(u)]^2} \sum_{i=1}^{N-1} G \left(\frac{d(i, l) + d(l, i+1)}{t(i, j) \cdot v(u)} \right)$$



Human Appearance Probability $P(H)$

$$P_l(H) = \frac{1}{M[t(1, N) \cdot v(u)]^2} \sum_{j=1}^M G \left(\frac{d(j, l)}{rt(j, l) \cdot v(u)} \right)$$

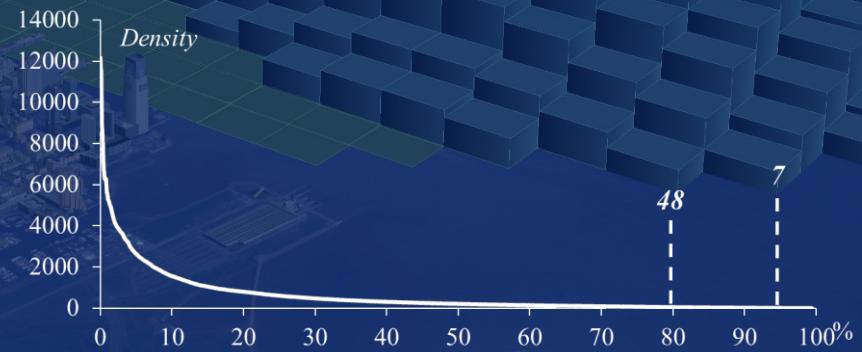
Citi Bike Station 08:14 PM

Midtown Manhattan 08:04 PM

Visiting probability

$$P(V) = P(A|H) = P(A) \cdot \frac{P(H|A)}{P(H)}$$

$$P(H|A) = \begin{cases} P(H) & D > p \\ P(A) & 0 < D \leq p \end{cases}$$



M

@M

An introvert masquerading as an extrovert

Gainesville, FL

Joined January 2013

Can you
8:51 PM · 03

M @M 8:52 PM 03 Feb 14

Apparently I was in Mexico

Port St. Lucie, FL

Reply Retweet

P Tweet Retweet

M @M 8:51 PM 03 Feb 14

Can you keep up? Baby boy

Baby boy in Mexico

For Fun

Inspiring to see the world

HOME LET'S GET OUT THERE TRAVEL ESSAYS VIAJERA PROFILES SAFE TRAVELS ABOUT VIAJERA FI

YOU ARE HERE: HOME / FEATURED / SETJETTING: GAME OF THRONES FILMING LOCATIONS

Setjetting: Game of Thrones Filming Locations

Glen and I are among the millions of avid fans of the show who are thrilled that much anticipated fifth season is finally here. I believe it's a function of the iPhone, detecting and saving the location of where the photo was taken, even when posted on Instagram.

Via Seeing the world through the eyes of the Filipina traveler
ATL/MNL/???
Joined March 2013

Via Sorry, I misunderstood your original question. No, I was not at those locations when I posted them on Instagram.
@jakobzhao

For marketing

Ja 8:51 PM 03 Feb 14

It be so cold in NYC #layover #pitstop #ohtheplacesyoullgo @ Queens, New York

Port St. Lucie, FL

Reply Retweet

P Tweet Retweet

Ja 8:51 PM 03 Feb 14

Bar that sells panties by day? So many questions... @ 万达广场 Wanda Plaza

Port St. Lucie, FL

Reply Retweet

P Tweet Retweet

Interview Text

Ja Apr 15

I was in NYC at that time. Pictures from China were geotagged and later uploaded on layover in Vancouver. Hope that helps!

View conversation

For recording visited places

Discussion – Identified Location Spoofers

2 个月前 · 9 Majestic Elegance Punta Cana, Punta Cana, Dominican Republic

SHOUT OUT TO OUR MANAGER OF DC LOCATION

@skeeterkelly TAKING SYN INTERNATIONALLY! WE GONNA MISS YOU BUDDYSEE YOU SOON!!

#dominicancanary #rockrichmond #werocktheDR# #GlowIndustries #islanddyes_chp #islanddyesvra #werocktheDR# #werocknorfolk #werocktheDR#

2 个月前 · 9 Majestic Elegance Punta Cana, Punta Cana, Dominican Republic

SHOUT OUT TO OUR MANAGER OF DC LOCATION

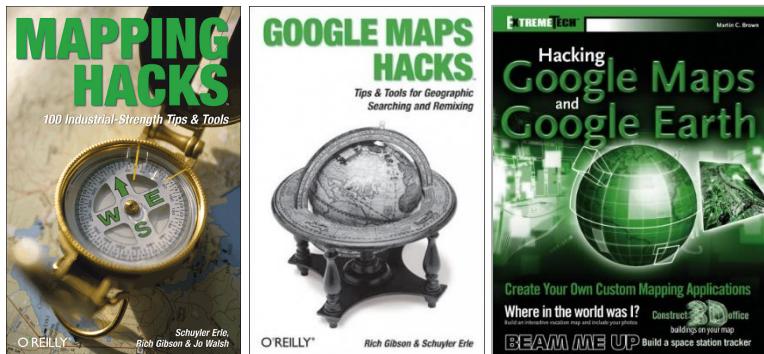
@ TAKING SYN INTERNATIONALLY! WE GONNA MISS YOU BUDDYSEE YOU SOON!!

#dominicancanary #puntAcana#syn #grecosciece #GlowIndustries #IslandDyes_chp #islanddyesvra #werocktheDR# #werocknorfolk #werocktheDR# #knorfolk #gotvape #heartofpercutal #19_isaandkate alta_tec and 25

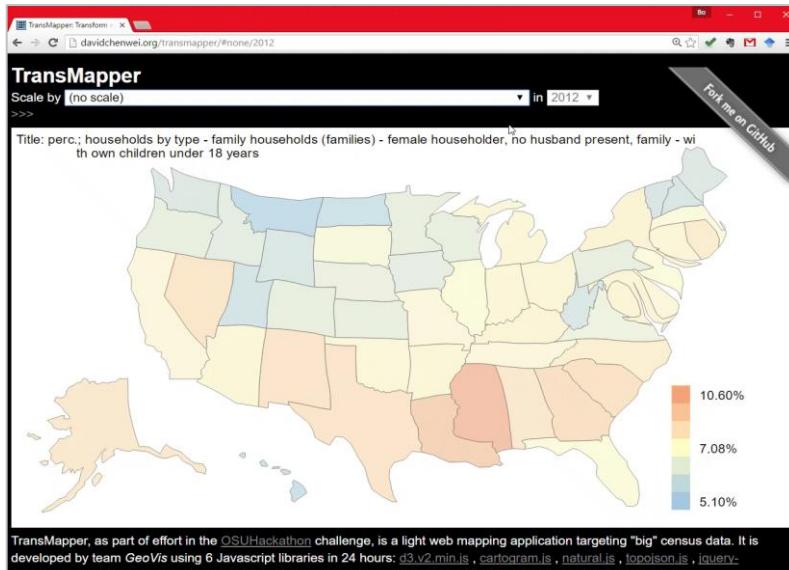
syndicate marijuana

For attracting audiences from elsewhere²³

New Cartographic Practices



Books on mapping hacks



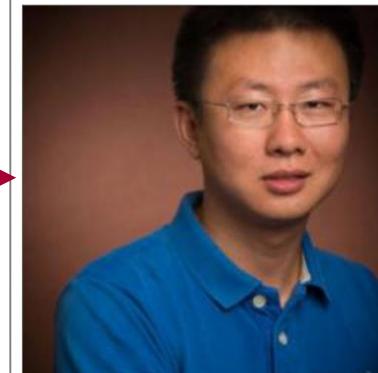
Web based Cartogram (Zhao et al, 2013)

Cartographers as Hackers?

Mapping as Hackathon?

CURA Affiliate Wins Third Place at OSU's Hackathon

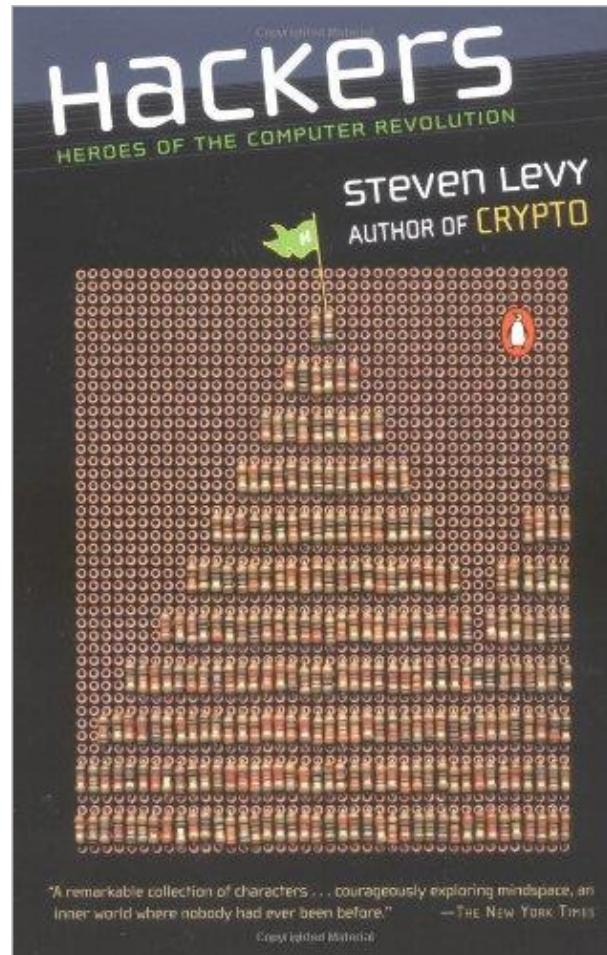
November 12, 2013



CURA Graduate Affiliate [Bo Zhao](#) was part of a three-person team that won third prize at [OSU's Hackathon 2013](#).

To view the team's light web mapping application for big data, the Transmapper, you can click [here](#). And to read stories about the event, you can check out this [Dispatch article](#) or this [Lantern article](#).

New Cartographic Ethics?



1. Access to computers should be unlimited and total.
2. All information should be free.
3. Mistrust authority -- promote decentralization.
4. Hackers should be judged by their hacking, not bogus criteria such as degrees, age, race, or position.
5. You can create art and beauty on a computer.
6. Computers should change our life for the better.

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Conclusion: Shifting Cartographic Paradigms

Paradigms	Research Focus	
	Map Construction	Map use
Map as Images (The communicative/cognitive tradition)	Visual symbol design, color use, graphical hierarchy, and figure/ground	Reading, visualizing, communicating, and metaphor
Map as Model (The analytical tradition)	Data structure design, and algorithm development	Analytical modelling, hypothesis testing, and simulation
Maps as Intent/Social Construction (The critical tradition)	Distortion/biases built-in, power relationship, ethical consideration	Power and control, governance, propaganda tool
<i>Maps as Wiki</i>	<i>Mashing up via heterogeneous media/ sensors from both amateurs and experts</i>	<i>Geo-narrative, map story telling</i>



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Thanks For Choosing GEOG 371: Web Mapping!

