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Machine Learning and Artificial Intelligence to Advance Earth System Science: Opportunities and Challenges – A Workshop

February 7, 10, 11, 2022 | 1:00-4:00 pm (All times EST)

Final Agenda

Workshop Goal: This workshop will consider the opportunities and challenges, including the ethical development and use, of using machine learning and artificial intelligence (ML/AI) to advance Earth system science. The workshop will convene Earth system science experts, ML and AI researchers, social and behavioral scientists, ethicists, and decision-makers across sectors to explore how these approaches can contribute to improving understanding, analysis, modeling, prediction, and decision making. Workshop discussions will examine state of the art approaches for using ML/AI for Earth system science, consider challenges and ways to mitigate risks of using ML/AI, and identify future opportunities to accelerate progress.

Day 1: Monday, February 7, 2022
Emerging Approaches for Using, Interpreting, and Integrating ML/AI for Earth System Science

1:00 pm	**Welcome and Opening Remarks**
	Ruby Leung, Planning Committee Chair, Pacific Northwest National Laboratory

Session 1: Overview of State of the Art Use of ML/AI for Earth System Science
Moderators: Amy McGovern, University of Oklahoma and Ruby Leung, PNNL

Session 1 will provide a broad overview of how ML/AI is currently being used for Earth system science, remaining conceptual and technical challenges, and opportunities to address those challenges.

1:10 pm	*20 minute talk followed by discussion*
	Peter Dueben, European Centre for Medium-Range Weather Forecasts
1:40 pm	Break

Session 2: Emerging Approaches for Using and Interpreting ML/AI
Moderators: Patrick Heimbach, UT Austin and Aarti Singh, CMU

Session 2 will consider unique challenges in Earth system science that emerging ML/AI approaches can help to address. Specific approaches will include integrating physics, expert knowledge, multiple modalities of data, and ML/AI techniques; explainable AI and interpretable ML; and, data assimilation.

1:45 pm	*12 minute talks followed by discussion*
	• **Pierre Gentine**, Columbia University
	• **Elizabeth Barnes**, Colorado State University
	• **Stephen Penny**, Sofar Ocean

2:45 pm   Break

Session 3: Emerging Opportunities from Social and Human Engineered Systems
Moderators: Ann Bostrom, UW and Ruby Leung, PNNL

Session 3 panelists will discuss opportunities for using ML/AI to understand social and human engineered systems, and the prospects for using ML/AI to integrate social and human engineered system science into Earth system science.

3:00 pm   *5 minute panelist remarks followed by discussion*
- **Auroop Ganguly**, Northeastern University
- **Abigail Snyder**, Pacific Northwest National Laboratory
- **David Rolnick**, McGill University
- **Jennifer Chayes**, UC Berkeley

3:50 pm   **Closing Remarks and Plans for Day 2**
Amy McGovern, University of Oklahoma

4:00 pm   Adjourn

Day 2: Thursday, February 10, 2022
Challenges and Risks of Using ML/AI for Earth System Science

1:00 pm   **Welcome and Opening Remarks**
Ruby Leung, Committee Chair, Pacific Northwest National Laboratory

1:10 pm   **Recap of Workshop Day 1**
Patrick Heimbach, UT Austin and Diego Melgar, U of Oregon

Session 1: Responsible and Ethical Use and JEDI Issues for ML/AI in Weather, Climate and Earth System Science
Moderators: Amy McGovern, University of Oklahoma and Ann Bostrom, UW

Session 1 panelists will consider what ethical standards should guide Earth system science, and how such standards relate to the lenses of justice, equity, diversity, and inclusion (JEDI). Panelists will also discuss potential biases in ML/AI for Earth system science and promising ways to avoid those biases.

1:20 pm   *5 minute panelist remarks followed by discussion*
- **David Danks**, UC San Diego
- **Imme Ebert-Uphoff**, Colorado State University
- **Priya Donti**, Carnegie Mellon University
- **Abhishek Gupta**, Montreal Ethics AI Institute

2:10 pm   Break

Session 2: Workforce Development Capacity and Skill Sets
Moderators: Diego Melgar, U of Oregon and Amy McGovern, University of Oklahoma

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Session 2 conversationalists will discuss gaps in education for those working at the intersection of ML/AI and Earth system science, needs and strategies for the private sector and academia in workforce development, the role of continued education in the current workforce, and capacity building at earlier educational stages.

2:20 pm   *Brief introductions followed by conversation*
- **Lak Lakshmanan**, Google
- **Hamed Alemohammad**, Radiant Earth
- **Terri Adams**, Howard University
- **Rebecca Nugent**, Carnegie Mellon University

Session 3: Challenges and Opportunities for Earth Science Technology and Data
Moderators: Patrick Heimbach, UT Austin and Laure Zanna, NYU

Session 3 panelists will consider open data, standards, and platforms to facilitate open science for ML/AI and Earth system science as well as technology development, funding models, and education challenges and opportunities for Earth system science technology and data.

3:00 pm   *5 minute panelist remarks followed by discussion*
- **Ryan Abernathey**, Columbia University
- **Chelle Gentemann**, Farallon Institute
- **Jason Hickey**, Google
- **Ana Privette**, Amazon Sustainability Data Initiative
- **Katie Dagon**, National Center for Atmospheric Research

3:50 pm   **Closing Remarks and Plans for Day 3**
Laure Zanna, NYU

4:00 pm   Adjourn

Day 3: Friday, February 11, 2022
Identifying Future Opportunities to Accelerate Progress

1:00 pm   **Welcome and Opening Remarks**
Ruby Leung, Committee Chair, Pacific Northwest National Laboratory

1:10 pm   **Recap of Workshop Day 2**
Ruby Leung, PNNL and Ann Bostrom, UW

Session 1: Using ML/AI for Data-Driven Decision Making
Moderators: Ann Bostrom, UW and Diego Melgar, University of Oregon

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Session 1 speakers will discuss the role of ML/AI at the interface of predictive physical models and real-time decision-making, handling uncertainties, and the remaining scientific, engineering, societal and ethical challenges in this space.

1:20 pm   *12 minute talks followed by discussion*
- **Elizabeth Cochran**, US Geologic Survey
- **Pierre Lermusiaux**, MIT
- **Daniel Rothenberg**, Waymo

2:20 pm   Break

Session 2: Novel Funding Mechanisms, Partnerships, and Knowledge Transfer Between Academia, Industry, Nonprofits and Government
Moderators: Aarti Singh, CMU and Laure Zanna, NYU

Session 2 conversationalists will consider funding opportunities, effective mechanisms, and creative new approaches to facilitate partnerships knowledge transfer between academia, industry, nonprofits and government to advance ML/AI for Earth system science.

2:40 pm   *Brief introductions followed by conversation*
- **Lynne Parker**, White House Office of Science and Technology Policy
- **Gary Hattem**, Independent Advisor
- **Jennifer Chayes**, UC Berkeley
- **Qingkai Kong**, Lawrence Livermore National Laboratory
- **David Spergel**, Simons Foundation

3:40 pm   **Summary of Workshop Day 3**
                 Aarti Singh, CMU and Amy McGovern, University of Oklahoma

3:50 pm   **Closing Remarks**
                 Ruby Leung, Committee Chair, Pacific Northwest National Laboratory

4:00 pm   Adjourn