

Lars Ruthotto

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Education

Doctor of Natural Sciences, University of Münster, Germany, 2012, thesis entitled *Hyperelastic Image Registration - Theory, Numerical Methods, and Applications*, advisors: Martin Burger and Jan Modersitzki.

Diploma in Mathematics, University of Münster, Germany, 2010.

Full-time Positions

Associate Professor, Departments of Mathematics and Computer Science, Emory University, since Sept. 2020.

Assistant Professor, Departments of Mathematics and Computer Science, Emory University, Sept. 2014 – Aug. 2020.

Postdoctoral Research Fellow, Department of Mathematics / Earth and Ocean Sciences, University of British Columbia, Canada, Jan. 2013 – Aug. 2014.

Research and Teaching Assistant, Institute of Mathematics and Image Computing, University of Lübeck, Germany, Oct. 2010 – Dec. 2012.

Research Assistant, Institute of Biomagnetism and Biosignalanalysis, University of Münster, Germany, Aug. and Sept. 2010.

Research and Teaching Assistant, Institute for Computational and Applied Mathematics, University of Münster, Germany, April 2010 – July 2010.

Other Positions

Senior Fellow, Institute for Pure and Applied Mathematics (IPAM), Long program on Machine Learning for Physics and the Physics of Learning, Sept. 2019 – Dec. 2019.

Senior Consultant, XTract Technologies Inc., Jan. 2017 – Sept. 2019.

Publications

Submitted Papers and Preprints

- [P.5] Kan K, Nagy JG, Ruthotto L
[Avoiding The Double Descent Phenomenon of Random Feature Models Using Hybrid Regularization](#)
arXiv preprint arXiv:2012.06667 [cs.LG], 2020
- [P.4] Ephrath J, Ruthotto L, Treister E
[Multigrid-in-Channels Architectures for Wide Convolutional Neural Networks](#)
arXiv preprint arXiv:2006.06799 [cs.LG], 2020
- [P.3] Onken D, Ruthotto L
[Discretize-Optimize vs. Optimize-Discretize for Time-Series Regression and Continuous Normalizing Flows](#)
arXiv preprint arXiv:2005.13420 [cs.LG], 2020

- [P.2] Treister E, Ruthotto L, Sharoni M, Zafrani S, Haber E
[Low-Cost Parameterizations of Deep Convolution Neural Networks](#)
 arXiv preprint arXiv:1805.07821 [math.NA], 2018
- [P.1] Haber E, Lucka F, Ruthotto L
[Never look back - The EnKF method and its application to the training of neural networks without back propagation](#)
 arXiv preprint arXiv:1805.08034 [math.NA], 2018

Journal Articles (all peer-reviewed)

- [J.32] Newman D, Ruthotto L
[hessQuik: Fast Hessian computation of composite functions](#)
 The Journal of Open Source Software, 2022.
- [J.31] Onken D, Nurbekyan L, Li X, Wu Fung S, Osher S, Ruthotto L
[A Neural Network Approach for High-Dimensional Optimal Control Applied to Multi-Agent Path Finding](#)
 IEEE Transactions on Control Systems Technology, accepted, 2022.
- [J.30] Newman E, Chung J, Chung M, Ruthotto L
[slimTrain—A Stochastic Approximation Method for Training Separable Deep Neural Networks](#)
 SIAM Journal on Scientific Computing, accepted, 2022.
- [J.29] Newman E, Ruthotto L, Hart J, Van Bloemen Waanders B
[Train Like a \(Var\) Pro: Efficient Training of Neural Networks with Variable Projection](#)
 SIAM Journal on Mathematics of Data Science, 3(4), 2021.
- [J.28] Kan K, Wu Fung S, Ruthotto L
[PNKH-B: A Projected Newton-Krylov Method for Large-Scale Bound-Constrained Optimization](#)
 SIAM Journal on Scientific Computing, 2021.
- [J.27] Ruthotto L, Haber E
[An Introduction to Deep Generative Modeling](#)
 GAMM Mitteilungen, 44(2), 2021
- [J.26] Sharma M, Hahn M, Leyffer S, Ruthotto L, van Bloemen Waanders B
[Inversion of convection–diffusion equation with discrete sources](#)
 Optimization and Engineering, 1–39, 2020
- [J.25] Ruthotto L, Osher S, Nurbekyan L, Li W, Wu Fung S
[A machine learning framework for solving high-dimensional mean field game and mean field control problems](#)
 Proceedings of the National Academy of Sciences 117 (17), 9183–9193, 2020.
- [J.24] Wu Fung S, Tyrväinen, Ruthotto L, Haber E
[ADMM-Softmax: An ADMM Approach for Multinomial Logistic Regression](#)
 Electronic Transactions on Numerical Analysis (ETNA), 52, 214–229, 2020.
- [J.23] Ephrath J, Eliasof M, Ruthotto L, Haber E and Treister E
[LeanConvNets: Low-cost Yet Effective Convolutional Neural Networks](#)
 IEEE Journal of Selected Topics in Signal Processing, 2020.
- [J.22] Günther S, Ruthotto L, Schroder JB, Cyr EC, Gauger NR
[Layer-parallel training of deep residual neural networks](#)
 SIAM Journal on Mathematics of Data Science 2 (1), 1-23, 2019.

- [J.21] Herring JL, Nagy J, Ruthotto L
[Gauss-Newton Optimization for Phase Recovery from the Bispectrum](#)
 IEEE Transactions on Computational Imaging 6, 235-247, 2019
- [J.20] Ruthotto L, Haber E
[Deep Neural Networks motivated by Partial Differential Equations](#)
 Journal of Mathematical Imaging and Vision, 13 pages, 2020
- [J.19] Wu Fung S, Ruthotto L
[An Uncertainty-Weighted Asynchronous ADMM Method for Parallel PDE Parameter Estimation](#)
 SIAM Journal on Scientific Computing, 41(5), S129–S148, 2019.
- [J.18] Tabelow K, Balteau E, Ashburner J, Callaghan MF, Draganski B, Helms G, Kherif F, Leutritz T, Lutti A, Phillips C, Reimer E, Ruthotto L, Seif M, Weiskopf N, Ziegler G, Mohammadi S
[hMRI – A toolbox for quantitative MRI in neuroscience and clinical research](#)
 NeuroImage, 194, 191–210, 2019
- [J.17] Wu Fung S, Ruthotto L
[A Multiscale Method for Model Order Reduction in PDE Parameter Estimation](#)
 Journal of Computational and Applied Mathematics, 350, 19–34, 2019.
- [J.16] Mustonen L, Gao X, Santana A, Mitchell R, Vigfusson Y, Ruthotto L
[A Bayesian framework for molecular strain identification from mixed diagnostic samples](#)
Inverse Problems, 34(10), 22 pages, 2018
- [J.15] Herring JL, Nagy JG, Ruthotto L
[LAP: a Linearize and Project Method for Solving Inverse Problems with Coupled Variables](#)
 STSIP Special Issue on Harmonic Analysis and Inverse Problems 2018, 21 pages, 2018.
- [J.14] Ruthotto L, Chung J, Chung M
[Optimal Experimental Design for Inverse Problems with State Constraints](#)
SIAM Journal on Scientific Computing, 40(4), B1080–B1100, 2018.
- [J.13] Haber E, Ruthotto L
[Stable Architectures for Deep Neural Networks](#)
Inverse Problems, 34(1), 22 pages, 2017.
- [J.12] Lin C, Veneziani A, Ruthotto L
[Numerical Methods for Polyline-to-Point-Cloud Registration with Applications to Patient-Specific Stent Reconstruction](#)
 International Journal on Numerical Methods in Biomedical Engineering, 34(3), 20 pages, 2017.
- [J.11] Macdonald J, Ruthotto L
[Improved Susceptibility Artifact Correction of Echo Planar MRI using the Alternating Direction Method of Multipliers](#)
Journal of Mathematical Imaging and Vision, 15 pages, 2017.
- [J.10] Mang A, Ruthotto L
[A Lagrangian Gauss-Newton-Krylov Solver for Mass-and Intensity-Preserving Diffeomorphic Image Registration](#) *SIAM Journal on Scientific Computing*, 39(5) B5860-B5885, 2017.
- [J.9] Ruthotto L, Treister E, Haber E
[jInv—a flexible Julia package for PDE parameter estimation](#)
SIAM Journal on Scientific Computing, 39(5), S702-S722, 2017.
- [J.8] Ruthotto L, Greif C, Modersitzki J
[A stabilized multigrid solver for hyperelastic image registration](#)
Numerical Linear Algebra with Applications, 10.1002/nla.2095, 16 pages, January 2017.

- [J.7] Chung J, Ruthotto L,
[Computational Methods for Image Reconstruction](#)
NMR in Biomedicine, 30(4), 13 pages, 2017.
- [J.6] Mohammadi S, Tabelow K, Ruthotto L, Feiweier T, Polzehl J, Weiskopf N
[High-resolution diffusion kurtosis imaging at 3T enabled by advanced post-processing](#),
Frontiers in Neuroscience, 14 pages, 2014.
- [J.5] Haber E, Ruthotto L,
[A Multiscale Finite Volume Method for Maxwell's Equations at low Frequencies](#),
Geophysical Journal International, 199(2), 1268–1277, 2014.
- [J.4] Fohring J, Haber E, Ruthotto L,
[Geophysical Imaging of Fluid Flow in Porous Media](#),
SIAM Journal on Scientific Computing, 36(5), S218–S236, 2014.
- [J.3] Burger M, Modersitzki J, Ruthotto L,
[A Hyperelastic Regularization Energy for Image Registration](#),
SIAM Journal on Scientific Computing, 35(1), B132–B148, 2013.
- [J.2] Ruthotto L, Kugel H, Olesch J, Fischer B, Modersitzki J, Burger M, Wolters CH,
[Diffeomorphic Susceptibility Artifact Correction of Diffusion-weighted Magnetic Resonance Images](#),
Physics in Medicine and Biology, 57(18), 5715–5731, 2012.
- [J.1] Gigengack F, Ruthotto L, Burger M, Wolters CH, Jiang X, Schäfers KP
[Motion Correction in Dual Gated Cardiac PET using Mass-preserving Image Registration](#),
IEEE Transactions on Medical Imaging, 31(3), 698–712, 2012.

Book Chapter

- [B.1] Ruthotto L, Modersitzki J,
[Nonlinear Image Registration](#),
Handbook of Mathematical Methods in Imaging, 2015, 2005–2051.

Selected Peer-Reviewed Conference Proceedings

(presenters underlined)

- [C.16] Kan K, Aubet FX, Januschowski T, Park Y, Benidis K, Lars Ruthotto, Gasthaus J
[Multivariate Quantile Function Forecaster](#) accepted as a talk at AISTATS, virtual, 2022.
- [C.15] Onken D, Nurbekyan L, Li X, Wu Fung S, Osher S, Ruthotto L
[A Neural Network Approach Applied to Multi-Agent Optimal Control](#) accepted as a talk at the European Control Conference, virtual, 2021.
- [C.14] Onken D, Wu Fung S, Li X, Ruthotto L
[OT-Flow: Fast and Accurate Continuous Normalizing Flows via Optimal Transport](#)
35th AAAI Conference on Artificial Intelligence, acceptance rate 21%, 2021
- [C.13] Ephrath J, Ruthotto L, Haber E, Treister E
[LeanResNet: A Low-cost yet Effective Convolutional Residual Networks](#)
accepted as poster at the Joint Workshop on On-Device Machine Learning & Compact Deep Neural Network Representations, 5 pages, 2019.
- [C.12] Haber E, Lensink K, Treister E, Ruthotto L
[IMEXnet: A Forward Stable Deep Neural Network](#)
presented at spotlight talk and poster at the 36th International Conference on Machine Learning (ICML), acceptance rate 22.6%, 10 pages, 2019.

- [C.11] Chang B, Meng L, Haber E, Ruthotto L, Begert D, Holtham E
[Reversible Architectures for Arbitrarily Deep Residual Neural Networks](#)
 AAAI Conference on Artificial Intelligence, acceptance rate 24.6%, 8 pages, 2018.
- [C.10] Haber E, Holtham E, Ruthotto L, Jun SH
[Learning across scales-A multiscale method for Convolution Neural Networks](#)
 AAAI Conference on Artificial Intelligence, acceptance rate 24.6%, 8 pages, 2018.
- [C.9] März M, Ruthotto L,
[Combined Background Field Removal and Reconstruction for Quantitative Susceptibility Mapping](#)
Bildverarbeitung für die Medizin, 6 pages, 2016.
- [C.8] Heck C, Ruthotto L, Berkels B, Modersitzki J,
[Model-Based Parameter Estimation in DCE-MRI without an Arterial Input Function](#),
Bildverarbeitung für die Medizin, 6 pages, 2014.
- [C.7] Ruthotto L, Mohammadi S, Weiskopf N,
[A new Method for Joint Susceptibility Artefact Correction and Super-Resolution for dMRI](#),
Proceedings of SPIE Medical Imaging, 90340P-90340P-4, 2014.
- [C.6] Gigengack F, Ruthotto L, Jiang X, Modersitzki J, Burger M, Hermann S, Schäfers KP,
[Atlas-based whole-body PET-CT Segmentation using a Passive Contour Distance](#),
Medical Computer Vision. Recognition Techniques and Applications in Medical Imaging, 82-92, 2013.
- [C.5] Ruthotto L, Mohammadi S, Heck C, Modersitzki J, Weiskopf N,
[HySCO - Hyperelastic Susceptibility Artefact Correction of DTI in SPM](#),
Bildverarbeitung für die Medizin (Workshop on Medical Imaging), 344-349, 2013.
- [C.4] Ruthotto L, Hodneland E, Modersitzki J,
[Registration of Dynamic Contrast Enhanced MRI with Local Rigidity Constraint](#),
5th Workshop on Biomedical Image Registration, 190-198, 2012.
- [C.3] Ruthotto L, Gigengack F, Burger M, Wolters CH, Jiang X, Schäfers K, Modersitzki J,
[A Simplified Pipeline for Motion Correction in Dual Gated Cardiac PET](#),
Bildverarbeitung für die Medizin (Workshop on Medical Imaging), 51-56, 2012.
- [C.2] Gigengack F, Ruthotto L, Burger M, Wolters CH, Jiang X, Schäfers KP,
[Motion Correction of Cardiac PET using Mass-preserving Registration](#),
Nuclear Science Symposium Conference Record (NSS/MIC), 3317-3319, 2010.
- [C.1] Olesch J, Ruthotto L, Kugel H, Skare S, Fischer B, Wolters CH,
[A Variational Approach for the Correction of Field-inhomogeneities in EPI Sequences](#),
Proceedings of SPIE Medical Imaging Conference, 4 pages, 2010.

Contributed and Invited Talks

[How to Train Better: Exploiting the Separability of DNNs](#), Simons Institute Workshop on Dynamics and Discretization: PDEs, Sampling, Optimization, joint talk with Elizabeth Newman, Oct 2021.

Machine Learning Approaches for High-Dimensional Optimal Transport and Control, held in different versions at various occasions including:

invited talk at the IPAM HJRC1 Reunion workshop, January 2022.

invited seminar talk at the Institute of Computing, Università della Svizzera italiana (USI) (invited by O. Schenk), February 2022 (virtual)

invited seminar talk at Courant Institute (invited by G. Stadler), February 2022 (virtual)

invited seminar talk at the UNRAVEL project meeting (invited by W. Schilders), June 2021 (virtual)

invited seminar talk at the DAMUT Colloquium at University of Twente (invited by C. Brune), May 2021 (virtual)

invited mini symposium talk at the CAIMS Annual Meeting, July 2021 (virtual)

invited seminar talk at the Berlin "Oberseminar" on Optimization, Control and Inverse Problems (invited by M. Hintermüller), May 2021 (virtual)

invited seminar talk at the COMinDS Seminar seminar (invited by M. Stoll), May 2021 (virtual)

invited seminar talk at the Twente Applied Math Colloquium (invited by C. Brune), May 2021 (virtual)

A Machine Learning Framework for Mean Field Games and Optimal Control, held in different versions at various occasions including:

invited talk in the Continuum Mechanics Seminar at University of Nebraska-Lincoln, November 2021 (virtual)

invited talk at the Oberwolfach Workshop on Computation and Learning in High Dimensions, August 2021 (virtual)

invited talk at the Deep learning and partial differential equations workshop at Isaac Newton Institute, November 2021 (virtual)

[An Introduction to Generative Modeling](#), held at various occasions including:

invited 1-hour guest lecture at the University of Nuremberg-Erlangen (invited by D. Tenbrinck), June 2021 (virtual).

invited 3-hour workshop at the University of South Carolina (invited by W Dahmen), April 2021 (virtual)

New Bridges between Deep Learning and Partial Differential Equations, held at various occasions including

invited seminar talk in the DNA seminar at the Norwegian University of Science and Technology NTNU (invited by K Ebrahimi-Fard), April 2021 (virtual)

[invited plenary talk at the Second Joint SIAM/CAIMS Annual Meeting \(AN20\), Toronto, July 2020 \(virtual\)](#)

A Machine Learning Framework for High-Dimensional Optimal Transport, held at various occasions including

invited applied math seminar talk at National University of Singapore, (invited by Q Li), January 2021 (virtual)

invited talk in the IMA Data Science Seminar (invited by Jeff Calder), April 2021 (virtual)

[contributed talk at SIAM CSE 2021, \(invited by H Antil\), February 2021 \(virtual\)](#)

[invited talk in the Sayas Numerics Seminar, \(invited by H Antil\), October 2020 \(virtual\)](#)

[invited talk in the One World Seminar on Mathematics for Arbitrary Data Sources, \(invited by M Burger\), April 2020 \(virtual\)](#)

[invited talk at the Institute for Pure and Applied Mathematics workshop on Deep Learning with Medical Applications, January 2020.](#)

invited talk at the Lake Arrowhead culminating workshop of IPAM's MLP 2019 program, December 2019.

Deep Neural Networks motivated by PDEs, held at various occasions including

[invited talk at the Institute for Pure and Applied Mathematics \(invited by Frank Noé\), September 2019](#)

invited talk at the Institute for Mathematics and Image Computing, Lübeck (invited by J Modersitzki), July 2019

invited talk at Banff International Research Station, (invited by O Scherzer), July 2019

contributed talk at ICIAM 2019, (invited by F Lucka), July 2019

invited talk at OakRidge National Lab, (invited by C Webster), July 2019

contributed talk at SIAM Conference on Computer Science and Engineering, (invited by E Cyr), February 2019

invited talk at Georgia State University, (hosted by Xiaojing Ye), October 2018

invited talk at the University of Florida ISE Risk Management Workshop, (hosted by Stanislav Uryasev), October 2018

invited plenary lecture at the Finite Element Symposium, Chemnitz, Germany, September 2018

invited talk at Sandia National Laboratory (hosted by Pavel Bochev), Albuquerque, August 2018

contributed talk at SIAM Conference on Imaging Sciences, Bologna, Italy, June 2018

invited talk at the Cantab Capital Institute for the Mathematics of Information (hosted by Carola Schönlieb), Cambridge, UK, May 2018

invited talk at Mini-Workshop on Inverse Problems and Deep Learning, Oberwolfach, March 2018.

A Numerical Analysis Perspective on Deep Neural Networks, held at various occasions including

invited seminar talk at North Carolina State University (invited by A Krishna Saibaba), April 2021 (virtual)

[invited talk at the IPAM Workshop From Passive to Active: Generative and Reinforcement Learning with Physics](#) (invited by Frank Noé), September 2019

Optimal Control Methods for Training Deep Neural Networks, held at various occasions including

[invited talk at the Institute for Pure and Applied Mathematics](#) (invited by Frank Noé), September 2019

contributed talk at ICIAM 2019, (invited by G Kutyniok), July 2019

contributed talk at SIAM Conference on Imaging Sciences, Bologna, Italy, June 2018

invited seminar talk at UCLA (hosted by Stanley Osher), April 2018

invited seminar talk at UT Austin (hosted by Kui Ren), April 2018

contributed talk at the 15th Copper Mountain Conference on Iterative Methods, March 2018

invited seminar talk at IBM TJ Watson Research Center (hosted by Lior Horesh), January 2018.

invited seminar talk at Courant Institute (hosted by Georg Stadler), New York University, November 2017.

invited talk at workshop on Variational methods and effective algorithms for imaging and vision, Isaac Newton Institute, Cambridge, November 2017.

A Lagrangian Solver for Diffeomorphic Image Registration, held at various occasions including:

contributed talk at SIAM Conference on Imaging Sciences, Bologna, Italy, June 2018

contributed talk in mini symposium at SIAM Conference on Computer Science and Engineering, Atlanta, GA, 2017.

invited colloquium talk at Institute for Mathematics and Image Computing (hosted by Jan Modersitzki), University of Lübeck, July 2016.

A Bayesian framework for molecular strain identification from mixed diagnostic samples, held at:

invited colloquium talk at the Advanced Molecular Detection (AMD) seminar at the CDC, Atlanta, July 2018.

Dynamic Inverse Problems in Deep Learning

invited colloquium talk at Institute for Mathematics and Image Computing (hosted by Jan Modersitzki), University of Lübeck, July 2017.

invited seminar talk at Weierstrass Institute for Applied Analysis and Stochastics (hosted by Karsten Tabelow), Berlin, Germany, July 2017

contributed talk in mini symposia on Non-standard Regularisation at Applied Inverse Problems, Hangzhou, China, June, 2017.

LAP: a Linearize and Project Method for Solving Coupled Inverse Problems, contributed talk in mini symposia on Hybrid models for inverse imaging problems at Applied Inverse Problems, Hangzhou, China, May, 2017.

A Multigrid Preconditioner for Hyperelastic Image Registration

contributed talk in mini symposium at International Conference on Preconditioning Techniques, Vancouver, Aug 2017.

contributed talk in mini symposium at SIAM Conference on Imaging Sciences, Hong Kong, May 2014.

Tutorial on PDE-Constrained Optimization with Julia, invited talk at SAMSI Workshop on Mixed-Integer PDE-Constrained Optimization, Raleigh, NC, March 30, 2017.

Optimal Experimental Design for Constrained Inverse Problems

invited talk at SAMSI Transition Workshop, Raleigh, NC, May 1, 2017.

invited talk at SAMSI Workshop on Statistical Inverse Problems, Raleigh, NC, January 26, 2017.

Perspectives on Diffeomorphic Image Registration,

invited talk at Weill Cornell Medicine (hosted by Yi Wang), New York City, NY, February 2017

invited talk at Georgia Institute of Technology (hosted by Martin Short), Atlanta, GA, October 2016

jInv - A Flexible Julia Package for Parallel PDE Parameter Estimation,

contributed e-poster at SIAM Conference on Computer Science and Engineering, Atlanta, GA, 2017.

invited colloquium talk at Virginia Tech (hosted by Julianne Chung), Blacksburg, VA, September 2016

contributed talk at JuliaCon, Boston, MA, June 2016

invited talk in ICES seminar, University of Texas at Austin (hosted by George Biros), TX, March 2015.

contributed talk, 14th Copper Mountain Conference on Iterative Methods, Copper Mountain, CO, March 2015.

contributed talk in mini symposium on Numerical Methods and Scientific Computing, AMS Southeastern Sectional Meeting, Athens, GA, 2015.

Efficient Iterative Methods for Quantitative Susceptibility Mapping

invited talk at Imaging Group (hosted by Martin Burger), University of Münster, Germany, July 2017.

contributed talk in mini symposium on Efficient Algorithms for Large-scale Inverse Problems in Medical Imaging, SIAM Conference on Imaging Sciences, Albuquerque, May 2016.

contributed talk in mini symposium on Recent Advances in Numerical Linear Algebra for Inverse Problems, SIAM Conference on Applied Linear Algebra, Atlanta, Oct 2015.

Optimization Through Multiscale Methods

contributed talk in mini symposium on PDE-Constrained Optimization with Reduced Order Models, SIAM Conference on Optimization, Vancouver, Canada, May 2017.

contributed talk in mini symposium on Multiscale and Reduced Space Modeling, SIAM Conference on Geoscience, Stanford, CA, June 2015.

Distributed Algorithms for Full-Waveform-Inversion (FWI), contributed talk at JuliaCon, Cambridge, MA, June 2015.

Tutorial on Distributed Optimization for Full Waveform Inversion in Julia, invited workshop at Platform for Advanced Scientific Computing (PASC) (hosted by Olaf Schenk), Zurich, CH, June 2015.

Distributed and Parallel Algorithms for PDE Constrained Optimization in Julia, contributed talk in mini symposium on large-scale scientific computing with Julia, PASC Conference, Zurich, CH, June 2015.

Parameter Estimation with Reduced Models, invited talk at the Institute of Mathematics and Image Computing (hosted by Jan Modersitzki), University of Lübeck, Germany, June 2014.

Registration and Super-Resolution Techniques for Diffusion Tensor Imaging, contributed talk at the GAMM Annual Meeting, Erlangen, Germany, March 2014.

Numerical Methods for Hyperelastic Image Registration, 60 minutes lecture, held at various occasions including:

invited talk at Ferenc Jolesz Research Seminar (hosted by Ron Kikinis), Brigham and Women's Hospital, Boston, MA, USA, April 2015

invited talk at Mathematics Colloquium at Emory University (hosted by James Nagy), Atlanta, USA, January 2014

invited talk at Mathematics Colloquium at University of Bergen (hosted by Antonella Munthe-Kaas), Bergen, Norway, March 2014

invited talk at Geometry Seminar, University of Georgia (hosted by Jason Cantarella), Athens, November 2014.

HySCO - Hyperelastic Susceptibility Artifact Correction of DTI, invited talk at the Department of Psychiatry (hosted by Andreas Jansen), Philipps-University Marburg, Germany, September 2013.

A Numerical Framework for Inverse Problems with Hyperbolic PDE-Constraints, invited talk at the Institute of Mathematics and Image Computing (hosted by Jan Modersitzki), University of Lübeck, Germany, September 2013.

Hyperelastic Image Registration: Theory, Numerical Methods, and Applications, invited talk at Scientific Computing seminar at University of British Columbia (hosted by Eldad Haber), Vancouver, January 2013.

Image Registration Techniques for Field Inhomogeneity Artifact Correction of DTI and beyond, invited talk at Center for Neuroimaging Techniques seminar (hosted by Nikolaus Weiskopf), University College London, UK, November 2012.

Introduction to Medical Image Registration, invited seminar talk at Geophysical Inversion Facility (hosted by Eldad Haber), University of British Columbia, Vancouver, June 2012.

The DCE-MRI Motion Correction Challenge, contributed talk at mini symposium on advances in 4D imaging, SIAM Conference on Imaging Sciences, Philadelphia, June 2012.

Undergraduate Teaching Experience

(ordered by course number)

MATH 347 Introduction to Nonlinear Optimization,
Emory University, Atlanta, Fall 2016, Fall 2018, and Spring 2020.

MATH 346 Introduction to Optimization Theory,
Emory University, Atlanta, Fall 2014, Spring 2015.

MATH 315 Numerical Analysis,
Emory University, Atlanta, Fall 2017 and Spring 2019.

MATH 211 Advanced Calculus,
Emory University, Atlanta, Fall 2016.

Linear Algebra and Discrete Structures with Bernd Fischer,
University of Lübeck, Germany, October 2010 - September 2012,

Responsibilities included several lectures, organization of weekly tutorials, supervision of teaching assistants, preparation of weekly homework assignments and final exams.

Numerical Partial Differential Equations with Frank Wübbeling,
University of Münster, Germany, April – September 2010,
Responsibilities included weekly tutorials and homework assignments.

Graduate Teaching Experience

(ordered by course number)

MATH 789R RTG Seminar on Computational Mathematics for Data Science
Emory University, Atlanta, GA, USA, Fall 2021.

MATH 789R Bayesian Inverse Problems and Uncertainty Quantification
Emory University, Atlanta, GA, USA, Spring 2016.

MATH 771 (now MATH 517) Numerical Optimization
Emory University, Atlanta, GA, USA, Fall 2015, Fall 2018, Spring 2022.

CS 584/MATH 789R Numerical Methods for Deep Learning
Emory University, Atlanta, GA, USA, Spring 2018, Spring 2020.

MATH 516 Numerical Analysis II,
Emory University, Atlanta, GA, USA, Spring 2015.

Undergraduate Advisees

Xindi Gong, *Linear Programming Approaches for Reinforcement Learning*, **Honors Project**, Emory University, September 2021 – March 2022.

Yu-Jan Ting, *Variance Reduction Methods for Neural Network-Based Optimal Control*, **Honors Project**, Emory University, September 2021 – March 2022.

Elle Buser, Emma Hart, Ben Hueneman, Justin Smith (in-service K-5 teacher), *Image-based diagnosis of Chiari malformation*, **Emory REU/RET Computational Mathematics for Data Science**, Summer 2021.

Uriel Yang, *Estimating and Predicting the Effect of Quarantine in the COVID-19 Pandemic: Using a Modified SEIR Model*, **Honors Project**, Emory University, April 2019 – March 2020.

Emily Rexer, Esteban Ramos, Ishan Saran, *A Monetary Evaluation of Ecosystem Services*, **Outstanding Winners in the 2019 Interdisciplinary Contest in Modeling (ICM)**. The team was among the top 8 submissions of 4,852 teams and their paper was selected for publication in the UMAP Journal.

Neeharika Kotte and Haoruo Zhao, *Lagrangian Methods for Optimal Mass Transport*, **Summer Research Experience** in Summer 2019.

Evan Scope Crafts, *Multiscale Training of Deep Neural Networks*, **Honors Project, Research Partners Program, Summer Undergraduate Research Experience 2018** Emory University, Jan. 2018 – March 2019; PhD student in Computational Science and Engineering at U of Texas at Austin, since Aug. 2019.

Qihang Zhang, *Stable Discretization of Variational Problems in Deep Learning*, **Honors Project and Summer Undergraduate Research Experience 2018**, Emory University, Jan. 2018 – March 2019. MSc in Data Science at GA tech, since in Aug. 2019.

Kathy Wu, *Trainable Krylov Methods for Inverse Problems*, **Honors Project**, Emory University, April 2018 – March 2019. MSc in Data Science at U of Chicago, since Aug. 2019.

Cayce Rimland and Daniel Flores, *Combined reconstruction and classification with deep neural networks*, **Summer Research Experience** in Summer 2018. Rimland is now in PhD program at UC Riverside and Flores joined Purdue University as PhD student.

Huiying Zhu, *Global Optimization in Image Registration*, **Honors Project** (with Dr. Manuela Manetta), Emory University, Dec 2016 – Dec. 2017; MSc in Data Science at GA tech, since Aug 2018.

Claire Lin, *Line-to-Point Registration with Applications in Coronary Stent Reconstruction*, **Honors Project** (with Dr. Alessandro Veneziani), Emory University, Sep. 2015 – April 2016. PhD student at U of Michigan, since Aug. 2016.

Graduate Advisees

Haley Rosso, *Interpolation Schemes for Neural ODEs*, collaborative project between Sandia National Laboratories and Emory, since January 2022.

Abigail Julian, *Machine Learning Techniques for brain MRI*, PhD project in Computer Science and Informatics, **Awarded an NSF Graduate Research Fellowship**, Emory, since January 2020.

Malvern Madondo, *Optimal Control and Reinforcement Learning*, PhD project in Computer Science and Informatics, **Awarded a Google PhD Fellowship**, Emory, since January 2020.

Xingjian Li, *Machine Learning and Optimal Control*, PhD project in Computational Mathematics, Emory, since January 2020.

Derek Onken, *Optimal Control Approaches for Designing Neural Ordinary Differential Equations*, PhD in Computer Science and Informatics, Emory, September 2018 – March 2021. Joining Eli Lily as a scientific researcher.

Kelvin Kan, *Numerical Optimization in Semantic Segmentation and Inverse Problems*, PhD project in Computational Mathematics, Emory, since January 2019.

Samy Wu Fung, *Large-Scale PDE Parameter Estimation*, PhD in Computational Mathematics, Emory University, Sept. 2015 – May 2019. Now an Assistant Adjunct Professor in the Department of Mathematics at UCLA.

James Herring, *Numerical Methods for Coupled Optimization Problems* (with Dr. James Nagy), PhD in Computational Mathematics, Emory University, June 2016 – May 2018. Now a scientific researcher at Numerica Corp. in Fort Collins, CO.

Supervision of Visiting Students

Xiangxi Gao, *Numerical Methods for Parameter Estimation*, Sept. 2017 - Sept. 2018. Now a PhD student at Emory.

Jan Macdonald, *Numerical Optimization for EPI-MRI Susceptibility Artifact Correction*, Sept. 2015 – May 2016. Now a PhD student at TU Berlin.

Maximilian März, *Inverse Problems in Quantitative Susceptibility Mapping*, Sept. 2014 – May 2015. Now a PhD student at TU Berlin.

Honors Thesis Committees

(my own students are listed above)

Mai Phuong Pham Huynh, Mathematics, March 2022

Jonathan Valyou, Mathematics, March 2022

Jennifer Zhang, Mathematics, March 2022

Sihan Yue, Mathematics, March 2019

Siqi Xue, Mathematics, March 2017

Robert Bamford, Economics, March 2017

Graduate Thesis Committees

(my own students are listed above)

Chang Meng, Computational Mathematics, March 2022

Yiliang Ji, Computational Mathematics, March 2022

Ru Huang, Computational Mathematics, March 2022

Alessandro Barone, Computational Mathematics, October 2019

Blair Rosetti, Computer Science and Informatics, March 2019

Sofia Guzzetti, Computational Mathematics, March 2019

Yunyi Hu, Computational Mathematics, April 2019

Clarissa Garvey, *Truncated SVD of Structured Matrices via Kronecker Product Summation Decomposition*, Computer Science and Informatics, May 2018

Postdoctoral Mentees

Deepanshu Verma, *Optimal Control, Reinforcement Learning, Active Learning*, Postdoctoral Fellow, Emory University, since August 2021.

Elizabeth Newman, *Deep Learning in PDE Parameter Estimation*, Postdoctoral Fellow, Emory University, since June 2019.

Bas Peters, *Reinforcement Learning and Optimal Control*, Postdoctoral Fellow, Emory University, August 2020 – July 2021.

Lauri Mustonen, *Bayesian Inverse Problems in Biostatistics and Parameter Estimation*, Postdoctoral Fellow, Emory University, November 2017 – September 2018; Now postdoc at Stanford University since Oct. 2018.

Conference, Workshop, and Mini-Symposium Organization

Co-chair of the SIAM Conference on Mathematics of Data Science, hybrid, San Diego, Fall 2022.

Co-organizer of workshop on *Theory of Deep Learning* at the Isaac Newton Institute for Mathematical Sciences, University of Cambridge, UK, August 2021.

Co-organizer of workshop on *Optimization under Uncertainty: Learning and Decision Making* at the Banff International Research Station, CAN, February 2021 (virtual)

Co-organizer of two-part mini-symposia on *Advances in Machine Learning and Data-driven Methods for Computational Science* at the SIAM Conference on Mathematics of Data Science, Cincinnati, OH, May 2020 (virtual).

Lecturer of a five-hour mini-course on *Numerical Methods for Deep Learning* at the school on *Mathematical and Computational Aspects of Machine Learning* held at the Scuola Normale Superiore, Pisa, Italy, October, 2019.

Co-organizer of two-part mini-symposia on *Mathematical Advances in Deep Learning* at the SIAM Conference on Computer Science and Engineering, Spokane, WA, February 2019.

Lecturer at Summer School on Applied Analysis on *Numerical Methods for Deep Learning*, Chemnitz, Germany, September 2018.

Chair of focus session on *Machine learning and PDEs* at the 5th European Conference on Computational Optimization – EUCCO 2018, Trier, Germany, September 2018.

Co-organizer of mini-symposia on *Computational Methods for Large-Scale Machine Learning in Imaging* at the SIAM Conference on Imaging Sciences, Bologna, Italy, June 2018.

Co-organizer of two-part mini-symposia on *Preconditioning Methods in Large-Scale Ill-Posed Inverse Problems* at the International Conference on Preconditioning Techniques, Vancouver, Canada, Aug 2017.

Co-organizer of mini-symposia on *PDE-Constrained Optimization with Reduced Order Models* at the SIAM Conference on Optimization, Vancouver, Canada, May 2017.

Co-organizer of mini-symposia on *Advanced Scientific Computing using Julia* at the SIAM Conference on Computer Science and Engineering, Atlanta, GA, March 2017.

Workshop on *Numerical Methods for PDE Constrained Optimization*, Doktorandenkolleg in Weissensee, Austria, September 2016.

Tutorial on *Tutorial on Distributed Optimization for Full Waveform Inversion in Julia* (with Eldad Haber), Platform for Advanced Scientific Computing, Zurich, CH, June 2015

Mini-symposium on *Large-Scale Scientific Computing with Julia* at the Platform for Advanced Scientific Computing, Zurich, CH, June 2015

Co-organizing mini-symposia on *Parametric Model Reduction and Inverse Problems* at the SIAM Conference on Computer Science and Engineering, Salt Lake City, March 2015.

Co-organizing mini-symposia on *High-level technical computing with Julia* to be held at the SIAM Conference on Computer Science and Engineering, Salt Lake City, March 2015.

Co-organized mini-symposium on *Numerical Methods for Large-Scale Imaging Problems* held at the SIAM Conference on Imaging Science, Hong Kong, 2014

Course on Medical Image Registration with Jan Modersitzki and Lars König
by invitation of The Fields Institute Toronto, 2012

Fully responsible for special topic lecture on Susceptibility Artifact correction of EPI-MRI and organization of two computer labs (4 hours each).

Workshop on Image Registration with Jan Modersitzki and Fabian Gigengack,
14th International Conference on Medical Image Computing and Computer Assisted Intervention, Toronto, 2011, *Fully responsible for special topic lecture on Susceptibility Artifact correction of EPI-MRI.*

Summer School on Image Registration with Jan Modersitzki,
by invitation of the Swedish Society for Automated Image Analysis (SSBA), Linköping, Sweden, 2011,
Fully responsible for four computer labs (3 hours each).

Workshop on Image Registration with Jan Modersitzki and Fabian Gigengack,
by invitation of Medical Visualisation Network (MedViz) at University of Bergen, Norway, 2011,
Fully responsible for a four hour computer lab.

Software Contributions

Developer of several open-source packages that can be found on my [Github page](#). Highlights:

[Meganet.m](#) and [Meganet.jl](#) main developer of open source packages for optimal control-based deep learning, since January 2018.

[JuliaInv](#) Founding member of Github organization providing efficient open source code for solving inverse problems in Julia, since March 2016.

[Flexible Algorithms for Image Registration \(FAIR\)](#) with Jan Modersitzki,
Extensions for hyperelastic and mass-preserving image registration and application specific add-ons.

[Artifact Correction in Diffusion MRI \(ACID\)](#) with Siawoosh Mohammadi,
Provided tool for Hyperelastic Susceptibility Artefact Correction.

Awards and Grants (titles of current support are in bold)

Efficient training of stochastic Neural ODEs and ResNets via weight parametrization, contract funded by Sandia National Laboratories, Emory budget \$60,000, January 2022 – December 2022.

NSF DMS 2051019: REU/RET Site for Computational Mathematics for Data Science, funded by the US National Science Foundation, Co-PI Bree Ettinger, total budget \$397,178, May 2021, April 2024.

Active and Reinforcement Learning for Decision Support, subcontract with Sandia National Laboratories funded as part of a collaborative DOE ASCR proposal, Emory budget \$600,000, October 2020 – September 2023

A Machine Learning Framework for High-Dimensional Mean Field Games and Real-Time Control, US Air Force Office of Scientific Research FA9550-20-1-0372, total budget \$449,141, September 2020 – September 2023

New Architectures and Algorithms For Continuous Convolutional Neural Networks, funded by the US Israeli Binational Science Foundation. Emory budget \$74,999, Oct 2019 – Sept. 2021.

CAREER DMS 1751636: A Flexible Optimal Control Framework for Efficient Training of Deep Neural Networks, funded by NSF Computational Mathematics, total budget \$400,000, June 2018 - May 2023.

Data-driven surrogate models of complex physical simulators, subcontract funded by Sandia National Laboratories, Emory budget \$120,000, April 2019 – August 2020.

Bayesian Algorithms for disambiguation of wgMLST types in culture-independent diagnostic samples funded by the Centers for Disease Control, Co-PIs Dr. Rebecca Mitchell and Dr. Ymir Vigfusson, total budget \$382,383, Sep 2017 - Sep 2018.

NVIDIA GPU Grant for a TitanX, May 2017.

Numerical Methods for Quantitative MRI funded by Emory University Research Council, total budget \$30,000, April 2016.

DMS 1522599: Fast Algorithms for Solving Big Data PDE Parameter Estimation Problems on Cloud Computing Platforms funded by NSF Computational Mathematics, total budget \$179,999, Sept. 2015 - Sept. 2018.

IdeaLab2015, travel award to attend one-week workshop at ICERM, Providence, RI, July 2015.

Award for the best scientific contribution at *Bildverarbeitung für die Medizin* (Workshop on Medical Imaging), Berlin, Germany, 2012

Research grant (principal investigators Jan Modersitzki and Martin Burger), ***Nonlinear mass-preserving registration for MRI and PET***, funded for two years with an equivalent of about \$183,500 by the *Deutsche Forschungsgemeinschaft* (German Research Foundation).

Professional Activities

Vice Chair, SIAM Activity Group on Data Science, 2022–2024.

Secretary, SIAM Activity Group on Imaging Science, 2018–2020.

Associate Editor

[SIAM Journal on Scientific Computing](#), since January 2021

[Machine Learning for Biomedical Imaging \(MELBA\)](#), since December 2020

Guest editor

Royal Mathematical Society Special Issue on PDEs for Machine Learning, 2021

European Journal of Applied Mathematics special issue on Deep Learning and PDEs, 2020 – 2021

Reviewer for several journals, including:

[Proceedings of the National Academy of Sciences](#)
[SIAM Journal on Scientific Computing](#)
[SIAM Journal of Matrix Analysis](#)
[SIAM Journal on Applied Dynamical Systems](#)
[Journal of Mathematical Imaging and Vision](#)
[Journal of Visual Communication and Image Representation](#)
[Magnetic Resonance in Medicine](#)
[Journal of Computational Physics](#)
[IEEE Transaction on Medical Imaging](#)
[International Journal on Computer Mathematics](#)
[Inverse Problems](#)
[Medial Image Analysis](#)
[Numerical Linear Algebra with Applications](#)
[Applied Mathematical Modeling](#)
[Communications in Applied and Industrial Mathematics](#)
[Optimization and Engineering](#)
[Numerical Algorithms](#)

Reviewer for several conferences, including:

[Conference on Learning Theory \(COLT\), 2021](#)
[IEEE/CVF Conference on Computer Vision and Pattern Recognition \(CVPR\), 2021](#)
[International Conference on Scale Space and Variational Methods in Computer Vision \(SSVM\) 2019](#)
[International Conference on Machine Learning \(ICML\) 2019](#)

Reviewer and panelist for federal funding agencies:

[European Research Council](#)
[Swiss National Supercomputing Centre](#)
[Deutsche Forschungsgemeinschaft \(German Research Foundation, DFG\)](#)
[US National Science Foundation, Division of Mathematics, three review panels and one mail-in review.](#)
[US Department of Energy, one review panel and mail-in reviewer of four proposals](#)

Member of Program Committee

[Mathematical and Scientific Machine Learning 2021](#) [Mathematical and Scientific Machine Learning 2020](#)
[IEEE 18th International Conference on CSE 2015 and 2016.](#)

Member of the [American Mathematical Society](#).

Member of the [Society for Industrial and Applied Mathematics \(SIAM\)](#).

Member of the [Deutsche Mathematiker-Vereinigung \(DMV\)](#).

Member of the [Gesellschaft für Angewandte Mathematik und Mechanik e.V. \(GAMM\)](#).