CGA Conference 2018

Illuminating Space and Time in Data Science

April 26th - 27th, 2018

1730 Cambridge St., Cambridge, MA 02138

Co-organizers:
Center for Geographic Analysis
The Harvard Data Science Initiative
Esri
Co-sponsors:
I/UCRC Spatiotemporal Innovation Center
MapD Technologies, Inc.

* Image Source: ResearchGate

Introduction

The rapid proliferation of ‘smart’ objects has enabled a variety of sensors operating at a wide range of scales -- from the body to the planet -- resulting in unprecedented volumes of digital data. The field of Data Science has emerged to take on the challenges of this proliferation. Data Science includes discovering, under-standing and communicating complex behaviors, patterns, relationships and trends from “big data” using mathematics/statistics, computation/automation, and domain knowledge -- combined. Data Science has as its subject nearly any domain for which there exists high-volume, high-velocity and/or high-variety information that demands cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.

Data Science provides a renewed opportunity to consider the importance of spatial relationships at the heart of these smart sensors and Internet of Things (IoT). In-deed, space and time are core properties of so-called ‘big data,’ and spatiotemporal analysis is inherently an important facet of Data Science. From satellite images to social media streams, from census and parcels to records of trade, food, energy, climate, disease, crime, conflicts, etc., big data with space and time signatures are essential for understanding our world and responding to its challenges.

This conference aims at bringing together mainstream data scientists and geo-graphic information scientists, to review the status of both fields, explore commonalities between the two, and explore the interrelationships of space and time in Data Science. The program will highlight new breakthroughs in Data Science; examine how to incorporate them into GIScience; demonstrate GIScience contributions to Data Science, particularly in terms of handling space and time; explore the relationship between Data Science and GIScience; discuss opportunities for reaching new audiences; and identify common training needs for data scientists and GIScientists.

The event will start with a half-day of hands-on demo and training workshops on Thursday afternoon, followed by a full day of plenary sessions on Friday, which will include keynote addresses, presentation sessions, panel discussions, and closing remarks. Invited speakers will engage with the audience in discussions on the current status, achievements, lessons learned, unmet needs, challenges, potentials, and perspectives of spatiotemporal analytics in the context of Data Science, particularly as it relates to academic research and learning.

For more information about CGA conferences, please go to http://gis.harvard.edu/events/conferences

Program

DAY 1 - Thursday, April 26, 2018 1:00-5:30PM **Room CGIS S020**

1:00PM *Registration*

1:30PM **Welcome & Orientation**
Jason Ur
Moderator: Matthew Wilson

1:40PM **Interacting with National Water Model (NWM) Predictions**
Devika Kakkar (CGA), Aaron Williams (MapD)
Moderator: Ben Lewis

2:20PM **Spatiotemporal Methodologies and Analytics for Extreme Weather Study – Using Dust Storm Event as an Example**
Manzhu Yu (STC & GMU)
Moderator: Ben Lewis

3:00PM *Coffee Break*

3:15PM **GeoAI: Machine Learning Meets GIS**
Omar Maher (Esri)
Moderator: Wendy Guan

4:45PM **Big Flow Data Visual Analytics through TrajAnalytics**
Xinyue Ye (KSU & CGA)
Moderator: Wendy Guan

Program

DAY 2 - Friday, April 27, 2018 8:30 – 5:40PM **Room CGIS S010**

8:30AM	***Registration***
9: 00AM	**Welcome, Introduction and Overview** *Elizabeth Hess (Harvard)* *Moderator: Jason Ur*
9:10AM	**Keynote - DATA SCIENCE AND OUR ENVIRONMENT** *Francesca Dominici (Harvard)* *Moderator: Jason Ur*
9:40AM	**Panel 1: Sensors, Smart Objects and Infrastructure for Data Science** *Peter Fox (Rensselaer), Michael Goodchild (UCSB), Brendan Meade (Harvard), Carlo Ratti (MIT), Chaowei Phil Yang (GMU)* *Moderator: Matt Wilson*
11:00AM	***Coffee Break***
11:10AM	**Panel 2:Crowdsourcing, Geocomputation, and Spatiotemporal Analysis** *Amen Ra Mashariki (Esri), Amelia McNamara (Smith College), Shashi Shekhar (UMN), Alex Singleton (Liverpool), Robert Stewart (ORNL)* *Moderator: Ben Lewis*
12:30PM	***Lunch Break & Poster Session – CGIS South Concourse***
2:00PM	**Keynote - THE LANDSCAPE OF GISCIENCE** *Michael Goodchild (USCB)* *Moderator: Jason Ur*
2:30PM	**Panel 3: Data Science for Cities, Health, and Environment** *Emad Khazraee (Harvard Berkman/Kent State), Amy Lobben (Oregon), Bjoern Menze (TU Munich), Andres Sevtsuk (Harvard GSD), Renee Sieber (McGill)* *Moderator: Stephen Ervin*
3:50PM	***Coffee Break***
4:00PM	**Panel 4: Geography, Civic Engagement, and the Future of Data Science** *Jessica Block (UCSD), Chris Cappelli (Esri), Robert Chen (Columbia), Krzysztof Janowicz (UCSB), Diana Sinton (UCGIS)* *Moderator: Matt Wilson*
5:20PM	**Poster Awards** *Jason Ur* *Moderator: Jeff Blossom*
5:30PM	**Closing Remarks - Convergence of Data Science and GIScience** *David DiBiase (Esri) and Matt Wilson (UKY)* *Moderator: Jason Ur*

Abstract and Biography

Day 1 April 26, 2018

Welcome & Orientation

Jason Ur

Jason Ur is Professor of Anthropology in the Department of Anthropology at Harvard University, and director of its Center for Geographic Analysis. He specializes in early urbanism, landscape archaeology, and remote sensing, particularly the use of declassified US intelligence imagery. He has directed field surveys in Syria, Iraq, Turkey, and Iran. He is the author of Urbanism and Cultural Landscapes in Northeastern Syria: The Tell Hamoukar Survey, 1999-2001 (2010). Since 2012, he has directed the Erbil Plain Archaeological Survey, an archaeological survey in the Kurdistan Region of northern Iraq. He is also preparing a history of Mesopotamian cities.

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Interacting with National Water Model (NWM) Predictions

Devika Kakkar (CGA), Aaron Williams (MapD)

Abstract: *In this workshop, we will show how CGA researchers are using MapD's open-source, GPU-powered SQL database to provide true interactive access to NWM predictions for stream flow and ground saturation across the entire continental US, from present conditions to 18 days in the future. Predictions can be viewed prospectively, "how will conditions change going forward?" as well as retrospectively, "how did condition predictions evolve up to any given present?" Water conditions can also be tracked in space and time together as storms move across the country. Immerse, a Web-based MapD visualization tool, makes many such model interpretations quick to set up and interact with.*

The speed and flexibility of the GPU analytics platform allows questions such as "how did the stream flow prediction error change over time?" to be answered quickly with SQL queries, and facilitates joining in additional data such as the location of bridges and other vulnerable infrastructure, all with relatively low-cost computing resources. MapD, as an open-source high-performance geospatial computing tool, has the potential to greatly broaden access to the full benefits of large-scale environmental models being deployed today.

Devika Kakkar is a former researcher at Fraunhofer IIS in Germany where she developed indoor navigation systems. Prior to that, she worked as a research assistant with the London School of Economics and at the German Research Foundation. Devika holds a Master's degree in Geodesy and Geoinformation Science from the Technical University of Berlin and a Bachelor in Civil Engineering from the Harcourt Butler Technological Institute in India. Her past research has focused on Indoor Positioning, GIS, and Urban Economics.

Aaron Williams is responsible for MapD's developer, user and open source communities. He comes to MapD with more than
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two decades of previous success building ecosystems around some of software's most familiar platforms. Most recently, he ran the global community for Mesosphere, including leading the launch and growth of DC/OS as an open source project. Prior to that, he led the Java Community Process at Sun Microsystems, and ecosystem programs at SAP. Aaron has also served as the founding CEO of two startups in the entertainment space. Aaron has an MS in Computer Science and BS in Computer Engineering from Case Western Reserve University.

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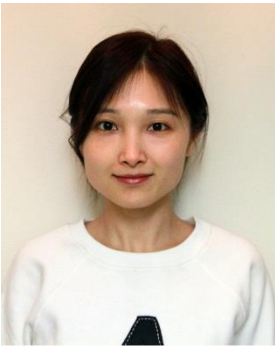
Spatiotemporal Methodologies and Analytics for Extreme Weather Study – Using Dust Storm Event as an Example

Manzhu Yu (STC & GMU)

Abstract: *Dust storm represents a serious hazard to health, property, and the environment in arid and semi-arid areas. To mitigate the hazardous impact of dust storms, it is crucial to detect an upcoming dust event and predict its evolution to inform the early warning and decision-making process. Various dust models have been developed in the past decades to predict dust storms to provide valuable information for early warning. A series of challenges associated with dust modeling and the computational analysis of dust simulation was determined via a critical review of existing approaches in the literature. This research introduces the problems associated with dust model uncertainty, challenges of automatically identifying dust features, tracking the evolution pattern of dust events, and challenges in spatiotemporal data framework. This research is presented into spatiotemporal methods for addressing the above-mentioned problems and challenges. This research provides a pipelined strategy for efficiently translating forecast to real-time early warning information, and relieves scientists and forecasters from labor-intensive interpretation. The result of this research is a ready-to-use application, visualizing dust events over space and time in a graphic user interface. These algorithms provide insight on how dust processes transport in the vertical dimension, helping meteorologists better understand the dust process and forecasters to test hypotheses and enhance dust prediction capabilities. Additionally, policy makers can use the information derived from the application to mitigate the impact of dust storms on populations that are particularly vulnerable to airborne and respiratory diseases and to better determine whether a disease outbreak is the causal effect of transported dust. With this intuitively derived information, the public can better prepare and protect their health, avoid traffic accidents and shelter personal assets.*



Manzhu Yu received her bachelor's degree in Remote Sensing from Wuhan University in 2008 and was awarded her Ph.D. degree in Earth Systems and Geoinformation Sciences in 2017 from George Mason University. Currently, she works as a postdoc research associate at the NSF Spatiotemporal Innovation Center. Her research mainly focuses on the core areas of GIScience and outreach to environmental science and computational science. And her research interest includes spatiotemporal analytics, deep learning, remote sensing, and big spatial data and cloud computing, and the application of these to solve pressing environmental issues. Her researches are published in
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top-tier journals including International Journal of Geographic Information Science (IJGIS), Computers, Environment and Urban Systems (CEUS), and PLoS ONE. She is the second author of a textbook and author of multiple book chapters. Her research won first place in the Best Paper Competition at the Second International Symposium on Spatiotemporal Computing in Boston in August 2017.

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GeoAI: Machine Learning Meets GIS

Omar Maher (Esri)

Abstract: *The intersection between AI and GIS (GeoAI) is creating massive opportunities that were not possible before. Organizations will be able to utilize GeoAI to detect deep and complex spatiotemporal patterns in their data, and use that to predict geospatial events of interest – at scale, and in real-time. Come and explore live GeoAI applications in Logistics, commercial, environment protection, public safety, national security, etc.. Demonstrations include Road Accidents Prediction, ETA Prediction, Automated Road Detection, Object Detection from Satellite Imagery, and more.*

Omar Maher is a Machine Learning enthusiast with 10+ years of experience in Analytics & Artificial Intelligence (AI). He's currently the Practice Lead for Machine Learning at ESRI – the global GIS provider, working on the intersection of AI and GIS. Omar cofounded two tech startups that heavily used machine learning for providing smart user recommendations and personalized experience, and served as the analytics lead for other multinational companies. Most recently Omar has been working with a variety of government entities to look at ways of utilizing AI for high resolution land cover, smart digitization of roads, automating neighborhood stabilization processes, and road accidents probability prediction.

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Big Flow Data Visual Analytics through TrajAnalytics

Xinyue Ye (KSU & CGA)

Abstract: *Thanks to advanced technologies in sensing and computing, the mobility patterns and dynamics of urban cities and their citizen are recorded and manifested in a variety of urban trajectory datasets, which include the moving paths of human, taxi, bus, fleets, cars, and so on. Understanding and analyzing such large-scale, complex data is of great importance to enhance both human lives and urban environments. TrajAnalytics provides exploratory data visualization tools for researchers, administrations, practitioners and general public to understand the data and to reveal knowledge intuitively. TrajAnalytics is a visual analytics software, which integrates scalable data management and interactive visualization with a powerful web-based computing platform.*

Xinyue Ye is the founding director of Computational Social Science Lab at Kent State University since 2013. He was elected to Chair of AAG Regional Development and Planning Specialty Group (2014-15), Co-Chair of AAG Asian Geography Specialty Group (2015-17), and President of International Association of Chinese Professionals in Geographic Information Science (2016-17).

Day 2 April 27, 2018

Welcome, Introduction & Overview

Elizabeth Hess (Harvard)

Exploring the Relationship between Data Science and GIScience

Elizabeth Hess is the Executive Director of the Institute for Quantitative Social Science. In partnership with the IQSS Faculty Director, Gary King, she is responsible for overall strategic, programmatic, and financial management of IQSS, working across the organization to ensure delivery of first-class research and administrative infrastructure to support its constituents. In addition, she oversees programmatic activities including software development projects, cloud computing resources, internal and external collaborations, and new program development.

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Keynote – Data Science and Our Environment

Francesca Dominici (Harvard)

Abstract: *What if I told you I had evidence of a serious threat to American national security – a terrorist attack in which a jumbo jet will be hijacked and crashed every 12 days. Thousands will continue to die unless we act now. This is the question before us today – but the threat does not come from terrorists. The threat comes from climate change and air pollution.*

We have developed an artificial neural network model that uses on-the-ground air-monitoring data and satellite-based measurements to estimate daily pollution levels across the continental U.S., breaking the country up into 1-square-kilometer zones. We have paired that information with health data contained in Medicare claims records from the last 12 years, and for 97% of the population ages 65 or older. We have developed statistical methods and computational efficient algorithms for the analysis over 460 million-health records.

Our research shows that short and long-term exposure to air pollution is killing thousands of senior citizens each year. This data science platform is telling us that federal limits on the nation's most widespread air pollutants are not stringent enough.

This type of data is the sign of a new era for the role of data science in public health, and for the associated methodological challenges. For example, with enormous amounts of data, the threat of unmeasured confounding bias is amplified, and causality is even harder to assess with observational studies. These and other challenges will be discussed.

Francesca Dominici is Professor of Biostatistics at Harvard T.H. Chan School of Public Health, and the Co-Director of Harvard Data Science Initiative. Dr. Francesca Dominici is a data scientist whose pioneering scientific contributions have advanced public health research around the globe. Her life's work has focused broadly on developing and advancing methods for the analysis of large, heterogeneous data sets to identify and understand the health impacts of environmental threats and inform policy.

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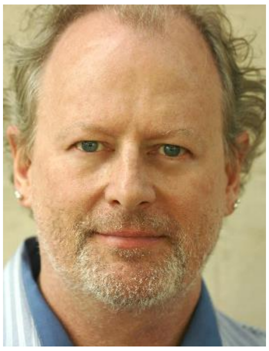
Panel 1: Sensors, Smart Objects and Infrastructure for Data Science
Peter Fox (Rensselaer), Michael Goodchild (UCSB), Brendan Meade (Harvard), Carlo Ratti (MIT), Chaowei Phil Yang (GMU)

This panel will discuss the variety of new systems for sensing, including smart objects and location-based services, an expansion of the Internet of Things (IoT), and new infrastructure for research and development.

Implementation of Open-World, Integrative, Transparent, Collaborative Research Data Platforms - The University of Things (UoT)

***Abstract*: *University-based scientific research collaborations are complex interactions among people who require multiple resources, tools, skills and competencies. While traditional modes of collaboration such as face-to-face are common, many interactions are increasingly virtual / asynchronous. The organization and management of data, information and knowledge artifacts in collaborations is non-trivial: emails, threaded discussions, recorded video conferences, cloud storage/ shared drives, online collaborative editing, online notebooks, and more. In this contribution, we will discuss essential aspects of interoperation in computer-to-computer environments with the goal of accommodating heterogeneous research scenarios. Since university administration is increasingly attentive to research activities, outputs and impacts, but also the interconnectedness of these elements to people in the research enterprise we also discuss progress toward a university of things (cf. internet of things) and implications for research and administrative information infrastructures.*



Peter Fox is Tetherless World Constellation Chair, Professor of Earth and Environmental Science, Computer Science and Cognitive Science, and Director of the Information Technology and Web Science Program at Rensselaer Polytechnic Institute. Fox has a B.Sc. (hons) and Ph.D. in Applied Mathematics (physics and computer science) from Monash University. Fox researches in computational and computer science; ocean and environmental informatics; and distributed semantic data frameworks, with applications to large-scale distributed data science investigations. Fox served as President of the Federation of Earth Science Information Partners (ESIP; 2014-2016), and as chair of the International Union of Geodesy and Geophysics Union Commission on Data and Information (2007-2015). Fox serves on the editorial boards of many prominent Earth and space science informatics and data journals. In 2012, Fox was awarded the European Geoscience Union, Ian McHarg/ Earth and Space Science Informatics (ESSI) Medal, and ESIP's Martha Maiden Lifetime Achievement award for service to the Earth Sciences Information communities and in 2015 was elected as the first ESSI fellow for the American Geophysical Union. http://tw.rpi.edu/web/person/PeterFox

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Sensing in Space and Time

***Abstract*: *Today GPS enables easy attribution of sensor records with location in space and time. Yet many applications in research require interpolation from point records to continuous fields in two, three, or four dimensions. How, for example, can records from a few expensive and sparsely located sensors of atmospheric*
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PM2.5 be extended to support estimation of exposure to individuals traveling through a 4D field? What effect will the locations of sensors have on interpolated estimates and their uncertainties? How can "soft" data from cheaper and more abundant sensors be integrated with the "hard" data from expensive sensors? In another example, how can the uncertainties associated with socioeconomic estimates from the American Community Survey be integrated into research in the spatially and temporally empowered social sciences? The presentation will use these and other examples to illustrate some of the issues associated with sensing in space and time.

Michael F. Goodchild is Professor Emeritus of Geography at the University of California, Santa Barbara. Until 2012 he held the Jack and Laura Dangermond Chair of Geography and was Director of UCSB's Center for Spatial Studies. He received his BA degree from Cambridge University in Physics in 1965 and his PhD in Geography from McMaster University in 1969. His research and teaching in-terests focus on issues in geographic information science, including uncertainty in geographic information, discrete global grids, and volunteered geographic infor-mation. He has directed or co-directed several large funded projects, including the National Center for Geographic Information and Analysis, the Alexandria Digital Library, and the Center for Spatially Integrated Social Science. He was elected member of the US National Academy of Sciences in 2002, and Foreign Member of the Royal Society and Corresponding Fellow of the British Academy in 2010; and in 2007 he received the Prix Vautrin Lud. He has published over 550 books and articles. He moved to Seattle upon retirement in 2012, and currently holds part-time positions as Research Professor at Arizona State University and as Dis-tinguished Chair Professor at Hong Kong Polytechnic University. His full CV is at www.geog.ucsb.edu/~good.

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Scientific Discovery in the Age of AI

Abstract: *The AI revolution is rebuilding science. No longer are scientists the exclusive creators of hypotheses but rather are becoming the interpreters of hypotheses developed by neural networks. In this era, our new goal is not to understand nature but rather to understand the most effectively learned predictive models of nature. Here I'll describe the extraordinary predictive capacity of simple neural networks to predict 100,000+ aftershocks following hundreds of magnitude 6+ earthquakes across the globe. In contrast to the common wisdom that neural networks are black boxes, neural networks representing this physical system are highly interpretable and reveal new physics that govern the triggering of earthquake cascades. This approach provides not only an AI derived law for the spatial distribution of aftershocks but also a template for scientific discovery in the age of AI.*

Brendan Meade is Professor of Earth & Planetary Sciences and Affiliate in Computer Science at Harvard University. He received a B.A. in Science, Medicine & Technology from Johns Hopkins University and a Ph.D. in Earth, Atmospheric & Planetary Sciences from MIT and has spent sabbaticals as a visiting researcher at Google. His work is
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focused on machine learning and computational approaches to earthquake and environmental prediction. ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Senseable Cities

Abstract: *The increasing deployment of sensors and hand-held electronics in recent years is allowing a new approach to the study of the built environment. The way we describe and understand cities is being radically transformed - alongside the tools we use to design them and impact on their physical structure. The contribution from Prof. Carlo Ratti will address these issues from a critical point of view through projects by the Senseable City Laboratory, a research initiative at the Massachusetts Institute of Technology, and the International design and innovation practice Carlo Ratti Associati.*

Carlo Ratti is the Director of MIT Senseable City Lab, and the Funding Partner of Carlo Ratti Associati. An architect and engineer by training, Professor Carlo Ratti teaches at MIT, where he directs the Senseable City Laboratory, and is a founding partner of the international design and innovation practice Carlo Ratti Associati. A leading voice in the debate on new technologies' impact on urban life, his work has been exhibited in several venues worldwide, including the Venice Biennale, New York's MoMA, London's Science Museum, and Barcelona's Design Museum. Two of his projects – the Digital Water Pavilion and the Copenhagen Wheel – were hailed by Time Magazine as 'Best Inventions of the Year'. He has been included in Wired Magazine's 'Smart List: 50 people who will change the world'. He is currently serving as co-chair of the World Economic Forum's Global Future Council on Cities and Urbanization, and as special advisor on Urban Innovation to the European Commission. ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Big Spatiotemporal Data Challenges and Opportunities

Abstract: *Big data is becoming a new norm for scientific research and engineering development, a key source of such big data is the spatiotemporal recording and evolution of natural/social phenomena. Based on the NSF spatiotemporal I/UCRC research examples, I will demonstrate how we deal with relevant scientific and application challenges with spatiotemporal algorithms, tools, and computing infrastructure.*

Phil Yang is a leader of GIS and computing on geospatial cyberinfrstructure, spatial cloud computing, spatiotemporal computing, and spatial computing. He is PI on over $10M research grants and participated in over $30M projects. Several of his >100 publications have been among the top five cited and read papers of IJDE and CEUS. His PNAS spatial computing definition paper was captured by Nobel Intent Blog in 2011. He has placed 15+ professors in the U.S. and China, and served in 10+ leader positions.

Panel 2: Crowdsourcing, Geocomputation, and Spatiotemporal Analysis

Amen Ra Mashariki (Esri), Amelia McNamara (Smith College), Shashi Shekhar (UMN), Alex Singleton (Liverpool), Robert Stewart (ORNL)

This panel will discuss the analytical and methodological dimensions of data science, including volunteered geographic information, crowdsourcing, geocomputation, and spatiotemporal analysis.

Growing Trust and Transparency in Communities Where Predictive Algorithms are Deployed

Abstract: *Governments are adopting machine learning and AI technologies in order to provide faster, more cost effective, efficient services to citizens, all while looking to drive positive impact. With the rise of organizations like AI-Now, Data4BlackLives, Data and Civil Rights and the scholarly work that is coming out of Academia, we are hearing more and more about the role that data bias plays in these advanced analytics efforts as well as the desire for the effects of these algorithmic "black boxes" to be more transparent to everyday citizens. My brief discussion will discuss how Geocomputation and targeted crowdsourcing of information can play a role in enhancing the trust citizens have in the deployment of algorithms in their community.*

Amen Ra Mashariki leads Urban Analytics at Esri. He is responsible for the messaging and strategy for applying data science principles to urban challenges, ensuring that data-driven decision makers will realize impactful and positive outcomes in urban policy and operations. Previously, Dr. Mashariki was the Chief Analytics Officer for the City of New York and the Director of the Mayor's Office of Data Analytics (MODA). MODA used urban analytics to more effectively build solutions that address crime, public services, and quality of life in the city. In 2012, Dr. Mashariki was appointed by the President of the United States to the 2012-2013 class of White House Fellows. Immediately after the Fellowship, he was appointed the Chief Technology Officer for the Office of Personnel Management. Amen earned a Doctorate in Engineering from Morgan State University, as well as a Master of Science degree in Computer Science from Howard University. He was an Adjunct Associate Professor at New York University and currently serves as a Fellow at the Harvard Ash Center for Democratic Governance and Innovation.
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Making Spatial Aggregation More Transparent

Abstract: *Choropleth maps are a common visualization, seen often in mass media. However, while the general public may be familiar with the visual presentation, many people are unaware of the effect aggregation has on the spatial pattern they observe. In geostatistical literature, this is referred to as the Modifiable Areal Unit Problem. Because of the far-reaching effects of the choice of spatial polygons (including gerrymandering, and issues such as the Flint water crisis), it seems vitally important to make this more transparent. My work combines data visualization and statistics in an attempt to provide an average reader with the ability to understand how parameter choices in an analysis affect the final outcome.*
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Amelia McNamara is currently a visiting assistant professor of Statistical and Data Sciences at Smith College. Starting Fall 2018, she will be an assistant professor in the Computer & Information Sciences department at the University of St Thomas. Amelia received her BA in English and mathematics from Macalester College, and her PhD in statistics from UCLA. Her research interests include statistics education, statistical computing, data visualization, and spatial statistics. She is active on twitter, tweeting from @AmeliaMN.

Transdisciplinary Foundations of Geospatial Data Science

Abstract: *Recent developments in data mining and machine learning approaches have brought lots of excitement in providing solutions for challenging tasks (e.g., computer vision). However, many approaches have limited interpretability, so their success and failure modes are difficult to understand and their scientific robustness is difficult to evaluate. Thus, there is an urgent need for better understanding of the scientific reasoning behind data mining and machine learning approaches. This requires taking a transdisciplinary view of data science and recognizing its foundations in mathematics, statistics, and computer science. Focusing on the geospatial domain, we apply this crucial transdisciplinary perspective to common geospatial techniques (hotspot detection, colocation detection, prediction, outlier detection and teleconnection detection). We also describe challenges and opportunities for future advancement. More details are available in our 2017 paper in the ISPRS International Journal on Geo_Information (6,395, 2017. www.mdpi.com/2220-9964/6/12/395/pdf).*

Shashi Shekhar, a McKnight Distinguished University Professor at the University of Minnesota and an U.C. Berkeley alumnus, is a leading scholar of spatial computing and Geographic Information Systems (GIS). He is serving as the President of the University Consortium for GIS, a member of the Computing Research Association (CRA) board, and a co-Editor-in-Chief of Geo-Informatica journal (Springer). Earlier, he served on many National Academies' committees. Recognitions include IEEE-CS Technical Achievement Award, UCGIS Education Award, IEEE Fellow and AAAS Fellow. Contributions include algorithms for evacuation route planning and spatial pattern (e.g., colocation, linear hot-spots) mining, an Encyclopedia of GIS and a Spatial Databases textbook.

Challenges and Solutions for the Analysis of New Forms of Data

Abstract: *Many data sources that social scientists have traditionally relied upon for their scholarly work are increasingly under threat, which may challenge future progress if we are slow to adapt to the evolving data economy. Such threats include a trend of declining response rates in many large scale social surveys leading to increased uncertainty, growing scrutiny of the rising costs of conducting a national Census, and numerous cases of either access to open data being removed or their use stifled through more restrictive licenses. In parallel, many new forms of data are emerging that are challenging traditional models of inquiry*

within the social sciences, both from the perspective of infrastructure that enable their management, aligned with skills shortages in those methods that enable insight to be extracted. This talk will highlight progress made in the UK through the establishment of the ESRC funded Consumer Data Research Centre.

Alex Singleton is a Professor of Geographic Information Science at the University of Liverpool, where he was appointed as a Lecturer in 2010. Previously he held research positions at University College London, where he was also awarded a PhD in 2007. He completed a BSc in Geography at the University of Manchester, graduating with a First-class honours degree in 2003.

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Progress in the Pipeline: Advances and Challenges in Curating, Analyzing, and Conveying New Insights from a Tsunami of Open and Commercial Space-time Data

Abstract: *The astonishing growth of open and commercial spatio-temporal data continues to yield a wealth of insights about human activity at unprecedented spatial and temporal resolution. This growing ecosystem of "big" and "big enough" data demands interdisciplinary collaborations between data science, GIS, and domain subject matter experts to produce innovative advancements in data architecture, modeling, and space-time representations. This talk will use examples drawn from on-going work at the Oak Ridge National Laboratory to illuminate how we are curating, fusing, and leveraging open source and commercial data to produce better models and new insights about our world. The talk will demonstrate how we are engaging the pipeline from curating data, to advancing end-user spatio-temporal information systems. We will emphasize the roles that uncertainty quantification, machine learning, and human-computer interaction play in this process. The latter, especially in combination with iterative agile development cycles and continual user feedback, have been critical in fielding space-time information systems that bring stakeholders into useful contact with this information*

Robert Stewart leads the Geographic Data Sciences Team at the Oak Ridge National Laboratory, a joint faculty assistant professor in Geography at the University of Tennessee, and scientist in the Urban Dynamics Institute. The team spans a wide spectrum of expertise including imagery analytics, remote sensing, data mining, modeling and simulation, visualization, machine learning, and other big data challenges applied to a wide range of research domains. His own work is focused on saleable computational methods and tools in the spatiotemporal analytics, uncertainty quantification, risk and decision analysis. Areas of application include population and urban dynamics, socio-cultural/economic, energy-water nexus, and environmental restoration. As joint faculty, Robert regularly engages graduate students by serving on thesis committees, teaching, and facilitating internships at ORNL.

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Keynote:
The Landscape of GIScience

Michael Goodchild (USCB)

Abstract: *Many of the core issues of data science, including metadata and data search, interoperability, data curation, and analytics have long been central issues in GIScience. Massive volumes of data that are far beyond our handling ability have also been available in GIScience, at least since the inception of the Landsat program in the early 1970s, and the issues they raise have been addressed through a range of approaches, including divide-and-conquer and loss of spatial resolution. Variety and velocity, on the other hand, have only recently emerged as central to GIScience. As we know "the map is not the territory," and uncertainty in geospatial data has become a central issue in GIScience in recent decades. No geospatial database can be a perfect replica of geographic reality, implying that while analysis of data can tell us much about data, its ability to tell us useful things about the geographic world may be limited. New methods of fusing or hardening data from multiple sources, and new methods for addressing data un-certainties, will be of great value to GIScience.*

Michael F. Goodchild – See page 9

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Panel 3: Data Science for Cities, Health, and Environment

Emad Khazraee (Harvard Berkman/Kent State), Amy Lobben (Oregon), Bjoern Menze (TU Munich), Andres Sevtsuk (Harvard GSD), Renee Sieber (McGill)

This panel will discuss a range of case studies and applications of spatial data science including in the management of cities, health and behaviors, and environmental monitoring.

Empowering Local Communities through Data Analytics and AI

Abstract: *The definition of digital divide has been evolved through time. It has always been defined across haves and not haves. While its roots go back to the information divide discussions in the 1960s, there has been five phases of expansion of the definition of this term, respectively emphasizing, access, adaption and use, participation and governance, and the last emerging phase focusing on smart decision making and the role of AI. The new developments in AI and data analytics created a new landscape which mandates certain skills and resources to be competitive and succeed. Local communities which cannot acquire such skills and resources are disadvantaged in this new era and will experience the latest form of digital divide. Within this context, Library Knowledge Extension (KNEXT) project is an attempt to create a community partnership to bring the advances of data analytics and AI within the reach of local communities to address their needs. This talk presents a community centered framework for developing an information infrastructure to support local community data analytic needs addressing three aspects of engagement, empowerment, and enablement.*

Emad Khazraee is a sociotechnical information scientist and an assistant professor in the school of information (iSchool) at Kent State University. He is currently a fellow at Berkman Klein Center for Internet and Society at Harvard University. His research is formed around the interplay between social and technical phenomena. His main research interest formed around the inquiry about how human ensembles use information technology to organize their collective
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action and the role information technologies play in such formations.

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A Convergence of Spatial Access

***Abstract**: Pedestrian travel is at the very heart of the intimate relationship between humans and urban space. Nearly all activity that people engage in outside the home relies on pedestrian transportation of some kind. Though pedestrian travel has long been framed as beneficial to many aspects of the human experience, urban spaces and their representations continue to be designed in ways that hinder, rather than facilitate urban environment accessible pedestrian movement.*

Enormously popular routing applications (like Google Maps) are now nearly ubiquitous and have changed how pedestrians find their way around a city. The ubiquity is owed to its usefulness and nearly homogenous, one-size-fits-all usage. And, yet, while widespread usability is assumed, it's not achieved. As much as geospatial technologies revolutionized an industry, a spatial data science, consumer products, and behavior, they have not revolutionized accessibility for people with disabilities.

The barrier is more one of willingness on the part of the spatial data scientists and the geospatial technologies industry, not on the ease of execution. But, these barriers are simple to remove and overcome. Illustrated through the presentation of two case studies from my lab, I'll provide some simple examples of how perspective and technology can transform barriers to facilitators for access.

Amy Lobben is Professor of Geography and Affiliate in Computer and Information Science at the University of Oregon. She received a PhD in Geography from Michigan State University. Her work focuses on neurogeography (the intersection of geospatial cognition and neuroscience using methods such as fMRI to identify behavioral and neurological correlates of geospatial thinking) and geospatial accessibility for people with disabilities. She also runs the new Spatial Data Science and Technology program at the University of Oregon.

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Putting Clinical (image) Data on a Map

***Abstract**: The future of digital medicine will be in large data sets, and tools capable of mining them. I am working in the field of image processing, focusing on medical images, the largest sources of data in the clinical setting. Right now we see that healthcare information is digitized, and stored in a structured fashion in large repositories. These repositories will offer standardized interfaces and unprecedented access to clinical records, for analyzing health information at a national and international level. Large scale cohort studies, like the UK biobank or the German National Cohort offer similar means for obtaining significant snapshots of the current population.*

In my field of work - the design of algorithms for processing the information of images acquired in clinical routine - this will allow us to systematically extract image biomarkers, indicating specific diseases, disease precursor states, and related preclinical modifications at an unprecedented scale. It will also offer means for a systematic study of anatomy and function in the general population. With hundreds of thousands of quantitative anatomical measurements available at a national scale, we will be able to put disease patterns on a map - even where current repositories suffer from non-systematic local recording - as well as the spatial variation of human anatomy and function.

Bjoern Menze is Assistant Professor of Computer Science and of Medicine at TU München, heading the Image-based Biomedical Modeling group at the TUM Institute of Medical Engineering. Before, I was member of the Asclepios team at the Inria Sophia-Antipolis, the Computer Vision Lab at ETH Zurich, the Medical Computer Vision group of CSAIL at MIT, and the Department of Anthropology at Harvard. I received a PhD degree from Heidelberg University. My research is in medical image computing, exploring topics at the interface of medical computer vision, machine learning, and computational physiology. In this, my work strives towards transforming the descriptive interpretation of biomedical images into a model-driven analysis that infers properties of the underlying physiological and patho-physiological processes by using models from biophysics and computational physiology. I am also interested in how to apply such models to big data bases in order to learn about correlations between model features and disease patterns at a population scale. My work on translating computational methods from medical image analysis towards remote sensing applications in Near Eastern Archaeology has been featured, for example, in The Atlantic magazine or Nature.

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Estimating Pedestrian Flows on Street Networks: Revisiting the betweenness Index

Abstract: *A number of cities seek to increase walkability as part of broader sustainability, public health, community building and economic development strategies. But tools are lacking to predict pedestrian activity in future developments. This paper discusses how the betweenness index from social network analysis can be adapted to predict pedestrian flows on spatial networks. I introduce a tool that allows planners to model pedestrians from origins to destinations along plausible paths and use it to predict foot-traffic around a subway station during a peak commuting period. Results confirm that predicted estimates offer a robust approximation of observed pedestrian counts at the same locations.*

Andres Sevtsuk is an Assistant Professor of Urban Planning at the Harvard Graduate School of Design, with technical expertise in spatial analytics and urban technology. His research interests include urban design and spatial analysis, urban mobility, automated vehicles, real estate economics, transit and pedestrian oriented development and spatial adaptability. Andres holds a PhD from the Department of Urban Studies and Planning at MIT, where he also worked with William J. Mitchell as a researcher in the Smart Cities group at the MIT Media Laboratory. He has collaborated with a number of city governments, international organizations, planning practices and developers on urban designs, plans and policies in both developed and rapidly developing urban environments, most recently including those in Indonesia and Singapore. He is the author of the Urban Network Analysis toolbox, which is used by researchers and practitioners around the world to study coordinated land use and transportation development along networks. He has led var-
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ious international research projects; exhibited his research at TEDx, the World Cities Summit and the Venice Biennale; and received the President's Design Award in Singapore, International Buckminster Fuller Prize and Ron Brown/Fulbright Fellowship. He was previously an Assistant Professor of Architecture and Planning at the Singapore University of technology and Design (SUTD), and a lecturer at MIT.

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A Moral Compass for Data Science and AI in the City

Abstract: *Hardware/software, data, and algorithms – the components of geo data science – have no meaning if they are not valued. The moment we introduce the concept of value, we need to address questions of what is the value, who gains from that valuation, and what is the nature of the data that serves as input. I look at these questions through the lens of our pan Canadian grant, Geothink and Waterfront Toronto, the largest proposed smart city in North America. Smart cities offer an excellent testing ground for geo data science because so much of the data occurs in space-time. In geo data science much of the emphasis placed on Volunteered Geographic Information (VGI) – crowdsourced locational data. This raises issues of accuracy, motivation, and location masking (e.g., to anonymize information and protect privacy). Research also suggests our increasing inability to accurately assess the quality of data. Smart cities allow us to examine various tensions, such as technocratic urges that emphasize service delivery efficiencies over civic empowerment and standardization efforts so data can be made seamlessly interoperable for app developers.*

A moral compass is needed because data and its analysis increasingly determine how we move in space-time. It determines how congestion is alleviated (via WAZE) and who goes to prison (via predictive policing). It suggests our own culpability in this process. I will discuss what could go into a moral compass for data science for cities.

Renee Sieber is an Associate Professor, jointly appointed at the McGill Department of Geography and School of Environment and is affiliated with McGill's School of Computer Science. She investigates the use and value of information technology by marginalized communities, community based organizations, indigenous peoples, and social movement groups. She is best known for her research on public participation Geographic Information Systems, which is the use of GIS by marginalized communities to influence policy. For the past five years, Sieber has led a pan-Canadian Social Sciences and Humanities Partnership Grant, Geothink (geothink.ca) on how the geospatial web, open data, crowdsourcing and citizen science are transforming interactions between cities and citizens. Additionally she has given numerous talks to international, national and civic audiences. This includes recent talks on subjects such as artificial intelligence, digital inclusion, and open government data to the Canadian federal government. This month, she presented on smart cities and AI at the British National Science Fiction Convention. In 2016, the Canadian Association of Geographers awarded her the Lifetime Achievement and GIScience Excellence Award. This coming year, she will be conducting research on smart cities.

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Panel 4: Geography, Civic Engagement, and the Future of Data Science
Jessica Block (UCSD), Chris Cappelli (Esri), Robert Chen (Columbia), Krzysztof Janowicz (UCSB), Diana Sinton (UCGIS)

This final panel will discuss the broad theoretical, conceptual, and applied opportunities of data science for the discipline of geography and more generally for civic life.

SocioEcological Applications of Remote Sensing Analysis at Scale

Abstract: *The Big Pixel Initiative at UCSD was founded to address the world's greatest challenges combining state-of-the-art geospatial analysis and remote sensing techniques with computer vision and machine learning that utilize big (geo) data. A challenge in integrating data science to civic engagement is the automation and scalability of methods to data we capture on an ongoing basis. This presentation discusses how we apply our analytic techniques and scale them for socially urgent issues including wildfire response, the preterm birth epidemic, and sustainable city analysis with actionable outcomes.*

Jessica Block is a spatial data scientist with the Qualcomm Institute at UC San Diego, and co-founded of their Big Pixel Initiative, applying big data techniques to satellite imagery analysis at scale. She is an interdisciplinary geologist and urban ecologist specializing in the use of sensor networks, remote sensing, and geospatial visualization tools for disaster response, public health, policy decision-making, and sustainability.

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Giving Relevance to Spatial Analytics and Spatial Data

Abstract: *2019 will be the 50th anniversary of Esri's founding. Over those years we've seen several common patterns of use of geographic information systems (GIS) emerge. Several of those patterns are relevant to this discussion. In particular, one we call Constituent Engagement involves communication and collaboration with citizens and communities of interest. One practical challenge associated with this pattern is the mixing of authoritative data from GIS (based on operational uses such as tax mapping, for example) with crowd-sourced observations (such as complaints or feedback from citizens). More broadly, I will discuss a language of spatial analytics that has crystalized in recent years, in the hope that its relevance to data science will be apparent, and that its potential to enrich professional practice is compelling.*

Christopher Cappelli is a corporate director at Esri, Inc. the developers of the ArcGIS system (www.arcgis.com) for mapping and geographic knowledge management. Chris has been with Esri for the last 27 years in a variety of roles. He is a computational geographer who is intrigued by the spatial aspects of data science. His current role takes him all over the world and affords the opportunity to help leaders in both the government and private sectors formulate strategies for getting the most from the intersection of policy, business and geography.

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Why We Need Both Geography and Data Science to Achieve Sustainable Development

Abstract: *The 17 Sustainable Development Goals (SDGs) adopted in 2015 represent an unprecedented commitment by the world's nations to tackle a wide range of pressing sustainable development challenges in an integrated way, with a particular focus on leaving no one behind. To achieve the SDGs, we need much better understanding of where people live, work, and move; how they impact and are affected by environmental and societal changes; and how to assist remote and disadvantaged populations around the world. Improved geographic data and models, coupled with new data science methods and resources, offer ways not only to guide sustainable development policy and actions at national and global levels, but also to greatly enhance how individuals, households, communities, businesses, local governments, and others from all walks of life and around the globe can achieve the SDGs more rapidly and effectively. Equitable access to these data, models, methods, and resources is essential to ensure that no one is left behind.*

Robert Chen is director of CIESIN, the Center for International Earth Science Information Network, a unit of the Earth Institute at Columbia University in New York. He has managed the NASA Socioeconomic Data and Applications Center (SEDAC), part of NASA's network of Earth science data centers, for more than 2 decades. He co-manages the Intergovernmental Panel on Climate Change (IPCC) Data Distribution Center and co-chairs the Thematic Research Network on Data and Statistics (TReNDS) of the UN Sustainable Development Solutions Network (SDSN). Dr. Chen is active in many organizations and networks including the American Geographical Society, the Group on Earth Observations, the Research Data Alliance, the ESIP Federation, the Committee on Data for Science and Technology, and the Global Partnership for Sustainable Development Data. He received his Ph.D. in geography from the University of North Carolina at Chapel Hill and holds B.S. and M.S. degrees from the Massachusetts Institute of Technology.

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Top-Down and Bottom-Up

Abstract: *Future advances in Spatial Data Science will happen at the intersection of top-down, theory-driven work and bottom-up learning. This short presentation will support this claim by discussing spatially explicit machine learning models. The presentation will also argue for the need of geographic knowledge graphs and services developed on top of them.*

Krzysztof Janowicz is an Associate Professor for Geographic Information Science at the Geography Department of the University of California, Santa Barbara, USA. He is the program chair of UCSB's Cognitive Science Program, associate director of the Center for Spatial Studies, and Editors-in-Chief of the Semantic Web journal. He is an expert in knowledge graphs, semantics, and geographic information retrieval and currently works on social sensing.

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Opening and Maintaining Lines of Communication between Data Science and Geographic Information Science

Abstract: *Data Science is sold as a key way for extracting insights from big data noise, but the paths are incomplete and poorly lit. Significant portions of data are location-based and maps are a common form of the visualization graphics that are produced but there is no systematic inclusion of geospatial approaches integrated into programs. Data Science programs rarely incorporate geographic information science (or scientists) in a manner that is collaborative or productive for ensuring that key knowledge is shared with learners. How or if this undermines the power and capacity for Data Science programs to achieve their desired outcomes is unknown, but it compromises the versatility of graduates to transfer between jobs and shape a career. Building networks for cooperation and open lines of communication between geographic information science and data science is both a logical and obvious step towards better outcomes. This is a key component of the current UCGIS agenda.*

Diana Sinton is the Executive Director of the University Consortium for Geographic Information Science (UCGIS), a non-profit organization that supports a community of practice around GIScience research and teaching in higher education. As an adjunct associate professor at Cornell University, she teaches courses in spatial analysis and GIS. Her interests include the roles of geospatial technologies and spatial literacy in teaching and learning, the use of social and cultural data within GIS applications, and humanitarian mapping projects. Diana worked previously for the University of Redlands where she led a campus-wide initiative to integrate mapping and spatial perspectives into diverse academic disciplines, and prior to that, she was the GIS Program Director for the National Institute for Technology in Liberal Education. Her book publications include The People's Guide to Spatial Thinking and Understanding Place: GIS and Mapping across the Curriculum. She holds degrees from Middlebury College (BA) and Oregon State University (MS, PhD).

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Closing Remarks - Convergence of Data Science and GIScience

David DiBiase (Esri), Matt Wilson (UKY)

Summing Up. Co-orgainizers reflect on the day's discussions, on prospects for a convergence of GIScience with Data Science, and suggest possible next steps.

David DiBiase leads the Education Team within Esri's Industry Solutions group. The Team promotes GIS use and spatial thinking in higher education, schools, and youth groups worldwide. Before joining Esri, David founded and led the Penn State Online GIS Certificate and Masters degree programs. He served as lead editor of the U.S. Department of Labor's Geospatial Technology Competency Model and the GIS&T Body of Knowledge published by Association of American Geographers. He also led the National Science Foundation-funded "GIS Professional Ethics" project from 2008-2010, and continues to lead professional ethics workshops for Penn State Online.
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Matthew W. Wilson, PhD, is Associate Professor of Geography at the University of Kentucky and Visiting Scholar at the Center for Geographic Analysis at Harvard University. He co-founded and co-directs the New Mappings Collaboratory, which studies and facilitates new engagements with geographic representation. He has previously taught at the Harvard Graduate School of Design, and his current research examines mid-20th century, digital mapping practices. He earned his PhD and MA from the University of Washington and his BS from Northwest Missouri State University.

Poster Awards

Jason Ur

Jason Ur – See page 4

Panel Moderators

Jeff Blossom, Stephen Ervin, Wendy Guan, Ben Lewis, Jason Ur, Matt Wilson

Jeff Blossom is the GIS Service Manager of the CGA. He has experience working in the GIS industry as a technician, analyst, developer, manager, and educator. Prior to joining the CGA, Jeff was the GIS Photogrammetry Administrator for the City and County of Denver, and served as Chairman of Denver's GIS Steering Committee. Jeff earned an M.A. in Geography from the University of Denver in 2002, and a B.S. from Willamette University (OR) in 1995. Jeff is especially interested in developing tools, teaching methods, and maps using geographic information that can be used by any student or professional to enhance their work. Related to this effort is the graduate level class he teaches at the Harvard Extension School: Geographic Communication Today. Jeff is also an adjunct faculty member at Salem State University, where he teaches Computer Cartography.

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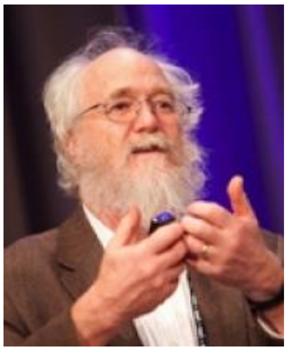

Stephen M. Ervin is the Assistant Dean for Information Technology at the Harvard University Graduate School of Design, and a Lecturer in the Department of Landscape Architecture, where he has taught since 1989. Ervin teaches and conducts research in the areas of design, computing, media and technology, with a special interest in landscape modeling and visualization, and the integration of CAD, GIS and emerging technologies including GeoDesign. The founding chairman of the American Society of Landscape Architects' (ASLA) Open Committee on Computers in Landscape Architecture and a Fellow of the ASLA, he holds a Master's degree in Landscape Architecture from the University of Massachusetts at Amherst and a PhD in Urban Studies from the Massachusetts Institute of Technology. A regular contributor to the International Digital Landscape Architecture (DLA) conference, he has been a prominent player in the development of the theoretical basis for the integration of computing tools and design methods.

Wendy Guan is the Executive Director who manages daily operations of the CGA. She came to Harvard in 2006 as the Director of GIS Research Services for the newly
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established Center. Prior to that, she managed professional services at a GIS consulting firm in Washington State; headed a geospatial information technology department for a multinational forestry corporation; and supervised GIS teams in a Florida government agency. Wendy has a Ph.D. in ecology and GIS; a M.A. and M.S. in geography and natural resource management, and a B.S. in biology. She taught GIS in various universities, including the Harvard Extension School.

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Ben Lewis is the Geospatial Technology Manager of the CGA. He is the system architect and project manager for WorldMap, an open source infrastructure that supports collaborative research centered around geospatial information. Before joining Harvard, Ben was a project manager with Advanced Technology Solutions of Pennsylvania, where he led the company in adopting platform independent approaches to GIS system development. Ben studied Chinese at the University of Wisconsin and has a Masters in Planning from the University of Pennsylvania. After Penn, Ben worked at the U.C Berkeley GIS Lab, started the GIS group for the transportation engineering firm McCormick Taylor, and coordinated the Land Acquisition Mapping System for the South Florida Water Management District. Ben is especially interested in technologies that lower the barrier to GIS access.

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Jason Ur – See page 4

Matt Wilson – See page 21

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