LUKE LOZENSKI

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SUMMARY

Ph.D. Candidate in Systems Science and Mathematics at Washington University in St. Louis. My thesis topic is about improving dynamic and multispectral photoacoustic and ultrasound computed tomography through the development of large-scale computational imaging methods. My research includes the development of scientific machine learning frameworks, such as neural fields and CNNs, for solving inverse problems.

EDUCATION

Washington University in St. Louis, McKelvey School of Engineering **May 2025**
Ph.D. in Science in Systems Sciences and Mathematics
Advisor: Umberto Villa
Secondary Advisory: Joseph O'Sullivan

Washington University in St. Louis, McKelvey School of Engineering **May 2020**
Masters of Systems Sciences and Mathematics

Washington University in St. Louis, McKelvey School of Engineering **May 2020**
Bachelor of Science in Systems Sciences and Engineering
Second Major in Mathematics (Applied Track), School of Arts and Sciences
Minor in Electrical Engineering

TRAINING

Summer Internship at Los Alamos National Laboratory 2023
Applied Machine Learning Summer Fellowship from Los Alamos National Laboratory 2022
Independent Study in Computational Chemistry at University of St. Mary, 2016

HONORS AND AWARDS

Imaging Science Pathway Fellow NIH funded training fellowship, 2022-2023
Distinction in Mathematics Awards from the Washington University in St. Louis Math Department 2020
Dean's List: *Recognition of exceptional undergraduate scholarship* Fall 2016, Spring 2017, Spring 2019, Fall 2019

PUBLICATIONS

L. Lozenski, R. Cam, M. Anastasio, U. Villa, "ProxNF: Neural Field Proximal Training for High-Resolution 4D Dynamic Image Reconstruction" (In preparation)
L. Lozenski, H. Wang, F. Li, M. Anastasio, B. Wohlberg, Y.Lin, U. Villa "Learned Full Waveform Inversion Incorporating Task Information for Ultrasound Computed Tomography" IEEE Transactions on Computational Imaging (2024)[journal]
L. Lozenski, H. Wang, B. Wohlberg, U. Villa, Y. Lin,"Data-Driven Methods for Ultrasound Computed Tomography" Medical Imaging 2023: Physics of Medical Imaging. Vol 12463. SPIE, 2023.
B. Liang, J. Tan, L. Lozenski, D. Hormuth, T. Yankeelov, U. Villa, D. Faghihi "Bayesian Inference of Tissue Heterogeneity for Prediction of Glioma Growth" IEEE Transactions on Medical Imaging (2023) [journal]
L. Lozenski, M. Anastasio, U. Villa, "A Memory-Efficient Self-Supervised Dynamic Image Reconstruction Method using Neural Fields" IEEE Transactions on Computational Imaging (2022) [journal]
L. Lozenski, M. Anastasio, U.Villa, "Neural Fields for Dynamic Imaging" Medical Imaging 2022: Physics of Medical Imaging. Vol. 12031. SPIE, 2022.
L. Lozenski, U. Villa, "Consensus ADMM for inverse problems governed by multiple PDE Models", ArXiv Preprint arXiv:2104.13899 (2021) [preprint]
M. Watanabe, and L. Lozenski, "Thermodynamics study of absorption of aromatic organic compounds to carbon nanotubes." Abstracts of Papers of the American Chemical Society. Vol. 251. 1155

ORAL PRESENTATIONS

"Learned measurement correction for simplified acoustic forward models in ultrasound computed tomography" SPIE Medical Imaging 2024, San Diego, CA, US February 19, 2024,

"Accurate Efficient Multispectral Spatiotemporal Image Reconstruction Using Neural Field Representations" Electronic Imaging 2024, San Francisco CA, US, January 25, 2024
"Proximal Splitting Methods for Neural Field Based Dynamic-Image Reconstruction" SIAM Optimization 2023, Seattle, WA, US, June 2, 2023
"Proximal Splitting Methods for Neural Field Based Dynamic-Image Reconstruction" WashU Imaging Science Retreat 2023, St. Louis MO,, US, March 30, 2023
"Data-driven Methods for Ultrasound Computed Tomography" SPIE Medical Imaging 2023, San Diego, CA, US February 21, 2023,
"Neural Fields for Dynamic Imaging" SPIE Medical Imaging 2022, San Diego, CA, US February 23, 2022
"Consensus ADMM for Inverse Problems Governed by Multiple PDE Models" FEniCS 2021 Conference Proceedings (pg. 749). Virtual. March 22- 26, 2021

POSTER PRESENTATIONS

Lozenski, L., Villa, U., "Neural Fields for Dynamic Imaging" WashU Imaging Sciences Pathway Retreat 2022
Lozenski, L., Villa, U., "Implicit Neural Representations for Dynamic Photoacoustic Tomography Imaging" WashU ESE Research Showcase 2021
Datta, A., Lozenski, L., Xiao J., Villa, U., "Learning from data through the lens of mathematical models" WashU ESE Research Showcase 2020

RESEARCH EXPERIENCE

Learned Measurement Correction for Simplified Acoustic Forward Models in USCT June 2023-

- Work done during summer internship at Los Alamos National Laboratory under supervision of Youzuo Lin
- Development of convolutional neural network for model correction from accurate USCT data for inversion using a simplified physical model.
- Combines state of the art machine learning approaches with traditional model guided reconstruction methods

Proximal Splitting Methods for Neural Field Based Dynamic-Image Reconstruction March 2022-

- Development of scalable, memory-efficient dynamic image reconstruction algorithms using neural fields to represent 5D images
- Application to photoacoustic dynamic imaging (circular Radon transform)
- Implementation of algorithm in PyTorch and comparison with compressed sensing (low-rank based dynamic image reconstruction algorithms)

Learned Full Waveform Inversion Incorporating Task Information for USCT June 2022-August 2023

- Applied Machine Learning Fellowship at Los Alamos National Laboratory under supervision of Youzuo Lin
- Development of convolutional neural network for data driven solutions to USCT inverse problems
- Machine learning framework using PyTorch on GPU and HPC clusters

Neural Field for Dynamic Imaging March 2021-September 2022

- Development of scalable, memory-efficient dynamic image reconstruction algorithms using neural fields
- Application to photoacoustic dynamic imaging (circular Radon transform)
- Implementation of algorithm in PyTorch and comparison with compressed sensing (low-rank based dynamic image reconstruction algorithms)

Inversion Algorithms for Photoacoustic Tomography Applications in Biological Tissue June 2019-

- Development of techniques for image reconstruction of biological tissue optical absorption properties
- Python implementation utilizing Fenics and hiPPylib for solving inverse problems
- Collaboration with Dr. Mark Anastasio at University of Illinois at Urbana-Champaign

Consensus ADMM for Inverse Problems Governed by Multiple PDE Forward Models May 2020-August 2021

- Solution methods for inverse problems with multiple PDE forward models and nonsmooth regularization
- Implemented the alternating direction method of multipliers (ADMM) with demonstrated scalability with respect to problem size and number of PDE forward models

Bayesian Inference of Tissue Heterogeneity for Glioma Growth May 2020-April 2023

- Investigation on modeling tumor growth under the effects of radiotherapy as a time-dependent PDE
- Collaboration with Dr. Danial Faghihi at the University at Buffalo.

TEACHING EXPERIENCE

Washington University

Assistant Instructor– E35 ESE Optimization (Dr. Tunay) August 2023-December 2024
Assistant Instructor– E35 ESE Large-Scale Optimization (Dr. Kamilov) August 2023-December 2024
Assistant Instructor– E35 ESE 5931Mathematics of Imaging Science (Dr. Jha) August 2022-December 2022
Assistant Instructor– E35 ESE 524 Detection and Estimation Theory (Dr. Nehorai) January 2022-May 2022
Assistant Instructor– E35 ESE 520 Probability and Stochastic Processes (Dr. Kurenok) January 2021-May 2021

RELEVANT COURSEWORK

Optimization

- Large-Scale Optimization for Data Science E81 CSE 534A
- Optimization and Optimal Control E35 ESE 544
- Convex Optimization E35 ESE 519

Imaging Science

- Biological Imaging Technologies E62 BME 589
- Imaging Science Series E35 ESE 5931-5933 Mathematics, Computation and Theory of Imaging Science
- Mathematics of Imaging Science, Computational Methods for Imaging Science, Theoretical Imaging Science

Probability and Statistics

- Detection and Estimation Theory E35 ESE 524
- Probability and Stochastic Processes E35 ESE 520
- Advanced Systems Science for Learning and Control of Stochastic Dynamic Systems ESE 5581

Mathematics and Systems Analysis

- Data-Integrated Frameworks for Systems Analysis and Control Design E35 ESE 559
- Linear/Nonlinear Dynamic Systems E35 ESE 551-552
- Harmonic Analysis L24 Math 519
- Geometry/Topology L24 Math5045- 5047
- Measure Theory and Functional Analysis L24 Math 5051-5052

COMPUTER SKILLS

- Expert in Python and skilled in use of a wide variety of packages
    - Expert knowledge of PyTorch, an open source machine learning library
    - Experience with Fenics, a parallel finite element program for solving PDEs
    - Experience with Devito, an optimized finite difference program for solving PDEs
    - Skilled with hiPPylib, a computational framework for solving inverse problems.
- Expert with MATLAB for numerical methods and data science
- Linux shell, computer clusters, and MPI parallel jobs

SERVICE

Peer review: contributed to peer review of scientific manuscripts for *Photacoustics* and *SoftwareX*
Graduate Student Advisory Board: Served on advisory board for graduate students in ESE department
Student Welcome Days: Lead and assisted events for admitted Ph.D. students and introduction events

PROFFESIONAL MEMBERSHIPS

IEEE. (*since 2021);* **SIAM.** (*since 2021);* **SPIE.** (*since 2021)*

REFERENCES

Dr. Umberto Villa, Research Scientist Oden Institute for Computational Engineering and Sciences, University of Texas at Austin uvilla@oden.utexas.edu *Ph.D. advisor*
Dr. Youzuo Lin, Scientist, Team Leader Geophysics Group, Los Alamos National Laboratory ylin@lanl.gov *Internship Advisor*