The SIGSPATIAL Special

Newsletter of the Association for Computing Machinery
Special Interest Group on Spatial Information

Volume 12 Number 3 November 2020

The SIGSPATIAL Special

The SIGSPATIAL Special is the newsletter of the Association for Computing Machinery (ACM) Special Interest Group on Spatial Information (SIGSPATIAL).

ACM SIGSPATIAL addresses issues related to the acquisition, management, and processing of spatially-related information with a focus on algorithmic, geometric, and visual considerations. The scope includes, but is not limited to, geographic information systems.

For more details and membership information for ACM SIGSPATIAL as well as for accessing the newsletters please visit http://www.sigspatial.org.

The SIGSPATIAL Special serves the community by publishing short contributions such as SIGSPATIAL conferences' highlights, calls and announcements for conferences and journals that are of interest to the community, as well as short technical notes on current topics. The newsletter has three issues every year, i.e., March, July, and November. For more detailed information regarding the newsletter or suggestions please contact the editor via email at martin.werner@tum.de.

The SIGSPATIAL Special (ISSN 1946-7729) Volume 12, Number 3, November 2020.

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Introduction to this Special Issue: SIGSPATIAL 2020 Event Reports

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Dear SIGSPATIAL Community,

The 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2020) was originally planned to take place in Beijing, China. Due to the coronavirus outbreak, the conference was first moved to Seattle, Washington, USA and then transitioned into a fully virtual conference. This newsletter provides event and experience reports of the organizers of the main conference and the ten satellite workshops.

The first section of this newsletter features the main conference report by the SIGSPATIAL 2020 General Chairs and Program Chairs. This report provides details on the program, including submissions and acceptance rates, and also describes the "journey" of moving the conference from Beijing, via Seattle, to the first fully virtual ACM SIGSPATIAL event. This report also provides shoutouts to all organizers who worked together to make this conference a great success with almost 1,000 registrations.

The second section consists of workshop reports of all ten workshops that were virtually co-located with ACM SIGSPATIAL 2020 and, additionally, one ACM SIGSPATIAL 2019 workshop:

- 4th ACM SIGSPATIAL Workshop on Location-Based Recommendations, Geosocial Networks, and Geoadvertising (LocalRec 2020)
- 3rd ACM SIGSPATIAL International Workshop on GeoSpatial Simulation (GeoSim 2020)
- 9th ACM SIGSPATIAL International Workshop on Analytics for Big Geospatial Data (BIGSPATIAL 2020)
- 4th ACM SIGSPATIAL Workshop on Geospatial Humanities (GeoHumanities 2020)
- 2nd ACM SIGSPATIAL International Workshop on Geospatial Data Access and Processing APIs (SpatialAPI 2020)
- 3rd ACM SIGSPATIAL Workshop on Advances in Resilient and Intelligent Cities (ARIC 2020)
- 13th International Workshop on Computational Transportation Science (IWCTS 2020)
- 2nd ACM SIGSPATIAL International Workshop on Spatial Gems (SpatialGems 2020)
- 1st ACM SIGSPATIAL International Workshop on Modeling and Understanding the Spread of COVID-19
- 6th ACM SIGSPATIAL International Workshop Emergency Management using GIS (EM-GIS 2020)
- 5th ACM SIGSPATIAL International Workshop Emergency Management using GIS (EM-GIS 2019)

I would like to sincerely thank all workshop organizers for their generous contributions of time and effort to summarize keynotes, presentations, and other planned or unplanned events (such as a "Zoom Bombing").

The third section highlights the winner of our 5th ACM SIGSPATIAL Student Research Competition (SRC) held virtually at the ACM SIGSPATIAL Conference 2020. This year, only one winner was crowned for the undergraduate SRC category which will represent our community in the ACM Student Research Competition Grand Finals. The winner is Nikita Saxena, Space Applications Center, ISRO, Ahmedabad, Gujarat, India whose SRC paper is reprinted in the third section.

Good luck Nikita Saxena in the 2020 ACM SRC Grand Finals!

I hope that you will find the newsletters interesting and informative and that you will enjoy this issue. You can download all Special issues from:

`http://www.sigspatial.org/sigspatial-special`

Finally, we want to remark that after a period of nine issues organized and edited by Andreas Züfle, this role is passed on to Martin Werner, who will edit this newsletter in the coming times. If you have any requests, ideas, or papers suited for this newsletter, feel free to get in touch at `martin.werner@tum.de`.

Dear Andreas, in the name of the community, let me thank you for your dedication to this newsletter in the past years! You have done a great job!

Martin Werner
(future ACM SIGSPATIAL Newsletter Editor)

Yours sincerely,
Andreas Züfle
SIGSPATIAL Newsletter Editor

The SIGSPATIAL Special

Section 1:
ACM SIGSPATIAL 2020
Conference Report

ACM SIGSPATIAL

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Conference Report: The 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2020) Virtual, Online, USA November 3—6, 2020

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1 Introduction

This report describes the development and finalization of the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2020), held virtually online, November 3-6, 2020. The attendance for the 2020 conference was 999, the highest in the history of ACM SIGSPATIAL.

Historically, what is now the ACM SIGSPATIAL conference started as a series of workshops and symposia in 1993. Its aim was to promote the interdisciplinary discussions among researchers, developers, users, and practitioners and fostering research in all aspects of Geographic Information Systems – hence the original workshop acronym ACM GIS. The focus was on novel systems based on geospatial data and knowledge. It continued its mission of providing a forum for original research results, addressing conceptual, design, and implementation aspects of geospatial data ranging from applications, user interfaces and visualization, to data storage, query processing, indexing and data mining. The conference is now the premier annual event of the ACM Special Interest Group on Spatial Information (ACM SIGSPATIAL).

2 Program

The technical program of the conference was decided in a two-stage process:

(1) Each submitted paper was first reviewed by at least three members of a carefully chosen program committee (PC) consisting of experts in the relevant fields. Our PC had a total of 114 invited members from academia and industry, plus an additional 23 members who were designated as the Senior PC. The assignment of papers to reviewers followed a bidding stage, during which PC members were allowed to express ranked preferences regarding their willingness to review a particular submission. In addition to three reviewers from the PC, each

paper was also assigned a designated Senior PC member who studied the reviews, discussed the merits of the submission with the reviewers, wrote a metareview, and formulated an accept/reject recommendation.

(2) Similar to 2019, we implemented a rebuttal phase where the authors received preliminary versions of the reviews and were offered the opportunity to address the concerns raised therein by submitting a response. The reviews, meta-reviews, and accept/reject recommendations were then finalized, taking into account the author responses. The selection of papers to include in the conference program was ultimately made by the PC Chairs. Certain papers that were not accepted for the conference, with the permission of the authors, were forwarded to the conference's Workshop Chairs to be considered for inclusion in relevant workshops co-located with SIGSPATIAL.

The conference had a total of 198 submissions. Among these were 149 research submissions 33 of which were accepted as full 10 page papers, corresponding to an acceptance rate of 22.1%. Further, eight industrial experience and systems papers were accepted. The remaining papers in the proceedings correspond to demos and posters, which had 4 pages, and two 4 page vision papers. The latter were once again sponsored by the Computing Community Consortium (CCC) encouraging the submission of papers describing visionary ideas. Our reviewers put in a significant amount of effort in reviewing the papers and our hope is that the reviews were beneficial even to those authors whose papers were not accepted.

A paper to receive the best paper award was selected from all the accepted full papers in the research and industrial experience and systems categories. This paper was selected before the conference and the award presented at the conference. For the best paper award, the top five papers with the highest average review scores were selected as candidates. A best paper award committee consisting of six members including the three PC Co-Chairs reviewed the candidate papers and reviews and selected the best paper after discussions.

This year we held once again the SIGSPATIAL Cup programming contest, which focused on competitive spatio-temporal searching in which a managed fleet of mobile agents search for stationary resources on a road network. The competition received six submissions and the teams totaled 14 members submitting formal entries. Two entries were selected as winners, and were additionally qualified for an invited paper, an oral presentation and award prizes. Google, Maxar and Microsoft provided sponsorship for the SIGSPATIAL Cup and the awards for the winners.

The conference again held a Student Research Competition (SRC) that aimed at providing a forum for undergraduate and graduate students to share their research results and exchange ideas with other students, judges, and conference attendees. This year, four papers authored by undergraduate students and one paper authored by graduate students were selected for presentation during the conference and were further assessed for advancement to the next round of the competition, the ACM Grand Finals.

ACM SIGSPATIAL 2020 had two distinguished speakers: Ross Maciejewski (Arizona State University), who gave the first keynote presentation titled *Exploring Spatial Phenomenon with Geovisual Analytics* and Aya Soffer (IBM Research, Haifa Research Lab), who gave the second keynote presentation titled *What's next in AI - Fluid Intelligence*. In addition, this year's edition also had a tutorial entitled *A Tutorial on Learned Multi-dimensional Indexes* presented by Abdullah-Al-Mamun, Hao Wu and Walid G. Aref, all from Purdue University.

The conference was preceded by 10 associated workshops managed by the Workshop Co-Chairs Mohamed Sarwat (Arizona State University, USA) and Ranga Raju Vatsavai (North Carolina State University, USA), in addition to the respective individual workshop organizers.

3 COVID-induced "Journey" of SIGSPATIAL 2020

Due to the growth of the ACM SIGSPATIAL conference over the past few years, in 2019 the planning of the future conferences expanded to a period of two years in advance. Thus, the original plan set during ACM SIGSPATIAL 2019 in Chicago was to have the 2020 edition in Beijing, and 2021 in Seattle.

However, the outbreak of Covid-19 which initially had a very impact in PR China, prompted the Organizing

Committee and the Executive Committee to consider alternatives. After monitoring the development of the situation throughout February of 2020, a decision was made to "switch" the original schedule, and have ACM SIGSPATIAL 2021 in Seattle – which seemed like a sound choice at the time. The OC and the EC of our SIG kept on monitoring the situation (Covid-19 spread and its ramifications) and conferred frequently, having the best interest of the attendees in mind. In the late Spring of 2020, the developments of the pandemic in the US brought the safety of the participants, as well as the feasibility of planning trips, into a serious question.

After multiple meetings and communications, and consulting with members of our SIG outside the US, in late July 2020 a decision was brought (and shortly afterwards disseminated to the community) to hold ACM SIGSPATIAL 2020 edition virtually[1]. A task force was quickly assembled, consisting of the General Co-Chairs (Chang-Tien Lu, Goce Trajcevski, Fusheng Wang), Program Committee Co-Chairs (Yan Huang, Xiong Li, Shawn Newsam) and the Local Organizing Co-Chairs (Yaxiao (Ashley) Song and Chengyang (Charlie) Zhang). The task force had regular weekly meetings, and on multiple occasions, when needed, they were joined by other members of the Organizing Committee (Workshops; Registration; Student Competitions and GIS CUP Co-Chairs) as well as members of the Executive Committee of the SIGSPATIAL. In addition, the task force meetings were regularly attended by a group student-volunteers.

At the end, all the events of the conference and the workshops were held virtually using Zoom, where the attendees could view pre-recorded presentations and had a real-time Q&A session with the authors, coordinated by the Session Chairs and the Zoom-hosts (the student-volunteers). The participants had an opportunity to (of course, virtually) meet and chat during the breaks using Gather.town, and do the same with the representatives from our sponsors.

One of the unique aspects of SIGSPATIAL 2020 conference was that we were able to lower the registration costs and, in collaboration with ACM, even provide free Zoom licences which, as mentioned, resulted in the record number of registered participants: 999.

4 Acknowledgements and Recognitions

Recreating and organizing such a vibrant forum from year to year takes tremendous efforts and collaboration among many dedicated individuals. We are especially grateful to our PC, Senior PC and external reviewers, who generously and carefully reviewed the submissions and produced valuable feedback for both us and the authors. To produce the proceedings, we had the pleasure to work closely with two individuals who took a lot of the burden – and did a great job – Proceedings Co-Chairs Yanhua Li (Worcester Polytechnic Institute, USA) and Rose Yu (University of California San Diego, USA), who took a lot of the burden and did a great job. We thank Dejun Teng (Stony Brook University), Chrysovalantis Anastasiou (University of Southern California) and Taoran Ji (Virginia Tech) who were extremely responsive as our Webmasters.

We are also very thankful to the Publicity Co-Chairs: Xin Chen (Amazon Web Services, USA), Matthias Renz (CAU University of Kiel, Germany) and Liang Zhao (George Mason University, USA). Furthermore we thank Zhe Jiang (University of Alabama, USA) and Xun Zhou (University of Iowa, USA) who served as Poster Co-Chairs, and extend our special thanks to Arnold P. Boedihardjo (Maxar Technologies, USA), Steven Tjiang (Google, USA) and Bo Xu (HERE, USA) who organized the SIGSPATIAL Cup programming contest this year. We also thank Farnoush Banaei-Kashani (University of Colorado, Denver, USA) and Haibo Hu (Hong Kong Polytechnic University, Hong Kong, China) who served as the Tutorials Co-Chairs.

There are many other individuals who did a tremendous job for the technical organization of the event and were in charge of many related activities. We thank Jing (David) Dai (Google, USA) who served as Treasurer Chair, along with our special thanks to Theodoros Chondrogiannis (University of Konstanz, Germany), Wei-Shinn Ku (Auburn University and National Science Foundation, USA) and Michael Xia (Shenzhen University,

[1] A special token of gratitude for the representatives of Hyatt Regency in Seattle, the planned venue, who were understanding of our situation and agreed to void any contractual obligations.

China) who were in charge of organizing the SRC (Student Research Competition). We are indebted to Yanjie Fu (University of Central Florida, USA) and Andreas Züfle (George Mason University, USA) who served as Registration Co-Chairs. We are also indebted to Local Arrangements Co-Chairs Yaxiao (Ashley) Song (Microsoft, USA) and Chengyang Zhang (Amazon, USA) together with the student volunteers Taoran Ji (Virginia Tech), Xu Teng (Iowa State University), Dejun Teng (Stony Brook University), Fanglan Chen (Virginia Tech), Kaiqun Fu (Virginia Tech), Menghai Pan (Worcester Polytechnic Institute), Po-Han Chen (Virginia Tech), and Prabin Giri (Iowa State University) for the tremendous amount of work that they put into enabling and testing the platforms, as well as ensuring that everything in all the sessions and breaks ran smoothly throughout the conference.

We are also thankful to the outgoing ACM SIGSPATIAL Officers for their expert, sustaining guidance of the conference: Cyrus Shahabi (Chair, University of Southern California, USA), Goce Trajcevski (Vice-Chair, Iowa State University, USA), John Krumm (Treasurer, Microsoft Research, USA) and Egemen Tanin (Secretary, University of Melbourne, Australia).

A distinguished token of gratitude is due to Hanan Samet, Cyrus Shahabi and Kentaro Toyama for bringing this conference to the forefront in 2007 and starting ACM SIGSPATIAL.

We give our very special thanks to our generous corporate sponsors - Apple (Platinum Sponsor), Google, Oracle, Esri (Bronze Sponsors), Microsoft, Maxar (Other Sponsors) - many of whom have supported this conference for multiple years; and it is in order to recognize the appreciation of the work of Yao-Yi Chiang (University of Southern California, USA) and Mark McKenney (Southern Illinois University Edwardsville, USA) who were instrumental as Sponsors Co-Chairs in getting these companies to support the conference. We greatly appreciate Google, Microsoft and Maxar who provided financial sponsorship for the SIGSPATIAL Cup and the awards for the winners. Last, but not the least, the two accepted vision papers received the Blue Sky Idea award from the Computing Research Association's Computing Community Consortium (CCC).

Every year, the conference highlights the most important advances in GIS and provides a forum for lively exchange of ideas among leading researchers and practitioners in the field. In conclusion, we would like to express once again our gratitude to all the authors who submitted papers, the members of the PC and the senior PC, the conference officers, and all the other individuals who contributed their expertise and time to make the conference possible.

The SIGSPATIAL Special

Section 2:
ACM SIGSPATIAL 2020
Workshop Reports

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LocalRec 2020 Workshop Report

The Fourth ACM SIGSPATIAL Workshop on Location-based Recommendations, Geosocial Networks and Geoadvertising

Online event — November 3, 2020

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The amount of publicly available geo-referenced data has seen a dramatic increase over the last years. Many user activities generate data that are annotated with location and contextual information. Moreover, it has become easier to collect and combine rich and diverse location information. In the context of geoadvertising, the use of geosocial data for targeted marketing is receiving significant attention from a wide spectrum of companies and organizations. With the advent of smartphones and online social networks, a multi-billion dollar industry that utilizes geosocial data for advertising and marketing has emerged. Geotagged social-media posts, GPS traces, data from cellular antennas and WiFi access points are used widely to directly access people for advertising, recommendations, marketing, and group purchases. Exploiting this torrent of geo-referenced data provides a tremendous potential to materially improve existing recommendation services and offer novel ones, with numerous applications in many domains, including social networks, marketing, and tourism.

Realizing the full potential of geo-referenced data requires new technologies to collect, store, analyze and use the data. It also raises issues in the area of responsibility, accountability, transparency, fairness, adequacy (e.g., avoiding ads in improper places) and preventing misconduct. This in turn means addressing many core challenges and combining ideas and techniques from various research communities, such as recommender systems, data management, geographic information systems, social network analytics, and text mining. By bringing together researchers and practitioners from these communities, the LocalRec workshop provides a unique forum for in-depth discussion about challenges, opportunities, novel techniques and applications related to location-based recommendation, geosocial networks and geoadvertising. LocalRec 2020 is the fourth occurrence of the conference, following the success of previous gatherings [1].

Due to the COVID-19 pandemic, LocalRec 2020 was a virtual workshop (`https://localrec2020.github.io`) on Zoom. It was a full-day workshop in conjunction with the ACM SIGSPATIAL 2020 conference. The program committee received and evaluated 5 submissions, out of which 3 papers were accepted

Figure 1: Collage of some of LocalRec 2020 participants.

as full, 1 paper as short, and 1 as a demo. In most of the sessions there were around 20 participants, with 30 attendees at peak time. Figure 1 shows a collage of all participants that had their cameras on.

There were two keynote talks and two research sessions in the workshop. Both keynote talks gained a lot of attention and led to fruitful discussions.

Francesco Ricci from Free University of Bozen-Bolzano, Italy, gave a keynote about *Computing Effective Recommendations for Tourists*. The talk started with contrasting *preferences*, which determine what people ideally want and is hard to model, with *choices*, which is what people actually choose and is easy to observe. It then analyzed the criteria with which tourists make choices. A next point of discussion was about what a recommender system should optimize for: the *expected utility* based on choices, or the *experienced utility* based on user feedback. Ideally, a system should optimize for experienced utility, and try to align expected utility with experienced utility. The talk concluded with presenting a novel Point of Interest (POI) recommender system that is based on reinforcement learning techniques.

Brennan Lake, Senior Director of Research Partnerships & Data For Good of Cuebiq, USA, gave a keynote on *Location Intelligence for COVID-19 Response – Building Data Collaboratives for COVID-19 Research and Public Policy*. Cuebiq is a location intelligence company that curates, creates and analyzes high quality location data from application SDKs (software development kits) of opted-in users in an anonymized fashion. While there are numerous adtech applications for location data, the talk focused on the use of location intelligence for studying human mobility patterns during the COVID-19 pandemic, and how they could be used to inform response strategies. Cuebiq data has been used by the CDC, UNICEF, World Bank, University of Oxford, Johns Hopkins University and New York City among others. For example, Cuebiq data helped measure changes in mobility patterns during pandemic related lockdowns, highlighting income disparities (richer white-collar neighborhoods worked at home and had low mobility while poorer neighborhoods that required physical presence at work displayed high mobility) and visitations to points of interest in defiance of "shelter in place" directives. These patterns were then used by institutions like the CDC to refine guidelines, create PSAs (public service announcements) regarding safety measures such as social distancing and wearing face masks during the pandemic. The presentation concluded with a lively Q&A session.

The research papers were organized into two sessions. The first session focused on *Spatial Embedding and Mobility Modeling* and included two full research papers and one vision paper. In [7], the authors investigated how to model POI data using concepts from Machine Learning (ML) and Natural Language Processing (NLP). A hierarchical, density-based and self-adjusting clustering approach was proposed which addresses the inability of the Place2Vec model to consider the spatial heterogeneity among different urban regions. In the same spirit, Paper [4] considered the use of word embeddings for representing geospatial ontologies. For this purpose,

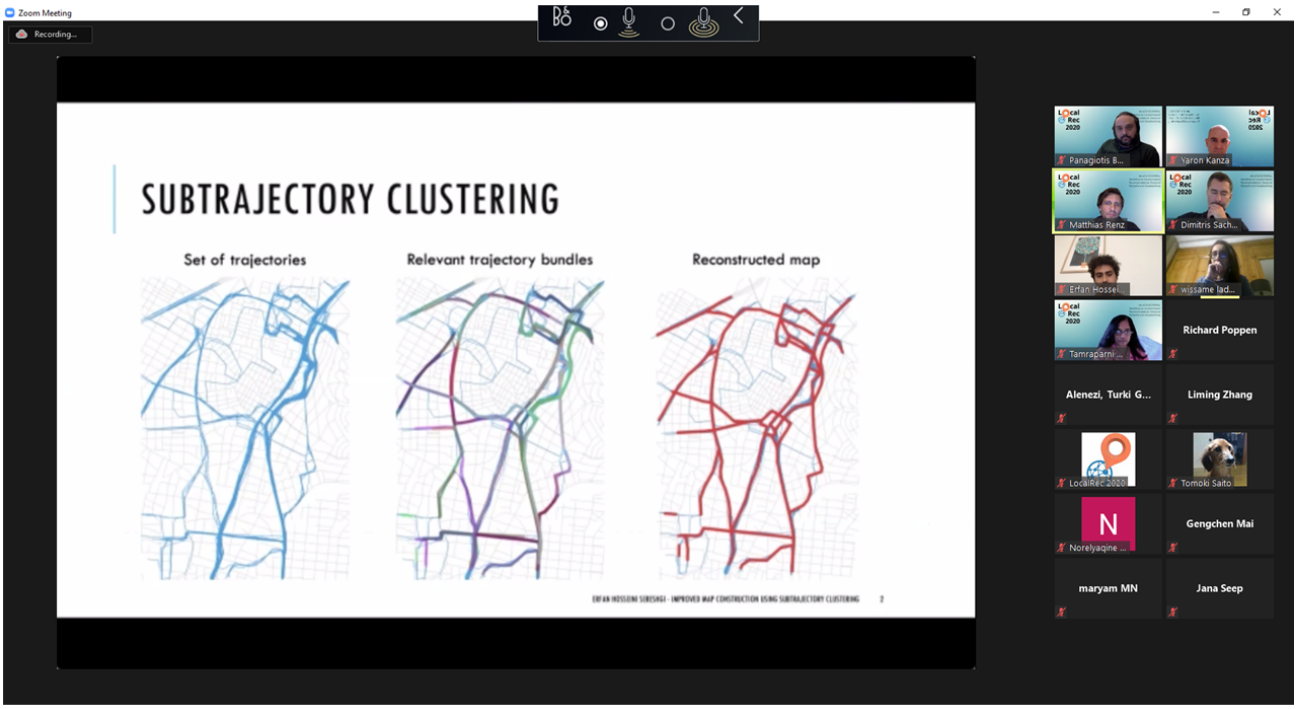

Figure 2: A view of the screen during a talk.

the authors presented an analysis that evaluates the effectiveness of a particular family of embeddings called hyperbolic embeddings. The proliferation of mobile devices has resulted in an unprecedented opportunity for modeling human behavior. The authors of Paper [6] presented their vision on how to incorporate location-based event detection and activity characterization in order to model both accurate and realistic mobility patterns.

The second session focused on *Map Construction and Spatial Recommendation*, and included one full paper and one demo. The authors of the full paper [5] presented an ontological model called NAREO (Neighborhood And Real Estate Ontology), which aims at providing neighborhood and real estate recommendations by means of SPARQL queries. In their presentation, they introduced the concepts and relationships contained in the ontology as well as the rules that enable reasoning and add some more semantics. In the second presentation, the authors of the demo paper [3] showed how sub-trajectory clustering could be used in order to advance reconstruction of travel networks by means of trajectory records. The authors showcased the principal challenges and issues and the gain of their approach over state-of-the-art based on real-world illustrations.

The research papers and the keynote talks emphasized the many facets of location recommendations and geoadvertising. They illustrated the potential of recommendation systems to help users find the geospatial information they need, whether it is points of interest, routes or recommended venues. They described methods for advertisers and marketing people to reach out to potential customers with high precision based on location information, and they also emphasized the need for awareness of privacy and fairness issues.

We thank the authors for publishing and presenting their papers in LocalRec 2020, and the program committee for their professional evaluation and help in the peer-review process. We hope that the proceedings [2] will inspire new research ideas and will help promoting the area of location-recommendations and geoadvertising.

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GeoSim 2020 Workshop Report
The 3rd ACM SIGSPATIAL International Workshop on Geospatial Simulation

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Space has long been acknowledged by researchers as a fundamental constraint which shapes our world. As technological changes have transformed the very concept of distance, the relative location and connectivity of geospatial phenomena have remained stubbornly significant in how systems function. At the same time, however, technology has advanced the science of geospatial simulation to bear on our understanding of how such systems work. While previous generations of scientists and practitioners were unable to gather spatial data or to incorporate it into models at any meaningful scale, new methodologies and data sources are becoming increasingly available to researchers, developers, users, and practitioners. These developments present new research opportunities for geospatial simulation.

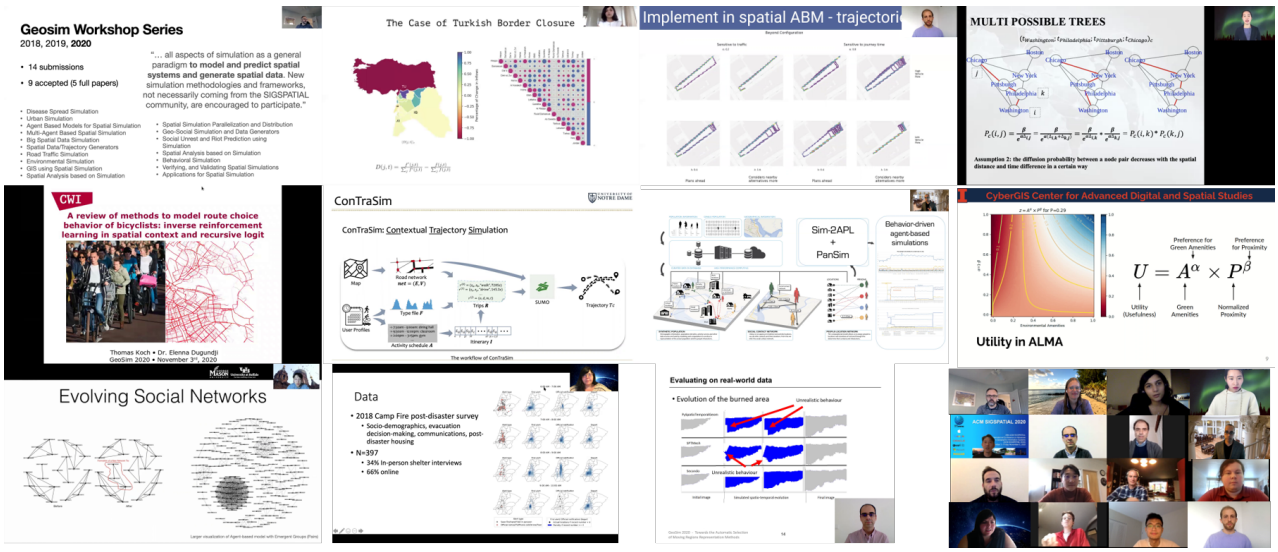

Figure 1: GeoSim 2020 presentations and attendees

The 3rd ACM SIGSPATIAL International Workshop on Geospatial Simulation (GeoSim) was held in conjunction with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. The purpose of GeoSim 2020 was to bring together researchers and practitioners from a range of disciplines to disseminate their cutting-edge research in geospatial simulation. Specifically, the aim of the workshop was to showcase all aspects of simulation as a general paradigm to model and predict the behavior of spatial systems and generate spatial data. Due to the COVID-19 pandemic, unlike GeoSim 2018-19 [6, 7], GeoSim 2020 was organized as a virtual workshop with 39 participants. This was among the top participation numbers

across all workshops at the ACM SIGSPATIAL 2020 conference. The workshop was attended by researchers from both academia (e.g., University of Maryland, University College London, Pennsylvania State University, Centrum Wiskunde en Informatica, Vrije Universiteit Amsterdam, University of Illinois at Urbana-Champaign, University of Notre Dame, George Mason University, University of Aveiro, University at Buffalo, and University of Virginia) and industry (e.g., Ford Motor Company and Esri).

GeoSim 2020 was organized as a half-day workshop comprising of two sessions. In all, the workshop featured one keynote and nine oral presentations. On behalf of the Steering Committee, Dr. Dieter Pfoser kicked off GeoSim 2020 with the welcome and opening remarks. Dr. Carola Wenk chaired the first session of oral presentations which had five full papers. Zahra Jafari from University College London (UCL) gave the first presentation of the day on "*Spatial Analysis Of Border Closure Intervention Scheme In Conflict-Induced Displacement*", which examined the effect of border control policies using a data-driven agent-based model for refugee flows from Syria [3]. Obi Thompson Sargoni from UCL presented a paper titled, "*A Sequential Sampling Model of Pedestrian Road Crossing Choice*" [10] by demonstrating how an agent-based model could represent the gradual process of deliberation between discrete road crossing choice alternatives to select a crossing location. Fangcao Xu from Pennsylvania State University presented her work "*STAND: A Spatio-Temporal Algorithm for Network Diffusion Simulation*" including both time and geographic distance as explanatory variables to simulate the diffusion process over two different network structures [11]. Thomas Koch from Centrum Wiskunde en Informatica presented "*A review of methods to model route choice behavior of bicyclists: inverse reinforcement learning in spatial context and recursive logit*," highlighting some of the challenges with using recursive logit, a form of inverse reinforcement learning for modeling bicycle route choice [8]. Jian Yang from University of Notre Dame gave a presentation of his research "*Generating Contextual Trajectories From User Profiles*" about creating more realistic representations of mobility patterns of traffic participants based on the Simulation of Urban MObility (SUMO) traffic simulator [12].

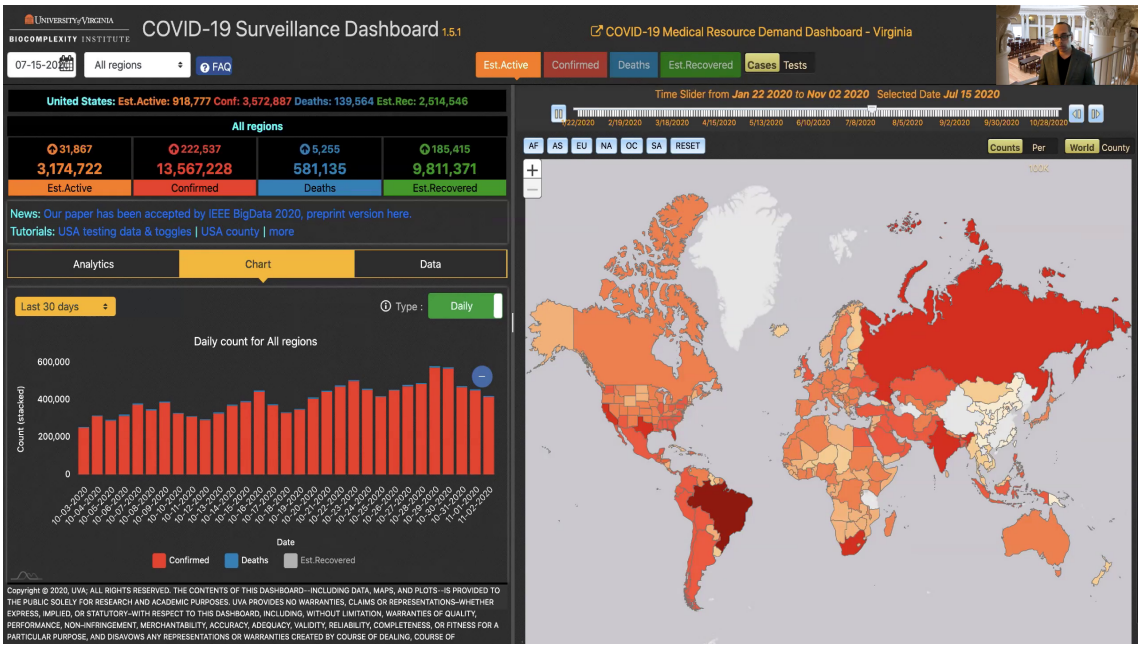

Figure 2: Dr. Samarth Swarup giving his invited talk titled "*Mobility and Behavior Modeling for COVID-19*".

The second session chaired by Dr. Joon-Seok Kim consisted of the keynote talk and oral presentations of four short papers. Dr. Samarth Swarup, who is a Research Associate Professor in the Biocomplexity Institute at the University of Virginia, gave the keynote titled "*Mobility and Behavior Modeling for COVID-19*". The

talk was in line with the special topic for GeoSim 2020 which sought to bring current trends in disease spread simulations, their practicality in predictive and prescriptive analytics, and the challenges practitioners face in their use. In his talk, Dr. Swarup explained how to use high-resolution mobility data for COVID-19 forecasting, and described how to build models of normative reasoning behavior for large-scale simulations. He presented the challenges of scale, realism, and complexity and shared his experiences and ongoing work to address these issues (Figure 2). Following the keynote, Alexander Michels from University of Illinois at Urbana-Champaign presented the paper, "*An Exploration of the Effect of Buyer Preference and Market Composition on the Rent Gradient using the ALMA Framework*" on extending the ALMA (Agent-based Land MArket) framework with two new parameters - heterogeneity and stochasticity, to explore how buyers with diverse preferences and a range of market compositions affect the rent gradient [9]. Na Jiang from George Mason University made a presentation on "*Integrating Social Networks into Large-scale Urban Simulations for Disaster Responses*" by demonstrating how social networks could be incorporated for better decision making and for creating a variety of new application areas where network structures matter in urban settings [4]. Sarah A. Grajdura from University of California Davis presented her research findings "*Agent-Based Wildfire Evacuation with Spatial Simulation: A Case Study*," by introducing an agent-based model that enables the development of behavioral models for nearest shelter evacuations using origin information, environment, and the spatiotemporal wildfire dynamics [2]. Dr. Rogéio Luís C. Costa from University of Aveiro presented his work "*Towards the Automatic Selection of Moving Regions Representation Methods*" by proposing the steps towards building a system that could suggest methods and configurations to generate representations fitting the requirements of any application [1].

We thank all the authors and the attendees for their active participation in GeoSim 2020. We truly appreciate the commitment of the program committee in the peer-review process which helped us create a high-quality program. We hope that the GeoSim'20 proceedings [5] will provide references and representative research trends in geospatial simulation to researchers and professionals beyond the SIGSPATIAL community.

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The 9th ACM SIGSPATIAL International Workshop on Analytics for Big Spatial Data (BigSpatial 2020) November 3, 2020

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Since the "Big Data Research and Development Initiative" launched by the White House in 2012, big data has received great attention from industry and federal agencies alike emerging as an important area of research for scientists worldwide. Within the realm of big data, spatial and spatiotemporal data continues to be among the fastest-growing types of data. With advances in remote sensors, sensor networks, and the proliferation of location sensing devices in daily life activities and common business practices, the generation of disparate, dynamic, and geographically distributed spatiotemporal data has exploded in recent years. In addition, significant progress in the ground, air- and space-borne sensor technologies have led to unprecedented access to earth science data for scientists from different disciplines, interested in studying the complementary nature of different parameters. Today, analyzing this data poses a massive challenge to researchers.

The workshop series on Analytics for Big Geospatial Data (BigSpatial), has become one of the key meeting points for researchers in the area of big geospatial data analytics since 2012. Held every year, in conjunction with the annual ACM SIGSPATIAL conference, this meeting has found strong support from researchers in government, academia, and industry. The workshop provides a platform for researchers and practitioners engaged in addressing the big data aspect of spatial and spatiotemporal data analytics to present and discuss their ideas. It brings together researchers from academia, government and industry, who have been working in the area of spatial analytics with an eye towards massive data sizes.

Building on the success of the previous eight editions, the 9th workshop on Analytics for Big Geospatial Data (BigSpatial 2020) was held in conjunction with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems on November 3, 2020. The main motivation of the workshop as has been in previous years was to serve as a forum to exchange ideas, present recent research results and to facilitate collaboration and dialog between academia, government, and industrial stakeholders. However, due to the COVID-19 situation, in-person meetings weren't possible and BigSpatial 2020 was organized as a half-day online-only event.

This year we received 9 technical submissions out of which 6 were accepted as full papers and 1 as a short paper. The accepted papers were presented over three sessions, broadly covering the areas of trajectory analysis [1], deep learning techniques [2, 3, 4, 5] and high performance visualization [6, 7] for geospatial data. The technical program also consisted of two invited talks. The first invited talk by Aniket Mitra from HERE Technologies, titled, "MoveTK: The Movement Toolkit", showcased an open-source toolkit for analyzing movement data with state of the art algorithms for computational movement analysis. The second talk by Dr. Ranga Raju Vatsavai from North Carolina State University, titled, "GeoAI: Recent Advances in Machine Learning for Global Earth Observations", explored recent advances in AI and machine learning for monitoring natural and man-made structures at local and global scales. The workshop was well-attended with an average of 38 participants in every session and a peak of 50 participants during the invited talks.

We thank all the speakers, authors and attendees who participated in the workshop. We express our sincere gratitude to Aniket Mitra and Dr. Ranga Raju Vatsavai for their insightful presentations and for setting the tone for the workshop sessions. Also, a special note of thanks to the program committee members, whose reviewing efforts ensured in selecting a competitive and strong technical program. We hope the BigSpatial workshop series will continue to provide a leading international forum for researchers, developers, and practitioners in the field of big geospatial data analytics to identify current and future areas of research.

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GeoHumanities 2020 Workshop Report

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Abstract

This article reports on the 4th ACM SIGSPATIAL Workshop on Geospatial Humanities, held in conjunction with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. The article outlines the objectives of the workshop, and briefly describes the technical program.

1 Introduction to the ACM SIGSPATIAL Workshop on Geospatial Humanities

The 4th ACM SIGSPATIAL Workshop on Geospatial Humanities (GeoHumanities'20) was held together with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems, on November the 3rd (online) Seattle, Washington, USA. The workshop addressed the use of geographic information systems and other spatial technologies in humanities research.

Scholars in the humanities have long paid attention to spatial theory and cartographic outputs. Moreover, in recent years, new technologies and methods have lead to the emergence of a field that is now commonly known as the Spatial Humanities. Despite recent developments, many challenges persist in the application of state-of-the-art techniques (e.g., text geoparsing), which have been showcased in venues such as the ACM SIGSPATIAL conference. The workshop is specifically concerned with the use of geographic information systems and other spatial technologies in humanities, including history, archaeology, cultural heritage, and digital humanities research, placing a strong emphasis on new methodologies that leverage recent technical and scientific developments.

2 The Workshop Program

The call for papers resulted in 8 submissions describing high quality research. A program committee of more than 20 members, which are listed on the workshop website[1], reviewed the submissions, and 5 papers were accepted for presentation. The workshop program featured two technical sessions, followed by a discussion at the end.

After a brief opening address, the workshop started with the presentation of work by Foka et al., [1] concerning the Digital Periegesis project. This work describes the use of semantic geo-annotation to capture and analyse the forms of space within and the spatial form of the Pausanias's narrative *Description of Greece*. In particular, it discusses the challenges and affordances of using geo-parsing, spatio-temporal analysis, network analysis, and Linked Open Data (LOD) for rethinking the geographies of a non-modern literary text as based more on topological connections than topographic proximity. The second presentation covered research by Michelin and Chadeyron [4] focused on crowdsourcing for georeferencing Napoleonic cadastre over a wide area. In particular, the presentation exposes the methodology of digitising a 19th-century cadastre of the Puy-de-Dôme department

[1] https://ludovicmoncla.github.io/sigspatial-geohumanities-2020/program-committee.html

in France.This work, addressed important real-world challenges of crowdsourced digitization such as quality and heterogeneity of results specifically for mapping historical land use. In the third presentation, Pérez Vera et al. [5] discussed the use of metadata of spatial footprints from Flickr to find regions of interest within the city of Havana. The authors describe a methodology using the HDBSCAN clustering algortithm on a Flickr dataset to find regions of interest. This study aims to analyse changes in tourism in Cuba co-related with political changes.

After the break, the second session started with the presentation of work by Hämäläinen et al. [2] describing a dialect normalization method for different Finland Swedish dialects. In this work, the authors have tested 5 different character based bi-LSTM models and propose a python package[2]. Results show that context and character level help to improve dialect normalization. Finally, Kogkitsidou and Gambette [3] presented their work on normalisation of 16th and 17th century texts in French and geographical named entity recognition[3]. In this presentation they focused on old French texts to evaluate the impact of manual and automatic normalisation. Then, the authors also describe the use of five geographical named entity recognition tools for identifying locations mentioned in ancient texts. Results show that normalisation of 16th and 17th French texts helps to improve geographical named entity recognition.

A discussion period followed the last presentation of the second session, covering ideas for future developments and common aspects between the different contributions presented at the workshop.

During the workshop, on average, 35 attendees were present during the first session and 22 during the second. We believe GeoHumanities'20 was a successful event that, although small, allowed the participants to explore the contributions that modern GIS and geo-spatial analysis technologies can enable within and beyond the digital humanities.

3 Acknowledgments and Final Remarks

The organizers would like to thank the authors for submitting and presenting their contributions, and also the program committee members for their commitment to the paper review process. We hope that the proceedings[4] of GeoHumanities'20 will inspire new research ideas, and that you will enjoy reading them. [5]

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[4] https://dl.acm.org/doi/proceedings/10.1145/3423337

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The 2nd ACM SIGSPATIAL International Workshop on Geospatial Data Access and Processing APIs (SpatialAPI 2020) Seattle, WA, USA - November 3, 2020

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(Workshop Co-chairs)

1 Introduction

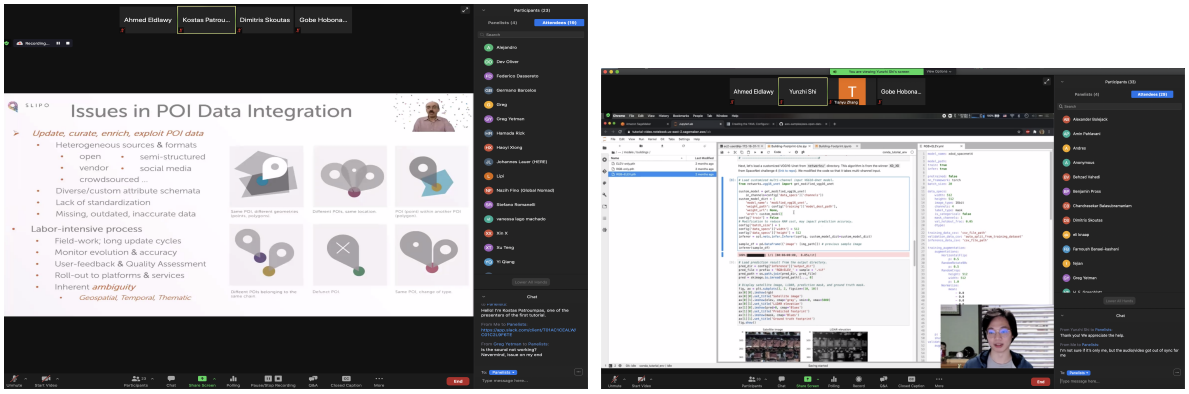
With the increasing amount of publicly available geospatial data, the demand on spatial data exploration and analysis kept growing. The SIGSPATIAL community is both a provider of new systems with cutting-edge technology on accessing and processing geospatial data, and a user for all these systems. The SpatialAPI workshop is designed to help the SIGSPATIAL community by growing the knowledge of the existing well-established systems that are available for accessing and processing geospatial data. This includes, but is not limited to, web APIs, programming libraries, database systems, and geospatial extensions to existing systems.

The SpatialAPI workshop provides a platform for API developers to educate the community about their systems. This year, the Covid-19 pandemic introduced a new challenge of how to maintain the interaction between the speaker and the attendees in a completely remote setting. We did not want to run pre-recorded tutorials which defy the idea of the workshop. Thus, we updated our selection criteria this year to consider the suitability for online settings and updated the call-for-proposals accordingly.

2 Submissions and Selection Process

We received six tutorials this year which all got reviewed by our Program Committee members. Each tutorial received two to three independent reviews and we chose three tutorials (acceptance rate: 50%) to be presented in the workshop. All the accepted tutorials received all positive reviews which speaks of the high quality of these tutorials. The final tutorial overviews were published as part of the workshop proceedings [1]. We would like to thank all the program committee members who helped us in the review process.

- Heba Aly - Amazon
- Peter Baumann - Jacobs University/Rasdaman
- Michael Gordon - Ordnance Survey
- Janet Reyes - University of California, Riverside
- Ibrahim Sabek - MIT
- Satish Sankaran - Esri
- Martin Werner - Technical University of Munich



(a) Session 1 (b) Session 2

Figure 1: Spatial API 2020 participation

3 Workshop Preparation and Program

To prepare the workshop, we asked each presenter to prepare a Github or a similar page that contains an overview of the tutorial with any required material such as prerequisites, datasets, and source code. We also asked every speaker to prepare a short 5-minute introductory video as a teaser for the tutorial. We were amazed by the quality of these videos and we used them to publicize the workshop and attract more audience to the workshop. All the videos are available on the workshop website [3].

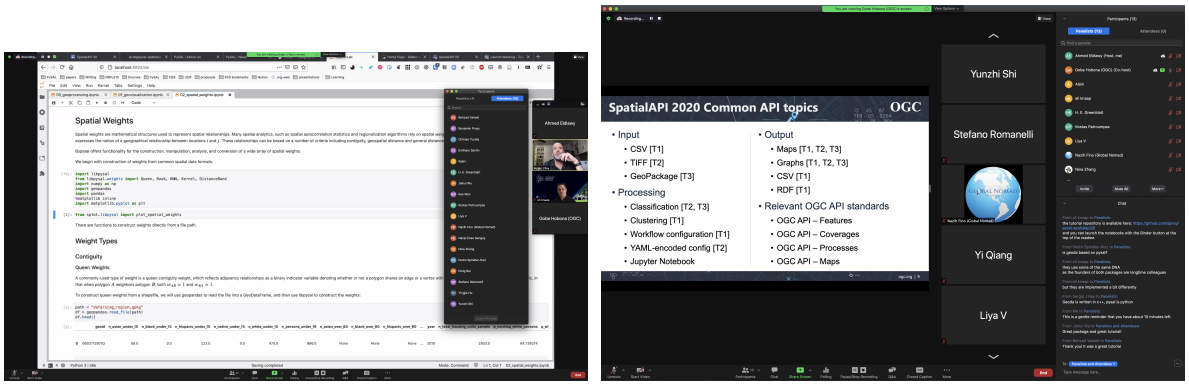
During the workshop, we started with a plenary session where we gave an overview of the workshop goals and logistics. The workshop was delivered entirely online via Zoom. The opening and plenary sessions were pre-recorded. After that, we had three sessions in sequence, one for each tutorial. Each session ran for about 100 minutes. We gave the speakers full control of their session and they all did a terrific job of making use of the online setting. Most of them had partially pre-recorded the tutorial into short sections that were played and then followed by a live section where the attendees can ask questions and the speakers can answer and comment.

The first tutorial presented a system called SLIPO which showed spatial data integration for point of interest data [2]. Figure 1(a) shows a screenshot of the participation during the first session. The second tutorial showed how to apply deep learning on satellite data on the AWS cloud platform [5]. The attendance peaked at 33 participants during the second session as shown in Figure 1(b). The third tutorial presented the PySAL library which runs spatial data analytics using Python [4]. Figure 2(a) shows a part of the PySAL tutorial.

The attendance came out really good with a maximum of 33 participants during the second tutorial which is almost double of the maximum during SpatialAPI 2019. We finished with some concluding remarks where Co-chair Gobe Hobona shared his thoughts about standardization and the role of both academia and industry in the standardization process. Gobe presented a summary of the OGC standards that were used in all tutorials as shown in Figure 2(b). All speakers and attendees actively participated in the discussion.

4 Conclusion

Despite the Covid-19 pandemic, we believe that the speakers and the audience had a positive experience during the SpatialAPI 2020 workshop. We had to update the workshop settings to take this into account but we are thankful to the conference and workshop organizers for their help, the speakers, and the audience. We could not reach these results without the help of everyone. We shifted to one track this year in response to the attendees feedback from last year which we recommend for the future since the audience liked it.



(a) Session 3 (b) Final remarks

Figure 2: Spatial API 2020 participation

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ARIC 2020 WORKSHOP REPORT
The 3nd ACM SIGSPATIAL International Workshop on Advances in Resilient and Intelligent Cities
Seattle, WA, USA November 3, 2020

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The advancements in sensor technology and ubiquity of connected devices has enabled the generation of large volume of disparate, dynamic and geographically distributed data both by scientific communities and citizens. With astonishing technological innovations and convergence, there have been major changes in peoples daily activities and social interactions. These innovations have contributed to the establishment of smart and connected cities. A smart city is forward-looking, progressive, and has the potential to provide high-quality life. A resilient city can preserve its activities and bounce back to its previous stage or to a new normal in the face of an emergency while meeting the daily activities and needs of its citizens. It is imperative to improve our understanding of Resilient and Intelligent Cities in order to leverage these new technologies to tackle the challenges ranging from climate change, public health, traffic congestion, economic growth, to digital divide, social equity, political movements, and cultural conflicts, among others.

A smart city is subjected to the same challenges as a conventional city, such as environmental damages, hazard impacts, access to services and resources, due to continuous population and economic growth. The COVID-19 pandemic has highlighted this difference between smart and resilient cities more so than any other hazard events. While the availability of real-time data and analytics, cloud computing and artificial intelligence (AI) has enabled the development of dashboards and platforms to help with decision-making during this pandemic, these platforms and dashboards fail to address the resilience of the impacted communities as evidenced by the economic stress and increase in COVID-19 spread across the United States and other countries around the world. The challenge is to plan and design intelligent cities under the framework of resilience so that the knowledge discovery from static and dynamic data streams could be used for policy, research and future expansion of cities.

The 3rd International Workshop on Advances on Resilient and Intelligent Cities (ARIC 2020) was timely. Following the success of ARIC 2019 workshop, the 2020 ARIC workshop brought together researchers and practitioners from different disciplines to address the challenges of integrating large-scale computing, geospatial analytics, public health research, infrastructure resilience and urban sciences in building intelligent and resilient cities that can withstand the impacts of future pandemics and extreme events. The workshop featured two keynotes, nine research papers and a panel session discussing the current trend in smart and resilient city research, future directions, and the role of geo-design, sensor technologies, edge computing, modeling and simulation to increase the resilience of cities.

The morning session of the workshop started with a Keynote titled *Smart Cities and Internet of Things* that was delivered by Dr.Sokwoo Rhee. Dr.Rhee is the Associate Director for Cyber-Physical Systems (CPS)

Innovation at the National Institute of Standards and Technology (NIST), U.S. Department of Commerce. He is leading smart city and Internet of Things (IoT) innovation programs at NIST, including the Global City Teams Challenge (GCTC) and the Smart Cities and Communities Framework (SCCF) program. This keynote (i) provided an overview of the structure of smart cities, global trends, and technical issues and challenges, and (ii) discussed how NIST is working with private sector stakeholders and other U.S. federal agencies to aid cities and communities across the world to share ideas and develop comprehensive solutions to address their issues.

Following the keynote, five papers were presented. The first paper titled *Constructing a Digital City on a Web-3D Platform* was presented by Toshikazu Seto, Yoshihide Sekimoto, Kosuke Asahi and Takahiro Endo (Japan). This paper discussed a platform to display 20 data types and create a digital twin of a city. This presentation was followed by the paper titled *Reducing and Linking Spatio-Temporal Datasets with kD-STR* that was presented by Liam Steadman, Nathan Griffiths, Stephen Jarvis, Mark Bell, Shaun Helman and Caroline Wallbank (United Kingdom) that discussed the kD-STR algorithm to link spatial and temporal datasets that are essential for the modeling of smart and resilient cities. The third paper titled *Exploiting Points of Interest for Predictive Policing* was presented by Luis Gustavo Coutinho Do Rego, Ticiana Linhares Coelho da Silva, Regis Pires Magalhes, Jose Antonio Fernandes de Macedo and Wellington Clay Porcino Silva (Brazil). This paper discussed a big data analytics approach to analyze and forecast spatio-temporal patterns of criminal activities to aid with policing. The fourth paper titled *Data-Driven Mobility Models for COVID-19 Simulation* was presented by John Pesavento, Andy Chen, Rayan Yu, Joon-Seok Kim, Hamdi Kavak, Taylor Anderson and Andreas Zfle (USA). This paper presented an Agent-based model using point of interest data along with topic modeling to simulate the spread of COVID-19. The last paper in this session titled *Characterizing the Spread of COVID-19 from Human Mobility Patterns and Socio Demographic Indicators* was presented by Avipsa Roy and Bandana Kar (USA). This paper presented a machine learning approach to model COVID-19 spread in Los Angeles City using socio-economic indicators and mobility data during March through July of 2020.

The afternoon session of the workshop featured a keynote titled *Public Private Partnerships: Value Capture in Urban Development* by Dr. Wilfred Pinfold. Dr. Pinfold is the Chief Executive Officer of urban.systems Inc, a company that builds vibrant communities using technology to facilitate civic engagement, deliver services and share resources. Dr. Pinfold discussed the need to improve public services and efficient resource-usage, and the role of public-private partnerships in benefiting communities and building their resilience.

Following the keynote, four papers were presented. The first paper titled *Green Infrastructures and Their Impact on Resilience - Spatial Interactions in Centralized Sewer Systems* was presented by Mayra Rodriguez, Guangtao Fu and David Butler (UK). This paper discussed the spatial interactions between green infrastructure placement and improvements in sewer networks to reduce flooding impacts. The second paper titled *Seismic Resilience Assessments of Water Pipelines - A Case Study for the City of Los Angeles Water System Pipeline Network* was presented by Yajie Lee, Jianping Hu, Alek Harounian, Zhenghui Hu and Ronald Eguchi (USA). This paper presented a stochastic method to assess the risk of water infrastructure networks to seismic events using the case study of the City of Los Angeles. The third paper titled *Designing Community-Based Intelligent Systems for Water Infrastructure Resilience* was presented by Nalini Venkatasubramanian, Craig Davis and Ronald Eguchi (USA). The paper discussed the use of IoT devices and machine learning based analytics to assess the resilience across the water infrastructure networks. The last paper in this session was *AI-supported Citizen Science to Monitor High-Tide Flooding in Newport Beach, California*. This paper authored by Behzad Golparvar and Ruo-Qian Wang (USA) presented an AI based approach to extract flood depth information from crowdsourced imagery using computer vision and photogrammetric techniques.

The last session of the workshop was a panel titled *Smart and Resilient Cities: Where To Go Next?*. The panelists David Cauffman (Department of Homeland Security), Dr. Ian McRae (Sherwood Design Engineers), Scott Tousley (Splunk), Dr. William Mobley (Texas A & M University) and Dr. Ronita Bardhan (University of Cambridge) discussed the issue of geo-design and its role in making cities resilient, current standards and policies that enable integration of smart city initiatives and resilience framework, and future directions to help stakeholders achieve their goal to make their city smart and resilient.

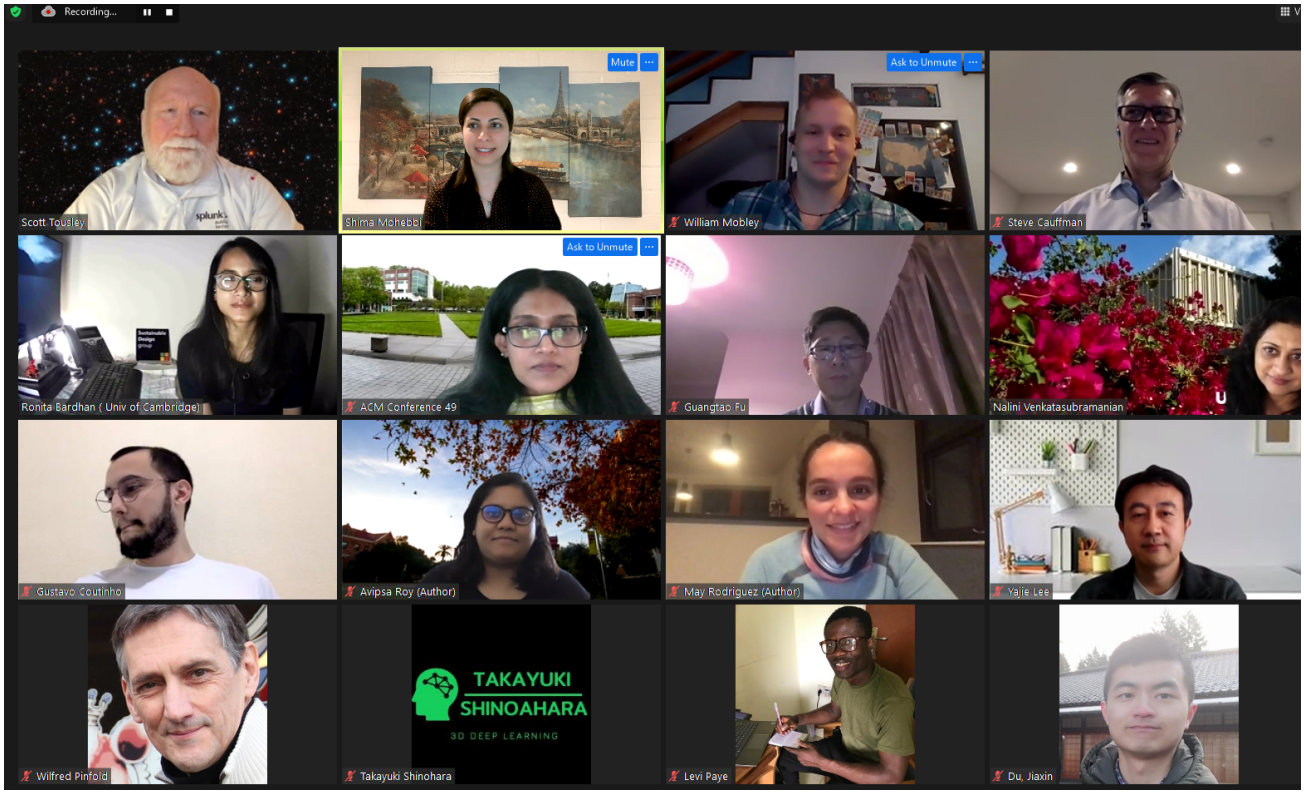

Figure 1: ARIC 2020 Participants

We sincerely thank the keynote speakers, panelists, authors and other participants for participating and sharing their valuable insights about this complex topic of smart and resilient cities in ARIC 2020. We also thank the program committee members for their time and effort in reviewing and evaluating the submitted papers. We hope that the proceedings of ARIC2020 will contribute to the field and stimulate new research. We also hope that the workshop series will continue to provide a leading international forum for researchers, developers and practitioners in the field of computing, urban and geospatial sciences, and data analytics, engineering to identify current and future areas of research and practice that will contribute to creating smart and resilient cities.

The 13th ACM SIGSPATIAL International Workshop on Computational Transportation Science (IWCTS 2020), Seattle, WA, USA - November 3, 2020

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Introduction

Today's growth in big data, edge computing, high-performance computing, and machine learning has opened tremendous opportunities for advances in mobility. The 13th International Workshop on Computational Transportation Science (IWCTS 2020) is particularly timely given the prominence of connected automated vehicles technologies in the global auto industry's near-term growth strategies, of big data analytics, unprecedented access to sensing data of mobility, and of integration of this analytics into the optimization of mobility and transport. These developments (as listed below) are deeply computational.

- Transportation Planning & Modeling: travel behavioral analysis, modeling and simulation of population movements and freight transportation systems.
- Transportation Operations: Connected and Autonomous (CAVs), Computational traffic flow models and control algorithms, role of transportation in community spread of a pandemic (COVID-19).
- Infrastructure Sensing: Digital Twin, Data-driven approaches to transportation systems operations
- Other Technologies: Urban sensing technologies, Geoinformatics and Regional Science

IWCTS 2020 Submissions

This year, we had a call for short papers or full papers. We received submissions for 3 short papers and 8 full papers. One of the full papers was withdrawn prior to completion of the review process. The remaining 10 papers were reviewed by the organizers and program committee members. Based on the peer review process, 3 short papers and 6 full papers were selected for presentation at the conference and publication in the workshop proceedings [1].

The program committee members are

- Anne Berres, Oak Ridge National Laboratory
- Kuldeep Kurte, Oak Ridge National Laboratory
- Srinath Ravulaparthy, Lawrence Berkeley National Laboratory
- Jibonananda Sanyal, Oak Ridge National Laboratory
- Gautam Thakur, Oak Ridge National Laboratory

- Ambarish Nag, National Renewable Energy Laboratory
- Chieh Ross Wang, Oak Ridge National Laboratory
- Lee Han, University of Tennessee at Knoxville
- Digvijay Pawar, IIT Hyderabad
- Mina Sartipi, University of Tennessee at Chattanooga
- Punit Tulpule, The Ohio State University
- Jackeline Rios-Torres, Oak Ridge National Laboratory

IWCTS 2020 Workshop Program

Since this year's workshop is fully virtual due to COVID, we changed this year's workshop program a little from the usual program to accommodate participants joining from Europe, Australia, and the Americas. Each provided an hour long break to give participants in different time zones the opportunity to have lunch or dinner at a reasonable time. Furthermore, we added a half-hour of open discussion at the end of the day, which served as an opportunity for all workshop participants to get to know each other and discuss future collaborations. Throughout the workshop, we had an average of 17-18 people, peaking at 21 attendees during the keyWe grouped the workshop presentations in the following three sessions.

Session 1

Session 1 groups papers on the advanced data-driven approaches in mobility. Swetava Ganguli presented a deep learning based approach called VAE-Info-cGAN (Variational Autoencoder with a conditional Information Maximizing Generative Adversarial Network (InfoGAN)) to generate target data for data augmentation of various geospatial applications [2]. Experimental results presented on a GPS trajectory dataset showed the applicability of the proposed approach in generating various forms of spatio-temporal aggregates across different geographic locations [3]. Next, Lukas Rottkamp presented their work on developing a generalised approach to calculate the cost associated with the various types of detours while travelling, such as charging stations, finding a place for parking, etc. Lukas also presented their approach on generating sufficiently realistic parking data when real-data is not available. Towards the end of session 1, Paolo Pintor explained that the traffic prediction solely based on the historical data may fail with the real-time events such as road works and traffic accidents [4]. Paolo presented a system that combines both the historical and real-time traffic data and uses a stochastic process for short-term traffic forecasting.

Keynote

The workshop keynote was presented by Dr. Mina Sartipi, an expert in the computation transportation domain. Dr. Mina Sartipi is the Founding Director of the Center for Urban Informatics and Progress (CUIP) at the University of Tennessee at Chattanooga (UTC), where she is also a Guerry Professor in the Computer Science and Engineering Department. She talked about how data, connectivity, and machine learning technologies can improve the traffic flow safely, while minimizing environmental impact. The talk started with the brief introduction to the safety in mobility and path to the data driven mobility approaches. Towards the end of the keynote session, all the participants engaged in a lively discussion and question and answer with Dr. Mina.

Fig 1. Dr. Mina Sartipi giving keynote talk

Session 2

Session 2 combined papers on driving pattern analysis. Christian Röger presented an interesting approach to implement the Floating Car Observers (FCO) that uses particulate matter sensors for obtaining road abrasion from cars driving ahead of a test vehicle [5]. Further, Christian explained the random forest based machine learning approach to predict the presence and absence of the ambient traffic in the vicinity of the vehicle using particulate matter readings. Next, Yan Li presented a lagrangian perspective for the hotspot discovery problem that considers the linear dependence of the events occurring on the paths and trajectories which usually is ignored in the state-of-the-art euclidean perspective of hotspot discovery [6]. At the end of session 2, Antonios Karatzoglou presented a preliminary work on relevant feature extraction from a spatio-temporal signal based on the topographic properties such as prominence and isolation for recognizing critical driving patterns in speed signals [7]. Various driving behaviours identified by this approach included harsh acceleration, abrupt braking as well as over-speeding phases.

Session 3

Session 3 combined the presentations on routing optimization. Bin Yang presented a deep learning based approach called dual-input long-short term memory (DI-LSTM) to estimate the travel speed distribution of paths [8]. The important objective of this work was to capture the traffic uncertainty from the speed information obtained from the sensor technologies. Next, Renjie Chen started the presentation by describing the importance of the fastest-path queries between two points in the large road network. Further, Renjie presented a Hierarchical Separator Heuristic (HSH) for fastest path travel time that accelerates the classical A* algorithm for fastest path [9]. At the end of session 3, Sadegh Motallebi presented a new route assignment algorithm for the era of connected autonomous vehicles that optimizes traffic based on both the real-time and prior traffic data [10].

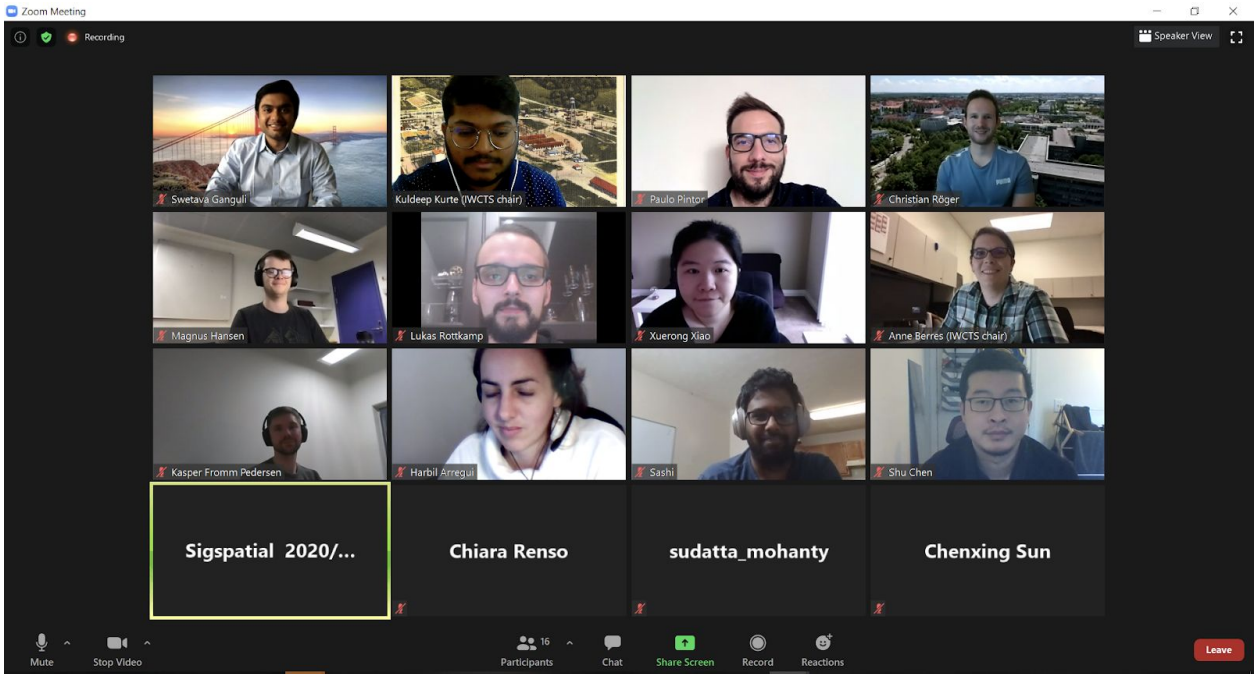
Conclusion

In summary, the 13th edition of IWCTS have seen a balanced mix of works ranging from the advancements in the traditional approaches to the deep learning based approaches to solve various computational transportation science problems. In subsequent series of this workshop, we expect to see more work on advanced data-driven approaches such as deep learning to address more complex problems at the intersection of computational transportation and geospatial domain.

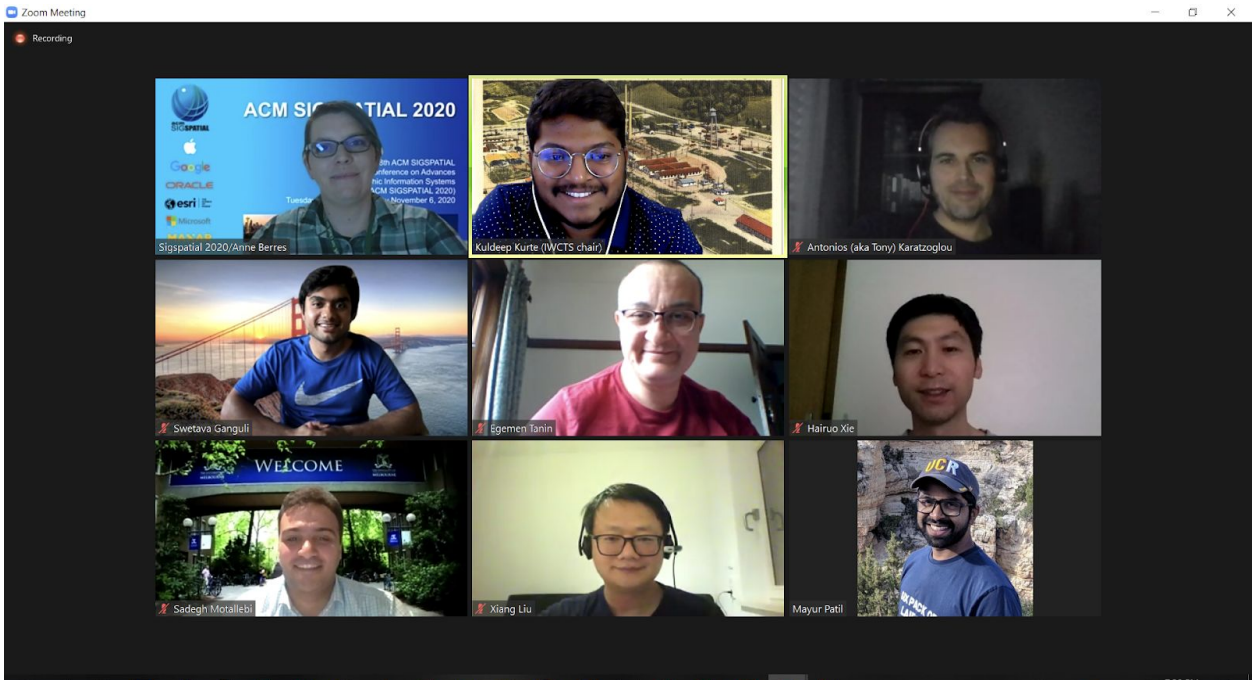
The workshop organizers thank all submitters, presenters, PC members, and participants for their contributions to this successful workshop. We hope the IWCTS workshop series will continue to provide a leading international forum for researchers, developers, and practitioners in the field of computational transportation sciences to identify current and future areas of research.

Snapshots from the Workshop Zoom Meeting

In lieu of a group photo, we took a few snapshots for which we asked participants to turn on their cameras.



(a) Before the beginning of the workshop



(b) During the final discussion session of the workshop

Fig. 2: Snapshots of zoom meeting during workshop

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Spatial Gems 2020 Workshop Report
The 2nd ACM SIGSPATIAL International Workshop on Spatial Gems

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1 Introduction to Spatial Gems

Researchers and practitioners working with spatial data often develop fundamental new techniques they would like to share with their community. These are not necessarily new research results, not yet in any textbook, but they are interesting, self-contained techniques for doing something useful in the domain of spatial data. We call these techniques "spatial gems".

The goal of this workshop is to publish several spatial gems contributed by the participants. While a gem may have already been published as a small part of a paper, extracting it into a gem makes it much more likely to be found and used by others. Good gems will stay relevant for a long time. Each gem will be two to ten pages long. Where appropriate, a good gem will include numerical examples so programmers can verify their implementations, but it should not be a research paper with results on multiple test cases. Spatial gems should be reproducible and usable. Thus, we encourage authors to provide implementation details and code whenever possible. Code can be included in short blocks of code in the paper, or longer code can be shared in an open source repository with a pointer in the paper. Different from a research paper, a spatial gem should not focus on describing "Look at what I can do!" but rather, a Spatial Gems paper should instead say: "Look at what you can do!". At the workshop, participants work together to edit all the accepted submissions for clarity and utility, with the goal of creating a reference archive of spatial techniques.

2 Spatial Gems 2020 Submissions

The 2nd ACM SIGSPATIAL International Workshop on Spatial Gems (Spatial Gems 2020, https://www.spatialgems.net) was held virtually in conjunction with the 27th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems in Seattle, Washington, USA. The workshop had ten paper submissions which were reviewed by eight program committee members. Each paper was assigned to three reviewers and all papers received at least two reviews. While the number of submissions was low, the quality of the submissions was high. Among the seven accepted papers, reviewers recommended 2 Strong Accepts, 7 Accepts, two Weak Accepts, and two Neutrals.

3 Spatial Gems 2020 Workshop Program

Spatial Gems puts the "work" back in "workshop". Therefore, the goal of this workshop is not only to present research, but also for workshop attendees to team up and to hands-on work on each others papers in LaTeX during the workshop. For this purpose, the workshop was split into three parts:

1. Paper Presentations
2. Editing Session I
3. Editing Session II and Best Paper Award Announcement

All sessions were held virtually on Zoom.

3.1 Paper Presentations

After a short introduction by the chairs at 2 PM PST, the workshop kicked off by having ten-minute presentation for each accepted spatial gem:

- The first paper, presented by Seshagiri Cherukuri from Microsoft, explained how to lay out an optimized network, such as fiber optic cable, that follows an existing road network [6]. ("A Practical Network Layout Planning System Using Geospatial Data")
- John Krumm presented the second paper on how to use the Brownian Bridge for making probabilistic interpolations of the location of moving objects between measurements [1]. ("The Brownian Bridge for Space-Time Interpolation")
- The third paper was from the Singapore company GrabTaxi, and it discussed how to efficiently find the k nearest neighbors on a road network in real time [7]. ("A Scalable In-Memory Solution for Real-Time K Nearest Search on Road Network")
- Salles V. G. de Magalhães, from Brazil, presented the fourth paper on using GPUs to accelerate geometric predicates for 3D queries, such as the orientation of four 3D points [2]. ("Employing GPUs to Accelerate Exact Geometric Predicates for 3D Geospatial Processing")
- The next paper came from Yuanyuan Pao of Lyft, explaining an innovative way to represent the locations of objects on a road network by their fractional distance along road segments [3]. ("Using Segment Fraction For Road-Network Locations")
- The sixth paper, presented by Samriddhi Singla, described a technique for computing multidimensional approximate histograms with a single pass over the data, which is useful for incremental and streaming applications [4]. ("Flexible Computation of Multidimensional Histograms ")
- The presentations concluded with a talk from Goce Trajcevski on how to compute with triangulated irregular networks that are evolving in time [5]. ("TINET: Triangulated Irregular Networks Evolving in Time")

During the presentations, we had about 30 people in the virtual room.

3.2 Editing Session I

After a short break, workshop attendees were paired to work hands-on the LaTeX source code of each others papers in two editing sessions starting at 3:45 PM PST. The pairing was done arbitrarily using Paper IDs. Since the workshop had an odd number of seven papers, non-author workshop chairs joined the unmatched teams. Paired teams were moved into breakout rooms for collaboration. Each team had 30 minutes to read each others paper to provide constructive feedback. Authors were instructed to focus on improving readability and ease of understanding, to improve the impact and usability of each others spatial gem. After this reading phase, teams had 30 minutes to discuss changes and another 30 minutes to implement changes in the LaTeX source code. For this purpose, all workshop papers were required to share their code in Overleaf to work concurrently on their papers. Changes of the papers included minor edits related to grammar and typos, but also major changes to clarity such as adding examples, adding motivation, or removing unnecessary sections for brevity.

During the nature of hands-on working on each others papers, the editing sessions had no attendees other than authors and organizers working on the papers. Each of the four breakout rooms had two to four people, including authors of two respective papers.

3.3 Editing Session II

After a 15 minute break, authors were assigned to new teams and met in breakout rooms for another 90minutes to read, discuss, and edit each others papers from 5:15-6:45 PM PST.

At the end of Editing Session II the organizers announced the Best Paper Award of Spatial Gems 2020 which was awarded to the paper titled "Employing GPUs to Accelerate Exact Geometric Predicates for 3D Geospatial Processing" by Marcelo Menezes, Salles V. G. de Magalhães, and others. Congratulations!

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COVID'2020 Workshop Report
The 1st ACM SIGSPATIAL International Workshop on Modeling and Understanding the Spread of COVID-19

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1 COVID'2020 Workshop Overview

In response to the COVID-19 pandemic, a number of spatially-explicit models have been developed to better explain the pathways of the disease, to predict the trajectory of the disease, and to test the effect of different health guidelines and policies on the number of cases and deaths. The 1st ACM SIGSPATIAL International Workshop on Modeling and Understanding the Spread of COVID-19 workshop (COVID'2020) featured research efforts that aim to understand the spatial processes and patterns of COVID-19 spread using a variety of spatial modeling, simulation, and mining approaches. The goal of this workshop was to bring together a range of interdisciplinary researchers in the SIGSPATIAL community in the fields of computer science, spatial modeling, social sciences, and epidemiology. Also, this workshop was advertised for anyone interested in infectious disease data and modelling, including but not limited to COVID-19.

2 Workshop Submissions

The 1st ACM SIGSPATIAL International Workshop on Modeling and Understanding the Spread of COVID-19 (COVID'2020, https://jiayuasu.github.io/covid19-workshop/) was held in conjunction with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems in Seattle, Washington, USA on November 3rd, 2020. The workshop had a total of twelve submissions. A total of eight quality submissions were selected for presentation and final publication for an acceptance rate of 66%. Each paper was reviewed by exactly three program committee members. Despite the high acceptance rate, the review process was highly selective. We accepted only papers that received an average rating from reviewers of at least +1.0. Among the eight accepted papers, reviewers recommended 2 Strong Accepts (+3), 11 Accepts (+2), 7 Weak Accepts (+1), 3 Neutrals (0), and one Weak Reject (-1) for an average rating of 1.42 among accepted papers.

3 Workshop Program

The workshop program included the following elements:

- **Keynote Presentations**: there were two keynote presentations by Drs. Nicholas Reich and Jeffrey Shaman.
- **Paper Presentations**: there were eight paper presentations which featured contributions submitted in response to the workshop's call for papers. The papers were reviewed by the program committee and selected based on their review by the program chairs.
- **Invited Presentations**: there were eight invited talks which featured contributions submitted to the ACM SIGSPATIAL Special Issues: Volume 12, Number 1 & 2: Modeling and Understanding the Spread of COVID-19 (SIGSPATIALSpecial,https://www.sigspatial.org/publications/newsletter/).

3.1 Keynote Presentations

- After a short introduction by the chairs, the workshop kicked off at 8:10 PT with a keynote talk by **Dr. Nicholas Reich**, an Associate Professor of Biostatistics at the University of Massachusetts Amherst. Dr. Reich's team leads two international infectious disease forecasting consortia, including the FluSight Network and the COVID-19 Forecast Hub. Dr. Reich gave a talk titled *"A critical evaluation of COVID-19 pandemic forecasts"* which focused on his experience with modeling and forecasting influenza using ensemble modeling approaches and how these approaches have recently been applied to forecast COVID-19 dynamics.
- Our second keynote was given at 10:00 PT by **Dr. Jeffrey Shaman**, a Professor in the Department of Environmental Health Sciences and Director of the Climate and Health Program at the Columbia University Mailman School of Public Health. Dr. Shaman studies the survival, transmission and ecology of infectious agents, including the effects of meteorological and hydrological conditions on these processes. Dr. Shaman shared his experience developing models that forecast the flu and COVID-19 in a talk titled *"Transmission Dynamics of SARS-CoV-2: Modeling, Inference and Projection"*.

3.2 Paper Presentations and Invited Presentations

There were a total of four research sessions beginning at 9:00 PT and ending at 14:30 PT, where each research session featured on average two paper presentations and two invited presentations. During the presentations there were on average 40 people in the room.

Research Session 1

- First, **Mohamed Mokbel** introduced their vision and guidelines for the next era of contact tracing [9] ("Contact Tracing: Beyond the Apps"),
- next, **Rachit Agarwal** introduced a COVID-19 infection risk score based on human contacts [2]("Infection Risk Score: Identifying the risk of infection propagation based on human contact"),
- next, **Muhammed Imran** presented a large-scale Twitter dataset called GeoCoV19 that contains more than 524 million tweets related to COVID-19 that was collected over 90 days [11]("GeoCoV19: A Dataset of Hundreds of Millions of Multilingual COVID-19 Tweets with Location Information"),
- and finally, **Michael Desjardins** reported their analysis results of daily COVID-19 case data at the county level using the prospective spatial-temporal scan statistic [6]("Rapid detection of COVID-19 clusters in the United States using a prospective space-time scan statistic: An update").

Research Session 2

- First, **Ignacio Segovia-Dominguez** introduced their approach to modeling COVID-19 using a combination of mechanistic models and machine learning [3] ("Geospatial forecasting of COVID-19 spread and risk of reaching hospital capacity"),
- next, **Amy Magdy** proposed enhanced reporting of COVID-19 cases, particularly in underserved communities, by utilizing open data posted to the web [1]("On Improving Toll Accuracy for COVID-like Epidemics in Underserved Communities Using User-generated Data"),
- next, **Gergely Biczók** demonstrated the effect of incentives on decision-making related to actions that prevent the transmission of COVID-19 like mask use and social distancing [10]("Corona Games: Masks, Social Distancing and Mechanism Design"),
- and finally, **Mehrdad Kiamari** proposed a hybrid model and-data-driven approach to risk scoring based on an SIR model [7]("COVID-19 Risk Estimation using a Time-varying SIR-model").

Research Session 3

- First, **Li Xiong** and **Cyrus Shahabi** jointly presented REACT, a real time contact tracing application that has enhanced privacy features [16] ("REACT: Real-Time Contact Tracing and Risk Monitoring using Privacy-Enhanced Mobile Tracking"),
- next, **Zhongying Wang** presented their results for their sensitivity analysis which tests the sensitivity of COVID-19 model parameters on time to peak number of cases [14]("Sensitivity Analysis for COVID-19 Epidemiological Models within a Geographic Framework"),
- and finally, **Zhu Wang** conducted a large scale study on the effect of COVID-19 on education using geotagged Twitter data [15]("Analysis of the Impact of COVID-19 on Education Based on Geotagged Twitter").

Research Session 4

- First, **Hanan Samet** introduced their data visualization application CoronaViz that can be used to visualize dynamic variables such as COVID-19 cases, recoveries, and deaths [12] ("Using Animation to Visualize Spatio-Temporal Varying COVID-19 Data"),
- next, **Zipei Fan** presents a simulation platform that aims to find patients that have not yet been diagnosed with COVID-19 by following the chain of transmission [4]("Human Mobility based Individual-level Epidemic Simulation Platform"),
- next, **Gautam Thakur** developed a situational awareness platform that can process multi-source data for better decision making related to disease spread [13]("COVID-19 Joint Pandemic Modeling and Analysis Platform"),
- next, **Song Gao** presented a web-based interactive mapping platform to show how people in different counties and states reacted to COVID-19 social distancing guidelines [5]("Mapping county-level mobility pattern changes in the United States in response to COVID-19"),
- and finally, **Hamdi Kavak** proposed an ensemble modeling approach using representing clustering to predict COVID-19 deaths [8]("COVID-19 Ensemble Models Using Representative Clustering").

4 Special Event: Zoom Bombing

The workshop had an unexpected event. About 20 Minutes after the workshop started, during the beginning of the first keynote, the workshop got "Zoom-Bombed". A group of 20 participants with generic names such as "Anne" and "Mike" joined the workshop. All at the same time, they started disrupting the keynote presentation by 1) screaming minor profanity, 2) using their camera to show pornographic material, 3) writing minor profanity in chat, and 4) using the screen annotation tool to draw lines across the screen.

The three workshop organizers collaboratively removed the Zoom Bombers from the meeting. Fortunately, we were assisted by George Mason University undergraduate student Justin Elarde who volunteered to help monitoring the meeting, for example, to mute participants who forgot to mute themselves. What made it easy to identify the Zoom bombers, was that they were all using the "raise hand" function to move themselves to the top of the participant list. However, as we removed bombers, new ones kept joining, which forced us to enable a waiting room.

In total, it took about six minutes until the storm was over and all Zoom bombers had been removed from the meeting. New Zoom bombers were continuously joining, but they were held in the waiting room. We decided the restart the first keynote by Dr. Reich. Since the keynote had already run for 20 minutes, we ran a total of 30 minutes late. We compensated this delay by moving the presentations of Dr. Hamdi Kavak to the very end of the workshop with his permission. After restarting the keynote presentation, there were no further disruptions.

While the keynote continued, the Zoom bombing attacks continued and Zoom bombers joined the waiting room. The Zoom bombers had adapted, and used the names of real participants (which they had learned when they were in the meeting) and they even copied the profile pictures of real attendees. To avoid further disruptions, General Chair Dr. Züfle required each participant in the waiting room to verify their ACM SIGSPATIAL Registration Number. Conveniently, Dr. Züfle was an ACM SIGSPATIAL Registration co-chairs, such that he had access to the registration system for verification. After about 5 minutes of verifying participants, the Zoom bombers left and did not return.

Unfortunately, during the removal of Zoom-bombers from the meeting, we also removed two false positives, meaning we removed two regular/authentic participants. One participant was classified as a false positive due to having raised their hand during the attack. The other participant only used their first-name and thus matched the pattern of generic names. Participants who were removed were no longer able to join the same room and were locked out permanently. While Zoom does have an option to allow removed users to rejoin, enabling this option did not help retroactively. To allow the two participants to re-join the workshop, we created a new room after the first session and asked all participants to move to the new room. We immediately updated the Zoom link on the workshop website and the SIGSPATIAL general and web chairs were lightning fast to update the links on the conference website.

In the new room, we continued to enable a waiting room to authenticate participants. But during the six hours this room was used, there was no more sign of any Zoom bombing.

Lessons Learned

We deliberately chose to use a Zoom meeting (versus a Zoom webinar) to host the workshop. While a Zoom webinar would have prevented Zoom bombing, a Zoom meeting allows participants to see each other, to share their video, ask questions (using audio), send private messages, and to enable break-out rooms for participants to have conversions in small groups. We think these features are important for an interactive workshop.

For future workshops, we would still use a Zoom meeting with the same room settings, sacrificing security to enable social interactions. But what we would do differently is 1) not to disclose the Zoom link until (a few minutes before) the workshop starts, and 2) not to embed the room password in the link. This way, there will not be enough time for Zoom bombers to crawl the link from the web and organize an attack. And even if they'd crawl it, they wouldn't have the password.

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EM-GIS2020 Workshop Report
The 6th ACM SIGSPATIAL International Workshop Emergency Management using GIS 2020

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Safety refers to the stable external environment and orders wherein society and citizens need to engage in and conduct normal life, work, study, entertainment, and communication. Resilience in public safety refers to the ability to withstand the shocks and pressures of emergencies. Emergency management is the creation of plans through which communities decrease the impact of disasters and prevent from unexpected events. GIS models and simulation capabilities are used to exercise response and recovery plans during non-disaster times. They help the decision-makers understand near real-time possibilities during an event. For example, while global communities are trying to respond to the COVID-19 pandemic, GIS tools are widely used by health departments, safety and emergency management authorities and wider professionals around the world for gathering and analyzing data to support informed decisions.

EM-GIS 2020(https://em-gis2020.github.io/CallForPaper/) was held in conjunction with the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2020) on November 3th, 2020 in Seattle, Washington, USA. The purpose of the EM-GIS 2020 Workshop is to provide a forum for researchers and practitioners to exchange ideas and progress in related areas. This workshop will bring together researchers and practitioners in massive spatio-temporal data management, spatial database, spatial data analysis, spatial data visualization, data integration, model integration, cloud computing, parallel algorithms, internet of things, complex event detection, optimization theory, intelligent transportation systems and social networks to support better public policy through disaster detection, response and rescue.

In light of on-going developments with COVID-19 and the unpredictable implications on both health and travel restrictions. EM-GIS 2020 was converted to a virtual conference. The virtual conference was run one-day with 7 researchers and practitioners registered via Zoom webinars. Overall, 7 research papers were presented and discussed (15 minutes for each paper). The presentations were divided into two sections:

(1) Firstly, invited expert *Prof. Danhuai Guo* presented his research in *How China Fast Controls the Second Waves of COVID-19 Outbreaks: A Case Study of Beijing Xinfadi Market Outbreak with Agent-Based Model*. And then, the authors discussed their topic in GIS technology (*Research on the LBS Applied in COVID-19: integrating GIS technology and personal information and The Study of Colleges Students Returning to Campus under the Epidemic Situation Based on GIS*), urban air quality sensing (*A cost aware crowdsensing approach for urban air quality sensing and computing*).
(2) In the second part, authors presented their research in Contact Network in a Research Institute (*Structural statistics of a Human Contact Network in a Research Institute*), Sentiment Analysis (*Sentiment Analysis for News and Social Media in COVID-19*), Trends for COVID 19 Pandemic (*Typical Patterns of Government Response Measures and Trends for COVID 19 Pandemic*∗).

We would also like to thank the authors for publishing and presenting their papers in EM-GIS 2020, and the program committee members and external reviewers for their professional evaluation and help in the paper review process. We hope that the proceedings of EM-GIS 2020 will inspire new research ideas, and that you will enjoy reading them.

EM-GIS 2019 Workshop Report

The 5th ACM SIGSPATIAL International Workshop on Safety and Resilience

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Safety is vital for people and emergency management helps keep people safe. Emergency management includes four stages: Planning and Mitigation, Preparedness, Response and Recovery. Geospatial applications (including GIS) have been extensively used in each stage of emergency management. Nowadays, on the technical side, artificial intelligence tools like deep learning could be put to good use. For example, one of the main benefits of deep learning over various machine learning algorithms is its ability to generate new features from limited series of features located in the training dataset. Therefore, deep learning algorithms can create new tasks to solve current ones. Decision-makers can utilize the geospatial information to develop planning and mitigation strategies with such advanced techniques. GIS models and simulation capabilities are used to exercise response and recovery plans during non-disaster times. They help the decision-makers sense the near real-time possibilities during an event. Once disaster occurs, GIS will take effect in real time response and recovery activities.

EM-GIS 2019 (https://em-gis2019.github.io/CallForPaper/index.html) was held in conjunction with the 27th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2019) on November 5th, 2019 in Chicago, Illinois, USA. The purpose of the EM-GIS 2019 workshop is to provide a forum for researchers and practitioners to exchange ideas and progress in related areas. This workshop in the ACM SIGSPATIAL conference addresses the challenges of emergency management based on advanced

GIS technologies. This workshop brought together researchers and practitioners in massive spatio-temporal data management, spatial database, spatial data analysis, spatial data visualization, data integration, model integration, cloud computing, parallel algorithms, internet of things, complex event detection, optimization theory, intelligent transportation systems and social networks to support better public policy through disaster detection, response and rescue.

EM-GIS 2019 was a one-day workshop with 20 researchers and practitioners registered. Overall, 31 research papers were submitted and 18 research papers were accepted and presented (20 minutes for each paper). The presentations were divided into three sessions:

1) Emergency detection and prediction. In this section, authors presented their research in the risk identification of safety on campus (*Information System and Management for Campus Safety**), Disaster recovery with GIS systems especially on the aspect of planning (*AI Planning Applied to GIS-based Disaster Response*), emergency management by using social media data (*Using Social Media to Geo-Target Emergency Management Efforts*), designing a regional evacuation path optimization method using meshing and matrixing (*Discentralized Human Movement Control and Management for Campus Safety*), emergency broadcasting transmission scheme *(Emergency Broadcasting Message Transmission Based on CDR System)* and foodborne disease forecast and visualization methods (*Risk Prediction and Assessment of Foodborne Disease Based on Big Data*).

2) Transportation safety. In this section, the discussion focused on finding the comfortable driving distance by fitting the changing of driving velocity of follower vehicles better *(Study on Comfortable Distance based Car-following model with Trajectory Data)*, proposing an unlicensed taxi detection algorithm using pass-records data collected from surveillance cameras *(Unlicensed Taxi Detection Algorithm Based on Traffic Surveillance Data)*, investigate the impact of altruistic task and self-interest task on driving behavior *(Personality Effect on Driving Behavior)* and enhancing the semantic trajectory model and a process to extract semantic from GPS and other sensors *(From Raw Sensor Data to Semantic Trajectories).*

3) Emergency evaluation. In this section, authors discussed topics on ensuring bridge safety by estimating bridge improvement cost *(Bridge Improvement Cost Estimation through Both Discrete and Continuous Features)*, detecting the leakage signal of buried water-filled pipeline by the sensor array on the surface (*Experimental Investigation into the Acoustic Characteristics of the ground surface response due to Leakage in Buried Water-Filled Pipelines*), exit choice and path planning by developing a behavior agent model (*Path Optimization of Integrating Crowd Model and Reinforcement Learning*), studying the source searching problem in the chemical cluster by intermittent search strategy (*A Promising Searching Method 'Entrotaxis-*

Jump' for Seeking Hazardous Gas Source in A Chemical Cluster), gas dispersion prediction and inverse traceability issue (*Strategy of hybrid optimization algorithms for source parameters estimation of hazardous gas in field cases)*, acquiring the number of charging stations by establishing a Multi-Objective programming model *(Determination of the Number and Distribution of Charging Stations for Electric Vehicles)*, determining the initial deployment of multiple patrol vehicles to supervise chemical production processes *(Chemical Cluster Environmental Protection Patrolling Game Based on Cooperation Mechanism)* and studying the dispersion of dangerous chemicals in transportation by building a platform for heavy gas leakage dispersion *(Spatial and Temporal Distribution of LPG Dispersion Concentration in Small-scale Space).*

The workshop had two Best Papers and one Best Student Paper. The Best Papers are *Risk Prediction and Assessment of Foodborne Disease Based on Big Data* authored by Mingke Zhang, Danhuai Guo, Jinyong Hu and Wei Jin and *Bridge Improvement Cost Estimation through Both Discrete and Continuous Features* authored by Zhaojun Lin, Yanyun Fu, Xinzhi Wang, Yiping Zeng and Hui Zhang. And the Best Student Paper i*s Discentralized Human Movement Control and Management for Campus Safety* authored by Xiaoxue Ma, Hui Zhang, Yanyun Fu, Yiping Zeng, Danhuai Guo and Yang Gao..

We would also like to appreciate the authors for publishing and discussing their papers in EM-GIS 2019 workshop, and the program committee members and external reviewers for their professional evaluation and help in the paper review process. We wish that the proceedings of EM-GIS 2019 will inspire new research ideas, and that you will benefit from reading them.

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Efficient Downscaling of Satellite Oceanographic Data With Convolutional Neural Networks

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ABSTRACT

Space-borne satellite radiometers measure Sea Surface Temperature (SST), which is pivotal to studies of air-sea interactions and ocean features. Under clear sky conditions, high resolution measurements are obtainable. But under cloudy conditions, data analysis is constrained to the available low resolution measurements. We assess the efficiency of Deep Learning (DL) architectures, particularly Convolutional Neural Networks (CNN) to downscale oceanographic data from low spatial resolution (SR) to high SR. With a focus on SST Fields of Bay of Bengal, this study proves that Very Deep Super Resolution CNN can successfully reconstruct SST observations from 15 km SR to 5km SR, and 5km SR to 1km SR. This outcome calls attention to the significance of DL models explicitly trained for the reconstruction of high SR SST fields by using low SR data. Inference on DL models can act as a substitute to the existing computationally expensive downscaling technique: Dynamical Downsampling. The complete code is available on this Github Repository.

1 INTRODUCTION

Sea Surface Temperature (SST) is the measurement of temperature at a depth ranging from 1 millimeter to 20 meters below the sea surface. It is an estimate of the energy in the sea due to the motion of molecules. SST is a strong indicator of global climate change and stress to aquatic life. SST Field (Figure 1) refers to the spatial and temporal distribution of temperature on an ocean's surface.

Radiometers (thermal infrared or microwave) in space-borne satellites measure SST. High spatial resolution (SR) satellite radiometers are operative under clear sky conditions. However, under cloudy conditions, high SR measurements are not obtainable and data analysis is restricted to the available low SR measurements.

Reconstruction of high SR observations from the available low SR data will help in accurate estimation of SST fronts and small-scale oceanic phenomena [5]. This reconstruction is termed as *Downscaling*. Experiments conducted by Ducournau et al. in [3] proved that Super Resolution CNN (SRCNN) [2], with just three convolutional layers, surpasses the bicubic and EOF-sampling baseline. We revive, and further expand their work by proposing a distinct deep network with faster convergence. We choose a different dataset: SST Fields of Bay of Bengal. We generate SST observations of SR 5km (from SR 15km) and SR 1km (from SR 5km) in separate experiments.

At present, *Dynamical Downscaling* is deployed to reconstruct high SR SST Fields. It involves dynamically extrapolating the effects of large-scale climate processes to local scales of interest. But this approach is resource intensive. Our study proposes a method to construct unavailable high SR observations in a relatively efficient manner. Though training DL models is computationally expensive, it is a one-time procedure. Once trained, they can be used for innumerable predictions, giving them an edge over the former.

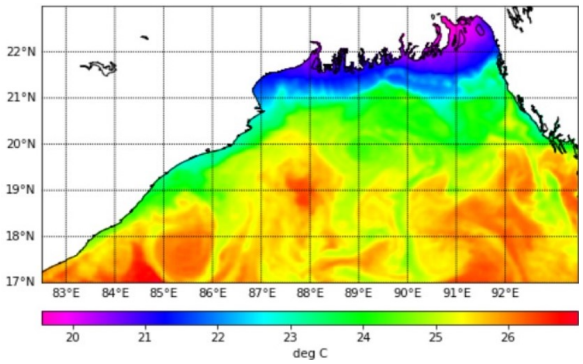

Figure 1: Sea Surface Temperature (°C) Field of Bay of Bengal (Spatial Resolution 1km)

2 METHOD

Model: We have used the Very Deep Super Resolution CNN (VDSR) [4] network. It comprises 20 convolutional layers each mapped via Rectified Linear Unit activation to the next (except for the last layer). The first layer operates on the input image. The last layer, used for image reconstruction, consists of a single filter of size 3 × 3 × 64. Remaining layers comprise of 64 filters, with kernel size (3,3). By cascading small filters many times in a deep network structure, contextual information over large image regions is exploited in an efficient way.

Data: Group of High Resolution Sea Surface Temperature (GHRSST) data engulfs SST observations dominantly from space-borne satellites. We downloaded L4 GHRSST product (gap-free SST maps) with a regular spatial resolution of 1 km from Physical Oceanography Distributed Active Archive Center [1]. By running an averaging function on the 1km SR observations (Figure 1), data resembling 5km SR was generated. A three point smoother was applied on the generated 5km SR data to generate 15km SR data. This dataset was used for all experiments in our work.

Preprocessing: Both land and sea (Figure 1) are present in a single SST Field. The pixel values in spatial regions representing land is a constant, called *fix value*. The *fix value* differs in each data file. To maintain uniformity, all SST Fields were rewritten to assign a single *fix value*. The region representing sea in each SST field was divided into 1800 overlapping patches (small areas) of size (33,33). These patches were normalised by the maximum SST.

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This work has been done during a research internship at SAC, ISRO. The author is currently pursuing a Bachelors in Computer Science at Birla Institute of Technology and Science (BITS) Pilani, Pilani Campus, India.

Table 1: Mean PSNR Values OF SST Reconstruction For Different Scales Between High SR And Low SR

Model	Low SR	High SR	Iterations	PSNR Gain
VDSR	5km	1km	1,42,870	12.78
SRCNN	5km	1km	1,74,270	2.19
VDSR	15km	5km	19,316	9.26
SRCNN	15km	5km	1,21,164	6.35

Training Setting: The network inputs a low SR patch and predicts *patch residuals*. *Residuals* are mathematical differences between the low SR and high SR patches. Once predicted, the *patch residuals* are added back to the input low SR patch to give the final image (high SR patch). Residual-learning accelerates training. To ensure that repeated convolutions don't reduce the size of feature maps significantly, zero padding is implemented. Training is optimized by Adaptive Moment estimation. The Mean Square Error (MSE) between the reconstructed and high SR patch is minimised using mini-batch (batch size 64) gradient descent based on back-propagation. Learning rate chosen is 0.001.

Evaluation: Peak Signal Noise Ratio (PSNR), the chosen accuracy metric, is defined as

$$PSNR = 20 \cdot log_{10}(MAX_I) - 10 \cdot log_{10}(MSE) \quad (1)$$

where (MAX_I) is the maximum pixel value of the image. Since our input is normalised, $MAX_I = 1$. The first term reduces to 0 and only the MSE component is computed. Smaller the MSE, greater is the PSNR and better is the image quality.

3 RESULTS

The evaluation results are presented in Table 1. PSNR Gain for a patch is defined by $PSNR_{model} - PSNR_{smooth}$, where $PSNR_{model}$ is computed between the expected and predicted patch and $PSNR_{smooth}$ is between the input and expected patch. The Mean PSNR Gain is the average PSNR Gain over all patches. Since SRCNN surpassed bicubic and EOF-sampling baselines in [3], a comparison between results obtained from training SRCNN and VDSR is made. VDSR converges faster with better PSNR gains in both cases.

Figure 2 shows a randomly chosen set of patches predicted by network trained to downsample 5km SR to 1km SR. (Visible difference between patches isn't observed as the magnitude of SST difference is in the order of 10^{-2} °C). VDSR has enhanced gradients that were not visible in low SR patches. The residual between predicted and high patches is roughly zero, proving high resemblance. Further work in progress is to be completed in order to compare VDSR with *Dynamical Downscaling*. The predicted patches were first rescaled and then appropriately joined to construct the SST Field. The pixels representing land regions were masked.

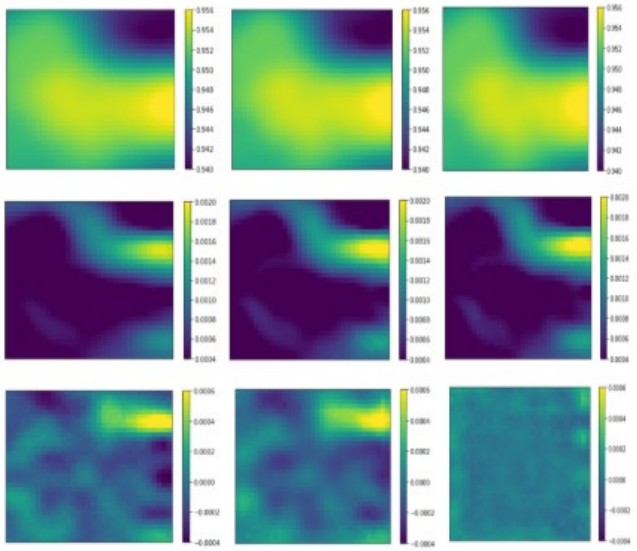

Figure 2: Results
Top Row (Left to Right): Low SR, Predicted and High SR Patches
Middle Row (Left to Right): Low SR, Predicted and High SR Gradients
Bottom Row (Left to Right): Patch Residuals between Low & High SR, Low & Predicted and Predicted & High SR

4 CONCLUSION

In a first-of-its kind approach, demonstrations have been carried out to downsample low SR SST Fields of Bay of Bengal. The chosen network addresses outperforms SRCNN in terms of significant PSNR gains on derived data. It is now worthwhile to perform tests on actual data. Further work planned also includes exploiting the *multi-scalefactor super-resolution* quality of VDSR [4], i.e., a single network to reconstruct fields irrespective of scale between high and low SR.

ACKNOWLEDGMENTS

I express thanks to Dr. Neeraj Agarwal at SAC, ISRO and Dr. Abhishek at BITS Pilani, Pilani for their valuable suggestions.

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