Neel Dey

Curriculum Vitae

Postdoctoral Associate, Computer Science and Artificial Intelligence Lab, dey@mit.edu
Massachusetts Institute of Technology www.neeldey.com

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.
- Developing fetal and maternal image analysis methods for non-invasive spatiotemporal MRI *in utero*.

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 displacement quantification 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

Journals and Full-length Conference Proceedings

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

CVPR Vivek Gopalakrishnan, **Neel Dey**, and Polina Golland
"Intraoperative 2D/3D Image Registration via Differentiable X-ray Rendering"
Computer Vision and Pattern Recognition (2024), Accepted. Preprint available as arXiv cs.CV 2312.06358.

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).

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‡, **Neel Dey**‡, Heejong Kim, and Guido Gerig
"Equivariant spherical deconvolution: Learning sparse orientation distribution functions from spherical data"
Information Processing in Medical Imaging (2021),
‡ **Equal contribution.**

TMI Mengwei Ren‡, **Neel Dey**‡, James Fishbaugh, and Guido Gerig
"Segmentation-renormalized deep feature modulation for unpaired image harmonization"
IEEE Transactions on Medical Imaging (2021), Impact factor: 10.6.
‡ **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), to appear.

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"
Application PCT/US2022/044288, pending (2022).

USPTO **Neel Dey**, Jo Schlemper, S. Sadegh Mohseni Salehi, Michal Sofka, and Prantik Kundu
"Deep Learning Methods for Noise Suppression in Medical Imaging"
Application PCT/US2021/053918, pending (2021).

Pre-prints

arXiv Benjamin Billot, Daniel Moyer, **Neel Dey**, Malte Hoffmann, Esra Abaci Turk, Borjan Gagoski, Ellen Grant, and Polina Golland
"SE(3)-Equivariant and Noise-Invariant 3D Motion Tracking in Medical Images"
arXiv eees.IV 2312.13534 (2023), currently under review.

Academic Service and Leadership

Organizing Committee

- Boston Medical Imaging Workshop 2023

Area Chair

- CHIL: Conference on Health, Inference and Learning 2024

Technical Reviewer

- ICLR: International Conference on Learning Representations 2024
- 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

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

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 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

Massachusetts Institute of Technology Sept 2022–now
co-supervised with Polina Golland

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