Robert Baraldi

Sandia National Laboratories
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Areas of specialization

Inverse Problems • Nonsmooth Optimization • Nonconvex Optimization • Trust Regions Methods • PDE-constrained Optimization • Uncertainty Quantification
My research focuses on algorithm design and convergence analysis for nonsmooth and nonconvex problems in physical/biological modeling and learning applications.

Employment

2023- Senior Computer Science R&D S&E, Sandia National Labs. **Group**: Optimization and Uncertainty Quantification (1463).

2021-2023 John von Neumann Postdoctoral Fellow, Sandia National Labs. **Group**: Optimization and Uncertainty Quantification (1463). **Postdoctoral Advisor**: Drew P. Kouri.

2020 Argonne National Lab: DOE CSGF Practicum: ADMM and Filter Methods. **Advisor:** Sven Leyffer.

2018 Lawrence Berkeley National Lab: DOE CSGF Practicum: Reduced Order Models and Implicit Sampling. **Advisor:** Matthew Zahr.

Education

2021 PhD in Applied Mathematics, University of Washington. **PhD Advisor**: Aleksandr Aravkin.

2017 MSc in Applied Mathematics, University of Washington.

2016 BS in Mathematics, NC State University. **Academic Advisor:** Alina Duca. **Research Advisor:** Harvey Thomas Banks.

Grants & Awards

Staff

2023 Laboratory Directed Research and Development: Robust Nonsmooth Stochastic Methods for Machine Learning
Team Members: Aurya Javeed, Drew P. Kouri.
Amount: $1.2 million over 3 years.
Consultants: Jong-shi Pang, Katya Scheinberg, Eric Cyr.

Postdoctoral

2022 Air Force Office of Scientific Research: Compression and Randomization of Extreme-Scale Training and Optimization (CREST-Opt).
Team Members: Harbir Antil, Evelyn Herberg, Drew P. Kouri, Denis Ridzal.

Amount: $700,000 over 3 years.

Graduate

2021 Department of Energy Advanced Scientific Computing Research: John von Neumann Postdoctoral Fellowship.
Amount: $170,000 over 2 years.

2017-2021 Department of Energy Computational Science Graduate Fellowship (DOE CSGF).

2017 National Science Foundation Graduate Research Fellowship (NSF-GFRP, declined).

2016 Department of Applied Math Boeing Fellowship/Top Scholar Award, UW.

Publications

In Review[1]

2023 Robert Baraldi, Drew P. Kouri (2023), "Local Convergence Analysis of an Inexact Trust-Region Method for Nonsmooth Optimization", *Optimization Letters*.

2022 Robert Baraldi, Aleksandr Aravkin, Dominique Orban (2022), "A Levenberg-Marquardt Method for Nonsmooth Regularized Least Squares", *SIAM Journal on Scientific Computing*.

Peer-Reviewed

2022 Robert Baraldi, Drew P. Kouri (2022), "A Proximal Trust-Region Method for Nonsmooth Optimization with Inexact Function and Gradient Evaluations", *Mathematical Programming*. 201(1), 1–40.

2022 Donsub Rim, Robert Baraldi, Christopher Liu, Randall LeVeque, Kenjiro Terada (2022), "Tsunami Early Warning from Global Navigation Satellite System Data using Convolutional Neural Networks", *Geophysical Review Letters* 49(20).

2021 Robert Baraldi, Aleksandr Aravkin, Dominique Orban (2021), "A Proximal Quasi-Newton Trust-Region Method for Nonsmooth Regularized Optimization", *SIAM Journal of Optimization.* 32(2): 900-929.

2021 Christopher Liu, Donsub Rim, Robert Baraldi, Randall LeVeque (2021), "Comparison of Machine Learning Approaches for Tsunami Forecasting from Sparse Observations", *Pure and Applied Geophysics* 178, 5129-5153.

2019 Robert Baraldi, Rajiv Kumar, Aleksandr Aravkin (2019), "Basis Pursuit Denoise with Nonsmooth Constraints", *IEEE Transactions on Signal Processing* 67(22): 5811-5823.

2019 Robert Baraldi, Carl Ulberg, Rajiv Kumar, Kenneth Creager, Aleksandr Aravkin (2019), "Relaxation Algorithms for matrix completion, with applications to seismic travel-time data interpolation", *Inverse Problems* 35(10):105009.

2016 Harvey Thomas Banks, Robert Baraldi, Jared Catenacci, Nicholas Myers (2016), "Parameter Estimation Using Unidentified Individual Data in Individual Based Models". *Mathematical Modeling of Natural Phenomena* 11(6):103-121.

2016 Harvey Thomas Banks, Robert Baraldi, Kevin Flores, Michael Stemkovski (2016), "Validation of a Mathematical Model for Green Algae (*Raphidocelis subcapitata*) Growth and Implications for a Coupled Dynamical System with *Daphnia Magna*", *Applied Sciences* 6(5): 155.

2015 Kaska Adoteye, Harvey Thomas Banks, Robert Baraldi, John Nardini, W Clay Thompson (2015), "Correlation of Parameter Estimators for Models Admitting Multiple Parametrizations", *International Journal of Pure and Applied Mathematics* 105(3): 497-522.

[1] Note that Sandia National Laboratories' Review and Approval process may prevent some of this work from being publically available on ArXiv until cleared.

2015 Harvey Thomas Banks, Robert Baraldi, Kevin Flores (2015), "Optimal Design for Minimizing Uncertainty in Dynamic Equilibrium Systems", *Eurasian Journal of Mathematical and Computer Applications* 3: 20-43.

2015 Harvey Thomas Banks, Robert Baraldi, Karissa Cross, Christina McChesney, Laura Poag, Emma Thorpe, Kevin Flores (2015), "Uncertainty quantification in modeling HIV viral mechanics.", *Mathematical Biosciences and Engineering* 12(5): 937-964.

Conference Proceedings

2023 Robert Baraldi, Evelyn Herberg, Drew P. Kouri, Harbir Antil (2023), "Adaptive Randomized Sketching for Dynamic Nonsmooth Optimization", *Proceedings of the International Model Analysis Conference XLI: Model Validation and Uncertainty Quantification*, #14609.

2014 Harvey Thomas Banks, Robert Baraldi, et al. (2014), Uncertainty quantification for a model of HIV-1 patient response to antiretroviral therapy interruptions. *Proceedings of the 2014 American Control Conference*, 2753-2758.

Book Chapters

2023 Robert Baraldi, Drew Kouri, Denis Ridzal (2023), "Trust-Region Methods with Inexact and Adaptive Computations", *Encyclopedia of Optimization.*

Technical Reports (Not peer-reviewed)

2014 Robert Baraldi, John Nardini, Emma Thorpe, and Harvey Thomas Banks (2014), The Effects of Parameterization on Inverse Problems, CRSC Technical report CRSC-TR14-07, Raleigh, NC.

2013 Robert Baraldi, Karissa Cross, Christina McChesney, Laura Poag, Emma Thorpe, Kevin Flores, and Harvey Thomas Banks (2013), "Mathematical Modeling of HCV Viral Kinetics". CRSC Technical report CRSC-TR13-07, Raleigh, NC.

Seminar/Conference Presentations

2023 Robert Baraldi, Drew P. Kouri (2023), "A Proximal Trust-Region Method for Nonsmooth Optimization with Inexact Function and Gradient Evaluations", Applied Inverse Problems, September 4, Göttingen, Germany.

2023 Robert Baraldi, Drew P. Kouri (2023), "A Proximal Trust-Region Method for Nonsmooth Optimization with Inexact Function and Gradient Evaluations", WIAS Research Seminar on Mathematical Optimization Nonsmooth Variational Problems and Operator Equations, August 29, Berlin, Germany.

2023 Robert Baraldi, Evelyn Herberg, Harbir Antil, Drew P. Kouri (2023), "Adaptive Randomized Sketching for Dynamic Nonsmooth Optimization", SIOPT, May 31 - June 4, Seattle, WA.

2023 Robert Baraldi, Drew P. Kouri (2023), "Efficient Proximal Subproblem Solvers for an Inexact Nonsmooth Trust-Region Method", SIAM CSE, February 28 - March 4, Amsterdam, ND.

2023 Robert Baraldi, Drew P. Kouri (2023), "An Inexact Trust-Region Algorithm for Nonsmooth Nonconvex Regularized Problems", Bayreuth Applied Mathematics Seminar, February 24, Bayreuth, Germany.

2023 Robert Baraldi, Evelyn Herberg, Harbir Antil, Drew P. Kouri (2023), "Adaptive Randomized Sketching for Dynamic Nonsmooth Optimization", IMAX XLI, February 15, Austin, TX.

2022 Robert Baraldi, Drew P. Kouri (2022), "An Inexact Trust-Region Algorithm for Nonsmooth Nonconvex Regularized Problems", Centre de recherches mathématiques Seminar at McGill, October

24, Montréal, Quebec.

2022 Robert Baraldi, Drew P. Kouri (2022), "An Inexact Trust-Region Algorithm for Nonsmooth Nonconvex Regularized Problems", GERAD Seminar, October 20, Polytechnique Montréal, Montréal, Quebec.

2022 Robert Baraldi, Drew P. Kouri (2022), "An Inexact Trust-Region Algorithm for Nonsmooth Nonconvex Regularized Problems", Center for Mathematics and Artificial Intelligence Colloquium, September 30 (Virtual).

2022 Robert Baraldi, Stefan Wild, Sven Lyeffer (2022), "Using Filter Methods to Guide Convergence for ADMM, with Applications to Nonnegative Matrix Factorization Problems", ICCOPT/MOPTA 2022, July 25-28. Bethlehem, PA.

2021 Robert Baraldi, Aleksandr Aravkin, Dominique Orban (2021), "A Proximal Quasi-Newton Trust-Region Method for Nonsmooth Regularized Optimization", SIOPT 2021 (virtual), July 22.

2021 Robert Baraldi, Stefan Wild, Sven Lyeffer (2021), "Using Filter Methods to Guide Convergence for ADMM, with Applications to Nonnegative Matrix Factorization Problems", SIAM CSE 2021 (virtual), March 1.

2020 "Moreau-Yoshida Regularization and First Order Methods with Firedrake", Firedrake 2020, Seattle, WA; February 22.

2019 "Basis Pursuit Denoise with Nonsmooth Constraints", DOE CSGF Annual Program Review, Arlington, VA; July 14-18.

2019 "An Acceleration Framework for Parameter Estimation using Implicit Sampling and Adaptive Reduced order Models", SIAM CSE, Spokane WA; 2/25-3/1.

2018 "Relaxation Algorithms for matrix completion, with applications to seismic travel-time data interpolation", DOE CSGF Annual Program Review, Arlington, VA; July 15-19.

2016 "Systems Modeling and Data Assimilation in Drug Development", SIAM Annual Life Sciences Conference, Boston, MA; July 11-15.

Code Development

2022- Rapid Optimization Library (part of Trilinos) - `C++`.

2019- RegularizedOptimization (part of JuliaSmoothOptimizers) - `Julia`.

2019- ShiftedProximalOperators (part of JuliaSmoothOptimizers) - `Julia`.

2019- RegularizedProblems (part of JuliaSmoothOptimizers) - `Julia`.

2019-2021 UW-AMO Group.

Coding Languages

Active Matlab, Python, PyTorch, Julia, C++.

Inactive Java, R, Markdown, HTML, OpenMP/MPI.

Service

2019- Reviewer: Advances in Continuous and Discrete Models, Inverse Problems, SIAM Journal On Scientific Computing, Mathematical Computing, Optimization Letters, Operations Research Letters, SIAM Journal on Optimization.

2021- Minisymposia Organizer: SIAM Optimization (2021), ICCOPT/MOPTA (2022), SIAM CSE (2021,2023).

Teaching/Tutorials

2023 Sandia + GMU PDECO Seminar
2016-2021 UW Applied Mathematics SIAM Student Chapter
2016-2019 Organizer - UW Applied Mathematics Numerical Analysis Research Club
2016 Teaching Assistant: MATH 126 Calculus 3, University of Washington.
2013 Mathematics Tutor: MA 121 Calculus 1, MA 241 Calculus 2, NC State University.

References

Drew P. Kouri - Sandia National Laboratories: dpkouri@sandia.gov
Aleksandr Aravkin - University of Washington: saravkin@uw.edu
Dominique Orban - Polytechnique Montréal: dominique.orban@gerad.ca
Harbir Antil - George Mason University: hantil@gmu.edu
Sven Leyffer - Argonne National Lab: leyffer@mcs.anl.gov
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