The Second International Symposium on Spatiotemporal Computing

ISSC 2017

August 7th – 9th, 2017 at Harvard University, Cambridge, Massachusetts

Harvard University
Cambridge, Massachusetts 02138
Email: stc@gmu.edu

ISSC 2017

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Aug 7-9, 2017

Harvard

Committee

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General Information

Spatiotemporal computing, the computing paradigm that utilizes spatiotemporal principles to devise cutting-edge computing technologies and solutions, enables the development of trailblazing new methodologies, tools and software to address global challenges such as climate change, natural disaster, or infectious disease. Following the successful 1st International Symposium on Spatiotemporal Computing (ISSC) held in July 2015 at George Mason University, the 2nd Symposium will be held in August 2017 at Harvard University. Its objective is to further academic exchange on new findings, achievements and breakthroughs in spatiotemporal computing. We hope to bring together people with different backgrounds and expertise who are engaged in the development and application of spatiotemporal computing and related topics. Through a series of presentations, panel discussions and research papers, ISSC strives to:

- Explore spatiotemporal principles and develop formal representations for spatiotemporal patterns from current research in computing, geospatial, and social sciences among other academic fields;
- Combine spatiotemporal patterns and modern computational technologies to foster next generation computing infrastructure to enable big data discovery, access, and processing;
- Develop new spatiotemporal computing tools and software to improve our capability on urgent events responding;

We invite materials from disciplines including but not limited to:

1. Mining and Analyses methodologies to extract spatiotemporal principles/patterns in various domains, such as climate change, ocean science, environmental science, disaster and public health;
2. New computing hardware, software, and tools utilizing spatiotemporal principles/patterns;
3. Advanced cyberinfrastructure integrating spatiotemporal principles and cutting-edging computational technologies (e.g. GPU, MapReduce, HPC and cloud computing);
4. Advances in modelling, simulation, and virtual environment concerning spatiotemporal data and applications;
5. Big Data processing, analysis and visualization using spatiotemporal computing;
6. Scientific workflow solutions based on spatiotemporal computing;
7. Education related to spatiotemporal computing;
8. Digital Earth, public health, economics, natural disasters, and other applications of spatiotemporal computing.

Plenary Sessions and Special Events

Dr. Huadong Guo

Director-General of the Institute of Remote Sensing and Digital Earth (RADI)

Huadong Guo is Director-General of the Institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Sciences (CAS), an Academician of CAS, a Fellow of the Academy of Sciences for the Developing World (TWAS), and an Academician of International Eurasian Academy of Sciences. He presently serves as President of the International Council for Science (ICSU) Committee on Data for Science and Technology (CODATA), Secretary-General of the International Society for Digital Earth (ISDE), and Editor-in-Chief of the International Journal of Digital Earth (IJDE) published by Taylor & Francis. He has over thirty years of experience in remote sensing, specializing in radar for Earth observation and remote sensing applications, and involving research on digital Earth since the end of the last century. He has been Principle Investigator for over twenty major national projects or programs in China, and Principle Investigator for seven international radar remote sensing projects. He also serves as Director of the International Center on Space Technologies for Natural and Cultural Heritage under the Auspices of UNESCO. He has published more than three-hundred papers and fifteen books, and is the principal awardee of thirteen national and CAS prizes, one being “National Outstanding Expert”, awarded by the State Council of China.

Keynote Title: DBAR Program Based on Earth Observing Technologies

Abstract: An international science program titled “Digital Belt and Road (DBAR)” was launched in Beijing last year, aiming for the sustainable development of the Belt and Road region using Earth observation big data. This presentation firstly introduces China’s Earth observation satellites including the four remote sensing satellite series, a high-resolution Earth observation system and other Earth observation technologies. Secondly, the paper presents DBAR’s vision, mission, and focus, which includes clusters of well-framed research questions related to UN Sustainable Development Goals (SDGs) and to the Belt and Road countries. Thirdly, it describes DBAR’s nine research fields consisting of infrastructure, agriculture, oceans, environment,

natural and cultural heritage, disasters, water, urban areas, and high-mountain areas. These topics demonstrate how DBAR is bringing new scientific collaboration opportunities for regional and global partners.

Dr. Sarah Williams

Associate Professor of Urban Planning, Massachusetts Institute of Technology

Sarah Williams is currently an associate professor of urban planning and the director of the Civic Data Design Lab at Massachusetts Institute of Technology's (MIT) School of Architecture and Planning School. The Civic Data Design Lab works with data, maps, and mobile technologies to develop interactive design and communication strategies that bring urban policy issues to broader audiences. Trained as a geographer (Clark University), landscape architect (University of Pennsylvania), and urban planner (MIT), Prof. Williams's work combines geographic analysis and design. Her design work has been widely exhibited, including work in the Guggenheim and the Museum of Modern Art (MoMA) in New York City. Before coming to MIT, Prof. Williams was co-director of the Spatial Information Design Lab at Columbia University's Graduate School of Architecture Planning and Preservation (GSAPP). She has won numerous awards, including being named one of the top 25 planners in the technology and 2012 Game Changer by Metropolis Magazine. Her work is currently on view in the Museum of Modern Art (MoMA), New York.

Keynote Title: Hack it, Build it, Share it: Unlocking Data for Policy Change

Dr. Lee Schwartz

Geographer

Director, Office of the Geographer and Global Issues, Bureau of Intelligence and Research, Department of State

For the past ten years, Dr. Lee Schwartz is the Geographer of the Department of State and the Director of its Office of the Geographer and Global Issues in the Bureau of Intelligence and Research.

Dr. Schwartz is the Department's 9th Geographer, a position that was established in 1921 and that, according to federal regulations, is responsible for providing guidance to all federal agencies on questions of international boundaries and sovereignty claims.

Previously, he held positions in the State Department as Division Chief for Global Issues and for United Nations and Humanitarian Concerns. Prior to joining the Office of The Geographer, Dr. Schwartz was a member of the faculty of The American University's School of International Service.

At the Department of State, he has directed research and analysis on global issues primarily related to complex humanitarian emergencies and has coordinated related fieldwork and applied geography projects overseas, in particular in the Balkans, Central Asia, Russia, Afghanistan, Iraq, Sudan, and the Horn of Africa. His recent work has focused on ethnic conflict, refugee flows, peacekeeping operations, strategic warning, and conflict mitigation and response – with an emphasis on Geographic Information Systems (GIS) and Remote Sensing information coordination, as well as Participatory Mapping. He was the State Department's 2005 winner of the Warren Christopher Award for Outstanding Achievement in Global Affairs.

Lee earned his Ph.D. in geography from Columbia University, with a focus on political and population geography.

Keynote Title: Translating Science into Policy: Challenges for the Use of Spatio-Temporal Computing

Dr. Anatoliy Gruzd

Associate Professor at the Ted Rogers School of Management at Ryerson University (Canada)

Dr. Anatoliy Gruzd is the Canada Research Chair in Social Media Data Stewardship, Associate Professor at the Ted Rogers School of Management and the Director of Research at the Ryerson University Social Media Lab in Toronto, Canada. His initiatives explore how the advent of social media and the growing availability of social media data are changing the ways in which people communicate, collaborate, and disseminate information and how these changes impact the social, economic, and political norms and structures of modern society. His research and commentaries have been reported across Canada and internationally in various mass media outlets such as Foreign Affairs, Los Angeles Times, Nature.com, The Atlantic, The Globe and Mail, The National Post.

Keynote Title: Studying Online and Offline Communities through the Prism of Social Media Data

Abstract: The presentation will explore the utility of social media data to examine external social, economic and political relations and trends. It asks whether there are observable linkages between the user-defined location, social connections among users, and their presence in online groups promoting a particular political position. The presentation will use a case study of online groups on VKontake (VK), a popular social networking site in Eastern Europe, advocating pro- or anti-Euromaidan Revolution in Ukraine in 2014. This case study will demonstrate possibilities and limitations of relying on social media data to support analysis on politically important relations between countries and nation-states, namely: immigration, economics, conflict, linguistics, and culture.

Organizing Societies

- **STC:** Many 21st century challenges to contemporary society, such as natural disasters, happen in both space and time, requiring that spatiotemporal principles and thinking be incorporated into the computing process. A systematic investigation of the principles would advance human knowledge by providing trailblazing methodologies to explore the next generation of computing for addressing the challenges. This NSF university, industry and government cooperative research center for spatiotemporal thinking, computing, and applications (STC) is to conduct deliverable-oriented shared research to address the 21st century challenges based on the computing conducted by the GMU center for intelligent spatial computing (CISC), thinking by UCSB Center for Spatial Studies (CSS), and applications by Harvard Center for Geographic Analysis (CGA). For more about STC, please visit http://stcenter.net/
- **ISPRS:** Photogrammetry and Remote Sensing is the art, science, and technology of obtaining reliable information from noncontact imaging and other sensor systems about the Earth and its environment, and other physical objects and processes through recording, measuring, analyzing and representation. The International Society for Photogrammetry and Remote Sensing is a non-governmental organization devoted to the development of international cooperation for the advancement of photogrammetry and remote sensing and their applications. The Society operates without any discrimination on grounds of race, religion, nationality, or political philosophy. For more about ISPRS, please visit http://www.isprs.org/
- **Beijing Advanced Innovation Center of Future Internet Technology:** The Beijing advanced innovation center of future internet technology is one of the top research centers funded by Beijing City as a special zone for technology and talents. The center objective is to promote system and mechanism innovation, to produce breakthrough on core and key technology, to accomplish influential achievements, to solve important and practical scientific and industrialized development problems, to cultivate a number of prominent talents. The center will integrate high quality innovative resources, persist on the principle of people oriented, fully represent the value of researchers, motivate and release the maximum creativity of researchers and become a special zone of technology and talents to attract top-class specialists, reform the system and mechanism, and achieve prominent innovations for the future. For more about Beijing Advanced Innovation Center of Future Internet Technology, please visit http://bjfnc.bjut.edu.cn/

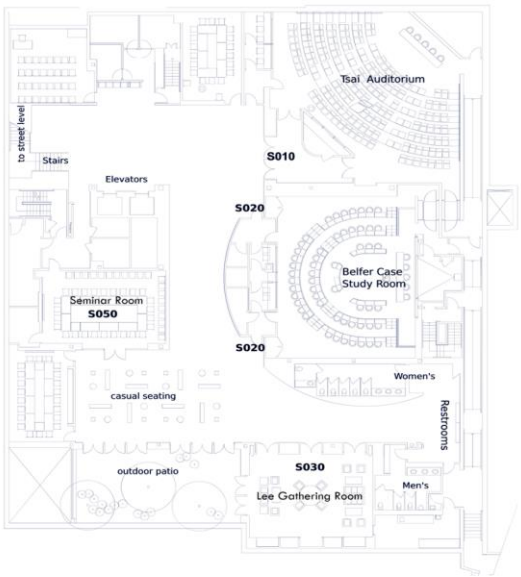
Meeting location

Meeting Location

CGIS South Building:

1730 Cambridge ST., Cambridge, MA 02138.

CGIS South Building Floor Plan:



For plenary session: S010 - Tsai Auditorium

For breakout sessions:

1. S020 - Belfer Case Study Room

2. S030 - Lee Gathering Room (Layout can change)

3. S050 - Seminar Room

For poster exhibit and lunch: Concourse

Agenda of 2017 International Symposium on Spatiotemporal Computing

Aug 7-9, 2017, Cambridge, MA

Monday, Aug 7, 2017

Time and Room	Session
8:00 am to 9:00 am CGIS South Concourse	Registration
9:00 am to 9:15 am CGIS South, Tsai Auditorium (S010)	Welcome Remarks: Dr. Peter K. Bol, Vice Provost and Past Site Director, NSF Spatiotemporal Innovation Center, Harvard University. Dr. Pengde Li, Deputy Administrator, National Adiministration of Surveying, Mapping and GeoInformation. Dr. Chaowei Yang, Director, NSF Spatiotemporal Innovation Center and Professor, George Mason University. Chair: Jason Ur
9:15 am to 10:00 am CGIS South, Tsai Auditorium (S010)	Keynote Address I: Huadong Guo, Director-General of the Institute of Remote Sensing and Digital Earth (RADI) Title: DBAR Program Based on Earth Observing Technologies. Chair: Chaowei Yang
10:00 am to 10:40 am CGIS South, Tsai Auditorium (S010)	Mini Panel Session P1: Big Geospatial Data and Beyond Panelists: Huadong Guo, The Institute of Remote Sensing and Digital Earth (RADI) Robert Stewart, Oak Ridge National Laboratory Dongmei Chen, Queen's University Wenwu Tang, University of North Carolina-Charlotte Chair: Keith Clarke
10:40 am to 10:55 am CGIS South Concourse	Coffee Break
10:55 am to 12:15 pm CGIS South, Belfer Case Study Room (S020)	Session A1: Modeling Chair: Robert Stewart • Spatio-temporal Data Model for Integrating Evolving Nation-level Datasets. Alexandre Sorokine and Robert Stewart.

	• A Spatiotemporal Prediction Framework for Air Pollution Based on Deep RNN. Junxiang Fan, Qi Li, Junxiong Hou, Xiao Feng, Hamed Karimian and Shaofu Lin. • SWE-IoT-based spatiotemporal access to critical sensor data using ad hoc sensor hub constellations. Joshua Lieberman.
10:55 am to 12:15 pm CGIS South, Lee Gathering Room (S030)	Session A2: Computing Optimization Chair: Shi Xuan • A novel approach of indexing and retrieving spatial polygons for efficient spatial region queries. Jianghua Zhao, Xuezhi Wang, Fengyang Wang, Zhihong Shen, Yuanchun Zhou and Yonglin Wang. • Making Temporal Search Central in a Spatial Data Infrastructure. Paolo Corti and Benjamin Lewis. • Leveraging LSTM for rapid intensifications prediction of tropical cyclones. Yun Li, Ruixin Yang, Manzhu Yu, Fei Hu and Chaowei Yang.
10:55 am to 12:15 pm CGIS South, Seminar Room (S050)	Session A3: Health Application Chair: Dongmei Chen • Spatiotemporal Analysis of Communicable Diseases based on Epidemic Tree: A Case Study of Dengue Fever in Guangzhou City, China. Meifang Li, Xia Li and Xun Shi. • Global Diffusion Pattern and Hot Spot Analysis of Vaccine-Preventable Diseases. Yongyao Jiang. • Challenges in fine-detailed disease risk modeling with time series remotely sensed data: a case study in WNVs in Ontario. Dongmei Chen.
12:15 pm to 12:35 pm CGIS South Concourse	Group Photograph
12:35 pm to 1:30 pm CGIS South Concourse	Lunch Break
1:30 pm to 2:15 pm CGIS South, Tsai Auditorium (S010)	Keynote Address II: Sarah Williams, Associate Professor of Urban Planning, Massachusetts Institute of Technology Title: Hack it, Build it, Share it: Unlocking Data for Policy Change. Chair: Wendy Guan.
2:15 pm to 2:55 pm CGIS South, Tsai Auditorium (S010)	Mini Panel Session P2: Civil & Urban Dynamics Panelists: Sara Williams, Massachusetts Institute of Technology

	Huayi Wu, Wuhan University Keith Clarke, University of California-Santa Barbara Clio Andris, Pennsylvania State University. Chair: James Pick, University of Redlands
2:55 pm to 3:10 pm CGIS South Concourse	Coffee Break
3:10 pm to 5:10 pm CGIS South, Belfer Case Study Room (S020)	Session B1: Pattern Identification Chair: Benjamin Lewis • Extracting Spatiotemporal Objects from Raster Data to Represent Physical Features and Analyze Related Processes. James Zollweg. • Analyzing Precipitation Pattern Using a Kinematics-based GIS Methodology. Kejin Cui. • Detection of Behavior Patterns of Interest using Big Data which have Spatial and Temporal Attribute. Richard La Valley, Abe Usher and Adam Cook. • Estimating Hourly Population Distribution Change at High Spatiotemporal Resolution in Urban Areas using Geo-Tagged Tweets, Land Use Data, and Dasymetic Maps. Ming-Hsiang Tsou, Hao Zhang, Atsushi Nara and Su Yeon Han. • Using multi-temporal remote sensing data to understand the spatio-temporal patterns of dry season rice production in Bangladesh. Aaron Shew and Aniruddha Ghosh.
3:10 pm to 5:10 pm CGIS South, Lee Gathering Room (S030)	Session B2: Best Paper Competition Chair: Keith Clarke. • GPU-accelerated adaptive kernel density estimation for point pattern analysis on spatial big data. Guiming Zhang. • The World Spatiotemporal Analytics and Mapping Project (WSTAMP): Further Progress in Discovering, Exploring, and Mapping Spatiotemporal Patterns across the World's Largest Open Source Data Sets. Jesse Piburn. • Hyperparameter optimization of neural network-driven spatial models accelerated using cyber-enabled high-performance computing. Minrui Zheng. • Watching the birdwatchers on Flickr: An adaptive kernel smoothing approach for visualizing spatiotemporal patterns of a cultural ecosystem service. Chang Zhao. • Normalization Strategies for Enhancing Spatio-Temporal Analysis of Social Media Responses during Extreme Events: A Case Study based on Analysis of Four Extreme Events using Socio-Environmental Data Explorer (SEDE). Jayakrishnan Ajayakumar. • Developing a spatiotemporal framework for 4D event tracking and analysis - an example with dust events. Manzhu Yu.

3:10 pm to 5:10 pm CGIS South, Seminar Room (S050)	Session B3: Geoscience Application Chair: Long Chiu. • Sequential classifier training for rice mapping with multitemporal remote sensing imagery. Yiqing Guo, Xiuping Jia and David Paull. • Real-Time Earthquake Monitoring with Data Stream-Based Temporal Fields. John. C. Whittier, Silvia Nittel and Iranga Subasinghe. • The impact of spatial and temporal resolutions in Tropical summer rainfall distribution: Preliminary Results. Qian Liu, Long Chiu and Xianjun Hao.

Tuesday, Aug 8, 2017

Time and Room	Session
9:00 am to 9:45 am CGIS South, Tsai Auditorium (S010)	Keynote Address III: Anatoliy Gruzd, Associate Professor at the Ted Rogers School of Management at Ryerson University Title: Studying Online and Offline Communities through the Prism of Social Media Data Chair: Ming-Hsiang Tsou
9:45 am to 10:30 am CGIS South, Tsai Auditorium (S010)	Mini Panel Session P3: Social Dynamics Panelists: Anatoliy Gruzd, Ryerson University Jun Luo, Missouri State University Ming-Hsiang Tsou, San Diego State University Xun Shi, Dartmouth University Chair: Wendy Guan
10:30 am to 10:45 am CGIS South Concourse	Coffee Break
10:45 am to 12:05 pm CGIS South, Belfer Case Study Room (S020)	Session C1: Methodology Chair: Zhipeng Gui • Applying Theissen Polygon Catchment Areas and Gridded Population Weights to Estimate Conflict-Driven Population Changes in South Sudan. Lisa Jordan. • Comparison of Spatiotemporal Mapping Techniques for Enormous ETL and Exploitation Problems. Ray Deiotte and Richard La Valley.

	• A Simple Spatially Weighted Measure of Temporal Stability for Data with Limited Temporal Observations. Jesse Piburn, Robert Stewart and April Morton. • Canopy Surface Reconstruction and Tropical Forest Parameters Prediction from Airborne Laser Scanner for Large Forest Area. Zongzhu Chen, Zhongyang Yang, Yiqing Chen, Chunxiao Wang, Qi Yang, Xiaohua Chen and Jinrui Lei.
10:45 am to 12:05 pm CGIS South, Lee Gathering Room (S030)	Session C2: Advanced Tools Chair: Benjamin Lewis. • Utilizing Hadoop to Efficiently Manage and Process LiDAR Point Cloud Data in Parallel. Chunxiao Wang, Fei Hu, Wei Wen and Chaowei Yang. • Building a Billion Spatio-Temporal Object Search and Visualization Platform. Devika Kakkar and Benjamin Lewis. • Elastic Cloud Computing Architecture and System for Spatiotemporal Computing. Xuan Shi.
10:45 am to 12:05 pm CGIS South, Seminar Room (S050)	Session C3: Transportation Application Chair: Xun Shi. • The design of a streaming analytical workflow for processing massive transit feeds. Hung Cao and Monica Wachowicz. • Investigating Street Accident Characteristics and optimal safe route recommendation: a case study of New York City. Enbo Zhou, Shanjun Mao and Mei Li. • Spatiotemporal analysis and modeling of individual travel behaviors. Changjoo Kim. • Place2vec: representation learning for places based on urban travel flows. Xi Liu, Bo Yan, Clio Andris and Sohrab Rahimi.
12:05 pm to 1:00 pm CGIS South Concourse	Lunch Break
1:00 pm to 1:45 pm CGIS South, Tsai Auditorium (S010)	Keynote Address IV: Lee Schwartz, Director, Office of the Geographer and Global Issues, Bureau of Intelligence and Research, Department of State Title: Translating Science into Policy: Challenges for the Use of Spatio-Temporal Computing Chair: Jason Ur
1:45 pm to 2:30 pm	Mini Panel Session P4: Secondary Cities and Spatial Data Infrastructure Panelists:

CGIS South, Tsai Auditorium (S010)	Lee Schwartz, Department of State Xuan Shi, University of Arkansas Joshua Lieberman, Harvard University Mei Li, Peking University Chair: Robert Stewart.
2:30 pm to 2:45pm CGIS South Concourse	Coffee Break
2:45 pm to 4:05 pm CGIS South, Belfer Case Study Room (S020)	Session D1: Methodology & Visualization Chair: Mei Li. • Agent Based Modeling: Fine-Scale Spatio-Temporal Analysis of Pertussis. David Mills. • Detecting illegal Migrant Vessels Using Machine Learning Methods. Alexandros Sfyridis, Tao Cheng and Michele Vespe. • A solution for 3D Urban Data Reconstruction and Visualization. Noura El Haje. • Spatiotemporal visualization of time-series satellite-derived CO2 flux data using volume rendering and GPU-based interpolation on a cloud-driven digital earth. Sensen Wu, Yiming Yan, Zhenhong Du, Feng Zhang and Renyi Liu.
2:45 pm to 4:05 pm CGIS South, Seminar Room (S050)	Session D2: Human Dynamics Application Chair: Jun Luo. • Multi-spatiotemporal patterns of residential burglary crimes in Chicago: 2006-2016. Jun Luo. • Spatiotemporal Patterns and Socioeconomic Dimensions of Shared Accommodations: The Case of Airbnb in Los Angeles, California. Avijit Sarkar, Mehrdad Koohikamali and James Pick. • Urban Human Spatiotemporal Dynamic Analyses Based on Social Media Data. An Zhang.
4:05 pm to 5:35 pm CGIS South, Belfer Case Study Room (S020)	Break Out Session 1a Chair: Ad Hoc.
4:05 pm to 5:35 pm CGIS South, Lee Gathering Room (S030)	Break Out Session 2a Chair: Ad Hoc.
5:35 pm to 7:35 pm CGIS South Concourse	Reception (Best Paper Award and Poster Session) Chair: Keith Clarke

Wednesday, Aug 9, 2017

Time and Room	Session
9:00 am to 10:30 am CGIS South, Belfer Case Study Room (S020)	Break Out Session 1b Chair: Ad Hoc.
9:00 am to 10:30 am CGIS South, Lee Gathering Room (S030)	Break Out Session 2b Chair: Ad Hoc.
10:30 am to 10:45 am CGIS South Concourse	Coffee Break
10:45 am to 11:45 am CGIS South, Tsai Auditorium (S010)	Report Back
11:45 am to 1:00 pm CGIS South Concourse	Grab and Go Lunch Available

Detailed Agenda (Abstracts)

Monday, Aug 7, 2017

Session A1: Modeling

Spatio-temporal Data Model for Integrating Evolving Nation-level Datasets.

Alexandre Sorokine, Oak Ridge National Laboratory
Robert Stewart, Oak Ridge National Laboratory

Abstract:
Ability to easily combine the data from diverse sources in a single analytical workflow is one of the greatest promises of the Big Data technologies. However, such integration is often challenging as datasets originate from different vendors, governments, and research communities that results in multiple incompatibilities including data representations, formats, and semantics. Semantics differences are hardest to handle: different communities often use different attribute definitions and associate the records with different sets of evolving geographic entities. Analysis of global socioeconomic variables across multiple datasets over prolonged time is often complicated by the difference in how boundaries and histories of countries or other geographic entities are represented. Here we propose an event-based data model for depicting and tracking histories of evolving geographic units (countries, provinces, etc.) and their representations in disparate data. Our model defines criteria for geographic entity existence, a set of events that may affect its existence, and rules for mapping between different representations (datasets). We use our model for maintaining an evolving compound database of global socioeconomic and environmental data harvested from multiple sources. Practical implementation of the proposed model is demonstrated using PostgreSQL object-relational database with the use of temporal, geospatial and NoSQL database extensions.

A Spatiotemporal Prediction Framework for Air Pollution Based on Deep RNN.

Junxiang Fan, Peking University
Qi Li, CyberGIS Studio, Peking University
Junxiong Hou, Peking University
Xiao Feng, Peking University
Hamed Karimian; Hamed Karimian
Shaofu Lin, Beijing University of Technology

Abstract:
Time series data in practical applications always contain missing values due to sensor malfunction, network failure, outliers etc. In order to handle missing values in time series, as well as the lack of considering temporal properties in machine learning models, we propose a spatiotemporal prediction framework based on missing value processing algorithms and deep recurrent neural network (DRNN). By using missing tag and missing interval to represent time series patterns, we implement three different missing value fixing algorithms, which are further incorporated into deep neural network that consists of LSTM (Long Short-term Memory) layers and fully connected layers. Real-world air quality and meteorological datasets (Jingjinji area, China) are used for model training and testing. Deep feed forward neural networks (DFNN) and gradient boosting decision trees (GBDT) are trained as baseline models against the proposed DRNN. Performances of three missing value fixing algorithms, as well as different machine learning models are evaluated and analysed. Experiments show that the proposed DRNN framework outperforms both DFNN and GBDT, therefore validating the capacity of the proposed framework. Our results also provides useful insights for better understanding of different strategies that handle missing values.

SWE-IoT-based spatiotemporal access to critical sensor data using ad hoc sensor hub constellations.

Joshua Lieberman, Tumbling Walls LLC

Abstract:
New sensor technologies provide an unparalleled capability to collect large numbers of diverse observations about the world around us. Ad hoc networks of such sensors are especially effective for capturing and analyzing unexpected, fast moving events if they can be deployed with a minimum of time, effort, and cost. A rapid-response

sensing, processing, and integrating capability is extremely important in quickly unfolding events to support response efforts with up-to-date and comprehensive knowledge of the situation as it evolves. Such a capability can also provide an archival trace of events in which the spatiotemporally indexed observations are available to be replayed backwards or forwards during and after the events so as to provide insight into event causes and evaluate the effectiveness of response actions. A recent OGC pilot activity combined Sensor Web Enablement (SWE) standards with Internet of Things (IoT) practices to understand better how to set up such rapid-response sensor networks disaster scenarios. A key feature of each network was a constellation of auto-configuring Sensor Hubs that connected local sensor device protocols to a common set of standard SWE data types and Web interfaces, providing interoperable space-time based real-time and archival access to data from dozens of different on-site sensors.

Session A2: Computing Optimization

A novel approach of indexing and retrieving spatial polygons for efficient spatial region queries.

Jianghua Zhao, Computer Network Information Center, Chinese Academy of Sciences
Xuezhi Wang, Computer Network Information Center, Chinese Academy of Sciences
Fengyang Wang, Computer Network Information Center, Chinese Academy of Sciences
Zhihong Shen, cnic
Yuanchun Zhou, Computer Network Information Center, Chinese Academy of Sciences
Yonglin Wang, Lawrence University

Abstract:
Spatial region queries are more and more widely used in web-based applications. Mechanisms to provide efficient query processing over geospatial data are essential. However, due to the massive geospatial data volume, heavy geometric computation, and high access concurrency, it is difficult to get response in real time. Spatial indexes are usually used in this situation. In this paper, based on k-d tree, we introduce a distributed KD-Tree (DKD-Tree) suitbable for polygon data, and a two-step query algorithm. The spatial index construction is recursive and iterative, and the query is an in memory process. Both the index and query methods can be processed in parallel, and are implemented based on HDFS, Spark and Redis. Experiments on a large volume of Remote Sensing images metadata have been carried out, and the advantages of our method are investigated by comparing with spatial region queries executed on PostgreSQL and PostGIS. Results show that our approach not only greatly improves the efficiency of spatial region query, but also has good scalability, Moreover, the two-step spatial range query algorithm can also save cluster resources to support a large number of concurrent queries. Therefore, this method is very useful when building large geographic information systems.

Making Temporal Search Central in a Spatial Data Infrastructure.

Paolo Corti, Harvard Center for Geographic Analysis
Benjamin Lewis, Harvard Center for Geographic Analysis

Abstract:
A temporally enabled Spatial Data Infrastructure (SDI) is a framework of geospatial data, metadata, users and tools intended to provide an efficient and flexible way to use spatial information which includes the historical dimension. One of the key software components of an SDI is the catalogue service which is needed to discover, query, and manage the metadata. A search engine is a software system capable of supporting fast and reliable search, which may use “any means necessary” to get users to the resources they need quickly and efficiently. These techniques may include features such as full text search, natural language processing, weighted results, temporal search based on enrichment, visualization of patterns in distributions of results in time and space using temporal and spatial faceting, and many others. In this paper we will focus on the temporal aspects of search which include temporal enrichment using a time miner, the storage of time ranges in Solr, handling historical dates (BC and AD), and the use of temporal histograms in the user interface to display the temporal distribution of search results.

Leveraging LSTM for rapid intensifications prediction of tropical cyclones.

Yun Li, George Mason University
Ruixin Yang, George Mason University

Manzhu Yu, George Mason University
Fei Hu, George Mason University
Chaowei Yang, George Mason University
Abstract:
Tropical cyclones(TCs) usually cause severe damages and destructions. TC intensity forecasting helps people prepare for the extreme weather to save lives and properties. Rapid Intensifications (RI) of TCs are the major error sources of TC intensity forecasting. A large number of factors, such as sea surface temperature, wind shear, affect the RI processes of TCs. Quite a lot of work have been done to identify the combination of conditions most favorable to RI. In this study, deep learning method is utilized to combine conditions for RI prediction of TCs. Experiments show that the long short-term memory(LSTM) network provides the ability to leverage both past and future conditions to predict TC intensity.

Session A3: Health Application

Spatiotemporal Analysis of Communicable Diseases based on Epidemic Tree: A Case Study of Dengue Fever in Guangzhou City, China.

Meifang Li, Sun Yat-sen Univerisity
Xia Li, Sun Yat-sen Univerisity
Xun Shi, Dartmouth College
Abstract:
Traditionally, epidemic models for characterizing communicable diseases focus on the temporal dimension and are non-spatial. The case-reproduction ratio (Rt), the most widely used measurement for understanding an epidemic process, is usually estimated as a simple mean value for the entire study area, without considering the spatial variation that would be important for analysing the transmission process. In this study, we implemented the epidemic tree method to spatialize the characterization of a communicable disease epidemic, and applied it to the 2013 dengue fever epidemic in Guangzhou City, China. Compared with previous works on epidemic trees, we introduce two novelties to the tree construction process: First, instead of starting from the latest child case and retrospectively tracing parents, we started with the imported cases which were determined to be the roots of potential trees, and grew the trees by keeping adding children to the trees; and second, we included time as a dimension in calculating the spatiotemporal distance between cases (for constructing the tree), and allow its weight in the calculation to be adjustable. Based on the constructed trees, we calculated Rt at three spatial scales, namely global, tree-specific, and pixel-wise. We further conducted correlation analysis, also at the three scales, between the weekly time series of Rt and corresponding climate factors including weekly mean temperature and weekly total precipitation, to detect dengue-climate associations. The findings of this study indicate that the overall Rt for the entire study area, the process-oriented Rt at the tree level, and the location-oriented Rt at the pixel level, as well as the dengue-climate associations detected based on them, offer different information that is all important in epidemiological studies and disease control practices. Through this study, we explored and intend to demonstrate what can be done to spatialize the epidemiological models, what information can be extracted from the output of this spatialization, and then how to use the extracted information. We also point out that spatialization of Rt is the basic process of mapping a communicable disease, corresponding to the spatialization of incidence /prevalence in mapping a chronic disease.

Global Diffusion Pattern and Hot Spot Analysis of Vaccine-Preventable Diseases.

Yongyao Jiang, George Mason University
Abstract:
The Global Health Program at the Council on Foreign Relations has been tracking news reports on global outbreaks of six vaccine-preventable diseases, including measles, mumps, polio, rubella, whooping cough, and other communicable diseases. A total of 905 geographical points, including 2,490,498 cases, were collected globally between January 2008 and December 2013. This dataset, along with several other layers derived from the National Atlas and from the Centers for Disease Control, will be used to identify movement of hot spots of the diseases and where these diseases are most likely to threaten vulnerable populations in the United States, as well as explore possible driving influences. Spatial characteristics reveal the concentration of vaccine-preventable disease is in Africa and the Near East and that disease dispersion is variable depending on disease. The exception is whooping

cough, which has a highly variable center of concentration from year to year. Measles exhibited the only statistically significant spatial autocorrelation among all the diseases under investigation. Hottest spots of measles are in Africa and coldest spots are in United States, warm spots are in Near East and cool spots are in Western Europe.

Challenges in fine-detailed disease risk modeling with time series remotely sensed data: a case study in WNVs in Ontario.

Dongmei Chen, Queen's University

Abstract: N/A

Session B1: Pattern Identification

Extracting Spatiotemporal Objects from Raster Data to Represent Physical Features and Analyze Related Processes.

James Zollweg, The College at Brockport

Abstract:
Numerous ground-based, airborne, and orbiting platforms provide remotely-sensed data of remarkable spatial resolution at short time intervals. However, this spatiotemporal data is most valuable if it can be processed into information, thereby creating meaning. We live in a world of objects: cars, buildings, farms, etc. On a stormy day, we don't see millions of cubes of atmosphere; we see a thunderstorm 'object'. Temporally, we don't see the properties of those individual cubes changing, we see the thunderstorm as a whole evolving and moving. There is a need to represent the bulky, raw spatiotemporal data from remote sensors as a small number of relevant spatiotemporal objects, thereby matching the human brain's perception of the world. This presentation reveals an efficient algorithm and system to extract the objects/features from raster-formatted remotely-sensed data. The system makes use of the Python object-oriented programming language, SciPy/NumPy for matrix manipulation and scientific computation, and export/import to the GeoJSON standard geographic object data format. The example presented will show how thunderstorms can be identified and characterized in a spatiotemporal continuum using a Python program to process raster data from NOAA's High-Resolution Rapid Refresh v2 (HRRRv2) data stream.

Analyzing Precipitation Pattern Using a Kinematics-based GIS Methodology.

Kejin Cui, George Mason University

Abstract:
Precipitation is one major type of dynamic geographic phenomena. With time changing, precipitation areas can move, merge, split or disappear. Existing methods are not sufficient to describe and analyze the dynamic characteristics of precipitation area. This paper applies kinematics based method in Geographic Information System (GIS) to analyze precipitation data. Three major types of spatial transitions are considered and applied: divergence, rotation and deformation. This project will use PRISM dataset (http://www.prism.oregonstate.edu), and annual precipitation data of U.S. Mainland from the recent 60 years are selected. According to the kinematics based model above, the overall pattern of high precipitation areas in U.S. Mainland during the recent 60 years will be discovered. How the high precipitation areas were dynamically changed will be analyzed and discussed.

Detection of Behavior Patterns of Interest using Big Data which have Spatial and Temporal Attribute.

Richard La Valley, OGSystems
Abe Usher, HumanGeo
Adam Cook, HumanGeo

Abstract:
New innovative analytical techniques are emerging to extract patterns in Big Data which have temporal and geo-spatial attributes. These techniques are required when geo-spatial datasets which have billions of rows and the imprecision of the exact latitude and longitude spatial data makes it extremely difficult to locate patterns of interest. The usual temporal vector approach of years, months, days, hours, minutes and seconds often are computationally expensive and often do not allow the user control of precision necessary to find patterns of interest.

Geohashing is an ASCII string representation of two-dimensional geometric coordinates. Time hashing is a similar ASCII representation which maps time to preserve all temporal aspects of date and time of the data into a one dimensional set of data points. Both methods utilize Z-order curves which maps multidimensional data into single dimensions while preserving locality of the data points. This paper explores the use of a combination of both geohashing and time hashing that is known as "geo-temporal" hashing or "space-time" boxes. This technique provides a foundation for reducing the data into bins that can yield new methods for pattern discovery and detection in Big Data.

Estimating Hourly Population Distribution Change at High Spatiotemporal Resolution in Urban Areas using Geo-Tagged Tweets, Land Use Data, and Dasymetic Maps.

Ming-Hsiang Tsou, San Diego State University
Hao Zhang, San Diego State University
Atsushi Nara, San Diego State University
Su Yeon Han, San Diego State University

Abstract:
This paper introduces a spatiotemporal analysis framework for estimating hourly changing population distribution in urban areas using geo-tagged tweets (the messages containing users' physical locations), land use data, and dasymetric maps. One main goal of the research is to facilitate evacuation planning and emergency management during disaster events for people in different regions by providing hourly estimated population at specific locations. In our case study, we collected geo-tagged social media (tweets) within the County of San Diego during one year (2015) by using Twitter's Streaming Application Programming Interfaces (APIs). A semi-manual Twitter content verification procedure for data cleaning was applied first to separate tweets created by humans and non-human users (bots). The next step is to calculate the number of unique Twitter users every hour with the two different geographical units: (1) census blocks, and (2) 1km by 1km resolution grids of LandScan. The final step is to estimate actual dynamic population by transforming the numbers of unique Twitter users in each census block or grid into estimated population densities with spatial and temporal variation factors. A temporal factor was based on hourly frequency changes of unique Twitter users within the County of San Diego. A spatial factor was estimated by using the dasymetric method with land use maps and 2010 census data. Several comparison maps were created to visualize the spatiotemporal pattern changes of dynamic population distribution in San Diego, U.S.A as our case study.

Using multi-temporal remote sensing data to understand the spatio-temporal patterns of dry season rice production in Bangladesh.

Aaron Shew, University of Arkansas
Aniruddha Ghosh, University of California, Davis

Abstract:
Remote sensing in the optical domain has been widely used for developing agricultural monitoring platforms. However, such initiatives for developing countries are challenging due to a lack of computational resources and high quality in situ information. In this study, we demonstrate the potential to quantify spatio-temporal patterns of dry season rice production in Bangladesh over the last three decades using temporal remote sensing data from the Landsat archive. To analyze approximately 90,000 km^2 of cultivated land in Bangladesh at 30 m spatial resolution, we used Google Earth Engine (GEE), a cloud-based geospatial data analysis platform built on Google infrastructure and capable of processing petabyte-scale remote sensing data. We reconstructed the seasonal patterns of vegetation indices (VIs) for each pixel using a harmonic model, which also minimizes the effects of noise and missing information. We combined the seasonality information of VIs with our knowledge of crop phenology and growing seasons to delineate rice areas in the dry season, which are predominantly High Yielding Varieties (HYV). Fine spatial scale information on HYV rice over the last 30 years will greatly improve our understanding of double-cropped rice systems, current status of production, and potential for HYV rice adoption in Bangladesh.

Session B2: Best Paper Competition

GPU-accelerated adaptive kernel density estimation for point pattern analysis on spatial big data.

Guiming Zhang, Department of Geography, University of Wisconsin-Madison

Abstract:

Kernel density estimation (KDE) with spatially adaptive bandwidths is a preferred approach for spatial point pattern analysis in many applications. However, bandwidths determination for adaptive KDE is extremely computationally intensive, particularly for large problem size. We present a graphics processing units (GPU)-accelerated adaptive KDE algorithm for efficient spatial point pattern analysis on spatial big data. Optimizations were designed to reduce complexity of the algorithm of bandwidths determination for adaptive KDE. The massively parallel computing resources on GPU were then exploited to further speed up the optimized algorithm. Performance evaluations demonstrated that the optimizations effectively improved the performance by a factor of tens. Compared to the sequential and OpenMP version of the adaptive KDE algorithm, the GPU-enabled algorithm accelerated point pattern analysis tasks by a factor of hundreds and tens respectively. The GPU-accelerated adaptive KDE algorithm scales reasonably well with increasingly large problem size. Empowered by the GPU-enabled adaptive KDE algorithm, point pattern analysis on spatial big point data sets can be performed efficiently. The GPU-accelerated adaptive KDE approach contributes to the geospatial computational toolbox that facilitates geographic knowledge discovery from spatial big data.

The World Spatiotemporal Analytics and Mapping Project (WSTAMP): Further Progress in Discovering, Exploring, and Mapping Spatiotemporal Patterns across the World's Largest Open Source Data Sets.

Jesse Piburn, Oak Ridge National Lab

Abstract:
Spatiotemporal (ST) analytics applied to major data sources such as the World Bank and World Health Organization has shown tremendous value in shedding light on the evolution of cultural, health, economic, and geopolitical landscapes on a global level. WSTAMP engages this opportunity by situating analysts, data, and analytics together within a visually rich and computationally rigorous online analysis environment. Since introducing WSTAMP at the First International Workshop on Spatiotemporal Computing, several transformative advances have occurred. Collaboration with human computer interaction experts led to a complete interface redesign that deeply immerses the analyst within a ST context, significantly increases visual and textual content, provides navigational crosswalks for attribute discovery, substantially reduce mouse and keyboard actions, and supports user data uploads. Secondly, the database has been expanded to include over 16,000 attributes, 50 years of time, and 200+ nation states and redesigned to support sub-annual, sub-national, city, and interaction data. Finally, two new analytics are implemented for analyzing large portfolios of multi-attribute data and measuring the behavioral stability of regions along different dimensions. These advances required substantial new approaches in design, algorithmic innovations, and increased computational efficiency. We report on these advances and inform how others may freely access the tool.

Hyperparameter optimization of neural network-driven spatial models accelerated using cyber-enabled high-performance computing.

Minrui Zheng, University of North Carolina at Charlotte

Abstract:
Artificial neural networks (ANNs) as a machine learning approach have been extensively used for the spatial modeling of complex geographic phenomena. However, because of complexity of computational process, configuration of architectures of neural networks have not been adequately investigated, such as the number of hidden layers, the number of nodes in each hidden layer, or learning rate. Given a specific dataset, the performance of a model driven by ANNs depends on parameter setting of the model. But, few studies in the literature discussed how to choose the parameter setting for ANN-driven spatial models. In this study, we develop an automated selection approach to identify optimal neural networks for spatial modeling using hyperparameter optimization. Hyperparameter optimization provides support for selecting the optimal architectures of ANNs. Yet, the use of hyperparameter optimization is often challenging because parameter space is often large and the associated computational demand is heavy. Thus, we utilize high-performance and parallel computing to accelerate the model selection process. The spatial model used in our case study is a land evaluation model that estimates the impact of amenity and land characteristics on land price in an urbanized county: Mecklenburg County, North Carolina. Our results demonstrate that the automated selection approach improves the model-level performance compared with traditional linear model, and high-performance and parallel computing is of great help for accelerating the selection of optimal neural networks for spatial modeling.

Watching the birdwatchers on Flickr: An adaptive kernel smoothing approach for visualizing spatiotemporal patterns of a cultural ecosystem service.

Chang Zhao, University of Iowa

Abstract:
Birdwatching is an important recreational cultural ecosystem services (CES) provided by natural ecosystems, which involves observing, photographing and documenting birds. Identifying when and where birdwatching activities take place is essential for informing policies and strategies for the planning and management of this CES at different operational scales. The availability and widespread use of social media data creates an unprecedented opportunity to capture spatiotemporal variation in demand for CES at broader scales. However, current methods that employ user-generated social media data suffer from two major problems: (1) user contribution bias in which the results are dominated by a few users with large number of contributions, (2) the small area problem in which the results exhibit spurious variation in areas with fewer observations. To address these problems, we first introduce a set of indicators to measure the relative demand in CES across geographic areas and time periods (e.g., seasons). Second, we develop a constrained adaptive kernel smoothing approach to address the user contribution bias and small area problem, and discover the temporal and spatiotemporal variation in CES demand using the big data of social media. Different from the traditional kernel smoothing approach, we employ constraints, i.e., the similarity of neighbors, and the maximum bandwidth size, in the bandwidth selection process to control the geographic uncertainty introduced by varying size, and characteristics of the neighbors. To demonstrate, we smooth the indicators for a spatiotemporal dataset of Flickr images in order to discover the temporal and spatiotemporal variation in birdwatching services. Birdwatching activities increase over years and exhibits seasonal changes, with higher intensity in the winter and spring months. Hotspots of birdwatching activities extensively overlap with the major bird migratory flyways in North America, natural parks, and wildlife refuges which serve as high quality habitat for birds, and provide infrastructure, accessibility and guidance for birdwatchers.

Normalization Strategies for Enhancing Spatio-Temporal Analysis of Social Media Responses during Extreme Events: A Case Study based on Analysis of Four Extreme Events using Socio-Environmental Data Explorer (SEDE)

Jayakrishnan Ajayakumar, Kent State University

Abstract:
With social media becoming increasingly location-based, there has been a greater push from researchers across various domains including social science, public health, and disaster management, to tap in the spatial, temporal, and textual data available from these sources to analyze public response during extreme events such as an epidemic outbreak or a natural disaster. Studies based on demographics and other socio-economic factors suggests that social media data could be highly skewed based on the variations of population density with respect to place. To capture the spatio-temporal variations in public response during extreme events we have developed the Socio-Environmental Data Explorer (SEDE). SEDE collects and integrates social media, news and environmental data to support exploration and assessment of public response to extreme events. For this study, using SEDE, we conduct spatio-temporal social media response analysis on four major extreme events in the United States including the “North American storm complex” in December 2015, the “snowstorm Jonas” in January 2016, the “West Virginia floods” in June 2016, and the “Hurricane Matthew” in October 2016. Analysis is conducted on geo-tagged social media data from Twitter and warnings from the storm events database provided by National Centers For Environmental Information (NCEI) for analysis. Results demonstrate that, to support complex social media analyses, spatial and population-based normalization and filtering is necessary. The implications of these results suggests that, while developing software solutions to support analysis of non-conventional data sources such as social media, it is quintessential to identify the inherent biases associated with the data sources, and adapt techniques and enhance capabilities to mitigate the bias. The normalization strategies that we have developed and incorporated to SEDE will be helpful in reducing the population bias associated with social media data and will be useful for researchers and decision makers to enhance their analysis on spatio-temporal social media responses during extreme events.

Developing a spatiotemporal framework for 4D event tracking and analysis - an example with dust events.

Manzhu Yu, George Mason University

Abstract:

Natural phenomena evolve in space and time and can be highly dynamic. Numerical simulations and earth observations have provided the capability to capture and study the complex evolvement of natural phenomena in a discrete fashion. Challenges include the automatic extraction of events from these discrete datasets, and the formalization of the representation of such phenomena over space and time. The objectives of this research are to: 1) conceptually represent the natural phenomenon as an event, 2) introduce movement tracking approach to reconstruct events by navigating through 4D simulation datasets, and 3) analyze the evolvements and dynamic movements of the events. Dust events are chosen as a case study to illustrate how this framework can be used to represent the 4D dynamic phenomena. With the proposed framework, a set of feature identification and tracking algorithms are introduced to construct dust events from a 4D simulation dataset over the broad North Africa, the Mediterranean, and the Middle East for a whole year from December 2013 to November 2014. Spatiotemporal queries are conducted to utilize the framework to analyze the evolution patterns and seasonality of dust events from major dust storm regions. Evaluation of the resulting dust events shows that the identified dust events align well with observations.

Session B3: Geoscience Application

Sequential classifier training for rice mapping with multitemporal remote sensing imagery.

Yiqing Guo, The University of New South Wales
Xiuping Jia, The University of New South Wales, Australian Defence Force Academy
David Paull, The University of New South Wales, Australian Defence Force Academy

Abstract:
Most traditional methods for rice mapping with remote sensing data are effective when they are applied to the initial growing stage of rice, as the practice of flooding during this period makes the spectral characteristics of rice fields more distinguishable. In this study, we propose a sequential classifier training approach for rice mapping that can be used to the whole growing period of rice for monitoring various growing stages. Rice fields are firstly identified during the initial flooding period. The identified rice fields are used as training data to train a classifier that separates rice and non-rice pixels. The classifier is then used as a priori knowledge to assist the training of classifiers for later rice growing stages. This approach can be applied progressively to sequential image data, with only a small amount of training samples being required from each image. In order to demonstrate the effectiveness of the proposed approach, experiments were conducted at one of the major rice-growing areas in Australia. The proposed approach was applied to a set of multitemporal remote sensing images acquired by the Sentinel-2A satellite. Experimental results show that, compared with the traditional spectral-index-based algorithms, the proposed method is able to achieve more stable and consistent rice mapping accuracies and it reaches higher than 80% during the whole rice growing period.

Real-Time Earthquake Monitoring with Data Stream-Based Temporal Fields.

John. C. Whittier, University of Maine
Silvia Nittel, University of Maine
Iranga Subasinghe, University of Maine

The impact of spatial and temporal resolutions in Tropical summer rainfall distribution: Preliminary Results.

Qian Liu, George Mason University
Long Chiu, George Mason University
Xianjun Hao, George Mason University

Abstract:
The abundance or lack of rainfall affects peoples' life and activities. As a major component of the global hydrological cycle (Chokngamwong, et al., 2007), accurate representations at various spatial and temporal scales are crucial for a lot of decision making processes. Climate models show a warmer and wetter climate due to increases of Greenhouse Gases (GHG). However, the models' resolutions are often too coarse to be directly applicable to local scales that are useful for mitigation purposes. Hence disaggregation (downscaling) procedures are needed to translate the coarse scale products to higher spatial and temporal resolutions. The aim of this paper is to examine the changes in the statistical parameters of rainfall at various spatial and temporal resolutions: The TRMM Multi-satellite Precipitation Analysis (TMPA) at 0.25 degree, 3 hourly grid rainfall data for a summer is aggregrated to 0.5,1.0, 2.0 and 2.5 degree and at 6, 12, 24 hourly, pentad (five days) and monthly

resolutions. The probability distributions (PDF) and cumulative distribution functions(CDF) of rain amount at these resolutions are computed and modeled as a mixed distribution. Parameters of the PDFs are compared using a Kolmogrov-Smironov (KS) test, both for the mixed and the marginal distribution. These distributions are shown to be distinct. The marginal distributions are fitted a Lognormal and Gamma distributions and it is found that the Gamma distributions fit much better than the Lognormal.

Tuesday, Aug 8, 2017

Session C1: Methodology

Applying Theissen Polygon Catchment Areas and Gridded Population Weights to Estimate Conflict-Driven Population Changes in South Sudan.

Lisa Jordan, Drew University

Abstract:
Recent violence in South Sudan produced significant levels of conflict-driven migration undermining the accuracy and utility of both national and local level population forecasts commonly used in demographic estimates, public health metrics and food security proxies. This article explores the use of Thiessen Polygons and population grids (Gridded Population of the World, WorldPop and LandScan) as weights for estimating the catchment areas for settlement locations that serve large populations of internally displaced persons (IDP), in order to estimate the county-level in- and out-migration attributable to conflict-driven displacement between 2014-2015. Acknowledging IDP totals improves internal population estimates presented by global population databases. Unlike other forecasts, which produce spatially uniform increases in population, accounting for displaced population reveals that 15 percent of counties (n = 12) increased in population over 20 percent, and 30 percent of counties (n = 24) experienced zero or declining population growth, due to internal displacement and refugee out-migration. Adopting Thiessen Polygon catchment zones for internal migration estimation can be applied to other areas with United Nations IDP settlement data, such as Yemen, Somalia, and Nigeria.

Comparison of Spatiotemporal Mapping Techniques for Enormous ETL and Exploitation Problems.

Ray Deiotte, Issac Corporation
Richard La Valley, OGSystems

Abstract:
The need to extract, transform, and exploit enormous volumes of spatiotemporal data has exploded with the rise of social media, advanced military sensors, wearables, automotive tracking, etc. However, current methods of spatiotemporal encoding and exploitation simultaneously limit use of that information and increase computing complexity. Current spatiotemporal encoding methods from Niemeyer and Usher rely on a Z-order space filling curve, a relative of Peano's 1890 space filling curve, for spatial hashing and interleaving temporal hashes to generate a spatiotemporal encoding. However, there exist other space-filling curves and that provide different manifold coverings that could promote better hashing techniques for spatial data and have the potential to map spatiotemporal data without interleaving. The concatenation of Niemeyer and Usher provide a highly efficient space time index, however they have some limitations that may be overcome by other techniques. Each of these three methods has advantages and disadvantages in terms of computational cost, efficiency and utility. This paper explores the three on a range of sizes of datasets from 1K to 10M observations and provides a comparison of the methods.

A Simple Spatially Weighted Measure of Temporal Stability for Data with Limited Temporal Observations.

Jesse Piburn, Oak Ridge National Lab
Robert Stewart, Oak Ridge National Laboratory
April Morton, Oak Ridge National Laboratory

Abstract:
Identifying erratic or unstable time-series is an area of interest to many fields. Recently, there have been successful developments towards this goal. These new developed methodologies however come from domains where it is typical to have several thousand or more temporal observations. This creates a challenge when attempting to apply these methodologies to time-series with much fewer temporal observations such as for socio-cultural understanding, a domain where a typical time series of interest might only consist of 20-30 annual observations. Most existing methodologies simply cannot say anything interesting with so few data points, yet researchers are

still tasked to work within in the confines of the data. Recently a method for characterizing instability in a time series with limited temporal observations was published. This method, Attribute Stability Index (ASI), uses an approximate entropy based method to characterize a time series' instability. In this paper we propose an explicitly spatially weighted extension of the Attribute Stability Index. By including a mechanism to account for spatial autocorrelation, this work represents a novel approach for the characterization of space-time instability. As a case study we explore national youth male unemployment across the world from 1991-2014.

Canopy Surface Reconstruction and Tropical Forest Parameters Prediction from Airborne Laser Scanner for Large Forest Area.

Zongzhu Chen, Forestry Research Institute of Hainan Province
Zhongyang Yang, Forestry Research Institute of Hainan Province
Yiqing Chen, Forestry Research Institute of Hainan Province
Chunxiao Wang, Hainan Geomatics Center, National Administration of Surveying, Mapping and Geoinformation of China
Qi Yang, Forestry Research Institute of Hainan Province
Xiaohua Chen, Forestry Research Institute of Hainan Province
Jinrui Lei, Forestry Research Institute of Hainan Province

Abstract:
Canopy height model(CHM) and tree mean height are critical forestry parameters that many other parameters such as growth, carbon sequestration, standing timber volume, and biomass can be derived from. LiDAR is a new method used to rapidly estimate these parameters over large areas. The estimation of these parameters has been derived successfully from CHM. However, a number of challenges limit the accurate retrieval of tree height and crowns, especially in tropical forest area. In this study, an improved canopy estimation model is proposed based on dynamic moving window that applied on LiDAR point cloud data. DEM, DSM and CHM of large tropical forest area can be derived from LiDAR data effectively and efficiently.

Session C2: Advanced Tools

Utilizing Hadoop to Efficiently Manage and Process LiDAR Point Cloud Data in Parallel.

Chunxiao Wang, Hainan Geomatics Center, National
Administration of Surveying, Mapping and Geoinformation of China
Fei Hu, George Mason University
Wei Wen, Hainan Geomatics Center, National Administration of Surveying, Mapping and Geoinformation of China
Chaowei Yang, George Mason University

Abstract:
Light Detection and Ranging (LiDAR) is one of the most promising technologies in surveying and mapping, city management, forestry, object recognition, computer vision engineer and others. However, it is challenging to efficiently manage and query them and will be computing-intensive in indexing, searching, classification, recognition etc. In this study, a Hadoop-based framework is proposed to manage and process data in a distributed and parallel manner, which take advantage of Hadoop's scalable storage and computing ability. To avoid the repeated development of the complex LiDAR data processing algorithms, the Point Cloud Library (PCL), a standalone, large scale, open source library for 2D/3D image and point cloud processing, will be leveraged and integrated with HDFS and MapReduce to directly process these LiDAR data in parallel in a scalable computing environment. The experiment results show that the proposed framework can efficiently manage and process such big LiDAR data.

Building a Billion Spatio-Temporal Object Search and Visualization Platform.

Devika Kakkar, Harvard Center for Geographic Analysis
Benjamin Lewis, Harvard Center for Geographic Analysis

Abstract:
With funding from the Sloan Foundation and Harvard Dataverse, the Harvard Center for Geographic Analysis (CGA) has developed a spatio-temporal visualization platform dubbed the Billion Object Platform or "BOP". The goal of the project is to lower barriers for scholars who wish to access large, streaming, spatio-temporal datasets. The BOP is initially loaded with the latest billion geo-tweets, and it is fed a real-time stream of about 1 million tweets per

day. The geo-tweets are enriched with sentiment and census/admin boundary codes. The system is open source and is currently hosted on Massachusetts Open Cloud (MOC), an OpenStack environment. All components are deployed in Docker orchestrated by Kontena. This paper will provide an overview of the BOP architecture built using an open source solution stack of Apache Lucene, Solr, Kafka, Zookeeper, and frameworks Swagger, scikit-learn, OpenLayers, and AngularJS. It will further discuss the approach used for harvesting, enriching, streaming, storing, indexing, visualizing and querying a billion streaming geo-tweets.

Elastic Cloud Computing Architecture and System for Spatiotemporal Computing.

Xuan Shi, University of Arkansas

Abstract:
Spatiotemporal computation implements a variety of different algorithms. When big data are involved, desktop computer or standalone application may not be able to complete the computation task due to limited memory and computing power. Now that a variety of hardware accelerators are available to improve the performance of geocomputation, different algorithms may have different behavior on different computing infrastructure and platforms. Some are perfect for implementation on a cluster of GPUs, while GPUs may not be useful on certain kind of spatiotemporal computation. This is the same situation in utilizing a cluster of Intel's many-integrated-core (MIC) or Xeon Phi to handle big geospatial data. Furthermore, considering the energy efficiency requirement in general computation, FPGA may be a better solution for better energy efficiency when the performance of computation could be similar or better than GPUs and MICs. It is expected that an elastic cloud computing architecture and system that integrates all of GPUs, MICs, and FPGAs could be developed and deployed to support spatiotemporal computing over heterogeneous data types and computational problems.

Session C3: Transportation Application

The design of a streaming analytical workflow for processing massive transit feeds.

Hung Cao, University of New Brunswick
Monica Wachowicz, University of New Brunswick

Abstract:
Retrieving and analyzing transit feeds relies on working with analytical workflows that can handle the massive volume of data streams that are relevant to understand the dynamics of transit networks which are entirely deterministic in the geographical space in which they takes place. In this paper, we consider the fundamental issues in developing a streaming analytical workflow for analyzing the continuous arrival of multiple, unbounded transit data feeds for automatically processing and enriching them with additional information containing higher level concepts accordingly to a particular mobility context. This workflow consists of three tasks: (1) stream data retrieval for creating time windows; (2) data cleaning for handling missing data, overlap data or redundant data; and (3) data contextualization for computing actual arrival and departure times as well as the stops and moves during a bus trip, and also performing mobility context computation. The workflow was implemented in a Hadoop cloud ecosystem using data streams from the CODIAC Transit System of the city of Moncton, NB. The Map() function of MapReduce is used to retrieve and bundle data streams into numerous clusters which are subsequently handled in a parallel manner by the Reduce() function in order to execute the data contextualization step. The results validate the need for cloud computing for achieving high performance and scalability, however, due to the delay in computing and networking, it is clear that data cleaning tasks should not only be deployed using a cloud environment, paving the way to combine it with fog computing in the near future.

Investigating Street Accident Characteristics and optimal safe route recommendation: a case study of New York City.

Enbo Zhou, Peking University
Shanjun Mao, Peking University
Mei Li, Peking University

Abstract:
With the growing traffic accidents, cities meet the problem of traffic safety. In order to reduce the traffic accidents, vehicle collision’s spatio-temporal distributions and characteristics need to be analyzed. This paper focuses on investigating the spatio-temporal distributions and characteristics of vehicle collisions and detecting the accident prone streets. Besides, an optimal safe route is proposed based on the dangerous index defined in this paper. We

calculated the number of collisions on each street by hour from 0 to 23 and got a collision-curve for each street to delineate the temporal characteristics of collisions which indicated the inherent functions and locations of each street. The streets were clustered into several types based on the collision-time curves to find different spatial patterns. A dangerous index was defined and calculated for each street. The accident prone streets were detected using the index to reveal the spatial distributions of dangerous streets. Finally, the optimal safe route method was tested on the data of New York City. This paper's methods and findings may contribute to the governance and planning of the city and the optimal safe routing method provides a new insight to route under some circumstances such as the school bus's travel.

Spatiotemporal analysis and modeling of individual travel behaviors.

Changjoo Kim, University of Cincinnati

Abstract:
Understanding individual travel behavior is vital in travel demand management as well as in urban and transportation planning. New data sources including mobile phone data and location-based social media (LBSM) data allow us to understand mobility behavior on an unprecedented level of details. Recent studies of trip purpose prediction tend to use machine learning (ML) methods, since they generally produce high levels of predictive accuracy. Few studies used LSBM as a large data source to extend its potential in predicting individual travel destination using ML techniques. In the presented research, we created a spatio-temporal probabilistic model based on an ensemble ML framework named "Random Forests" utilizing the travel extracted from geotagged Tweets in 419 census tracts of Greater Cincinnati area for predicting the tract ID of an individual's travel destination at any time using the information of its origin. We evaluated the model accuracy using the travels extracted from the Tweets themselves as well as the travels from household travel survey. The Tweets and survey based travels that start from same tract in the south western parts of the study area is more likely to select same destination compare to the other parts. Also, both Tweets and survey based travels were affected by the attraction points in the downtown of Cincinnati and the tracts in the north eastern part of the area. Finally, both evaluations show that the model predictions are acceptable, but it cannot predict destination using inputs from other data sources as precise as the Tweets based data.

Place2vec: representation learning for places based on urban travel flows.

Xi Liu, Department of Geography, The Pennsylvania State University
Bo Yan, Department of Geography, University of California, Santa Barbara
Clio Andris, Department of Geography, The Pennsylvania State University
Sohrab Rahimi, Department of Geography, The Pennsylvania State University

Abstract:
Places are important components of urban systems. Due to the finer classification of POI types and more mixed land use, representing the functions of places as categories have limitations in either contributing to our understanding of places or being used as inputs for applications such as urban planning. Urban travel flows are driven by transitions of people's activities, which have strong temporal patterns. The function of a place can thus be inferred by integrating its spatiotemporal properties preserved in flows: flow context – where people would come from and where they would leave for; and temporal dynamics – when people would visit it. In this study, by leveraging flow context and temporal dynamics of places, we propose a neural-network-based method, place2vec, to generate vector representations that embed places in a continuous vector space. In this representation, places have similar functions, or used by people similarly, are close to each other in the vector space. Our representation of places can enhance the understanding of places in cities, provide precise and computable inputs for place related studies, and support ontology engineering for places. The method is tested with two case studies using social media check-in data and taxi trip record data, respectively.

Session D1: Methodology & Visualization

Agent Based Modeling: Fine-Scale Spatio-Temporal Analysis of Pertussis.

David Mills, Texas State University

Abstract:
In epidemiology, spatial and temporal variables are used to compute vaccination efficacy and effectiveness. The chosen resolution and scale of a spatial or spatio-temporal analysis will affect the results. When calculating

vaccination efficacy, for example, a simple environment that offers various ideal outcomes is often modeled using coarse scale data aggregated on an annual basis. In contrast to the inadequacy of this aggregated method, this research uses agent based modeling of fine-scale neighborhood data centered around the interactions of infants in daycare and their families to demonstrate an accurate reflection of vaccination capabilities. Despite being able to prevent major symptoms, recent studies suggest that acellular Pertussis does not prevent the colonization and transmission of Bordetella Pertussis bacteria. After vaccination, a treated individual becomes a potential asymptomatic carrier of the Pertussis bacteria, rather than an immune individual. Agent based modeling enables the measurable depiction of asymptomatic carriers that are otherwise unaccounted for when calculating vaccination efficacy and effectiveness. Using empirical data from a Florida Pertussis outbreak case study, the results of this model demonstrate that asymptomatic carriers bias the calculated vaccination efficacy and reveal a need for reconsidering current methods that are widely used for calculating vaccination efficacy and effectiveness.

Detecting illegal Migrant Vessels Using Machine Learning Methods.
Alexandros Sfyridis, SpaceTimeLab, UCL
Tao Cheng, SpaceTimeLab, University College London
Michele Vespe, JRC, European Commission
Abstract:
Consecutive years of political instability and conflicts in Africa and the Middle East resulted into huge numbers of people fleeing to Europe in search of a better life and stability. The assisted illegal crossing into European soil via sea routes is often followed up by loss of lives highlighting the need to find ways to intervene. This paper intends to expand the knowledge available on smuggling operations and contribute to migrant vessel detection to enable effective intervention. We first examine real-world examples of illegal migrants vessels and their behaviours such as "vessel has stopped in a waiting area outside some predefined ports in East Med for a few days". Then we define rules and features to describe such behaviours. Next, one class SVM algorithm is developed to detect such behaviours from AIS and trajectory data. Finally, the algorithm is applied to identify the potential illegal migrant vessels from a one month maritime dataset of 5000 vessels in the East Mediterranean. Nine vessels are considered as illegal, subject to further investigation by authorities.

A solution for 3D Urban Data Reconstruction and Visualization.
Noura El Haje, IRIT
Abstract:
Working on and managing real urban data is challenging, the main reason being the heaviness of the 3D files and the developer obligation to go through a pre-processing step for files preparation and conversion before usage in applications . Many software have been developed and adopted for constructing, editing and visualizing 3D GIS-based cities. However, the processing and visualizing of this kind of data on the web is still restrictive.
In this paper, we propose a web-based user intuitive solution for real cities reconstruction and visualization based on standards and libraries.
A possibility of user interaction by means of procedural editing will be explained throughout the document, without any need for additional plugins or extensions.
Our research also includes the development of several functionality and 3D operations that allow the user to visualize the buildings according to their importance, create new buildings and launch queries on a specific building or a group of buildings with a specific architecture.
The overall contribution of this paper is to validate the concept of combining GIS real data and procedural creation rules to the data in one web application. This is also to show the great potential of geographic data and its management flexibility.

Spatiotemporal visualization of time-series satellite-derived CO2 flux data using volume rendering and GPU-based interpolation on a cloud-driven digital earth.
Sensen Wu, Zhejiang University
Yiming Yan, Zhejiang University
Zhenhong Du, Zhejiang University
Feng Zhang, Zhejiang University
Renyi Liu, Zhejiang University

Abstract:
The ocean carbon cycle has a significant influence on global climate, and is commonly evaluated using time-series satellite-derived CO2 flux data. Location-aware and globe-based visualization is an important technique for analyzing and presenting the evolution of climate change. To achieve realistic simulation of the spatiotemporal dynamics of ocean carbon, a cloud-driven digital earth platform is developed to support the interactive analysis and display of multi-geospatial data, and an original visualization method based on our digital earth is proposed to demonstrate the spatiotemporal variations of carbon sinks and sources using time-series satellite data. Specifically, a volume rendering technique using half-angle slicing and particle system is implemented to dynamically display the released or absorbed CO2 gas. To enable location-aware visualization within the virtual globe, we present a 3D particle-mapping algorithm to render particle-slicing textures onto geospace. In addition, a GPU-based interpolation framework using CUDA during real-time rendering is designed to obtain smooth effects in both spatial and temporal dimensions. To demonstrate the capabilities of the proposed method, a series of satellite data is applied to simulate the air-sea carbon cycle in the China Sea. The results show that the suggested strategies provide realistic simulation effects and acceptable interactive performance on the digital earth.

Session D2: Human Dynamics Application

Multi-spatiotemporal patterns of residential burglary crimes in Chicago: 2006-2016.

Jun Luo, Missouri State University

Abstract:
This research attempts to explore the patterns of burglary crimes at multi-spatiotemporal scales in Chicago between 2006 and 2016. Two spatial scales are investigated that are census block and police beat area. At each spatial scale, three temporal scales are integrated to make spatiotemporal slices: hourly scale with two-hour time step from 12:00am to the end of the day; daily scale with one-day step from Sunday to Saturday within a week; monthly scale with one-month step from January to December. A total of six types of spatiotemporal slices will be created as the base for the analysis. Burglary crimes are spatiotemporally aggregated to spatiotemporal slices based on where and when they occurred. For each type of spatiotemporal slices with burglary occurrences integrated, spatiotemporal neighborhood will be defined and managed in a spatiotemporal matrix. Hot-spot analysis will identify spatiotemporal clusters of each type of spatiotemporal slices. Spatiotemporal trend analysis is conducted to indicate how the clusters shift in space and time. A Web-based 3-D visualization platform will be created to visualize the analysis results. The analysis results will provide helpful information for better target policing and crime prevention policy such as police patrol scheduling regarding times and places covered.

Spatiotemporal Patterns and Socioeconomic Dimensions of Shared Accommodations: The Case of Airbnb in Los Angeles, California.

Avijit Sarkar, University of Redlands
Mehrdad Koohikamali, University of Redlands
James Pick, University of Redlands

Abstract:
In recent years, disruptive innovation by peer-to-peer platforms in a variety of industries, notably transportation and hospitality have altered the way individuals consume everyday essential services. With growth in sharing economy platforms such as Uber for ridesharing and Airbnb for short-term accommodations, interest in examining spatiotemporal patterns of participation in the sharing economy by suppliers and consumers is increasing. This research is motivated by key questions: who are the sharing economy workers, where are they located, and does their location influence their participation in the sharing economy? This paper is the first systematic effort to analyze spatiotemporal patterns of participation by hosts in the shared accommodation-based economy. Using three different kinds of shared accommodations listed in a 3-year period in the popular short-term accommodation platform, Airbnb, we examine spatiotemporal dimensions of host participation in a major U.S. market, Los Angeles CA. The paper also develops a conceptual model by positing associations of demographic, socioeconomic, occupational, and social capital attributes of hosts, along with their attitudes toward trust and greener consumption with hosts' participation in a shared accommodation market. Results confirm host participation to be influenced by young dependency ratio, the potential of supplemental income, as well as the sustainability potential of collaborative consumption, along with finance, insurance, and real estate occupation,

but not so much by trust for our overall study area. These results add new insights to limited prior knowledge about the sharing economy worker and have policy implications.

Urban Human Spatiotemporal Dynamic Analyses Based on Social Media Data.

An Zhang, State Key Laboratory of Resources and Environmental Information System, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences

Abstract:
The dynamic distribution characteristics of urban population are researched by location microblog (Weibo) data in grids, which mainly contain the sum location microblogs, the daytime location microblog quantities, the night location microblog quantities and the difference value between daytime quantities and nighttime quantities. And here we applied the spatiotemporal statistics and spatial autocorrelation analysis to study the space-time distribution characteristics and laws of position microblog data from maximum and minimum, global spatial autocorrelation and local spatial autocorrelation. Finally, the results of maximum and minimum indicated that the number of days of grids which were more than the nights` concentrated on the workplace as well as the garden scenic region, and the number of nights of grids which were more than the days` focused on the residential areas and the university campuses. The results of global spatial autocorrelation showed that the sum position microblogs, the day microblog quantities and the night microblog quantities were randomly distribution, however the distribution of the difference value between day quantities and night quantities appeared the obvious agglomeration characteristic. Then we analyzed local spatial autocorrelation (LISA) of the difference value and we found that the high-high regions were mainly concentrated upon the areas of the gardens, the conference centers, the shopping malls and the schools, and the low-low regions were mainly in the residential areas. Overall, these characteristics are similar with people distribution, therefore, location microblog data could reflect the spatiotemporal characteristics of urban population in some degrees.

Logistics

Lodging

Boston Marriott Cambridge
Marriott Cambridge
50 Broadway
MA 02142

Hotel Shuttle

- August 7th mooring, from Boston Marriott Cambridge to Event, departing 8:10am, arriving no later than 8:40am.
- August 7th afternoon, from Event to Boston Marriott Cambridge, departing at 5:30pm.
- August 8th morning, from Boston Marriott Cambridge to Event, departing 8:30am, arriving no later than 9:00am.
- August 8th afternoon, from Event to Boston Marriott Cambridge, departing at 7:30pm.
- August 9th morning, from Boston Marriott Cambridge to Event, departing 8:30am, arriving no later than 9:00am.
- August 9th afternoon, from Event to Boston Marriott Cambridge, departing at 12:10pm

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Transportation around Boston

Massachusetts Bay Transportation Authority http://www.mbta.com/

Internet Access for Guest of Harvard University at IQSS

1. Log onto the internet;
2. Connect to the Harvard University signal that appears on your screen;
3. Read the Client Management System instructions and click that you have read them and then hit next;
4. XID info:
   Username: Cgisevent@harvard.edu
   Password: cgisevent@harvard.edu

   **Notice that C is capitalized in the username and lowercase in the password.

5. Click next when prompted after seeing that your firewall is being checked;

6. Click continue to get started;
7. Click finish.

Contact

Contact Details

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