Bao Wang

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Research

- General interests: deep learning and scientific computing.
- Specialization: recurrent neural nets, graph neural nets, data privacy, stochastic optimization, and computational chemistry.

Employment

- Assistant Professor. Department of Mathematics, University of Utah, 7/1/2020-present.
- Assistant Professor. Scientific Computing and Imaging Institute, University of Utah, 7/1/2020-present.
- PIC Assistant Adjunct Professor. Department of Mathematics, University of California, Los Angeles, 7/1/2018-06/30/2020.
- Assistant Adjunct Professor. Department of Mathematics, University of California, Los Angeles, 7/1/2016-6/30/2018.

Education

- Ph.D. Applied Mathematics, Michigan State University, USA, 2016.
- B.S. Mathematics, Suzhou University, China, 2012.

Awards

Chancellor's Award for Postdoctoral Research, University of California, 2020.

Grants

- NSF DMS-1924935, ATD: Collaborative Research: Robust, Accurate and Efficient Graph-Structured RNN for Spatio Temporal Forecasting and Anomaly Detection (2019-2022, PI, $120,000.)
- NSF DMS-1952339, FRG: Collaborative Research: Robust, Efficient, and Private Deep Learning Algorithms (2020-2023, co-PI, $434,750.)
- DoE DE-SC0021142, Trustworthy Physics-informed Deep Learning for Predictive Scientific Computing (2020-2022, co-PI, $300,000.)

Preprints

1. Tan M. Nguyen, Richard G. Baraniuk, Andrea L. Bertozzi, Stanley J. Osher, **Bao Wang**, "MomentumRNN: Integrating Momentum into Recurrent Neural Networks", *arXiv preprint.* `arXiv:2006.0691`. (2020).

2. Zhicong Liang, **Bao Wang**, Quanquan Gu, Stanley J. Osher, and Yuan Yao, "Exploring Private Federated Learning with Laplacian Smoothing", *arXiv preprint.* `arXiv:2005.00218`. (2020).

3. **Bao Wang***, Tan M. Nguyen*, Andrea L. Bertozzi, Richard Baraniuk, Stanley J. Osher, "Scheduled Restart Momentum for Accelerated Stochastic Gradient", *arXiv preprint.* `arXiv:2002.10583`. (2020).

4. **Bao Wang***, Difan Zou*, Quanquan Gu, and Stanley J. Osher, "Laplacian Smoothing Stochastic Gradient Markov Chain Monte Carlo", *arXiv preprint.* `arXiv:1911.00782`. (2019).

5. **Bao Wang**, and Stanley J. Osher, "Graph Interpolating Activation Improves Both Natural and Robust Accuracies in Data-Efficient Deep Learning", *arXiv preprint.* `arXiv:1907.06800`. (2019).

6. Lisa Maria Kreusser, Stanley J. Osher, and **Bao Wang**, "A Deterministic Approach to Avoid Saddle Points", *arXiv preprint.* `arXiv:1901.06827`. (2019).

7. Zehao Dou, Stanley Osher, and **Bao Wang**, "Mathematical Analysis of Adversarial Attacks", *arXiv preprint.* `arXiv:1811.06492`. (2018).

8. Zuoqiang Shi, **Bao Wang**, and Stanley Osher, "Error estimation of weighted nonlocal Laplacian on random point cloud", *arXiv preprint.* `arXiv:1809.08622`. (2018).

9. Stanley Osher, **Bao Wang**, Penghang Yin, Xiyang Luo, Minh Pham, and Alex Lin, "Laplacian Smoothing Gradient Descent", *arXiv preprint.* `arXiv:1806.06317`, (2018).

Peer-Reviewed Conference Publications

10. **Bao Wang**, Quanquan Gu, March Boedihardjo, Lingxiao Wang, Farzin Barekat, and Stanley J. Osher, "DP-LSSGD: A Stochastic Optimization Method to Lift the Utility in Privacy-Preserving ERM", *The 1st Mathematical and Scientific Machine Learning Conference (MSML)*, 328-351 (2020).

11. Thu Dinh*, **Bao Wang***, Andrea L. Bertozzi, Stanley J. Osher, Jack Xin, "Sparsity Meets Robustness: Channel Pruning for the Feynman-Kac Formalism Principled Robust Deep Neural Nets", *6th Int. Conf. on machine Learning, Optimization, and Data Science (LOD)*, (2020) (Oral).

12. **Bao Wang**, Zuoqiang Shi, and Stanley Osher, "ResNet Ensemble via the Feynman-Kac Formalism to Improve Both Natural and Robust Accurcies", *Advances in Neural Information Processing Systems (NeurIPS)*, 32, 1657-1667 (2019).

13. Zhijian Li, Xiyang Luo, **Bao Wang**, Andrea L. Bertozzi, and Jack Xin, "A Study on Graph-Structured Recurrent Neural Networks and Sparsification with Application to Epidemic Forecasting", *6th World Congress on Global Optimization (WCGO)*, 730-739, (2019).

14. **Bao Wang**, Xiyang Luo, Zhen Li, Wei Zhu, Zuoqiang Shi, and Stanley Osher, "Deep Neural Nets with Interpolating Function as Output Activation", *Advances in Neural Information Processing Systems (NeurIPS)*, 31, 749-759 (2018).

15. **Bao Wang***, Xiyang Luo*, Fangbo Zhang*, Baichuan Yuan, Andrea Bertozzi, and P. Jeffrey Brantingham, "Graph-based Deep Modeling and Real-time Forecasting of Sparse Spatio-temporal data", *Workshop on Mining and Learning from Time Series (MileTS), KDD*, (2018).

16. **Bao Wang**, Duo Zhang, Duanhao Zhang, P. Jeffrey Brantingham, and Andrea Bertozzi, "Deep Learning for Real-time Crime Forecasting", *2017 International Symposium on Nonlinear Theory and Its Applications (NOLTA)*, Cancun, Mexico, December 4-7, 330-333, (2017). (Best Paper Award–Final List)

Referred Journal Publications

17. Chueh-Yu Wu, **Bao Wang**, Joseph de Rutte, Alexis Joo, Matthew Jacobs, Kyung Ha, Andrea Bertozzi, and Dino Di Carlo, "Monodisperse Emulsions Templated by 3D-structured Microparticles", *Science Advances*, to appear, `bioRxiv doi 10.1101/2020.03.22.001065` (2020).

18. **Bao Wang**, Binjie Yuan, Zuoqiang Shi, and Stanley J. Osher, "EnResNet: ResNets Ensemble via the Feynman–Kac Formalism for Adversarial Defense and Beyond", *SIAM Journal on Mathematics of Data Science*, 2(3), 559-582, (2020).

19. **Bao Wang**, Alex Lin, Wei Zhu, Penghang Yin, Andrea Bertozzi, and Stanley Osher, "Adversarial Defense via Data-dependent Activation Function and Total Variation Minimization", *Inverse Problems and Imaging*, doi:10.3934/ipi.2020046 (2020).

20. Wei Zhu, Qiang Qiu, **Bao Wang**, Jianfeng Lu, Guillermo Sapiro, and Ingrid Daubechies, "Stop Memorizing: A Data-dependent Regularization Framework for Intrinsic Pattern Learning", *SIAM Journal on Mathematics of Data Science*, 3, 476-496, (2019).

21. **Bao Wang**, Penghang Yin, Andrea Bertozzi, P. Jeffrey Brantingham, Stanley Osher, and Jack Xin, "Deep Learning for Real-Time Crime Forecasting and its Ternarization", *Chinese Annals of Mathematics, Series B*, 40(6), 949-966, (2019).

22. Wei Zhu, **Bao Wang**, Richard Barnard, Cory Hauck, Frank Jenko, Stanley Osher, "Scientific Data Interpolation with Low Dimensional Manifold Model", *Journal of Computational Physics*, 352, 213-245 (2018).

23. **Bao Wang**, Chengzhang Wang, Kedi Wu and Guowei Wei, "Breaking the Polar-nonpolar Division in Solvation Free Energy Prediction", *Journal of Computational Chemistry*, 39, 217232 (2018).

24. Yin Cao, **Bao Wang**, Kelin Xia and Guowei Wei, "Finite Volume Formulation of the MIB Method for Elliptic Interface Problems", *Journal of Computational and Applied Mathematics*, 321, 60-77 (2017).

25. **Bao Wang**, Zhixiong Zhao, and Guowei Wei, "Feature Functional Theory - Binding Predictor (FFT-BP) for the Blind Prediction of Binding Free Energy", *Theoretical Chemistry Account*, 136, 55 (2017).

26. **Bao Wang** and Guowei Wei, "Accurate, Robust and Reliable Calculations of Poisson-Boltzmann Binding Energies", *Journal of Computational Chemistry*, 38, 941-948 (2017).

27. Beibei Liu, **Bao Wang**, Rundong Zhao, Yiying Tong and Guowei Wei, "ESES: Software for Eulerian Solvent Excluded Surface", *Journal of Computational Chemistry*, 38, 446-466 (2017).

28. **Bao Wang**, Zhixiong Zhao and Guowei Wei, "Automatic Parametrization of Non-polar Implicit Solvent Models for the Blind Prediction of Solvation Free Energies", *Journal of Chemical Physics*, 145, 124110 (2016).

29. **Bao Wang** and Guowei Wei, "Objective-oriented Persistent Homology", *Journal of Computational Physics*, 305, 276-299 (2016).

30. **Bao Wang** and Guowei Wei, "Parameter Optimization in Differential Geometry based Solvation Models", *Journal of Chemical Physics*, 143, 134119 (2015).

31. **Bao Wang**, Kelin Xia and Guowei Wei, "Second-order Method for Solving 3D Elasticity Equations with Complex Interfaces", *Journal of Computational Physics*, 294, 405-438 (2015).

32. **Bao Wang**, Kelin Xia and Guowei Wei, "Matched Interface and Boundary Method for Irregular Elastic Interface Problems", *Journal of Computational and Applied Mathematics*, 285, 203-225 (2015).

Mentoring

REU, Summer 2017, Project: Deep Learning for Body Worn Video Object Detection.

RIPS, Summer 2019, Project: Quantifying Privacy Leakage in Google's Ads Data Hub.

Undergraduate Student Mentoring: Duo Zhang (UCLA, 2016-2017) and Duanhao Zhang (UCLA, 2016-2017)

Graduate Student Mentoring & Collaboration: Xiyang Luo (UCLA, 2017-2018), Fangbo Zhang (UCLA, 2017-2017), Lisa Maria Kreusser (Cambridge, 2018-2018), Zhijian Li (UCI, 2017-2018), Thu Dinh (UCI, 2019-2019).

Synergistic Activities

Co-organizer (with Anima Anandkumar, Richard G. Baraniuk, Animesh Garg , Stanley Osher, and Tan M. Nguyen), ICLR Workshop on Integration of Deep Neural Models and Differential Equations,

April 2020.

Course Taught

Math 2270, Linear Algebra, Utah, Fall 2020.
PIC 10B, Programming in C++-II, UCLA, Winter 2019, Winter 2020.
PIC 10A, Programming in C++-I, UCLA, Fall 2018, Fall 2019, Winter 2020, Spring 2020.
Math 142, Math modeling, Lecture, UCLA, Winter 2018.
Math 151B, Applied numerical method-II, Lecture, UCLA, Spring 2017, Spring 2018.
Math 151A, Applied numerical method-I, Lecture, UCLA, Fall2016, Winter 2017.
Math 133, Single-variable calculus, Lecture, MSU, Fall 2015.
Math 234, Multi-variable calculus, Lecture, MSU, Summer 2014.

Invited Talks

Applied and Computational Math Seminar, Tsinghua University, Beijing, Aug 6, 2020.

Optimal Control in Data Science and Mini-symposium, SIAM MDS, virtual, June 17, 2020.

Seminar on Data Science and Applied Mathematics, The Hongkong University of Science and Technology, HongKong, May 7, 2020.

The MDL collective, Iowa State University, Ames IA, May 1, 2020.

CCMA Seminar on Mathematics of Data and Computation, Penn State University, State College PA, Apr 24, 2020.

Data Science Seminar, Institute of Natural Science, Shanghai Jiaotong University, Shanghai, Apr 23, 2020.

Applied Math Seminar, Department of Mathematics, The University of Utah, Salt Lake City UT, Feb 21, 2020.

Colloquium, Department of Mathematics, The University of Utah, Salt Lake City UT, Feb 20, 2020.

Colloquium, Department of Mathematics, University of California, Merced, Merced CA, Feb 11, 2020.

Colloquium, Department of Mathematics, University of California, Santa Barbara, Santa Barbara CA, Feb 6, 2020.

Colloquium, Department of Mathematics, Washington State University, Pullman WA, Feb 3, 2020.

Colloquium, Department of Mathematics, The University of Texas at Dallas, Dallas TX, Jan 31, 2020.

Colloquium, Department of Mathematics, The University of Arizona, Tucson AZ, Jan 27, 2020.

Colloquium, Department of Mathematics, Emory University, Atlanta GA, Jan 23, 2020.

Colloquium, Department of Mathematics, University of Kentucky, Lexington KY, Jan 21, 2020.

Colloquium, Department of Mathematics, University of North Carolina at Chapel Hill, Chapel Hill NC, Jan 16, 2020.

Colloquium, Department of Mathematics, University of California, Davis, Davis CA, Jan 10, 2020.

Colloquium, Department of Mathematics, University of Massachusetts Amherst, Amherst MA, Dec 18, 2019.

Colloquium, Department of Mathematics, University of South Carolina, Columbia SC, Dec 13, 2019.

Colloquium, Department of Mathematics, The University of Texas at Arlington, Arlington TX, Nov 25, 2019.

Algorithms for Threat Detection Kickoff Workshop. D.C., Oct 21-23, 2019.

Applied Math Seminar. UCLA. Oct 16, 2019.

Computer Science Seminar. Indiana University - Purdue University Indianapolis. Indianapolis, Aug 30-31, 2019.

STROBE Annual Meeting. University of Colorado Boulder. Boulder, Jun 12-14, 2019.

Recent Developments on Mathematical/Statistical approaches in Data Sciences (MSDAS). University of Texas at Dallas. Dallas, Jun 1-Jun 2, 2019.

NSF-CBMS Conference: Mathematical Molecular Bioscience and Biophysics. University of Alabama. Tuscaloosa, May 13 - May 17, 2019.

SIAM Conference on Computational Science and Engineering (CSE19). Spokane, Feb 25-March 1, 2019.

Simons MATH + X Symposium. Rice University. Huston, Jan 23-25, 2019.

STROBE Annual Meeting. University of Colorado Boulder. Boulder, Sep 24-25, 2018.

Applied and Computational Math Seminar. UC Irvine. Irvine, May 14, 2018.

STROBE seminar series. UCLA. Los Angeles, May 02, 2018.

Applied Math Seminar. UC Berkeley. Berkeley, Feb 21, 2018.

Algorithms for Threat Detection Kickoff Workshop. D.C., Sep 14-15, 2017.

The Level Set Collective. UCLA. Los Angeles, Jan 30, 2018; May 08, 2018; Dec 18, 2018; Apr 30, 2019.

Journal and Conference Reviewer

ECCV, ICLR, NeurIPS, Communication in Mathematical Sciences, Journal of Computer Science and Technology, IEEE Transactions on Computational Social Systems, IEEE Transactions on Signal Processing, Journal of Computational Physics, Physics Review Fluids, etc.