Yuheng Bu

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Research Interests

My research interests lie in the intersection of *information theory*, *machine learning*, and *signal processing*. I have recently leveraged tools from information theory and signal processing to develop *theoretically justified* learning algorithms for diverse applications, including model compression, anomaly detection, fair selective prediction, and uncertainty quantification. More broadly, the primary goal of my research is to lay information-theoretic foundations for trustworthy learning algorithms, particularly with generalization, fairness, and privacy guarantees.

Professional Experiences

- Assistant Professor, Department of Electrical and Computer Engineering, Herbert Wertheim College of Engineering, **University of Florida** — Aug. 2022 - present
- Postdoctoral Research Associate, **Massachusetts Institute of Technology** — Sep. 2019 - May 2022
  Advisor: Gregory W. Wornell
- Undergraduate Visiting Research (UGVR), **Stanford University** — Jun. 2013 - Sep. 2013
  Only 18 students chosen from mainland China and Taiwan
  Advisor: Tsachy Weissman

Education

- Ph.D. in Electrical and Computer Engineering
  University of Illinois at Urbana-Champaign, USA — Jan. 2017 - Aug. 2019
  Advisor: Venugopal V. Veeravalli
  Thesis: "Information-theoretic Bounds in Learning Algorithms"
- Master in Electrical and Computer Engineering
  University of Illinois at Urbana-Champaign, USA — Aug. 2014 - Dec. 2016
  Advisor: Venugopal V. Veeravalli
  Thesis: "Estimation of KL Divergence: Optimal Minimax Rate"
- B.E. (**with honors**) in Electronic Engineering
  Tsinghua University, Beijing, China — Aug. 2010 - Jul. 2014
  Double Major in **Economics**

Publications

Preprints

[1] D. Zhuang, **Y. Bu**, G. Wang, S. Wang, J. Zhao, "SAUC: Sparsity-Aware Uncertainty Calibration for Spatiotemporal Prediction with Graph Neural Networks," submitted to *AAAI Conference on Artificial Intelligence (AAAI)*, Aug. 2023.

[2] H. Chen, **Y. Bu**, G. W. Wornell, "SGLD-Based Information Criteria and the Over-Parameterized Regime," submitted to *Conference on Neural Information Processing Systems (NeurIPS)*, May 2023.

[3] J. J. Ryu, X. Xu, H. SM Erol, **Y. Bu**, L. Zheng, G. W. Wornell, "Neural SVD of Kernel Operators via Nested Low-Rank Approximation," submitted to *Conference on Neural Information Processing Systems (NeurIPS)*, May 2023.

[4] B. Hu, **Y. Bu**, J. C. Príncipe, "Feature Learning in Image Hierarchies using Functional Maximal Correlation," submitted to *Conference on Neural Information Processing Systems (NeurIPS)*, May 2023.

[5] A. Shah, M. Shen, J. J. Ryu, S. Das, P. Sattigeri, **Y. Bu**, G. W. Wornell, "Group Fairness with Uncertainty in Sensitive Attributes," submitted to *Conference on Neural Information Processing Systems (NeurIPS)*, May 2023.

[6] G. Aminian*, **Y. Bu***, L. Toni, M. R. Rodrigues, G. W. Wornell. "Information-theoretic Characterizations of Generalization Error for the Gibbs Algorithm," (* equal contribution), submitted to *IEEE Transactions on Information Theory*, Oct. 2022.

Journal Papers

[1] J. K. Lee*, **Y. Bu***, P. Sattigeri, R. Panda, G. W. Wornell, L. Karlinsky, R. S. Feris. "A Maximal Correlation Framework for Fair Machine Learning," (* equal contribution), *Entropy 24*, no. 4, pp. 461, Mar. 2022.

[2] **Y. Bu**, W. Gao, S. Zou, V. V. Veeravalli. "Population Risk Improvement with Model Compression: An Information-Theoretic Approach," *Entropy 23*, no. 10, pp. 1255, Sept. 2021.

[3] **Y. Bu**, S. Zou, V. V. Veeravalli. "Tightening Mutual Information Based Bounds on Generalization Error," *IEEE Journal on Selected Areas in Information Theory*, vol. 1, no. 1, pp. 121-130, May 2020.

[4] C. Wilson, **Y. Bu**, V. V. Veeravalli. "Adaptive Sequential Machine Learning," *Sequential Analysis*, 38(4), pp. 545-568, Jan. 2020. (**16th Abraham Wald Prize**)

[5] **Y. Bu**, S. Zou, V. V. Veeravalli. "Linear-Complexity Exponentially-Consistent Tests for Universal Outlying Sequence Detection," *IEEE Transactions on Signal Processing*, vol. 67, no. 8, pp. 2115-2128, Apr. 2019.

[6] **Y. Bu***, S. Zou*, Y. Liang, V. V. Veeravalli. "Estimation of KL Divergence: Optimal Minimax Rate," (* equal contribution), *IEEE Transactions on Information Theory*, vol. 64, no. 4, pp. 2648-2674, Apr. 2018.

Conference Papers

[1] M. Shen, **Y. Bu**, G. W. Wornell. "On Balancing Bias and Variance in Unsupervised Multi-Source-Free Domain Adaptation," to appear in, *Proc. International Conference on Machine Learning (ICML)*, Jul. 2023.

[2] **Y. Bu**, H. V. Tetali, G. Aminian, M. R. Rodrigues, G. W. Wornell. "On the Generalization Error of Meta Learning for the Gibbs Algorithm," to appear in, *Proc. IEEE International Symposium on Information Theory (ISIT)*, Taipei, Jun. 2023.

[3] A. Weiss, A. Lancho, **Y. Bu**, G. W. Wornell. "A Bilateral Bound on the Mean Squared Error for Estimation in Model Mismatch," to appear in, *Proc. IEEE International Symposium on Information Theory (ISIT)*, Taipei, Jun. 2023.

[4] M. Shen, S. S. Ghosh, P. Sattigeri, S. Das, **Y. Bu**, G. W. Wornell. "Reliable Gradient-free and Likelihood-free Prompt Tuning," in *Proc. Conference of the European Chapter of the Association for Computational Linguistics (EACL)*, Dubrovnik, Croatia, May 2023.

[5] H. He, G. Aminian, **Y. Bu**, M. R. Rodrigues, V. YF Tan. "How Does Pseudo-Labeling Affect the Generalization Error of the Semi-Supervised Gibbs Algorithm?" in *Proc. International Conference on Artificial Intelligence and Statistics (AISTATS)*, Valencia, Spain, Apr. 2023.

[6] M. Shen, **Y. Bu**, P. Sattigeri, S. S. Ghosh, S. Das, G. W. Wornell. "Post-hoc Uncertainty Learning using a Dirichlet Meta-Model," in *Proc. AAAI Conference on Artificial Intelligence (AAAI)*, Washington DC, Feb. 2023.

[7] A. Lancho, A. Weiss, G. C. Lee, J. Tang, **Y. Bu**, Y. Polyanskiy, G. W. Wornell. "Data-Driven Blind Synchronization and Interference Rejection for Digital Communication Signals," in *Proc. IEEE Global Communications Conference*, Rio de Janeiro, Brazil, Dec. 2022.

[8] G. C. Lee, A. Weiss, A. Lancho, J. Tang, **Y. Bu**, Y. Polyanskiy, G. W. Wornell. "Exploiting Temporal Structures of Cyclostationary Signals for Data-Driven Single-Channel Source Separation," in *Proc. IEEE International Workshop on Machine Learning for Signal Processing*, Xi'an, China, Aug. 2022. (**Best Student Paper Award**)

[9] A. Shah*, **Y. Bu***, J. K. Lee, P. Sattigeri, R. Panda, S. Das, G. W. Wornell. "Selective Regression under Fairness Criteria," (* equal contribution), in *Proc. International Conference Machine Learning (ICML)*, Baltimore, MD, Jul. 2022.

[10] G. Aminian*, **Y. Bu***, G. W. Wornell, M. R. Rodrigues. "Tighter Expected Generalization Error Bounds via Convexity of Information Measures," (* equal contribution), in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Espoo, Finland, Jun. 2022.

[11] J. K. Lee*, **Y. Bu***, P. Sattigeri, R. Panda, G. W. Wornell, L. Karlinsky, R. S. Feris. "A Maximal Correlation Approach to Imposing Fairness in Machine Learning," (* equal contribution), in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Singapore, May 2022.

[12] **Y. Bu***, G. Aminian*, L. Toni, M. R. Rodrigues, G. W. Wornell. "Characterizing and Understanding the Generalization Error of Transfer Learning with Gibbs Algorithm," (* equal contribution), in *Proc. International Conference on Artificial Intelligence and Statistics (AISTATS)*, Mar. 2022.

[13] G. Aminian*, **Y. Bu***, L. Toni, M. R. Rodrigues, G. W. Wornell. "An Exact Characterization of the Generalization Error for the Gibbs Algorithm," (* equal contribution), in *Proc. Conference on Neural Information Processing Systems (NeurIPS)*, Dec. 2021.

[14] **Y. Bu***, J. K. Lee*, D. Rajan, P. Sattigeri, R. Panda, S. Das, G. W. Wornell. "Fair Selective Classification via Sufficiency," (* equal contribution), in *Proc. International Conference on Machine Learning (ICML)*, Jul. 2021. (**Long talk**, **Top 3%**)

[15] G. Aminian*, **Y. Bu***, L. Toni, M. R. Rodrigues, G. W. Wornell. "Characterizing the Generalization Error of Gibbs Algorithm with Symmetrized KL information," (* equal contribution), *ICML Workshop on Information-Theoretic Methods for Rigorous, Responsible, and Reliable Machine Learning*, 2021.

[16] **Y. Bu**, T. Wang, G. W. Wornell. "SDP Methods for Sensitivity-Constrained Privacy Funnel and Information Bottleneck Problems," in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Melbourne, Australia, Jul. 2021.

[17] **Y. Bu**, W. Gao, S. Zou, V. V. Veeravalli. "Information-theoretic Understanding of Population Risk Improvement with Model Compression," in *Proc. AAAI Conference on Artificial Intelligence (AAAI)*, New York, Feb. 2020.

[18] **Y. Bu**, K. Small. "Active Learning in Recommendation Systems with Multi-level User Preferences," *AAAI Workshop on Interactive and Conversational Recommendation Systems (WICRS)*, New York, Feb. 2020.

[19] **Y. Bu**, J. Lu, V. V. Veeravalli. "Active and Adaptive Sequential Learning with Per Time-step Excess Risk Guarantees," in *Proc. IEEE Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 2019.

[20] **Y. Bu**, S. Zou, V. V. Veeravalli. "Tightening Mutual Information Based Bounds on Generalization Error," in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Paris, France, Jul. 2019.

[21] **Y. Bu**, J. Lu, V. V. Veeravalli. "Model Change Detection with Application to Machine Learning," in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brighton, UK, May 2019.

[22] **Y. Bu**, S. Zou, V. V. Veeravalli, "Linear-Complexity Exponentially-Consistent Tests for Universal Outlying Sequence Detection," in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Aachen, Germany, Jun. 2017.

[23] **Y. Bu***, S. Zou*, Y. Liang, V. V. Veeravalli. "Estimation of KL Divergence Between Large-Alphabet Distributions," (* equal contribution), in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Barcelona, Spain, Jul. 2016.

[24] **Y. Bu**, S. Zou, Y. Liang, V. V. Veeravalli. "Universal Outlying Sequence Detection for Continuous Observations," in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Shanghai, China, Mar. 2016.

Invited Talks

- From Sensitivity-constrained Information Bottleneck to Fair Selective Prediction
  - Information Theory and Data Science Workshop (Virtual), NUS — Jan. 2023
- Post-hoc Uncertainty Learning using a Dirichlet Meta-Model
  - Allerton Conference on Communication, Control, and Computing, UIUC — Oct. 2022
- Can Information Theory Characterize Learning Algorithms?
  - CS Colloquium, UCSB — Oct. 2022
  - ECE department, University of Florida (UF) — Mar. 2022
  - ECE department, National University of Singapore (NUS) — Jan. 2022
  - ECE department, Hong Kong University of Science and Technology (HKUST) — Jan. 2022
  - EEE department, Hong Kong University (HKU) — Dec. 2021

Honors & Awards

- 16th Abraham Wald Prize, *Sequential Analysis* — 2023
- Outstanding Reviewer Award, **NeurIPS** — 2021
- **Yi-Min Wang and Pi-Yu Chung** Research Award, UIUC — 2019
- Nominee for Graduation Day at **IEEE ITA Workshop** — 2019
- Student Travel Grant, **IEEE ISIT** — 2016, 2017
- Student Travel Grant, **IEEE ICASSP** — 2016
- **Outstanding graduate**, Tsinghua University — 2014
- **National Scholarship** Granted by Ministry of Education of China (**top 2%**), — 2012 and 2013

Industrial Experiences

- Amazon.com Inc., Core machine learning group Jun. 2017 - Dec. 2017
  (Currently known as **Amazon AI Lab**)
  Title: Applied scientist intern
  - Built a conversational agent that can actively learn users' interests to make recommendations.
  - Conducted extensive research on customer purchase history with Yelp data.

Teaching & Mentorship

- Teaching:
  EEL 6935: Information-Theoretic Methods in Machine Learning Spring 2023, University of Florida
- Mentoring graduate students:
  Haobo Chen, Ph.D. candidate at UF ECE, Fall 2022 - present
  Maohao Shen, Ph.D. candidate at MIT EECS, Fall 2021 - present
  Abhin Shah, Ph.D. candidate at MIT EECS, Spring 2021 - present
  Gary Lee, Ph.D. candidate at MIT EECS, Summer 2020 - Summer 2022
  Tony T. Wang, MEng at MIT EECS, Summer 2020 - Spring 2021
  Joshua Ka-Wing Lee, Ph.D. at MIT EECS, Fall 2019 - Summer 2021
- Teaching and developing contents for **MIT IDSS MicroMaster** program:
  6.86x Machine Learning with Python–From Linear Models to Deep Learning Spring 2020, MIT
  14.310x Data Analysis for Social Scientists (live recitation and video recording) Fall 2019, MIT
- Teaching assistant:
  ECE 365: Data Science and Engineering Spring 2019, UIUC
  ECE 398: Making Sense of Big Data Fall 2018, UIUC
- Grader:
  ECE 398: Making Sense of Big Data Spring 2017, UIUC
  ECE 598: Computational Inference and Learning Fall 2016, UIUC

Service & Professional Activities

- **Panelist:** NSF CISE: CIF
- **Membership:** IEEE, IEEE Information Theory Society, IEEE Signal Processing Society
- **Reviewer:**
  Journals: Journal of Machine Learning Research (JMLR), Transactions on Machine Learning Research (TMLR), IEEE Transactions on Information Theory (TIT), IEEE Journal on Selected Areas in Information Theory (JSAIT), IEEE Transactions on Signal Processing (TSP), IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Transactions on Information Forensics & Security (TIFS), IEEE Transactions on Vehicular Technology (TVT), IEEE Journal on Selected Areas in Communications (JSAC), Entropy
  Conferences: NeurIPS, ICML, ICLR, AAAI, AISTATS, IJCAI, ISIT, ITW, ICASSP