JOSTEIN BARRY-STRAUME

Machine Learning Engineer | U.S. Citizen

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EXPERIENCE

Rolls-Royce Graduate Fellow

Rolls-Royce University Technology Center | Virginia Tech

📅 Fall 2023 – Present   ⚲ Blacksburg, VA

- Investigate uncertainty quantification (UQ) methods for neural networks to predict turbine gas temperature (TGT), using engine health management (EHM) data, with quantifiable uncertainty
- Correlate TGT predictions with engine degradation to prediction remaining useful lifespan (RUL) of various turbofan engines
- Leverage civilian EHM datasets and infer on naval EHM datasets via transfer learning
- Benchmark and evaluate success between the following: Bayesian method, bootstrap method, delta method, mean-variance estimation, lower upper bound estimation
- Evaluation metrics include: Prediction interval (PI) coverage probability, normalized mean PI width, coverage width criterion
- Follow American Society of Mechanical Engineers (ASME) standards of Verification, Validation and Uncertainty Quantification (VVUQ)
- Comply with National Institute of Standards and Technology's (NIST) standards of VVUQ
- Research improving upon existing UQ methods via knowledge-guided machine learning and physics-informed neural networks (PINNs)
- Present results to non-technical Rolls-Royce and U.S. Navy stakeholders in a digestible manner

Graduate Research Assistant

Computational Science Laboratory | Virginia Tech

📅 Aug 2020 – Present   ⚲ Blacksburg, VA

- Apply physics-informed neural networks (PINNs) to optimal control problems
- Leverage automatic differentiation to impart the physical laws of a dynamical system into a neural network's training regiment (PyTorch and TensorFlow)
- Implement custom neural network loss functions that use mixed and partial derivatives via automatic differentiation (PyTorch and TensorFlow)
- Develop a novel one-stage open-loop control physics-informed neural network (CPINN) to simultaneously solve the learning tasks of a dynamical system and its respective optimal control
- Demonstrate success of open-loop CPINN via optimal control problems of increasing complexity: analytical ODE, one-dimensional heat equation, and two-dimensional predator-prey (Lotka-Volterra) problem formulated as a reaction-diffusion problem
- Develop an ensemble based closed-loop optimal control using PINNs to learn the optimal cost-to-go, and subsequently the respective optimal control signal, by solving the Hamilton-Jacobi-Bellman (HJB) equation
- Demonstrate success of ensemble-based closed-loop CPINN by solving a time-invariant two-state continuous nonlinear system with an infinite time horizon, accounting of noisy, perturbed system states and varying initial conditions
- Present results at Association for the Advancement of Artificial Intelligence (AAAI) Fall 2022 Symposium on Knowledge-Guided Machine Learning; 2024 Society for Industrial and Applied Mathematics (SIAM) Annual Meeting

EDUCATION

Virginia Tech

Ph.D. in Computer Science

📅 Aug 2020 – Present   ⚲ Blacksburg, VA

- Major GPA: 3.95/4.0
- Advisor: Dr. Adrian Sandu (`https://csl.cs.vt.edu/`)
- Co-Advisor: Dr. Changmin Son (`https://rollsroyce.me.vt.edu/`)

Southern Methodist University

Master's in Data Science

📅 May 2017 – Dec 2018   ⚲ Dallas, TX

- Major GPA: 4.0/4.0
- Machine Learning Specialization
- Department of Engineering
- Advisor: Dr. Daniel W. Engels
- Co-Advisor: Edward Fine

University of Southern California

Bachelor's in Economics

📅 Los Angeles, CA

TECHNICAL SKILLS

Python   PyTorch   TensorFlow   Matlab   NumPy   Pandas   Scikit-learn   Keras   Anaconda Navigator   Jupyter Notebook   Git   GitHub   GitLab   R   SQL   LaTeX

PRESENTATIONS

- "Physics-Informed Neural Networks for PDE-Constrained Optimization and Control." 2024 SIAM Annual Meeting. July 11, 2024. Spokane, WA, USA. `https://meetings.siam.org/sess/dsp_programsess.cfm?SESSIONCODE=79952`
- "Machine learning for predicting turbine gas temperature under uncertainty." Internal meeting with executive stakeholders at Rolls-Royce North America. December 14, 2023. Indianapolis, Indiana, USA. Significant contribution to securing funding for three different Virginia Tech labs.
- "Physics-informed neural networks for PDE-constrained optimization and control." Knowledge-guided Machine Learning. AAAI Fall Symposium Series (FSS) 2022. November 17-19, 2022. Arlington, Virginia, USA. `https://sites.google.com/vt.edu/kgml-aaai-22`.
- "An evaluation of training size impact on validation accuracy for optimized convolutional neural networks." Southern Methodist University. December 18, 2018. Dallas, Texas, USA. Master's capstone presentation. Winner of best presentation award.

EXPERIENCE CONTINUED

Givens Associate - Mathematics & Computer Science

Argonne National Laboratory

📅 Summer 2022   📍 Lemont, IL

- The Givens Associate positions are intended to encourage professional growth in graduate students who are beginning careers in numerical analysis or computational mathematics
- Research the following automatic differentiation modes: reverse (back-propagation), forward, and mixed (mixing and matching both reverse and forward in the same neural network)
- Contribute to the development of AutoMAD, a mixed mode automatic differentiation API for PyTorch's automatic differentiation engine (Autograd): `https://github.com/jhueckelheim/AutoMAD`
- Develop alternative automatic differentiation formulations for machine learning frameworks
- Help develop new methods for gradient computations
- Apply new methods to a variety of neural networks

Information Systems & Modeling - Ph.D. Intern

Los Alamos National Laboratory

📅 Summer 2022   📍 Los Alamos, NM

- Research approaches in risk assessment and risk reduction for national critical cyber and physical infrastructure
- Apply natural language processing (NLP) techniques to decompose national critical functions (NCFs) into sub-functions for the purposes of highlighting vital functional resilience and potential vulnerabilities
- Contribute to graph analytics via network path analysis, critical node identification, and automated graph discovery (data analytics, machine learning, and NLP methods)
- Use NLP methods to highlight dependencies and cascading risk in NCFs as a functional graph
- Create a poster detailing accomplishments for the LANL Student Symposium
- Deliver project update presentations to group level management
- Summarize results of NLP work in a manuscript for publication

Graduate Teaching Assistant

Virginia Tech

📅 August 2020 – Present   📍 Blacksburg, VA

- CS3604: Professionalism in Computing:
  - Head Teaching Assistant (TA)
  - Lead class for the professor on an as need basis
  - Responsible for delegating grading to all TAs
  - Track overall grading weekly for over 300 students
  - Meet with students to approve and discuss project proposals, presentations, and reports
- CS3114/CS5040: Data Structures and Algorithm Analysis:
  - Course taught in Java
  - Debug homework/projects for students, explaining how and why their code isn't working properly to impart knowledge rather than simply telling them the answer
  - Grade coding assignments for space and time efficiency, object-oriented design principles, and well documented code commentary

Data Science Intern

Fortive

📅 Jun 2018 – Dec 2018   📍 Everett, WA

- Improve annual direct and indirect spend visibility with natural language processing (NLP) solutions
- Label unstructured procurement data with NLP methods to increase spend visibility by $658 million
- Use regression neural network to forecast daily spend by supplier per operating company (mean absolute error: 11%)

Data Analyst

Microsoft

📅 May 2016 – May 2017   📍 Redmond, WA

- Support Worldwide Licensing sales teams with customized agreement quotes, price sheets and amendments for contract negotiations
- Identify and resolve discrepancies between Customer/Channel Price Sheets
- Maintain team error rate below 3% target

PUBLICATIONS

- Jostein Barry-Straume, Jin-Sol Jung, Changmin Son, and Adrian Sandu. Machine learning for predicting turbine gas temperature under uncertainty. In preparation for ASME's Journal of Turbomachinery.
- Jostein Barry-Straume, Adwait D. Verulkar, Andrey A. Popov, Arash Sarshar, Adrian Sandu. Ensemble-based closed-loop optimal control using physics-informed neural networks. In preparation for Begell House's Journal of Machine Learning for Modeling and Computing.
- Jostein Barry-Straume, Arash Sarshar, Andrey A. Popov, and Adrian Sandu. Physics-informed neural networks for PDE-constrained optimization and control. arXiv:2205.03377 (2022). `https://arxiv.org/abs/2205.03377`. 19 citations as of 12/15/2024. Under review for publication in Springer's journal of Communications on Applied Mathematics and Computation.
- Jostein Barry-Straume, Adam Tschannen, Daniel W. Engels, and Edward Fine. An evaluation of training size impact on validation accuracy for optimized convolutional neural networks. SMU Data Science Review: Vol. 1: No. 4, Article 12 (2018). `https://scholar.smu.edu/datasciencereview/vol1/iss4/12/`. 35 citations as of 12/15/2024.