Yuheng Bu

Assistant Professor
Department of Electrical & Computer Engineering
Herbert Wertheim College of Engineering
University of Florida

Homepage: https://buyuheng.github.io/

Research Interests

My research interests lie in the intersection of *machine learning*, *information theory* 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, and fair/trustworthy machine learning. More broadly, the primary goal of my research is to lay information-theoretic foundations for the learning algorithms with limited labeled data, including transfer learning and federated learning, particularly with privacy, fairness, and communication constraints.

Academic Appointments

- Assistant Professor, Department of Electrical and Computer Engineering,   Aug. 2022 - present
  Herbert Wertheim College of Engineering, **University of Florida**

- Postdoctoral Research Associate, **Massachusetts Institute of Technology**   Sep. 2019 - May 2022
  Advisor: Gregory W. Wornell

- Research Assistant, **University of Illinois at Urbana-Champaign**   Aug. 2014 - Jan. 2019
  Advisor: Venugopal V. Veeravalli

- UGVR (Undergraduate Visiting Research), **Stanford University**   Jun. 2013 - Sep. 2013
  Only 18 students chosen from mainland China and Taiwan
  Advisor: Tsachy Weissman
  Project: Time-series forecaster based on Online Aggregation

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**

Research Projects

- **Exact Characterization of Generalization Errors using Information Measures**
  Massachusetts Institute of Technology   Sep. 2020 - present

- Exact characterizations of generalization errors for Gibbs algorithms (randomized ERM) in both supervised/transfer learning settings using symmetrized Kullback-Leibler (KL) information
- Information-theoretical framework that guides the selection of different transfer learning algorithms

- **Fair selective classification/regression**
  Massachusetts Institute of Technology   Sep. 2019 - present
  - Theoretical guarantees on using *sufficiency criterion* to mitigate disparities across groups
  - Fair selective classification/regression algorithms by minimizing mutual information

- **Information-theoretical Generalization bounds of Supervised Learning**
  University of Illinois at Urbana-Champaign   Jan. 2018 - Aug. 2019
  - Tighter generalization error bound for supervised learning algorithm with mutual information
  - Novel model compression algorithm that improves generalization performance by minimizing mutual information based upper bound

Publications

Selected Publications

- G. Aminian*, **Y. Bu***, L. Toni, M. R. D. 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.

- **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%**)

- **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.

- **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.

- **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.

Journal Papers and Preprints

[1] **Y. Bu***, G. Aminian*, L. Toni, M. R. D. Rodrigues, G. W. Wornell. "An Exact Characterization of the Generalization Error for the Gibbs Algorithm," (* equal contribution), submitted to *IEEE Transactions on Information Theory*, preliminary version appeared in NeurIPS 2021.

[2] A. Weiss, A. Lancho, **Y. Bu**, G. W. Wornell. "A Bilateral Bound on the Mean Squared Error for Estimation in Model Mismatch," submitted to *IEEE Signal Processing Letter*, Jul. 2022.

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

[4] **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.

[5] **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.

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

[7] **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.

[8] **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**, P. Sattigeri, S. Ghosh, S. Das, G. W. Wornell. "Post-hoc Uncertainty Learning using a Dirichlet Meta-Model," submitted to *Conference on Neural Information Processing Systems (NeurIPS 2022)*, May. 2022.

[2] M. Shen, **Y. Bu**, G. W. Wornell. "On the Benefits of Selectivity in Pseudo-Labeling for Unsupervised Multi-Source-Free Domain Adaptation," submitted to *Conference on Neural Information Processing Systems (NeurIPS 2022)*, May. 2022.

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

[4] G. 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," to appear in, *Proc. IEEE International Workshop on Machine Learning for Signal Processing*, Aug. 2022.

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

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

[7] J. K. Lee*, **Y. Bu***, P. Sattigeri, R. Panda, G. W. Wornell, L. Karlinsky, R. 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)*, May 2022.

[8] **Y. Bu***, G. Aminian*, L. Toni, M. R. D. 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.

[9] G. Aminian*, **Y. Bu***, L. Toni, M. R. D. 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.

[10] **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%**)

[11] G. Aminian*, **Y. Bu***, L. Toni, M. R. D. 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.

[12] **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.

[13] **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.

[14] **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.

[15] **Y. Bu**, J. Lu, V. V. Veeravalli. "Active and Adaptive Sequential learning," in *Proc. IEEE Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 2019.

[16] **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.

[17] **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.

[18] **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.

[19] **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.

[20] **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.

Professional 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 and Mentorship

- Mentoring graduate students:
  Joshua Ka-Wing Lee, Ph.D. at MIT EECS,   Fall 2019 - Summer 2021
  Tony T. Wang, MEng at MIT EECS,   Summer 2020 - Spring 2021
  Gary Lee, Ph.D. candidate at MIT EECS,   Summer 2020 - present
  Abhin Shah, Ph.D. candidate at MIT EECS,   Spring 2021 - present
  Maohao Shen, Ph.D. candidate at MIT EECS,   Fall 2021 - present
- Teaching and developing contents for **MIT IDSS MicroMaster** program:
  14.310x Data Analysis for Social Scientists (live recitation and video recording)   Fall 2019, MIT
  6.86x Machine Learning with Python–From Linear Models to Deep Learning   Spring 2020, 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

Honors & Awards

- 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
- **Third prize**, "Challenge Cup" the Tsinghua University
  Student extra-curricular academic science and technology competitions   2012

Service & Professional Activities

- **Membership:** IEEE, IEEE Information Theory Society, IEEE Signal Processing Society
- **Reviewer:**
  Journals: Journal of Machine Learning Research (JMLR), 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)
  Conferences: NeurIPS, ICML, ICLR, AAAI, IJCAI, AISTATS, ISIT, ICASSP