

Postdoctoral Associate, Computer Science and Artificial Intelligence Lab,  
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**Research Interests:** Biomedical Image Analysis, Data-efficient Machine Learning, Equivariant Networks

## Education

**Ph.D., Computer Science, New York University** 2017–2022

- Thesis: Better Visual Synthesis via Better Inductive Biases
- Thesis committee: Guido Gerig (advisor), Marc Niethammer, Daniel Rueckert, Sotirios Tsaftaris

**M.S., Electrical Engineering, New York University** 2015–2017

**B.E., Electronics & Telecommunications Engineering, University of Mumbai** 2010–2014

## Research experience

**Postdoctoral Associate, CSAIL, Massachusetts Institute of Technology, MA** 2022–now

- **PI: Polina Golland**
- Developing data-efficient representation learning and domain randomization methods to train networks that generalize to new datasets and tasks at test time with no retraining.
- Leading the development of a large-scale AI-based curation, annotation, and image analysis framework for tens of thousands of fetal and maternal MRI volumes with clinical partners at Harvard Medical School.

**Research Assistant, Computer Science & Engineering, New York University, NY** 2016–22

- **PI: Guido Gerig**
- Ph.D. research focused on data-efficient and prior-driven deep learning for image analysis via group-equivariant networks, generative adversarial networks, representation learning, and image registration.
- M.S. research (2016–17) developed robust non-negative tensor factorizations, nonlinear motion correction, and functional data analysis for multi-spectral microscopy analysis and molecular identification.

**Intern, Deep Learning Team, Hyperfine, NY** Summers 2020 & 2021

- Developed methods for self-supervised image enhancement (2020) and joint reconstruction and deformable registration (2021) on low-field 0.064T MRI, where standard MRI methods and deep networks fail.
- Research improved machine learning pipelines deployed in clinical settings and led to MICCAI, WACV, and Medical Image Analysis publications and several US patent applications.

**Image Data Science Intern, Merck Research Laboratories, Merck & Co., NJ** Summer 2019

- Developed equivariant generative adversarial networks, with parts of methodology published in ICLR.
- Methods improved data augmentation for digital pathology and oncology imaging pipelines.

**Graduate Assistant, Soil Mechanics Lab, New York University, NY** Spring 2016

- Deployed stereo-vision techniques for tracking quartz particle flow in oil under varying tunnel pressure.
- Enabled a civil engineering team to quantify displacements in physical toy models of underground tunnels.

## Awards

### Best paper

- MIDL 2023 Best Oral Paper Award 2023
- ISBI 2021 Best Student Paper Finalist 2021

### Outstanding Reviewer

- ICCV Outstanding Reviewer 2023
- CVPR Outstanding Reviewer 2022, 2023
- ECCV Outstanding Reviewer 2022
- MICCAI Outstanding Reviewer (top 1% of reviewers) 2020, 2021
- MICCAI Outstanding Reviewer Honorable Mention 2022, 2023

## Academic

- Pearl Brownstein Doctoral Research Award from NYU CSE for “*doctoral research which shows the greatest promise*” (equivalent to best departmental Ph.D. thesis at NYU CSE) 2022
- Deborah Rosenthal, MD Award for “*Outstanding Performance on the Ph.D. Qualifying Exam*” (given to 1–2 qualifying students each year in the NYU CSE department) 2019
- NYU School of Engineering Ph.D. Fellowship 2017
- NYU Electrical and Computer Engineering Graduate Student Scholarship 2015

## Publications

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### In submission

**Neel Dey**, Benjamin Billot, Hallee E. Wong, Clinton J. Wang, Mengwei Ren, P. Ellen Grant, Adrian V. Dalca, and Polina Golland

“Learning General-purpose Biomedical Volume Representations using Randomized Synthesis”

*Under review* (2024), **Preprint available [here](#).**

### Journals and Full-length Conference Proceedings

[Inter-disciplinary context: ICLR, CVPR, ICCV, and NeurIPS are flagship venues for machine learning and vision, and MICCAI, IPMI, MIDL, MedIA, and TMI are the premier conferences and journals for biomedical imaging.]

**NeurIPS** Axel Elaldi, Guido Gerig, and **Neel Dey**

“Equivariant spatio-hemispherical networks for diffusion MRI deconvolution”

*Advances in Neural Information Processing Systems* (2024),

**Accepted, to appear.**

**CVPR** Vivek Gopalakrishnan, **Neel Dey**, and Polina Golland

“Intraoperative 2D/3D Image Registration via Differentiable X-ray Rendering”

*Computer Vision and Pattern Recognition* (2024).

**WACV** **Neel Dey**, S. Mazdak Abulnaga, Benjamin Billot, Esra Abaci Turk, P. Ellen Grant, Adrian V. Dalca, and Polina Golland

“AnyStar: Domain randomized universal star-convex 3D instance segmentation”

*Winter Conference on Applications of Computer Vision* (2024).

**TMI** Benjamin Billot, **Neel Dey**, Daniel Moyer, Malte Hoffmann, Esra Abaci Turk, Borjan Gagoski, Ellen Grant, and Polina Golland

“SE(3)-Equivariant and Noise-Invariant 3D Motion Tracking in Medical Images”

*Transactions on Medical Imaging* (2024), Impact factor: 10.6.

**MIDL** Benjamin Billot, **Neel Dey**, Esra Abaci Turk, Ellen Grant, and Polina Golland

“Network conditioning for synergistic learning on partial annotations”

*Medical Imaging with Deep Learning* (2024),

**Oral presentation.**

**MIDL** Axel Elaldi, Guido Gerig, and **Neel Dey**

“ $E(3) \times SO(3)$ -Equivariant Networks for Spherical Deconvolution in Diffusion MRI”

*Medical Imaging with Deep Learning* (2023),

**Oral presentation. Invited for journal extension (top 6 papers out of 181 submissions).**

**MIDL** Nalini M. Singh, **Neel Dey**, Malte Hoffmann, Bruce Fischl, Elfar Adalsteinsson, Robert Frost, Adrian V. Dalca, and Polina Golland

“Data Consistent Deep Rigid MRI Motion Correction”

*Medical Imaging with Deep Learning* (2023),

**Best oral paper. Invited for journal extension (top 6 papers out of 181 submissions).**

**MICCAI** Neerav Karani, **Neel Dey**, and Polina Golland

“Boundary-weighted logit consistency improves calibration of segmentation networks”

*Medical Image Computing and Computer-Assisted Intervention* (2023),

**Early accept.**

**IPMI** Amin Nejatbakhsh, **Neel Dey**, Vivek Venkatachalam, Eviatar Yemini, Liam Paninski, and Erdem Varol  
“Learning Probabilistic Piecewise Rigid Atlases of Model Organisms via Generative Deep Networks”  
*Information Processing in Medical Imaging* (2023),

**Oral presentation.**

**WACV** Bo Zhou, **Neel Dey**, Jo Schlemper, S. Sadegh Mohseni Salehi, Chi Liu, James S Duncan, and Michal Sofka

“DSFormer: A dual-domain self-supervised transformer for accelerated multi-contrast MRI reconstruction”

*Winter Conference on Applications of Computer Vision* (2023).

**MICCAI** **Neel Dey**, Jo Schlemper, Seyed Sadegh Mohseni Salehi, Bo Zhou, Guido Gerig, and Michal Sofka

“ContraReg: Contrastive learning of multi-modality unsupervised deformable image registration”

*Medical Image Computing and Computer-Assisted Intervention* (2022),

**Travel award.**

**NeurIPS** Mengwei Ren, **Neel Dey**, Martin Styner, Kelly Botteron, and Guido Gerig

“Local spatiotemporal representation learning for longitudinally-consistent neuroimage analysis”

*Advances in Neural Information Processing Systems* (2022),

**Oral presentation.**

**MedIA** Bo Zhou, Jo Schlemper, **Neel Dey**, Seyed Sadegh Mohseni Salehi, Kevin Sheth, Chi Liu, James S Duncan, and Michal Sofka

“Dual-domain self-supervised learning for accelerated non-cartesian mri reconstruction”

*Medical Image Analysis* (2022), Impact factor: 10.9.

**ICLR** **Neel Dey**, Antong Chen, and Soheil Ghafurian

“Group Equivariant Generative Adversarial Networks”

*International Conference on Learning Representations* (2021).

**ICCV** **Neel Dey**, Mengwei Ren, Adrian V. Dalca, and Guido Gerig

“Generative adversarial registration for improved conditional deformable templates”

*International Conference on Computer Vision* (2021).

**IPMI** Axel Elaldi<sup>‡</sup>, **Neel Dey**<sup>‡</sup>, Heejong Kim, and Guido Gerig

“Equivariant spherical deconvolution: Learning sparse orientation distribution functions from spherical data”

*Information Processing in Medical Imaging* (2021),

<sup>‡</sup> **Equal contribution.**

**TMI** Mengwei Ren<sup>‡</sup>, **Neel Dey**<sup>‡</sup>, James Fishbaugh, and Guido Gerig

“Segmentation-renormalized deep feature modulation for unpaired image harmonization”

*IEEE Transactions on Medical Imaging* (2021), Impact factor: 10.6.

<sup>‡</sup> **Equal contribution.**

**ISBI** Shijie Li, **Neel Dey**, Katharina Bermond, Leon Von Der Emde, Christine A. Curcio, Thomas Ach, and Guido Gerig

“Point-supervised segmentation of microscopy images and volumes via objectness regularization”

*International Symposium on Biomedical Imaging* (2021),

**Best student paper finalist (3rd place).**

**MICCAI** Mengwei Ren, Heejong Kim, **Neel Dey**, and Guido Gerig

“Q-space conditioned translation networks for directional synthesis of diffusion weighted images from multi-modal structural MRI”

*Medical Image Computing and Computer Assisted Intervention* (2021),

**Oral presentation.**

**MedIA Neel Dey**, Sungmin Hong, Thomas Ach, Yiannis Koutalos, Christine A. Curcio, R. Theodore Smith, and Guido Gerig  
“Tensor decomposition of hyperspectral images to study autofluorescence in age-related macular degeneration”  
*Medical image analysis* (2019), Impact factor: 10.9.

**MICCAI Neel Dey**, Jeffrey Messinger, R. Theodore Smith, Christine A. Curcio, and Guido Gerig  
“Robust non-negative tensor factorization, diffeomorphic motion correction, and functional statistics to understand fixation in fluorescence microscopy”  
*Medical Image Computing and Computer-Assisted Intervention* (2019),  
**Early accept.**

**SPIE Neel Dey**, Shijie Li, Katharina Bermond, Rainer Heintzmann, Christine A. Curcio, Thomas Ach, and Guido Gerig  
“Multi-modal image fusion for multispectral super-resolution in microscopy”  
*Medical Imaging: Image Processing* (2019),  
**Oral presentation.**

## Peer Reviewed Workshops

**MedIPS Zeen Chi**, Zhongxiao Cong, Clinton J. Wang, Yingchen Liu, Esra Abaci Turk, Ellen Grant, Mazdak Abulnaga, Polina Golland, and **Neel Dey**  
“Dynamic Neural Fields for Learning Atlases of 4D Fetal MRI Time-series”  
*Medical Imaging meets NeurIPS workshop* (2023).

**AMAI Satyananda Kashyap**, Neerav Karani, Alexander Shang, Niharika D’Souza, **Neel Dey**, Lay Jain, Ray Wang, Hatice Akakin, Qian Li, Wenguang Li, et al.  
“Feature Selection for Malapposition Detection in Intravascular Ultrasound-A Comparative Study”  
*International Workshop on Applications of Medical AI at MICCAI* (2023).

**OMIA Guillaume Gisbert**, **Neel Dey**, Hiroshi Ishikawa, Joel Schuman, James Fishbaugh, and Guido Gerig  
“Self-supervised denoising via diffeomorphic template estimation: application to optical coherence tomography”  
*Ophthalmic Medical Image Analysis Workshop at MICCAI* (2020).

## Patents

**USPTO Neel Dey**, Jo Schlemper, S. Sadegh Mohseni Salehi, Li Yao, and Michal Sofka  
“Unsupervised contrastive learning for deformable and diffeomorphic multimodality image registration”  
*US Patent Application 18/611,128, pending* (2024).

**USPTO Bo Zhou**, Jo Schlemper, **Neel Dey**, and Michal Sofka  
“Dual-domain self-supervised learning for accelerated non-cartesian magnetic resonance imaging reconstruction”  
*US Patent Application 18/597,629, pending* (2024).

**USPTO Neel Dey**, Jo Schlemper, S. Sadegh Mohseni Salehi, Michal Sofka, and Prantik Kundu  
“Deep Learning Methods for Noise Suppression in Medical Imaging”  
*US Patent Application 17/496,104, pending* (2021).

## Academic Service and Leadership

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### **Organizing Committee**

◦ Boston Medical Imaging Workshop 2023

### **Area Chair**

◦ ML4H: Machine Learning for Health Symposium 2024  
◦ CHIL: Conference on Health, Inference and Learning 2024

### **Technical Reviewer**

- ICLR: International Conference on Learning Representations 2024–25
- CVPR: Computer Vision and Pattern Recognition 2022–24
- NeurIPS: Neural Information Processing Systems 2023
- ICCV: International Conference on Computer Vision 2023
- WACV: Winter Conference on Applications of Computer Vision 2023
- MICCAI: Medical Image Computing and Computer Assisted Interventions 2020–23
- MIDL: Medical Imaging with Deep Learning 2022–23
- MedIA: Medical Image Analysis 2023
- ECCV: European Conference on Computer Vision 2022
- TPAMI: Transactions on Pattern Analysis and Machine Intelligence 2020, 2022
- MELBA: The Journal of Machine Learning for Biomedical Imaging 2022
- MedNeurIPS: Medical Imaging meets NeurIPS 2022–23
- TMI: Transactions on Medical Imaging 2020
- ISBI: International Symposium on Biomedical Imaging 2018–20
- Neuroinformatics 2017

### Miscellaneous

- Graduate Student Mentor for NYU ECE helping MS students navigate research opportunities 2017

### Press

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- AI-ready Healthcare podcast interview (link) 2023
- MIT News (link), featuring our MIDL 2023 paper on MRI motion correction 2023
- NYU “The Future Of” podcast (link), discussing my early Ph.D. research 2019
- NYU press release (link) featuring my MS research career 2017

### Invited talks

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#### Representations Learnt from Synthetic Volumes Enable Training-free Medical Image Analysis

- PICS Colloquium, Penn Institute for Computational Sciences, University of Pennsylvania 2024
- Siemens Healthineers, Princeton, NJ 2024
- Sabuncu Lab, Cornell Tech and Weill Cornell Medicine 2024
- Laboratory for Computational Neuroimaging, Martinos Center, Harvard Medical School 2024
- Visual Computing Seminar, MIT 2024
- Laboratory for Ex vivo Modeling of Neuroanatomy, Martinos Center, Harvard Medical School 2024
- Clinical and Applied Machine Learning group, CSAIL, MIT 2024

#### Multi-scale Dense Representation Learning

- Jonasson Seminar, Division of Biomedical Imaging, KTH Royal Institute of Technology 2024
- Deep Learning Seminar, Biomedical Engineering & Radiology, Yale University 2023
- Surgical Planning Laboratory, Brigham and Women’s Hospital 2022
- Lab for Computational Neuroimaging, Martinos Center, Harvard Medical School 2022
- Biomedical Image Analysis Seminar, CSAIL, MIT 2022

#### Generative Deep Learning for Atlas Construction and Deformable Registration

- Machine Learning Team, National Institute of Mental Health 2022
- Sabuncu Lab, Cornell Tech and Weill Cornell Medicine 2022
- NYU Radiology, Grossman School of Medicine 2022
- VoxelTalk seminar series, MIT/Harvard Medical School 2021

#### Tensor factorization of multispectral images to study Age-related Macular Degeneration

- ARVO’18 Special Interest Group: ”Next-gen Autofluorescence Imaging: let’s get ready!” 2018
- NYU Tandon CS-GY 6923 (Graduate Machine Learning) 2017

### Student Mentorship

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Massachusetts Institute of Technology  
*co-supervised with Polina Golland*

Sept 2022–now

- *Zeen Chi, Zhongxiao Cong, MIT Undergraduate Research Opportunities Program (UROP):* 2023  
Learning biomedical atlases with neural fields.  
Published (as senior author) at the MedNeurIPS 2023 workshop.
- *Lay Jain, MEng thesis:* 2022-23  
Unsupervised learning for medical image time-series (co-supervised w/ Neerav Karani).
- *Haimoshri Das, MEng thesis:* 2022-23  
Joint registration and segmentation of placental image time-series.
- *Runqian (Ray) Wang, MIT Undergraduate Research Opportunities Program (UROP):* 2022-23  
Intravascular ultrasound time-series classification in collaboration with IBM Research and Boston Scientific.  
Published at the MICCAI AMAI 2023 workshop.

**New York University** 2017–22

*co-supervised with Guido Gerig*

- *Russell Wustenberg, MS thesis:* 2021–22  
Polyrigid kinematic modeling of carpal bone dynamics from low-resolution dynamic MRI.
- *Shijie Li, predoctoral research:* 2018–20  
Click-supervised semantic segmentation in 2D digital pathology and 3D fluorescence microscopy.  
Published at ISBI 2021 and won 3rd place for best student paper.
- *Guillaume Gisbert, 1-year BS/MS internship:* 2019–20  
Structured noise removal in dynamic OCT images using deformable templates and deep unsupervised denoising.  
Published at the MICCAI OMIA 2020 workshop.
- *Michelle La, MS thesis:* 2019–20  
Joint representations of fluorescence lifetime images and multi-spectral fluorescence microscopy of retinal tissue.
- *Shishir Lakshminarayan, MS capstone project:* 2017  
A user interface for joint registration and tensor factorization of multi-spectral fluorescence microscopy images.