

# Jiaming Liu

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## RESEARCH INTERESTS

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Computer Vision, Computational Imaging, Deep Learning, Signal/Image Processing, Large-scale Optimization.

## EDUCATION

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Washington University in St. Louis (WUSTL), St. Louis, MO, USA Ph.D. student in Electrical & Systems Engineering Advisor: Prof. Ulugbek Kamilov	Aug. 2019 – Expected 2023
WUSTL, St. Louis, MO, USA M.S. in Electrical & Systems Engineering	Aug. 2017 – Dec. 2018
University of Electronic Science and Technology of China (UESTC), Chengdu, China B.S. in Electronic and Information Engineering	Sep. 2013 – Jun. 2017

## WORK EXPERIENCE

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Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, USA Research Intern Mentor: Dr. Tim Marks	May. 2023 – Aug. 2023
Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA Research Intern Mentor: Dr. Rushil Anirudh	Jun. 2022 – Aug. 2022
Los Alamos National Laboratory (LANL), Los Alamos, NM, USA Research Intern Mentor: Dr. Brendt Wohlberg	Jun. 2021 – Aug. 2021

## AWARDS & HONORS

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NeurIPS 2022 Scholar Award, NeurIPS 2019 Travel Award, WUSTL Dean's Select PhD Fellowship, 2019

## RESEARCH EXPERIENCE

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- Model-based Deep Learning Methods
  - Proposed DOLCE, a new conditional *diffusion probabilistic model* based framework for limited-angle computational tomography. This work was performed on LLNL HPC with distributed training.
  - Proposed ODER, a first *online deep equilibrium RED* framework for data-intensive imaging modalities that adopts stochastic processing of measurements within an implicit neural network.
  - Provided a *coordinate-based internal learning* (CoIL) method for continuously representation of the measurement field, inspired by neural representation fields (NeRF).
  - Proposed and analyzed SGD-Net as a new methodology for improving the efficiency of deep unfolding through stochastic approximations of the data-consistency layers.

- Proposed RARE algorithm to broaden the current denoiser-centric view of RED by considering priors corresponding to networks trained for more general artifact-removal on datasets containing only undersampled measurements.
- Proposed to considerably improve the performance and stability of deep image prior (DIP) by incorporating traditional total variation (TV) regularization.
- Plug-and-Play priors (PnP) and Regularization by Denoising (RED)
  - Established theoretical recovery guarantees for PnP by assuming that the solution of these methods lies near the fixed-points of a deep neural network (i.e. denoisers and artifact removal operators).
  - Studied and provided a practically efficient denoiser scaling technique to explicitly control the amount of PnP regularization (noise level  $\sigma$ ).
  - Improved RED efficiency by providing various scalable RED algorithms for large-scale image reconstruction, including stochastic, block-coordinate, and asynchronous distributed variants.
  - Proposed a new Calibrated RED (Cal-RED) method that enables joint calibration of the measurement operator along with reconstruction of the unknown image.

## SELECTED PUBLICATIONS

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(\* indicates equal contribution)

### Preprints

- [1] S. Shoushtari\*, J. Liu\*, and U. S. Kamilov, “DOLPH: Diffusion Models for Phase Retrieval.” arXiv:2211.00529, 2022.

### Published

- [1] J. Liu, R. Anirudh, J. J. Thiagarajan, S. He, K. A. Mohan, U. S. Kamilov, and H. Kim, “DOLCE: A Model-Based Probabilistic Diffusion Framework for Limited-Angle CT Reconstruction.” ICCV 2023, [Acceptance rate: 2160/8088 = 27%], in press.
- [2] Z. Zou\*, J. Liu\*, B. Wohlberg, and U. S. Kamilov, “Deep Equilibrium Learning of Explicit Regularization Functionals for Imaging Inverse Problems.” IEEE Open J. Signal Process., in press.
- [3] T. Kerepecky, J. Liu, X.W. Ng, D.W. Piston, and U.S. Kamilov, “Dual-Cycle: Self-Supervised Dual-View Fluorescence Microscopy Image Reconstruction using CycleGAN.” Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (ICASSP 2023).
- [4] J. Liu, R. Hyder, M.S. Asif, and U.S. Kamilov, “Chapter 3 - Optimization Algorithms for MR Reconstruction.” Advances in Magnetic Resonance Technology and Applications, vol 7, pp. 59–72, 2022.
- [5] S. Shoushtari, J. Liu, Y. Hu, and U. S. Kamilov, “Deep Model-Based Architectures for Inverse Problems under Mismatched Priors.” IEEE J. Sel. Areas Inf. Theory., pp. 1–1, 2022.
- [6] Z. Zhang, J. Liu and D. Yang and U.S. Kamilov, and G. Hugo, “Best in Physics (Imaging): Deep Learning-Based Motion Compensation for 4D-CBCT Reconstruction.” Medical Physics, vol 49, 2022.
- [7] J. Liu\*, X. Xu\*, W. Gan, S. Shoushtari, and U. S. Kamilov, “Online Deep Equilibrium Learning for Regularization by Denoising.” NeurIPS 2022, [Acceptance rate: 2665/10411 = 26%].
- [8] Y. Sun, J. Liu, M. Xie, B. Wohlberg, and U. S. Kamilov, “CoIL: Coordinate-Based Internal Learning for Tomographic Imaging.” IEEE Trans. Comput. Imag., vol 7, pp. 1400-1412, 2021.
- [9] J. Liu, M. S. Asif, B. Wohlberg, and U. S. Kamilov, “Recovery Analysis for Plug-and-Play Priors using the Restricted Eigenvalue Condition.” NeurIPS 2021, [Acceptance rate: 2371/9122 = 26%].
- [10] J. Liu\*, M. Xie\*, Y. Sun, W. Gan, B. Wohlberg, and U. S. Kamilov, “Joint Reconstruction and Calibration using Regularization by Denoising with Application to Computed Tomography.” ICCV Workshop 2021 [Oral].
- [11] W. Gan, Y. Hu, C. Eldeniz, J. Liu, Y. Chen, H. An, and U. S. Kamilov, “SS-JIRCS: Self-Supervised Joint Image Reconstruction and Coil Sensitivity Calibration in Parallel MRI without Ground Truth,” ICCV Workshop 2021.

- [12] J. Liu, Y. Sun, W. Gan, X. Xu, B. Wohlberg, and U. S. Kamilov, "SGD-Net: Efficient Model-Based Deep Learning with Theoretical Guarantees." *IEEE Trans. Comput. Imag.*, vol 7, pp. 598-610, 2021.
- [13] J. Liu, Y. Sun, W. Gan, X. Xu, B. Wohlberg, and U. S. Kamilov, "Stochastic Deep Unfolding for Imaging Inverse Problems." *Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (ICASSP 2021)*.
- [14] Y. Sun, J. Liu, Y. Sun, B. Wohlberg, and U. S. Kamilov, "Async-RED: A Provably Convergent Asynchronous Block Parallel Stochastic Method using Deep Denoising Priors." *ICLR 2021*, [Spotlight: 114/2997 = 4%].
- [15] X. Xu, Y. Sun, J. Liu, B. Wohlberg, and U. S. Kamilov, "Provable Convergence of Plug-and-Play Priors with MMSE Denoisers." *IEEE Signal Process. Lett.*, vol. 27, pp. 1280-1284, 2020.
- [16] W. Gan, Y. Sun, C. Eldeniz, J. Liu, H. An, and U. S. Kamilov, "Deep Image Reconstruction using Unregistered Measurements without Groundtruth," *Proc. Int. Symp. Biomedical Imaging 2021 (ISBI 2021)*, pp. 1531-1534.
- [17] J. Liu, Y. Sun, C. Eldeniz, W. Gan, H. An, and U. S. Kamilov, "RARE: Image Reconstruction using Deep Priors Learned without Ground Truth." *IEEE J. Sel. Topics Signal Process.*, pp. 1-1, 2020.
- [18] C. Eldeniz, W. Gan, S. Chen, T. J. Fraum, D. R. Ludwig, Y. Yan, J. Liu, T. Vahle, U. B. Krishnamurthy, U. S. Kamilov, and H. An, "Phase2Phase: Respiratory Motion-Resolved Reconstruction of Free-Breathing Magnetic Resonance Imaging Using Deep Learning Without a Ground Truth for Improved Liver Imaging," *Invest. Radiol.*, in press.
- [19] W. Gan, C. Eldeniz, J. Liu, H. An, and U. S. Kamilov, "Image Reconstruction for MRI using Deep CNN Priors Trained without Groundtruth," *Proc. 54th Asilomar Conf. Signals, Systems, & Computers*, 2020.
- [20] X. Xu, J. Liu, Y. Sun, B. Wohlberg, and U. S. Kamilov, "Boosting the Performance of Plug-and-Play Priors via Denoiser Scaling." *Proc. 54th Asilomar Conf. Signals, Systems, & Computers*, 2020.
- [21] Z. Wu, Y. Sun, A. Matlock, J. Liu, L. Tian, and U. S. Kamilov, "SIMBA: Scalable Inversion in Optical Tomography using Deep Denoising Priors." *IEEE J. Sel. Topics Signal Process.*, pp. 1-1, 2020.
- [22] Y. Sun\*, J. Liu\*, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." *IEEE Trans. Comput. Imag.*, vol 6, pp. 908-921, 2020.
- [23] M. Torop, S. Kothapalli, Y. Sun, J. Liu, S. Kahali, D. A. Yablonskiy, and U. S. Kamilov, "Deep Learning using a Biophysical Model for Robust and Accelerated Reconstruction of Quantitative, Artifact-free and Denoised  $R_2^*$  Images," *Magn. Reson. Med.*, vol 84, pp. 2932-2942, 2020.
- [24] G. Song, Y. Sun, J. Liu, and U. S. Kamilov, "A New Recurrent Plug-and-Play Prior Based on the Multiple Self-Similarity Network." *IEEE Signal Process. Lett.*, vol.27, pp. 451-455, 2020.
- [25] J. Liu, Y. Sun, and U. S. Kamilov, "Infusing Learned Priors into Model-Based Multispectral Imaging." *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP 2019)*.
- [26] Y. Sun, J. Liu, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." *NeurIPS 2019*, [Acceptance rate: 1428/6743 = 21%].
- [27] Z. Wu, Y. Sun, J. Liu, and U. S. Kamilov, "Online Regularization by Denoising with Application to Phase Retrieval." *ICCV Workshop 2019*, [Oral].
- [28] J. Liu, Y. Sun, X. Xu, and U. S. Kamilov, "Image Restoration using Total Variation Regularized Deep Image Prior." *Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (ICASSP 2019)*, pp. 7715-7719.

## TECHNICAL SKILLS

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- Proficient with programming languages: Java, Python, C Programming, Matlab.
- Proficient with deep learning frameworks: Pytorch/Pytorch Lightning, TensorFlow, and Jax.
- Five years of experience in computer vision, deep learning, optimization, inverse problems and medical imaging.

- Fluency in imaging modality: single image super-resolution (SR), image deblur, compressive sensing, and tomography.

## APPLICABLE COURSEWORK

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| • <i>Sparse Modeling for Imaging and Vision</i> | • <i>Algorithms for Nonlinear Optimization</i> | • <i>Optimization</i>                  |
| • <i>Machine Learning</i>                       | • <i>Mathematics of Imaging Science</i>        | • <i>Stochastic Process</i>            |
| • <i>Probability and Stochastic Process</i>     | • <i>Digital Signal Processing</i>             | • <i>Digital Image Processing</i>      |
| • <i>Biological Imaging Technology</i>          | • <i>Topology</i>                              | • <i>Partial Differential Equation</i> |

## PROFESSIONAL SERVICES

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### Reviewer for journals

Neurocomputing, Neural Computing and Applications (NCAA), Optical Communication, IEEE Transactions on Image Processing (TIP), IEEE Transactions on Signal Processing (TSP), International Journal of Intelligent Systems (IJIS), IEEE Transactions on Computational Imaging (TCI), Applied Mathematical Modelling, Scientific Reports.

### Reviewer for conferences

International Conference on Machine Learning (ICML), International Conference on Learning Representations (ICLR), Neural Information Processing Systems (NeurIPS), IEEE/CVF Computer Vision and Pattern Recognition Conference (CVPR), IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), IEEE International Conference on Image Processing (ICIP), IEEE International Symposium on Biomedical Imaging (ISBI), IEEE/CVF International Conference on Computer Vision (ICCV / ICCV Workshop).

### Others

Student Member, IEEE Signal Processing Society (2019-present)

## TEACHING SERVICE

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### As Course Teaching Assistant:

- ESE 415 Optimization, Wash U. 2020 Spring, 2021 Spring.
- CSE 534 Large-Scale Optimization, Wash U. 2020 Fall, 2021 Fall, 2022 Fall.

## SUPERVISED STUDENTS

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### Current Students (Co-advised with Prof. Kamilov):

- Zihao Zou (M.S. ESE), *Now M.S. student at WUSTL*

### Former Students (Co-advised with Prof. Kamilov):

- Zichen Zhang (M.S. ESE), *Now M.S. student at WUSTL*
- Guangyu Meng (M.S. CSE), *Now Ph.D student at Uni. of Notre Dame*
- Jialu Wang (B.S. CSE) *Now B.S. student at WUSTL*
- Peter Ming (B.S. CSE), *Now in Google*
- Max Trop (M.S. CSE), *Now Ph.D student at Northeastern U.*
- Mingyang Xie (B.S. CSE), *Now Ph.D student at University of Maryland*
- Ziwen Wang (B.S. CSE), *Now B.S. student at WUSTL*