

# Jiaming Liu

Tel: (+1)314-203-5469  
Email: [jiaming.liu@wustl.edu](mailto:jiaming.liu@wustl.edu)  
Address: 9015 Eager Rd. APT 311,  
St. Louis, MO.  
Homepage: [jiamingliu.github.io](http://jiamingliu.github.io)  
Google Scholar: [scholar.google.com/jiaming.liu](https://scholar.google.com/jiaming.liu)

## RESEARCH INTERESTS

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Computational Imaging, Deep Learning, Signal Processing, Large-scale Optimization, Sparsity and Compressive Sensing.

## EDUCATION

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<b>Washington University in St. Louis (WUSTL)</b> , St. Louis, MO, USA Ph.D. student in Electrical & Systems Engineering Advisor: Prof. Ulugbek Kamilov	Aug. 2019 – Expected 2024
<b>WUSTL, St. Louis</b> , MO, USA M.S. in Electrical & Systems Engineering	Aug. 2017 – May 2019
<b>University of Electronic Science and Technology of China (UESTC)</b> , Chengdu, China B.S. in Electronic and Information Engineering Advisor: Prof. Zhiqin Zhao	Sep. 2013 – Jun. 2017

## WORK EXPERIENCE

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<b>Lawrence Livermore National Laboratory (LLNL)</b> , Livermore, CA, USA Research Intern Mentor: Dr. Rushil Anirudh	Jun. 2022 – Aug. 2022
<b>Los Alamos National Laboratory (LANL)</b> , 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 for Image Inverse Problem

- Proposed DOLCE, a new deep model-based framework for limited-angle computational tomography (LACT) that uses a conditional *denoising diffusion probabilistic model* (DDPM) as an image prior.
- Proposed ODER, a first *online deep equilibrium RED* framework for inverse problems 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.

## PUBLICATIONS

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(\*' indicates equal contribution)

### Published

- [1] **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.
- [2] 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.
- [3] 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.
- [4] **J. Liu\***, X. Xu\*, W. Gan, S. Shoushtari, and U. S. Kamilov, "Online Deep Equilibrium Learning for Regularization by Denoising." Proc. Ann. Conf. Neural Information Processing Systems (**NeurIPS 2022**), [Acceptance rate: 2665/10411 = 26%].
- [5] Y. Sun, **J. Liu**, M. Xie, B. Wohlberg, and U. S. Kamilov, "CoLL: Coordinate-Based Internal Learning for Tomographic Imaging." **IEEE Trans. Comput. Imag.**, vol 7, pp. 1400-1412, 2021.
- [6] **J. Liu**, M. S. Asif, B. Wohlberg, and U. S. Kamilov, "Recovery Analysis for Plug-and-Play Priors using the Restricted Eigenvalue Condition." Proc. Ann. Conf. Neural Information Processing Systems (**NeurIPS 2021**), [Acceptance rate: 2371/9122 = 26%].
- [7] **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." Proc. IEEE Int. Conf. Comp. Vis. Workshops (**ICCVW 2021**).
- [8] **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.
- [9] **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**).
- [10] 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." Proc. Int. Conf. Learn. Represent. (**ICLR 2021**), [Spotlight: 114/2997 = 4%].
- [11] 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.**
- [12] **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.
- [13] 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.
- [14] 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.

- [15] **J. Liu\***, Y. Sun\*, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." **IEEE Trans. Comput. Imag.**, vol 6, pp. 908-921, 2020.
- [16] 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.
- [17] **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**).
- [18] Y. Sun, **J. Liu**, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." Proc. Ann. Conf. Neural Information Processing Systems (**NeurIPS 2019**), [Acceptance rate: 1428/6743 = 21%].
- [19] Z. Wu, Y. Sun, **J. Liu**, and U. S. Kamilov, "Online Regularization by Denoising with Application to Phase Retrieval." Proc. IEEE Int. Conf. Comp. Vis. Workshops (**ICCVW 2019**), [Oral].
- [20] **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.

## Preprints

- [1] 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." arXiv:2209.11729, preprint, 2022.
- [2] S. Shoushtari\*, **J. Liu\***, and U. S. Kamilov, "DOLPH: Diffusion Models for Phase Retrieval." arXiv:2211.00529, preprint, 2022.
- [3] **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." arXiv:2211.12340, preprint, 2022.

## 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>                              |                                   |

## PROFESSIONAL SERVICES

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### Reviewer for journals

Neurocomputing, 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.

### 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 Workshops (**ICCVW**).

### Others

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