DeepSpatial'22: The 3rd International Workshop on Deep Learning for Spatiotemporal Data, Applications, and Systems

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ABSTRACT

With the advancement of GPS and remote sensing technologies and the pervasiveness of smartphones and IoT devices, an enormous amount of spatiotemporal data are being collected from various domains. Knowledge discovery from spatiotemporal data is crucial in addressing many grand societal challenges, ranging from flood disaster management to monitoring coastal hazards, and from autonomous driving to disease forecasting. The recent success in deep learning technologies in computer vision and natural language processing provides new opportunities for spatiotemporal data mining, but existing deep learning techniques also face unique spatiotemporal challenges (e.g., autocorrelation, non-stationarity, physics awareness). This workshop provides a premium platform for researchers from both academia and industry to exchange ideas on the opportunities, challenges, and cutting-edge techniques related to deep learning for spatiotemporal data.

CCS CONCEPTS

• **Computing methodologies** → **Machine learning**; • **Information systems** → **Spatial-temporal systems**; **Data mining**.

KEYWORDS

Spatiotemporal Data, Deep Learning, Data Mining

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1 INTRODUCTION AND MOTIVATION

Deep learning has exhibited outstanding performance in handling data in space and time in the context of remotely sensed geoimagery for identifying buildings, vehicles, roads, etc. Meanwhile, the novel applications such as location-based social media, data-driven climate, and Earth science, and ride-sharing have enabled and accumulated large-scale spatiotemporal data over the years, which in turn has presented unprecedented opportunities and prerequisites for the discovery of macro- and micro- spatiotemporal phenomena accurately and precisely. Further developments of spatial/spatiotemporal computing and deep learning call for synergistic techniques and collaborations between different communities, as evidenced by the recent momentum in both domains. On one hand, fast-increasing large-scale and complex-structured spatiotemporal data requires the investigation and extension toward more scalable and powerful models than traditional ones in domains such as computational geography and spatial statistics. On the other hand, deep learning techniques are evolving beyond regular grid-based (e.g., images), tree-based (e.g., texts), and sequence-based (e.g., audio) data to more generic or irregular data in space and time (e.g., in transportation, geomorphology, and protein folding), which calls for the expertise in the domains such as spatial statistics, geodesy, geometry, graphics, and geography. Consequently, the aforementioned complementary strengths and challenges between spatiotemporal data computing and deep learning in recent years suggest urgent needs to bring together the experts in these two domains in prestigious venues, which is still missing until now.

This workshop provides a premium platform for both research and industry to exchange ideas on opportunities, challenges, and cutting-edge techniques of deep learning in spatiotemporal data, applications, and systems. The targeted audience of this workshop includes (1) academic and industrial researchers from the field of data mining and machine learning, (2) academic and industrial researchers from the spatial computing and GIS community interested in using deep learning to solve their problems, (3) domain researchers and practitioners in relevant applications, such as climate scientists, transportation engineer, and business analysts. A website[1] has been set up to release related information.

[1] http://cs.emory.edu/~lzhao41/venues/DeepSpatial2022/

This workshop is the third of its series. The last two DeepSpatial workshops (DeepSpatial'21[2] and DeepSpatial'20[3]) were held as half-day workshops. Both achieved great success. DeepSpatial'20 has three keynote talks, 8 paper presentations (accepted from 11 submissions), and a panel. The workshop had a peak attendance of 153 on Zoom and an average of 80-120 attendees during the workshop. The panel discussion featured three NSF program directors (Dr. Wei Ding, Dr. Wei-shinn Ku, and Dr. Amarda Shehu) and Dr. Shashi Shekhar from the University of Minnesota. DeepSpatial'21 featured two keynote talks by leading academic professors in the field (Dr. Yan Liu, Dr. Shashi Shekhar) and 6 paper presentations (accepted from 9 submissions).

2 TOPICS OF INTEREST

Topics of interest to the workshop include, but not limited to, the following three broad categories:

- Novel Deep Learning Techniques for Spatial and Spatio-Temporal Data
  - Spatial representation learning and deep neural networks for spatio-temporal data and geometric data
  - Self-supervised and semi-supervised learning on spatiotemporal data with the paucity of ground truth
  - Deep learning model generalizability across heterogeneous space and time
  - Deep generative models for spatio-temporal data
  - Deep reinforcement learning for spatio-temporal decision-making problems
- Novel applications of Deep Learning techniques to spatiotemporal computing problems.
  - Fusing remote sensing imagery, in-situ sensor observation, and physics-based model simulations in Earth science (e.g., hydrology, agriculture, coastal hazard)
  - Deep learning for mobility and traffic data analytics
  - Location-based social network data analytics, geosocial media data mining, spatial event prediction and forecasting, geographic knowledge graphs
  - Learning for biological data with spatial structures (biomolecule, brain networks, etc.)
- Novel Deep Learning Systems for Spatio-temporal Applications
  - Real-time decision-making systems for traffic management, crime prediction, accident risk analysis, etc.
  - GIS systems using deep learning (e.g., mapping, routing, or Smart city)
  - Mobile computing systems using deep learning
  - GeoAI Cyberinfrastructure for Earth science applications
  - Interpretable deep learning systems for spatio-temporal temporal data
  - Spatiotemporal Deep Learning for COVID-19 response

The workshop calls for two types of submissions: (1) Full research papers – up to 9 pages (8 pages at most for the main body and the last page can only hold references). (2) Vision papers (that discuss potentially new research directions and applications) and short system papers - up to 5 pages (4 pages at most for the main body and the last page can only hold references).

[2]http://mason.gmu.edu/~lzhao9/venues/DeepSpatial2021/
[3]http://mason.gmu.edu/~lzhao9/venues/DeepSpatial2020/

3 WORKSHOP PROGRAM AND ORGANIZERS

3.1 Program Summary and Committee

This workshop is a half-day workshop. Activities of the workshop include paper presentations, keynote talks, and discussions. The program committee members are: Dr. Jie Bao (JD Digits, China), Dr. Arnold Boedihardjo (Radiant Solutions), Dr. Yanhua Li (Worcester Polytechnic Institute), Dr. Xiaowei Jia (University of Pittsburgh), Dr. Yiqun Xie (University of Maryland), Dr. Yanjie Fu (University of Central Florida), Dr. Song Gao (University of Wisconsin, Madison), Dr. Jing Dai (Google), Dr. Feng Chen (University of Texas at Dallas), Dr. Manzhu Yu (George Mason University), Dr. Jingyuan Wang (Beihang University), and Dr. Senzhang Wang (Central South University). We would like to thank them for their valuable help with the review process of the submissions.

3.2 Organizing Co-Chairs

Zhe Jiang is an assistant professor at the Department of Computer & Information Science & Engineering at the University of Florida. His research focuses on interdisciplinary data science and deep learning for spatiotemporal data for interdisciplinary applications (e.g., water resource management, monitoring coastal hazards).

Liang Zhao is an assistant professor at the Department of Computer Science at Emory University. His research interests include data mining, artificial intelligence, and machine learning, particularly in spatiotemporal data mining, deep learning on graphs, nonconvex optimization, and interpretable machine learning.

Xun Zhou is an Associate Professor at the Department of Business Analytics, Tippie College of Business at the University of Iowa. His research interests include spatial and spatiotemporal data mining, machine learning, big data management and analytics, geographic information systems (GIS), and business analytics.

Robert Stewart is a senior scientist at the Oak Ridge National Laboratory and joint assistant professor of Geography at the University of Tennessee. His research is focused on statistical and computational methods in spatiotemporal analytics, probability modeling, and uncertainty quantification for risk and decision support.

Junbo Zhang is a Senior Researcher of JD Intelligent Cities Research. He is leading the Urban AI Product Department of JD iCity at JD Technology, as well as AI Lab of JD Intelligent Cities Research. His team is focusing on the research, development, and innovation of urban computing and spatio-temporal data minging and AI, with a broad range of applications in smart city.

Shashi Shekhar is a McKnight Distinguished University Professor and Distinguished University Teaching Professor at the University of Minnesota. His research interests include spatial computing, spatial data science, and geographic information systems (GIS). He is a Fellow of the IEEE and AAAS.

Jieping Ye is a Vice President and Chief Scientist at Beike and also a Professor at the University of Michigan, Ann Arbor. His research interests include data mining and machine learning with applications in transportation and biomedicine. He is a Fellow of the IEEE Computer Society, as well as an ACM Distinguished Member.