Tackling Climate Change with Machine Learning: Fostering the Maturity of ML Applications for Climate Change

Climate change is a complex global challenge with increasingly severe consequences for humanity as natural disasters multiply, sea levels rise, and ecosystems falter. Collective and urgent action is necessary to limit the extent of climate change impacts and adapt to their effects. Such action can take many forms, from designing smart electric grids (Nweye et al. [2023]) to tracking greenhouse gas emissions through satellite imagery (Bonczak et al. [2023]). Machine learning (ML) can be one useful tool for tackling climate change across multiple scales and sectors via mitigation and adaptation (Rolnick et al. [2022]). Success in both strategies requires encouragement of closer collaboration between diverse disciplines and stakeholders. This workshop intends to bring together those applying ML to climate change challenges and facilitate cross-pollination between ML researchers and experts in complementary climate-relevant fields. Building on our past workshops on this topic, we specifically focus on two aspects that **fosters the maturity of ML applications for tackling climate change**. The workshop will shed light on work that deploys, analyzes or critiques ML methods and their use for climate change adaptation and mitigation. In addition, we will discuss the key investment mechanics and policy frameworks needed for these applications to leapfrog towards just and balanced large-scale deployment and achieve positive societal-scale impact.

Tagline: Fostering the Maturity of ML Applications for Climate Change
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Workshop Summary

This workshop focuses on the use of ML to help address climate change, encompassing mitigation efforts (reducing the impacts of climate change) and adaptation measures (preparing for unavoidable consequences). Specifically, we aim to (1) showcase high-impact applications of ML to climate change mitigation and adaptation, (2) explore future research directions to which the ML community can contribute, (3) discuss pathways to scale early research to societally impactful deployments, including by mitigating negative impacts, and (4) encourage fruitful collaboration between the ML community and a diverse set of researchers and practitioners from climate change-related fields. Through posters and presentations of contributed content, the workshop will aim to feature climate-relevant applications of machine learning to a wide variety of sectors and topics, including:

- the energy, buildings, and transportation sectors,
- agriculture, forestry, and other land use,
- heavy industry,
- carbon capture, storage, and sequestration,
- climate modeling and extreme event prediction, and
- climate policy, finance, and justice.

Additionally, through invited talks and panels featuring a diverse set of stakeholders across the community, we aim to foster deeper discussion on topics at the intersection of ML, climate change and pathways to sustained impact, following this year's workshop theme.

About the theme: Applications of ML to address climate change have rapidly multiplied in recent years (Cowls et al. [2021]). Deployments of this work, companies built on it, and policies for facilitating and funding research in this area are now increasingly mainstream. With the increased maturity of the field, it is essential that innovation be shaped by the current gaps between research and large-scale deployment. Such a holistic perspective requires bringing together disparate voices: ML researchers, industry leaders, policymakers, funders, and entrepreneurs.

As ML applications for climate change mature, we must also consider ML's potential for negative externalities that may counteract its benefits and thwart climate change mitigation goals. These negative impacts may, for example, be related to ML's direct carbon footprint (Lacoste et al. [2019], Kaack et al. [2022], Luccioni and Hernandez-Garcia [2023]), its potential to propagate misinformation about climate change (Galaz et al. [2023]), or its capacity to reinforce existing discriminatory structures and biases (Cowls et al. [2021]). ML research needs to be cognizant of these pitfalls, and the design of ML systems should seek to minimize negative climate impacts, including for climate-oriented applications. We hope this workshop will enable in-depth discussion of these topics and forward the conversation on how holistically to shape ML innovation with climate considerations in mind.

Planned Activities and Timing

Format: We plan to include 3 **invited talks** (35 min each, including 10 min of Q&A) and 2 **panel discussions** (40 min each) featuring ongoing Q&A. Depending on the speakers' preference, the talks will be in hybrid format, though we aim to host at least one panel and at least one keynote in person. We will also include 8 **spotlight talks** (10 min each, including Q&A) highlighting selected submissions to the workshop (including papers and proposals; see below), which will again be virtual or in person, depending on the author's physical attendance. We will hold 2 **hybrid poster sessions** (45 minutes each) in person and on Gather.town (or a similar platform), so that attendees can informally discuss research and exchange ideas. Furthermore, we will also offer both a virtual and an in person space for **networking and collaboration** (40 minutes) where participants and speakers are able to join discussion rooms on specific application areas. In addition to icebreaker questions, each room will discuss prompts that are shared with participants ahead of time; we will provide one facilitator for each room to moderate the conversations. We also plan to hold an asynchronous **tutorial session** to showcase relevant introductory content.

Submission timeline and logistics: Calls for (non-archival) submissions will be made both within and beyond the ML community in December, with a submission deadline in early February as suggested by the conference. Submissions will be solicited in two tracks: **papers** discussing research or deployed work and **proposals** for novel research projects. We will only consider previously unpublished works that will not appear at the main ICLR conference, and will specify this in the call for papers. Each submission will undergo double-blind review from multiple ML and domain-specific reviewers, and one meta-reviewer, using CMT; reviewer conflicts of interest will be appropriately managed via CMT. We will also select a few tutorials, and work with the authors to prepare these for an interactive educational session. We will notify authors by March 3, 2024, and abide by any centralized ICLR deadlines.

Reviewers and mentors: We have built up a considerable community of expert reviewers from ML and relevant domains, working on addressing climate change and on ML methods/implementations, through our previous workshops (at NeurIPS 2019, 2020, 2021, 2022 and 2023; ICML 2019 and 2021; and ICLR 2020 and 2023). We will leverage this community in selecting the Program Committee and the mentors for our mentorship program (described below under Diversity Commitment).

Estimated attendance: The previous edition at ICLR 2023 (hybrid) in Kigali, Rwanda had over 100-150 live viewers and 107 submissions (62 accepted). NeurIPS 2021 (virtual) had over 500 live viewers and 139 submissions (79 accepted). In addition, the other previous virtual editions at ICML 2021, NeurIPS 2020, and ICLR 2020 (which had fully public livestreams) had over 2000 live viewers each, and the in-person editions at ICML and NeurIPS 2019 were at capacity with lines out the door. We anticipate similarly strong attendance at ICLR 2024.

Invited Speakers

Through our speaker lineup, we aim to highlight prominent and diverse voices working at the intersection of ML and climate change, both within and outside the ML community. Talk titles and abstracts will be announced well in advance of the workshop. To date, we have invited/confirmed the following speakers:

Keynotes:

- **Prof. Emily Shuckburgh** (*confirmed*): Director of Cambridge Zero at the University of Cambridge
- **Prof. Priya Donti** (*confirmed*): Assistant Professor at MIT, Co-founder and Chair of Climate Change AI
- **Dr. Robert Wagner** (*invited*): Head of Application Lab for Artificial Intelligence and Big Data at the German Environment Agency

Panel 1: Pathways to Industry Deployment: Enabling and Sustaining Maturity of ML Applications for Climate Change

- **Dr. Amen Ra Mashariki** (*confirmed*): Director of Data Strategies at Bezos Earth Fund
- **Antonia Gawel** (*confirmed*): Director, Sustainability and Partnership at Google
- **Kate Kallot** (*confirmed*): Founder and CEO at Amini
- **Prof. Aidan O'Sullivan** (*invited*): Associate Professor at University College London, Co-founder and CTO of Carbon Re

Panel 2: Shaping the ML Innovation Landscape with a Climate Lens

- **Emily Campbell-Ratcliffe** (*confirmed*): Head of AI Assurance at the Department of Science, Innovation and Technology in the UK Government
- **Dr. Michal Nachmany** (*confirmed*): CEO and Founder of Climate Policy Radar and Visiting Policy Fellow at Graham Research Institute on Climate Change & the Environment
- **Dr. Olof Mogren** (*confirmed*): Senior Researcher Scientist at RISE Research Institutes of Sweden
- **Dr. Sasha Luccioni** (*confirmed*): Climate Lead and AI Researcher at Hugging Face
- **Elham Tabassi** (*invited*): Associate Director for Emerging Technologies at Information Technology Laboratory, U.S. National Institute of Science and Technology (NIST)

Diversity Commitment

Especially given the multifaceted nature of climate change and its disproportionate impacts on already disadvantaged populations, we firmly believe that diversity is essential to this workshop. Additionally, in selecting the event speakers we paid special attention to featuring influential female leaders in the ML and climate change space. For that, we are committed to the following diversity guidelines:

- **Speakers.** Our list of invited speakers (and the organizing team) encompasses diversity across various axes (such as gender, race, location, ethnicity, age, seniority, and field of study), and includes members of groups and areas of study currently under-represented at ML conferences (e.g. law, governmental policy-makers, foundations, etc.), with an especial emphasis on representing influential female voices of ML.
- **Mentorship.** We will reprise the successful mentorship program we have run at previous iterations of this workshop, matching potential submitters (particularly early-stage researchers and those from underrepresented backgrounds) with expert mentors for guidance and feedback prior to submission. This program has consistently proven to provide valuable resources to potential participants in our workshops, especially students and ML researchers starting out in the climate change space.
- **Ensuring diversity of submissions.** We maintain a rapidly growing international network of researchers and practitioners from diverse fields and institutions that will aid in soliciting submissions for our workshop. We will also encourage submissions from communities such as Black in AI, LatinX in AI, Women in ML, Queer in AI, DisAbility in AI, Muslims in ML, Indigenous in AI, and MLDS Africa, e.g., via direct outreach to their mailing lists (as we have done for past editions).
- **Participation grants.** As in our previous workshops, we plan to provide grants for registration and mobile data, aiming to increase accessibility for a diverse set of participants. This year, we also plan to offer travel grants for participants. Next to visa issues, travel costs often pose an obstacle for interested participants from middle and low-income countries.

Previous Related Workshops

Our previous workshops received overwhelming interest at NeurIPS 2019, 2020, 2021 and 2022; 2023; ICML 2019 and 2021; and ICLR 2020 and ICLR 2023, with several of the 2020/21 virtual editions attracting over 2000 attendees each. These workshops have received almost 900 total submissions from 58 countries (on 6 continents) and many different fields. We believe this signifies a clear need within the climate change and ML communities for further attention to this confluence of work. Several past events at major ML conferences have included climate-relevant work, but until our ICML 2019 workshop, none brought together ways ML can assist in climate change mitigation, adaptation, and climate science. At NeurIPS 2019, 2020, 2021 and 2022, the workshop "AI+HADR" highlighted a number of applications relevant to climate change adaptation. The ICLR 2020 and NeurIPS 2020 workshops "AI for Earth Sciences" and the ICLR 2022 workshop "AI for Earth and Space Science" explored the intersection of ML and geoscience, including climate science, but did not include ML for mitigating and adapting to climate change, which are the primary focus of our workshop. Other somewhat related workshops include Machine Learning for the Developing World (ML4D; NeurIPS 2019, 2020, 2021) or Fragile Earth (KDD 2022). In this year's workshop, we focus for the first time on challenges associated with the growing maturity of the field of ML and climate change and the potential for negative climate consequences from ML innovation. As in past iterations of our workshop, we will collaborate with relevant parallel workshops to explore synergies and continue to grow the discussion on ML and climate change from different angles.

Hybrid format

We believe that having the workshop in a hybrid format is advantageous for several reasons: on the one hand, it allows potential participants who have personal, professional or financial constraints to benefit from the conference by attending virtually; on the other, it contributes to reducing the overall carbon footprint of the workshop and of the conference at large, since authors who have accepted papers as well as invited speakers are not obliged to travel in order to present. Since the hybrid nature of the workshop can result in a bigger organizational workload, we have planned for this by assembling a larger organizational team, half of which is committed to attending the conference in person, while the other half will provide virtual support. Concretely, both keynote talks and spotlight talks will have the option to be in-person or virtual. Depending on the panelists' ability to travel, panels will either be in-person and live-streamed online, or held on Zoom and streamed at the venue. There will be three poster sessions: one in-person at the venue, and two virtual sessions to accommodate different time zones. The virtual poster sessions will be held on a social web-conferencing platform such as Gather.town or Remo to facilitate better conversations and simulate an in-person experience. Finally, a recording of the workshop will be made available afterwards with the permission of each speaker on the centralized workshop website climatechange.ai, on which we also provide extensive resources for attendees who wish to further explore the topic.

Organizers

Our organizing team includes a mixture of experienced organizers of past events in this series, and new members with complementary expertise. Shiva Madadkhani, David Rolnick and Yoshua Bengio have each helped to organize at least one previous workshop in this series. Many of the organizers are also leaders within Climate Change AI, a volunteer-driven initiative that works to facilitate meaningful applications of machine learning to climate change. First-time organizers Olivia Mendivil Ramos, Millie Chapman, Jesse Dunietz and Arthur Ouaknine bring new perspectives and ideas to the organizing committee. And while with seven members, our organizing committee is relatively large, we believe that this number is appropriate given the distinct challenges a hybrid workshop brings. To ensure a smooth coordination of the various organizing tasks, Shiva Madadkhani and Olivia Mendivil Ramos will act as lead-organizers of the workshop.

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Bio: Shiva is a doctoral candidate at the Center for Energy Markets and Munich Data Science Institute at the Technical University of Munich. Her research is focused on applications of machine learning to energy and environmental economics to help support the energy transition. Shiva is a member of the board of directors of Climate Change AI and serves as the vice-chair for Community Leads in that organization. She holds a bachelor's and master's in Chemical Engineering from the University of British Columbia and a master's in Management from the Technical University of Munich. Shiva is also on the organizing committee of TCCML workshop at NeurIPS 2023.

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Bio: Olivia is a computational biologist and currently a researcher at Climate Change AI. Prior to this, she was applying AI to discover novel targets for cancer and infectious diseases in a pre-clinical setting at a biotech startup. Before that she was postdoctoral fellow in computational biology at CSHL where she was part of multi-institutional large-scale genomics project of living-fossils plants to understand molecular adaptation to extreme weather changes, amongst other projects of longevity, functional translational genomics, regeneration, and simulation of genomics data. She completed her PhD in evolutionary biology and comparative genomics at the University of St Andrews (UK) and her MRes in Bioinformatics at the University of Glasgow. In addition to this, she organized and co-lead the CCAI Summer School 1st and 2nd editions, which had all together over 10000 applicants, over 10 publicly available lectures that have amassed over 60000 views.

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Bio: Millie completed her PhD at University of California Berkeley in Environmental Science, Policy, and Management and is currently Postdoctoral Fellow at the National Center for Ecological Analysis and Synthesis. Her research is at the intersection of decision theory, ecology, and data justice, asking how we can leverage AI to devise more effective and equitable strategies to meet global biodiversity targets under uncertainty. Millie has organized conference sessions at the World Biodiversity Forum and the North American Convention for Conservation Biology. She was also a co-organizer for the Bay Area Society for Conservation Biology Conference in 2018 which hosted over 100 scientists.

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Bio: Jesse currently works with the Responsible and Trustworthy AI team at the U.S. National Institute of Standards and Technology (NIST), where he leads the Information Technology Laboratory's international engagements on AI. He holds a bachelor's from MIT and a Ph.D. from Carnegie Mellon University, both in computer science. His graduate research focused on annotation and NLP tools for analyzing language about cause and effect. For several years, he contributed to research and development at Elemental Cognition, an AI startup building neuro-symbolic systems. In addition to his technical work, he has trained hundreds of researchers in science communication and written many articles and video scripts for

mass media outlets. Prior to his current position, he was a AAAS Science and Technology Policy Fellow at the U.S. Department of State, where he led the Department's international work on AI and human rights.

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Bio: Arthur is a postdoctoral researcher fellow at McGill University and Mila (Quebec Artificial Intelligence Institute), in collaboration with David Rolnick. He completed his PhD in collaboration between Institut Polytechnique de Paris and valeo.ai where he applied deep learning for scene understanding using automotive radar data. His projects are now focused on computer vision and deep learning applied to forest monitoring. He is also a core team member of Climate Change AI leading the webinar team.

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Bio: David Rolnick is an Assistant Professor and Canada CIFAR AI Chair in the School of Computer Science at McGill University and at Mila Quebec AI Institute, where his work focuses on applications of machine learning to help address climate change. He is a Co-founder and Chair of Climate Change AI and Scientific Co-director of Sustainability in the Digital Age. Dr. Rolnick received his Ph.D. in Applied Mathematics from MIT. He is a former NSF Mathematical Sciences Postdoctoral Research Fellow, NSF Graduate Research Fellow, and Fulbright Scholar, and was named to the MIT Technology Review's 2021 list of "35 Innovators Under 35."

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Bio: Yoshua Bengio is a Professor in the Computer Science and Operations Research departments at U. Montreal, scientific director of Mila and of IVADO, Canada Research Chair in Statistical Learning Algorithms, as well as a Canada AI CIFAR Chair. Bengio is a recipient of the 2019 Turing Award for pioneering deep learning, officer of the Order of Canada, member of the Royal Society of Canada, a member of the NeurIPS board, and co-founder and general chair for the ICLR conference. His goal is to contribute to uncovering the principles giving rise to intelligence through learning, as well as favor the development of AI for the benefit of all. He is involved in one other workshop proposal to NeurIPS 2022, on "AI for Science: Progress and Promises."

Program Committee: Our proposed Program Committee comprises past members of committees of previous workshops in this series, who have actively contributed to our review and meta-review processes on one or multiple occasions, and whom we will contact upon workshop acceptance. Based on the expected number of submissions (over 100), as in previous editions, we anticipate recruiting well over 100 Program Committee members to conduct reviews and meta-reviews, in order to ensure that each submission receives at least 3 high-quality reviews and no reviewer must referee more than 3 submissions. While we do not explicitly list the names of our proposed Program Committee members here owing to space constraints, the names of these Program Committee members can be found at the webpages associated with the past editions of our workshop (see https://www.climatechange.ai/events).

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