

# Yuheng Bu

Assistant Professor

Department of Electrical & Computer Engineering

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

## 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 watermarking generative AI, fair machine learning, uncertainty quantification, and model compression. More broadly, the primary goal of my research is to lay information-theoretic foundations for trustworthy learning algorithms.

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

## SPONSORED RESEARCH

- Collaborative Research: Elements: Empowering Semiconductor Device Research and Education through Integrated Machine Learning Models and Database  
Co-PI, in collaboration with Jing Guo (PI, UF ECE), Erik Deumens (Co-PI, UF IT)  
08/15/2024-7/31/2027, **NSF**, total share: \$383,998
- UF Research Opportunity Seed Fund (ROSF) 2023: Developing Graph Neural Networks to Quantify Uncertainty for Future of Remote Work in Cities.

Co-PI, in collaboration with Shenhao Wang (PI, UF DCP), Lingqian Hu (Co-PI, UF DCP)  
09/01/2023-08/31/2025, **UF**, total share: \$90,000

## FULL PUBLICATION LIST

### Journal Papers

- [1] G. Aminian\*, **Y. Bu\***, L. Toni, M. R. Rodrigues, G. W. Wornell. “Information-theoretic Characterizations of Generalization Error for the Gibbs Algorithm,” (\* equal contribution), *IEEE Transactions on Information Theory*, vol. 70, no. 1, pp. 632-655, Nov. 2023.
- [2] 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.
- [3] **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, Sep. 2021.
- [4] **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.
- [5] C. Wilson, **Y. Bu**, V. V. Veeravalli. “Adaptive Sequential Machine Learning,” *Sequential Analysis*, 38(4), pp. 545-568, Jan. 2020. (**16th Abraham Wald Prize**)
- [6] **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.
- [7] **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 and Workshop Publications

- [1] Y. Zhu, **Y. Bu**, “Information-theoretic Analysis of the Gibbs Algorithm: An Individual Sample Approach,” to appear in *IEEE Information Theory Workshop (ITW)*, Shenzhen, China, Nov. 2024.
- [2] D. Zhuang, **Y. Bu**, G. Wang, S. Wang, J. Zhao, “SAUC: Sparsity-Aware Uncertainty Calibration for Spatiotemporal Prediction with Graph Neural Networks,” to appear in *Proc. International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL)*, Atlanta, GA, Oct. 2024  
Short version at *NeurIPS Workshop on Temporal Graph Learning (TGL)*, New Orleans, LA, Dec. 2023. (**Spotlight talk**)
- [3] B. Hu, **Y. Bu**, J. C. Príncipe, “Learning Orthonormal Features in Self-Supervised Learning using Functional Maximal Correlation,” to appear in *Proc. IEEE International Conference on Image Processing (ICIP)*, Abu Dhabi, United Arab Emirates, Oct. 2024.  
Short version at *NeurIPS Workshop on Self-Supervised Learning - Theory and Practice*, New Orleans, LA, Dec. 2023. (**Spotlight talk**)
- [4] H. Chen, G. Aminian, **Y. Bu**, “An Algorithm for Computing the Capacity of Symmetrized KL Information for Discrete Channels,” in *Proc. Allerton Conference on Communication, Control, and Computing (Allerton)*, Urbana, IL, Sep. 2024.
- [5] C. Shi, **Y. Bu**, J. Fu, “Information-Theoretic Opacity-Enforcement in Markov Decision Processes,” in *Proc. International Joint Conference on Artificial Intelligence (IJCAI)*, Jeju, Korea, Aug. 2024. (**acceptance rate: 15%**)
- [6] Y. Liu, **Y. Bu**, “Adaptive Text Watermark for Large Language Models,” in *Proc. International Conference on Machine Learning (ICML)*, Vienna, Austria, Jul. 2024. (**acceptance rate: 28%**)

- [7] J. J. Ryu, X. Xu, H. SM Erol, **Y. Bu**, L. Zheng, G. W. Wornell, “Operator SVD with Neural Networks via Nested Low-Rank Approximation,” in *Proc. International Conference on Machine Learning (ICML)*, Vienna, Austria, Jul. 2024. (**acceptance rate: 28%**)  
Short version at *NeurIPS Workshop on Machine Learning and the Physical Sciences*, New Orleans, LA, Dec. 2023.
- [8] **Y. Bu**, “Towards Optimal Inverse Temperature in the Gibbs Algorithm,” in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Athens, Greece, Jul. 2024.
- [9] A. Shah, M. Shen, J. J. Ryu, S. Das, P. Sattigeri, **Y. Bu**, G. W. Wornell, “Group Fairness with Uncertainty in Sensitive Attributes,” in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Athens, Greece, Jul. 2024.
- [10] H. Chen, **Y. Bu**, G. W. Wornell, “Gibbs-Based Information Criteria and the Over-Parameterized Regime,” in *Proc. International Conference on Artificial Intelligence and Statistics (AISTATS)*, Valencia, Spain, May 2024. (**acceptance rate: 28%**)  
Short version at *NeurIPS Workshop on Mathematics of Modern Machine Learning (M3L)*, New Orleans, LA, Dec. 2023.
- [11] F. Laakom, **Y. Bu**, M. Gabbouj, “Information-Theoretic Generalization Bounds for the Subtask Problem,” *ICML workshop on PAC-Bayes Meets Interactive Learning*, Honolulu, HI, Jul. 2023.
- [12] M. Shen, **Y. Bu**, G. W. Wornell. “On Balancing Bias and Variance in Unsupervised Multi-Source-Free Domain Adaptation,” in *Proc. International Conference on Machine Learning (ICML)*, Honolulu, HI, Jul. 2023. (**acceptance rate: 28%**)
- [13] **Y. Bu**, H. V. Tetali, G. Aminian, M. R. Rodrigues, G. W. Wornell. “On the Generalization Error of Meta Learning for the Gibbs Algorithm,” in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Taipei, Jun. 2023.
- [14] A. Weiss, A. Lancho, **Y. Bu**, G. W. Wornell. “A Bilateral Bound on the Mean Squared Error for Estimation in Model Mismatch,” in *Proc. IEEE International Symposium on Information Theory (ISIT)*, Taipei, Jun. 2023.
- [15] 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.
- [16] 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. (**acceptance rate: 29%**)
- [17] 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. (**acceptance rate: 19%**)
- [18] 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.
- [19] 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**)
- [20] 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. (**acceptance rate: 22%**)

- [21] 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.
- [22] 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.
- [23] **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)*, virtual, Mar. 2022. (**acceptance rate: 29%**)
- [24] 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)*, virtual, Dec. 2021. (**acceptance rate: 26%**)  
Short version in *ICML Workshop on Information-Theoretic Methods for Rigorous, Responsible, and Reliable Machine Learning*, virtual, 2021.
- [25] **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)*, virtual, Jul. 2021. (**Oral, Top 3%**)
- [26] **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)*, virtual, Jul. 2021.
- [27] **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, NY, Feb. 2020.
- [28] **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, NY, Feb. 2020.
- [29] **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.
- [30] **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.
- [31] **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.
- [32] **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.
- [33] **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.
- [34] **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.

## Patents

- [1] J. K. Lee, **Y. Bu**, D. Rajan, P. Sattigeri, S. Das, R. Panda, and G. W. Wornell. “Fair selective classification via a variational mutual information upper bound for imposing sufficiency.” U.S. 17/565,411, Jun. 2023.

## INVITED TALKS

- Adaptive Text Watermark for Large Language Models
  - Annual Conference on Information Sciences and Systems, Princeton University Mar. 2024
- Group Fairness with Uncertainty in Sensitive Attributes
  - Allerton Conference on Communication, Control, and Computing, UIUC Oct. 2023
- 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?
  - ECE department, The Ohio State University (OSU) Mar. 2024
  - Information Theory and Applications Workshop (ITA), UCSD Feb. 2023
  - CS Colloquium, University of California, Santa Barbara (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
- **MLSP** 2022 Best Student Paper Award 2022
- 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, 2013

## TEACHING EXPERIENCE

- **University of Florida:**  
 EEL 3850: Data Science for ECE Fall 2023  
 EEL 6935: Information-Theoretic Methods in Machine Learning Spring 2023 and 2024
- Teaching and developing contents for **MIT IDSS MicroMaster** online program:  
 6.86x Machine Learning with Python—From Linear Models to Deep Learning Spring 2020  
 14.310x Data Analysis for Social Scientists (live recitation and video recording) Fall 2019
- Teaching assistant at **UIUC**  
 ECE 365: Data Science and Engineering Spring 2019  
 ECE 398: Making Sense of Big Data Spring 2017, Fall 2018  
 ECE 598: Computational Inference and Learning Fall 2016

## STUDENTS MENTORING

- Mentoring Ph.D. students at UF ECE:  
 Yepeng Liu, topic: Watermarking techniques for large language model Fall 2023 - present  
 Haobo Chen, topic: Over-parameterized models and Gibbs algorithm Spring 2023 - present
- Serving in Ph.D. supervisory committee at UF ECE:  
 Hongming Li, Haoxiang Ma, Bo Hu, Charlie Tran
- Serving in Ph.D. supervisory committee at UF CS:  
 Yuchen Sun, Jingzhou Hu
- Undergraduates Senior Design projects at UF ECE:  
 Cody Hutcheson, topic: Towards better domain adaptation via uncertainty quantification, Fall 2023
- Graduate students at MIT EECS:  
 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

## PROFESSIONAL ACTIVITIES

- **Panelist:** NSF CISE: CIF
- **Guest Editors:** Entropy Special Issue “Fairness in Machine Learning: Information Theoretic Perspectives,” 2022-2023.
- **Organizer:** 6th and 7th Annual Workshop on Cognition & Control at University of Florida, 2023-2024
- **Reviewer:** 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), IEEE Transactions on Neural Networks and Learning Systems (TNNLS), 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, AISTATS, IJCAI, ISIT, ITW, ICASSP