Artificial Intelligence for Robust Engineering & Science

AIRES 5: Assured Machine Learning for Robust Engineering

In-Person Workshop:

The Discovery Hall
Pacific Northwest National Laboratory
Richland, Washington

May 21-23, 2024

Overview

Robust engineering is the process of designing, building, and controlling systems to ensure resilience and reliability. Advances in AI and computing technologies are expected to enable robust engineering and science practices in a wide variety of scientific and industrial applications, providing the capability to understand and manage the lifecycle of complex systems. Over the past decade, data availability, advances in computing, and streamlined data-driven methods and tools widened the opportunities for transferring artificial intelligence (AI) and digital twin technology at the edge to enable real-time system operation. The inaugural Artificial Intelligence for Robust Engineering and Science (AIRES) workshop in January 2020 explored the foundations of AI for robust engineering while subsequent workshops in this series expanded on this theme. The next workshop in this series, AIRES 5 will build on the successes of previous workshops, and explore and develop the foundations of AI, with a focus on assurance and deployment, lifecycle management of AI solutions, and data management. Other closely related topics are also expected to be discussed in AIRES 5.

The workshop will be a venue for knowledge sharing about upcoming advances in AI, machine learning (ML), and digital twin and digital thread technologies for both engineered and natural systems, and for building collaborations between researchers across the spectrum of technologies and applications. While the focus of the workshop is on AI technologies, we recognize that applications are an important aspect driving the development of AI technologies. Researchers developing and deploying solutions across a wide range of application domains, including areas defined by the US DOE Earthshot Initiatives, are invited to participate.

The workshop will comprise three tracks:

Robust Multimodal AI and Data: This track focuses on all aspects of multimodal AI/ML models, and relevant data needs, including
- Techniques for multimodal data fusion
- Foundation models and their applications
- Learning and representation of transient dynamics in complex systems
- Knowledge informed, data driven methods
- Data driven control and examples of applications to real-world systems
- AI supporting data acquisition, communication, data management, and data validation
- Novel techniques for data reduction

- Novel experimental in-process and post-process characterization of systems

- Techniques for optimizing sensor selection and placement for digital twins
- Detecting and dealing with data bias
- Standards for data for digital twin technologies

Deployment on the computing continuum: This track focuses on the ecosystem and methods necessary for practical use of digital twins, such as:
- Real-time data integration, online and offline continual learning on edge-based systems
- Edge deployment for real-time and power- efficient deployment of AI models, digital twins, and integrating HPC and edge systems
- Federated learning, including data privacy
- Security and resilience
- Human-machine interface design
- Interoperability of digital twins
- Standards needs, and the use of digital twin technologies in standards

Assured AI: This track focuses on the technical challenges associated with developing and using robust digital models, such as
- Integrating physics or other knowledge into machine learning
- Methods for multi-scale prediction (especially multi-scale time-series prediction)
- Scaling issues associated with large models
- AI algorithms for control of complex systems
- Uncertainty quantification
- Assurance, including causal inference, explainability, and interpretability
- Verification, validation, and calibration

In addition, topics associated with detecting and dealing with bias, and diversity, equity, and inclusion associated with the development and use of AI solutions for robust engineering and science are of interest.

Meeting format

AIRES 5 is planned as an in-person meeting from May 21-23, 2024. The meeting will be hosted on site at Pacific Northwest National Laboratory (PNNL) in Richland, WA.

AIRES 5 is focused on user participation with the objectives of exploring current work in the use of artificial intelligence and machine learning for robust engineering and digital twins, identifying research challenges and investment areas, and developing collaborations among participants. The workshop is expected to include:
- *Invited talks.*
- *Contributed talks* (15 minutes each).
  Participants may propose a talk during the registration process by submitting an abstract (1 page or less preferred; 2-page maximum). The program committee will select from the proposed talks for presentation during the workshop.
- Short Tutorials
  Participants may propose a tutorial topic during the registration process by submitting an abstract (1 page or less preferred; 2-page maximum). Tutorials are expected to range in length from an hour to half a day. The program committee will select from the proposed tutorials, with proposals that include a hands-on element preferred. We expect to be able to accommodate 2-4 tutorials.
- *Networking opportunities* to enable attendees to identify opportunities for collaboration.

  The workshop will comprise multiple sessions dedicated to each track, with additional opportunities for small-group interactions and brainstorming activities. A brief workshop report is planned. Extended abstracts submitted by attendees will be considered for inclusion in the workshop report.

How to participate

With the goal of increased collaborations, AIRES 5 participants will be expected to actively contribute to the workshop. In addition to providing basic personal and contact information during registration, participants will also provide their research interests and be given the option to propose a contributed 15-minute talk and recommend a tutorial topic. Registration is free.

Participation is by invitation only. You may request to participate by visiting the "How to Participate" tab on the website. The final deadline to request an invitation is March 25, 2024. However, we ask that individuals who may be considering attending request an invitation as soon as possible to enable the organizing committee to meet the processing timelines for site access to PNNL.

Meeting organization

AIRES 5 will be hosted by Pacific Northwest National Laboratory.

General Chair:
Pradeep Ramuhalli, Oak Ridge National Laboratory

Executive Committee

Mahantesh Halappanavar, Pacific Northwest National Laboratory

Malachi Schram, Jefferson Lab

Logistics and Planning Chairs:
Taylor Bullock, Oak Ridge National Laboratory
Tanya Kauer, Pacific Northwest National Laboratory

For more information, please visit https://AIRES.ORNL.gov.