Fragile Earth: Accelerating Progress towards Equitable Sustainability

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ABSTRACT

Fragile Earth 2021, our annual workshop is taking place as part of the Earth Day events at ACM's KDD 2021 Conference on research in Machine Learning and its applications. The 5th edition of *Fragile Earth* will bring together the research community, industry, and policymakers to develop radically new technological foundations for advancing and meeting the Sustainable Development Goals in a way that ensures equitable and inclusive progress.

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1 INTRODUCTION

The United Nations launched the Sustainable Development Goals (SDGs) as part of a shared blueprint for peace and prosperity for people and the planet. The seventeen SDGs form the basis of this strategy. Ensuring security and sustainability of critical resources, namely food, energy, and water, form the backbone for meeting the bulk of the global goals for 2030. This year's proposed *Fragile Earth* workshop will bring together the research community, industry, and policymakers to develop radically new technological foundations for advancing and meeting the Sustainable Development Goals in a way that ensures equitable and inclusive progress. The last year has given us a glimpse of the devastation global crises can create. However, global mitigation efforts illustrate how lessening consumption, travel, and even work levels are possible and can have positive spill-over effects.

Artificial intelligence and Machine Learning are a vital component of optimizing our economic production and consumption behaviors; as the Brookings Institute's "Future of Work" finds, they reduce energy use per worker, and enable a move towards conscious circular consumption and footprint-aware societies. The technological challenges posed by these development goals are twofold: how to achieve accurate, robust and scalable modeling on physical, environmental, system and societal data, and how to ensure that the obtained models are socially acceptable in the chosen context. A key technological enabler for the former is theory-guided data science–augmenting data driven modeling with domain physics and constraints to realize both accuracy and flexibility in modeling. Adoption of data and AI-driven solutions can also benefit from further advancements in techniques that enable "human-in-the-loop AI" as well as co-design / participatory design of AI solutions that empower deeper engagement of expert scientists, stakeholders and citizen scientists. At the same time, leveraging the emerging techniques of trustworthy machine learning and artificial intelligence to attain interpretability, accountability, fairness and privacy-first models will be crucial to successful deployments.

The Workshop will target both methodological and applied research agenda within these areas of investigation. The methodological agenda of interest include but are not limited to the integration of physics into data-driven modeling and causal inference, the use of machine learning to enhance physical simulations, model interpretability, privacy aware data sharing, combining predictive and prescriptive tasks, and multi-agent systems for participatory modeling that integrate stakeholders into knowledge creation and decision processes. The application problems and agenda of interest include the Sustainable Development Goals, accelerating progress on the United Nations' 2030 agenda, and supporting economic models that encourage more sustainable global development practices. In particular, the workshop has maintained a strong focus and

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community in the following areas: food security, sustainable agricultural practices and supply chains, ecosystem restoration, water management, sustainable energy, climate action and adaptation, and disaster resilience.

2 AUDIENCE

As the target audience, we have in mind the scientific community across Machine Learning, Data Mining, Knowledge Discovery, and Statistics, as well as key professional stakeholders, policy makers, agronomists, crop scientists, hydrologists, environmental scientists, climatologists, agricultural practitioners (farmers, cooperatives), industrial players (seed producers, equipment manufacturers, fertilizer producers, energy utility companies, water companies, consumer products manufacturers and retailers, insurance companies), and food, energy, and water and sustainability related government agencies and policy makers in the public sector (e.g. UN, USGS, NASA, EPA). The workshop will offer opportunities for in-depth discussion, sharing of methodology, and the release of new data/algorithmic resources. The goals of this workshop (series) are three-fold: 1. To introduce the emerging area of "data science for security and sustainability of earth resources" to the KDD community; 2. To invite scientists and practitioners in the domains to the KDD community, and interest them in leveraging our technology and expertise; 3. To innovate new technology, leveraging existing KDD technology where appropriate, to address the challenges we face in the relevant domains, by bringing together a multi-disciplinary audience and enticing them to interact and synergize.

3 RELEVANCE

The *Fragile Earth* Workshop was one of three workshops associated with the planned Earth Day event at KDD 2019 (organized by our OC members, Shashi Shekhar and James Hodson) and provided keynotes and panels for Earth Day in 2020. It is hoped that the association will continue in 2021. The workshop theme, as described below, is central to that of "Earth Day," envisioning a better world through the framework of appropriate resource allocation and innovation through Artificial Intelligence. The affiliated workshop series has had strong industry interest and endorsement, including from the Midwest Big Data Hub, Cargill, AI for Good Foundation, and Syngenta, and has taken place at KDD every year since 2016. The *Fragile Earth* workshop provides the KDD community with a touchpoint for stakeholders outside of the community, including scientists, technologists, and policymakers, as evidenced by a special issue on the topic of "Big Data for Food, Energy and Water" in the Frontiers in Big Data journal, based on a collection of previous workshop papers (https://www.frontiersin.org/research-topics/8733/big-data-for-food-energy-and-water).

4 MOTIVATION

To combat climate change and build a sustainable future, the world must conserve resources and restore the planet. Disruptive solutions will be needed to ensure appropriate natural resource management. To reduce our dependence on fossil fuel, development of renewable energy resources, such as solar, wind, water and biofuel, must be accelerated. All of these imperatives call for new research breakthroughs in relevant branches of science and technology, and far more collaboration across disciplines and organizations. The U.N., European and U.S. federal agencies are enhancing efforts to ensure the security of these critical resources, understand their interactions and address common underlying agenda. This is evidenced by various global initiatives such as the Stockholm Environment Institute's "The Water, Energy and Food Security Nexus, Solutions for the Green Economy" conference; UK government funding programs on Food, Energy and Water (FEW); and the NSF's "Innovations in the Nexus of Food, Energy and Water Systems (INFEWS)"; among many other established and emerging programs. The *Fragile Earth* community at KDD has been engaging broader stakeholders through workshops and the Earth Day organization every year since 2016.

5 WORKSHOP PROGRAM

The *Fragile Earth* Workshop will consist of two keynote talks, each approximately 30 minutes in duration. There will also be a panel discussion and poster sessions, each about one hour long. Finally, there will be regular paper presentations from our selected submissions, each about 15 minutes long. The sessions will all be recorded for those who cannot attend the live sessions, though participation in the discussions and poster sessions will be strongly encouraged.

6 PROGRAM COMMITTEE

The program committee is led by Bistra Dilkina (USC) as PC chair, and consists of Udit Bhatia (IIT Gandhinagar), Jessica Ertel (World Resource Institute), Eliot Frazier (Cognism), Rong Fong (World Resource Institute), Carling Hay (risQ), Zhe Jiang (University of Alabama), Aurelie Lozano (IBM Research), Thomas Vandal (NASA Ames) in addition to the rest of the Organizers.

7 WORKSHOP ORGANIZERS

- Naoki Abe is a Distinguished Research Staff Member and research manager, IBM Research.
- Kathleen Buckingham is Director of Sustainability, Tentree and Veritree.
- Bistra Dilkina is an Associate Professor of Computer Science, Co-Director, Center for Artificial Intelligence in Society (CAIS), University of Southern California.
- Emre Eftelioglu is an Applied Scientist, Amazon.
- Auroop R. Ganguly is a Professor at Northeastern University, Director of the Sustainability and Data Sciences Laboratory (SDS Lab), Chief Scientist at the Pacific Northwest National Laboratory and a co-founder and the chief scientific adviser of risQ, Inc.
- James Hodson is CEO, AI for Good Foundation.
- Ramakrishnan Kannan is a Computational Data Scientist, Oak Ridge National Laboratory.