Milad Ramezankhani

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OBJECTIVE

I am a challenge-oriented and creative researcher skilled in conducting high-quality research in machine learning. My research focuses on data-efficient and uncertainty-aware machine learning in high-risk engineering systems. In particular, I am interested in improving the generalization of machine learning models in complex real-world applications with data paucity via transfer learning, active learning, scientific machine learning and meta-learning.

EDUCATION

Ph.D., Mechanical Engineering (Applied Machine Learning Specialization) 2018 - 2023
The University of British Columbia Kelowna, BC
Thesis: Data-Efficient and Uncertainty-Aware Hybrid Machine Learning in Advanced Composites Manufacturing.
Advisors: Dr. Abbas Milani and Dr. Seethaler

MASc, Mechanical Engineering (Applied Machine Learning Specialization) 2015 - 2017
The University of British Columbia Kelowna, BC
Thesis: Multi-objective Gaussian process approach for robust optimization and prediction of carbonization process.
Advisors: Dr. Abbas Milani and Dr. Seethaler

BASc, Mechanical Engineering 2010 - 2015
K.N. Toosi University of Technology Tehran, Iran

RESEARCH AND PROFESSIONAL EXPERIENCE

Postdoctoral Research Fellow June 2023 – present
Materials and Manufacturing Research Institute, The University of British Columbia Vancouver, BC

- Coordinator of Data Science and Engineering Research Cluster
- Leading cutting-edge research at intersection of machine learning, process design optimization and circular economy in collaboration with interdisciplinary teams and industrial partners
- Developing inverse physics-aware design optimization frameworks for advanced composites manufacturing applications

Graduate Researcher September 2018 – May 2023
The University of British Columbia Kelowna, BC

- Developed and applied transfer learning, active learning, physics-informed neural networks (PINNs), and meta-learning to improve generalization of machine learning models under data paucity
- Led several international research collaborations with industry partners including German Aerospace Center (DLR) and Kohler Co. on developing AI-assisted optimization tools for high-risk decision-making tasks
- Authored and co-authored over a dozen peer-reviewed journal and conference papers. As senior graduate student, mentored undergraduate and graduate students in lab and assisted in their academic growth

Data Analyst March 2018 – May 2019
QHR Technologies Kelowna, BC

- Developed SQL scripts for data preprocessing and data migration of Electronic Medical Records (EMR)
- Created analytics reports to optimize waitlist functionality of large-scale enterprises using MSSQL and JasperSoft

Graduate Researcher September 2015 – August 2017
The University of British Columbia Kelowna, BC

- Developed a Gaussian Processes (GPs) framework in MATLAB for uncertainty-aware prediction and multi-objective design optimization of carbon fibers production during the carbonization process.

RESEARCH PROJECTS

Scientific Machine Learning via Physics-informed Neural Networks (PINNs) 2021 – 2023

- Developed a sequential meta-transfer learning model in JAX for highly nonlinear systems with long temporal domains, improving the generalization of PINNs by 20% and making the task adaptation 100 times faster
- Conceptualized and designed a novel multi-fidelity PINNs framework in JAX that leverages physical laws and low-fidelity simulations to significantly improve PINNs training in terms of speed and convergence rate

Uncertainty Quantification with Hamiltonian Monte Carlo (HMC) 2022 – 2023

- Designed a holistic Bayesian multi-fidelity PINNs powered by HMC sampling using Nympyro and BlackJAX libraries for uncertainty quantification and data-efficient learning of nonlinear systems via transfer learning
- Performed thousands of GPU hours to empirically demonstrate the effectiveness of HMC in quantifying aleatoric and epistemic uncertainties in scientific ML applications

Data-Efficient Machine Learning in Advanced Manufacturing 2018 – 2021

- Conceptualized and developed an efficient transfer learning framework in Keras for composites manufacturing processes under limited data, reducing the data requirement by a factor of 100
- Developed an innovative active transfer learning strategy to reduce deep learning's data dependencies. Leveraged Variational GPs as the oracle via GPyTorch to query informative points from the target distribution
- Implemented a sim-to-real convolutional variational autoencoder in TensorFlow to tackle data heterogeneity and data paucity in multimodal domains. State-of-the-art performance is achieved by transferring knowledge from fast "physics-aware" simulations to real-world manufacturing processes

SKILLS AND ACHIEVEMENTS

SOFTWARE/LANGUAGES: JAX, TensorFlow, Keras, Numpyro, BlackJAX, PyTorch, MATLAB, MSSQL

RESEARCH: Transfer learning, Scientific machine learning, Bayesian inference, Meta-learning, Reinforcement learning, Computer vision, process design optimization and industry 4.0

HONORS AND AWARDS: UBC Graduate Dean's Thesis Fellowship ($6,000), Best Presentation Award for 2021 4th IEEE International Conference on ICPS, UBC Finch Family Graduate Award ($10,000), UBC University Graduate Fellowship ($10,000), UBC-Monash Joint Research Award ($31,000)

SOFTWARE DEVELOPMENT

Sequential Meta-transfer Learning of PINNs: https://github.com/miladramzy/SequentialMetaTransferPINNs

Bayesian PINNs with Hamiltonian Monte Carlo: https://github.com/miladramzy/HMC-PINNs

Multi-fidelity PINNs: https://github.com/miladramzy/Data-driven-MFPINNs

Active Transfer Learning (ATL) for Smart Manufacturing: https://github.com/miladramzy/ATL

NOTABLE PUBLICATIONS

Ramezankhani M and Milani AS, "Sequential meta-transfer learning of physics-informed neural networks in advanced composites manufacturing" (to appear on arxiv)

Ramezankhani M, et al., "Smart Manufacturing under Limited and Heterogeneous Data: A Sim-to-Real Transfer Learning with Convolutional Variational Autoencoder in a Thermoforming Case Study" International Journal of Computer Integrated Manufacturing (2023, under review)

Ramezankhani M, et al., "A Data-driven multi-fidelity physics-informed learning framework for smart manufacturing: A composites processing case study" IEEE 5th International Conference on ICPS (2022)

Ramezankhani M, et al., "Making costly manufacturing smart with transfer learning under limited data: A case study on composites autoclave processing" Journal of Manufacturing Systems (2021)

Ramezankhani M, et al. "A multi-objective Gaussian process approach for optimization and prediction of carbonization process in carbon fiber production under uncertainty" Advanced Composites and Hybrid Materials (2019)