Yu Sun

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BIOGRAPHY

I am a **third-year Ph.D.** student at the Department of CSE, **Washington University in St. Louis (Wash U)**, working under the supervision of **Dr. Ulugbek Kamilov**. I am currently working on efficient optimization frameworks for large-scale inverse problems by using trainable deep learning priors. The applications include image reconstruction from big noisy data, such as optical imaging and tomography. My research covers both algorithmic design and theoretical proofs.

Reach Interests: Machine Learning, Convex/Non-convex Optimization, Deep Learning, Image Reconstruction.

EDUCATION

Washington University in St. Louis, St. Louis, MO   Aug. 2018 – Expected 2022
Ph.D. student in Computer Science
Advisor: Prof. Ulugbek Kamilov

Washington University in St. Louis, St. Louis, MO   Aug. 2015 – May. 2018
M.S. in Data Analytics & Statistics
M.S. in Computer Science & Engineering

Sichuan University, Chengdu, China   Sep. 2011 – Jun. 2015
B.S. in Electronic and Information Engineering
Advisor: Prof. Qinggong Guo

AWARDS

- NeurIPS 2019 Travel Award

- CSE Dept. Honor (top 10%), 2019-2020

TECHNICAL SKILLS

- Three years of experience in machine learning, deep learning, numerical analysis.

- Proficient with deep learning frameworks: TensorFlow, Pytorch, and Matlab.

- Proficient with programming languages: Python and Matlab.

RESEARCH EXPERIENCE

Graduate Research Assistant   Jan. 2018 – Current
Computational Imaging Group, Washington University in St. Louis

- *Deep Learning for Computational Imaging (see reference in Publication)*

  – First to propose a deep learning model for reconstructing high-quality images from multiple-scattered light measurements [b.7].

  – Improved the the performance and stability of the unsupervised earning approach —deep image prior (DIP)—by infusing the traditional total variation (TV) regularization [b.16].

  – Used deep learning for joint image reconstruction and registration (similar to the optical flow in video processing) without using the ground-truth images [b.17].

- *Plug-and-play priors (PnP)*
  - PnP generalized the proximal methods by replacing the proximal map with a (deep) denoiser for white Gaussian noise.
  - Proposed and analyzed multiple online/stochastic PnP algorithms and validated its performance on real microscope data [a.3, b.4, b.5, b.12].
  - Studied and designed a practically efficient way to fine-tune the denoising strength (noise level σ) of the deep learning denoiser used in PnP algorithms [b.16].

- *Regularization by Denoising (RED)*
  - Proposed and analyzed block-coordinate RED (BC-RED) for large-scale image recovery. The algorithm decomposes a large-scale signal recovery problem into a sequence of updates over a small subset of the unknown signal [b.2, b.3].
  - Extended BC-RED to asynchronous parallel settings where a cluster of CPUs is considered (Async-RED). O(1/t) Convergence is also proved under transparent assumptions [b.1].
  - Unrolling the gradient-based RED algorithm to build SGD-Net to allow fast and memory-efficient training [a.1].

PUBLICATIONS

Pre-print:

[a.1] J. Liu, **Y. Sun**, W. Gan, X. Xu, B. Wohlberg, and U. S. Kamilov, "SGD-Net: Efficient Model-Based Deep Learning with Theoretical Guarantees." arXiv:2101.09379, **preprint**, 2021

[a.2] M. Xie, **Y. Sun**, J. Liu, B. Wohlberg, U. S. Kamilov "Joint Reconstruction and Calibration using Regularization by Denoising." arXiv:2011.13391, **preprint**, 2020

[a.3] **Y. Sun**, Z. Wu, B. Wohlberg, and U. S. Kamilov, "Scalable Plug-and-Play ADMM with Convergence Guarantees." arXiv:1912.07087, **preprint**, 2020.

Published:

[b.1] **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." International Conference on Learning Representations **(ICLR 2021)**, in press. **[Spotlight: 114/2997 = 4%]**

[b.2] **Y. Sun**, J. Liu, and U. S. Kamilov, "Block Coordinate Regularization by Denoising," Proc. Ann. Conf. Neural Information Processing Systems (**NeurIPS 2019**), pp. 382–392. **[Acceptance rate: 1428/6743 = 21%]**

[b.3] **Y. Sun***, J. Liu*, and U. S. Kamilov, "Block Coordinate Regularization by Denoising," **IEEE Trans. Comput. Imag.**, vol. 6, pp. 908-921, 2020.

[b.4] **Y. Sun**, B. Wohlberg, and U. S. Kamilov, "An Online Plug-and-Play Algorithm for Regularized Image Reconstruction." **IEEE Trans. Comput. Imag.**, vol.5, no.3, pp.395-408, September 2019.

[b.5] **Y. Sun**, S. Xu, Y. Li, L. Tian, B. Wohlberg, and U. S. Kamilov, "Regularized Fourier Ptychography using an Online Plug-and-Play Algorithm," Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (**ICASSP 2019**), pp.7665-7669. [**Oral**]

[b.6] **Y. Sun**, B. Wohlberg, and U. S. Kamilov, "Plug-In Stochastic Gradient Method," Proc. International Biomedical and Astronomical Signal Processing Frontiers Workshop (**BASP 2019**), p.75.

[b.7] **Y. Sun**, Z. Xia, and U. S. Kamilov, "Efficient and accurate inversion of multiple scattering with deep learning," **Optics Express**, vol.26, no.11, pp.14678-14688, May 2018.

[b.8] **Y. Sun** and U. S. Kamilov, "Stability of Scattering Decoder For Nonlinear Diffractive Imaging," Proc. 4th International Traveling Workshop on Interactions between Sparse models and Technology (**iTWIST 2018**), p.31. [**Oral**]

[b.9] 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.**, vol. 14, no. 6, pp. 1088-1099, 2020.

[b.10] 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.**, vol. 14, no. 6, pp. 1163-1175, 2020.

[b.11] 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 (RoAR) of quantitative and artifact-free R2* images." **Magn. Reson. Med.**, vol. 84, pp. 2932-2942, 2020.

[b.12] 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.

[b.13] 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.

[b.14] 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**).

[b.15] Z. Wu, **Y. Sun**, J. Liu, and U. S. Kamilov, "Online Regularization by Denoising with Application to Phase Retrieval," Workshop on Learning for Computational Imaging, **ICCVW 2019**, pp. 3887-3895.

[b.16] 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.

[b.17] W. Gan, **Y. Sun**, C. Eldeniz, H. An and U. S. Kamilov, "Deep Image Reconstruction using Unregistered Measurements without Groundtruth." Proc. Int. Symp. Biomedical Imaging 2021 (ISBI 2021) (Nice, France, April 13-16), in press.

[b.18] 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 (**ACSSC 2020**), in press.

APPLICABLE COURSEWORK

- *Sparse Modeling for Imaging and Vision*
- *Machine Learning*
- *Probability and Stochastic Process*
- *Measure Theory*
- *Algorithms for Nonlinear Optimization*
- *Bayesian Methods in Machine Learning*
- *Topology*
- *Optimization*
- *Stochastic Process*
- *Real Analysis*

PROFESSIONAL SERVICES

- Reviewer for IEEE Journal of Selected Topics in Signal Processing (**JSTSP**), IEEE Transaction on Computational Imaging (**TCI**), IEEE Transaction on Signal Processing (**TSP**), IEEE Signal Processing Letters (**SPL**), Digital Signal Process (**DSP**), SPIE Journal on Electronic Imaging (**JEI**), International Joint Conference on Artificial Intelligence (**IJCAI**), IEEE International Conference on Acoustics, Speech and Signal Processing (**ICASSP**)

- Student Member, IEEE (2018-present)