

# ABOLFAZL HASHEMI

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## RESEARCH DESCRIPTION

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My research interests include **Collaborative Signal Processing, Resource-Constrained Distributed Optimization, Optimization for Machine Learning, Online Learning, and Sparse Approximation**. The goal of my research is to enhance the performance and capabilities of the networked systems characterized by limited communication budget and data scarcity. In doing so, I design efficient algorithms with mathematical guarantees to render practical deployment of multi-agent systems possible in applications including computer vision, supervised learning, bioinformatics, and dynamical systems.

## EDUCATION

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**Doctor of Philosophy (Ph.D.)**, Electrical and Computer Engineering 2016 – 2020

University of Texas at Austin, Austin, Texas, USA

Dissertation: EFFICIENT ALGORITHMS FOR STRUCTURED INFERENCE AND COLLABORATIVE LEARNING

Advisor: Prof. Haris Vikalo

Committee: Prof. Alex Dimakis, Prof. Gustavo de Veciana, Prof. Sujay Sanghavi, Prof. Qiang Liu

**Master of Science in Engineering (M.S.E.)**, Electrical and Computer Engineering 2014 – 2016

University of Texas at Austin, Austin, Texas, USA

Advisor: Prof. Haris Vikalo

**Bachelor of Science (B.S.)**, Electrical Engineering 2010 – 2014

Sharif University of Technology, Tehran, Iran

Thesis: VISION-BASED GAIT ANALYSIS VIA EXPLOITING HUMAN BODY-PARTS PROPORTION

Advisor: Prof. Babak H. Khalaj

## RESEARCH EXPERIENCE

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### Postdoctoral Fellow

University of Texas at Austin

Fall 2020 – present

Oden Institute for Computational Engineering and Sciences

Advisors: Prof. Inderjit Dhillon, Prof. Rachel Ward, Prof. Ufuk Topcu

- Communication-efficient and optimal stochastic optimization algorithms for federated learning and multi-agent reinforcement learning
- Scalable algorithms and communication strategies for robust distributed optimization in adversarial environments
- Online learning algorithms for sequential decision making and Stackelberg games with time-varying tasks in adversarial environments
- Structure-aware function approximation and identification of governing equations using sparse random Fourier features

### Graduate Research Assistant

University of Texas at Austin

2014 – 2020

Department of Electrical and Computer Engineering

Advisor: Prof. Haris Vikalo

- Efficient communication strategies for network optimization
- Submodular observation selection and information gathering for collaborative sensing systems
- Evolutionary self-expressive models for subspace clustering with applications to real-time motion segmentation and formation of ocean water masses

- Sparse tensor decomposition algorithms for haplotype assembly and study of genetic variations
- Greedy schemes for sparse reconstruction and sparse learning

#### **Data Scientist Intern**

Cognitive Scale, Austin, Texas

Summer 2017

Mentor: Dr. Suyog Dutt Jain

Project: Relation extraction for clinical text data using attention-based deep recurrent neural networks

#### **Undergraduate Research Intern**

Hong Kong University of Science and Technology

Summer 2013

Department of Electrical and Computer Engineering

Host: Prof. Daniel Palomar

Project: Robust estimation of covariance matrices from heavy-tailed distributions

#### **Undergraduate Research Assistant**

Sharif University of Technology

2013 – 2014

Department of Electrical Engineering

Advisor: Prof. Babak H. Khalaj

Project: Vision-based gait analysis via exploiting human body-parts proportion

### **SCHOLASTIC HONORS**

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1. Best student paper award finalist, American Control Conference, June 2018
2. 1 of 4 selected as an invited student speaker at 15th CSL conference at UIUC, Machine Learning for Signal Processing session, February 2020
3. 1 of 4 selected as an invited student speaker at 12th CSL conference at UIUC, Bioinformatics and Computational Genomics session, February 2017
4. Inclusive Classrooms Leadership Certificate, UT Austin, February 2015
5. Professional Teaching Assistant Certificate, UT Austin, August 2014
6. Top 33% Reviewer of ICML 2020, August 2020
7. Travel awards for ICML 2019, ACC 2019, ACC 2018, CNB-MAC 2017, ICASSP 2017, GlobalSIP 2016
8. Qualified as an Exceptional Talent eligible to enter Graduate Studies without entrance exam, Sharif University of Technology, 2013
9. Ranked 79th among more than 277,000 participants in the Nationwide University Entrance Exam for B.Sc. degree, 2010
10. Recipient of Iranian National Elite Foundation fellowship, 2010-2014

### **TEACHING EXPERIENCE**

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#### **Graduate Teaching Assistant**

University of Texas at Austin

Department of Electrical and Computer Engineering

- Statistical Machine Learning Fall 2019
- Estimation Theory Fall 2017
- Digital Signal Processing Fall 2014 and Spring 2015

#### **Undergraduate Teaching Assistant**

Sharif University of Technology

Department of Electrical Engineering

- Digital Signal Processing Fall 2013
- Communication Systems Fall 2013
- Principles of Electronics Spring 2013 and Fall 2013
- Computer Architecture Spring 2013
- Logic Circuits Spring 2013
- Analog Circuits Spring 2013
- Electromagnetism Fall 2012

## MENTORSHIP

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- Bobby Shi (Ph.D. student, UT Austin): Sparse random features for function approximation and identification of dynamical systems, since Fall 2020
- Rudrajit Das (Ph.D. student, UT Austin): Communication-efficient and privacy-preserving federated learning, since Summer 2020
- Anish Acharya (Ph.D. student, UT Austin): Robust federated learning and distributed optimization in high dimensions, since Summer 2020
- Yiuye Chen (Ph.D. student, UT Austin): Distributed optimization over resource-constrained networks, since Fall 2019
- Émilie Thomé (Intern at Oden Institute, UT Austin): Communication-efficient multi-task learning and sequential decision making, since Spring 2021
- Banghua Zhu (Visiting undergrad from Tsinghua, UT Austin): Sparse tensor decomposition for haplotype assembly (now at UC Berkeley), Fall 2017
- Hussain Almatarr (Visiting undergrad from KAUST, UT Austin): Distributed vs. federated learning: Exploring the trade-offs in collaborative learning schemes, Summer 2019

## INVITED TALKS

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1. Weak Submodular Optimization: Theory, Algorithm, Application, *Department of Computer Science at UIUC*, Feb. 2020.
2. Progressive Stochastic Greedy Sparse Reconstruction and Support Selection, *15th CSL student conference at UIUC*, Feb. 2020.
3. Tutorial on Submodular Maximization, *The Oden Institute for Computational Engineering and Sciences at UT Austin*, Nov. 2019.
4. Tutorial on Submodular Minimization, *The Oden Institute for Computational Engineering and Sciences at UT Austin*, Oct. 2019.
5. Sparse Tensor Decomposition for Haplotype Assembly of Diploids and Polyploids, *12th CSL student conference at UIUC*, Feb. 2017.

## PUBLICATIONS

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### Preprints

1. Ghasemi, M., **Hashemi, A.**, Vikalo, H., Topcu, U., “No-Regret Learning with High-Probability in Adversarial Markov Decision Processes,” *Submitted to UAI 2021*.
2. **Hashemi, A.**, Schaeffer, H., Shi, B., Tran, G., Ward, R., “Function Approximation via Sparse Random Features,” *Submitted to ICML 2021*.

3. Chen, Y., **Hashemi, A.**, Vikalo, H., “Communication-Efficient Variance-Reduced Decentralized Stochastic Optimization over Time-Varying Directed Graphs,” *Submitted to IEEE Transactions on Automatic Control*, 2021.
4. Acharya, A., **Hashemi, A.**, Jain, P., Sanghavi, S., Dhillon, I., Topcu, U., “Robust SGD via Block coordinate Geometric Median Descent,” *Submitted to ICML 2021*.
5. Das, R., Acharya\*, A., **Hashemi\***, A., Sanghavi, S., Dhillon, I., Topcu, U., “Faster Non-Convex Federated Learning via Global and Local Momentum,” *Submitted to ICML 2021*.
6. **Hashemi, A.**, Acharya\*, A., Das\*, R., Vikalo, H., Sanghavi, S., Dhillon, I., “On the Benefits of Multiple Gossip Steps in Communication-Constrained Decentralized Optimization,” *Submitted to ICML 2021*.
7. Ghasemi, M., **Hashemi, A.**, Vikalo, H., Topcu, U., “Learning in Markov Decision Processes with Varying Rewards: High Probability Regret Bounds under Bandit Feedback and Unknown Horizon,” *Manuscript in preparation*, 2021.
8. **Hashemi, A.**, Vikalo, H., de Veciana, G., “Progressive Stochastic Greedy Sparse Reconstruction and Support Selection,” *Submitted to IEEE Transaction on Signal Processing*, 2021.
9. Chen, Y., **Hashemi, A.**, Vikalo, H., “Communication-Efficient Algorithms for Decentralized Optimization Over Directed Graphs,” *Submitted to IEEE Transaction on Signal Processing*, 2021.

### Journal Papers

1. **Hashemi, A.**, Ghasemi, M., Vikalo, H., Topcu, U., “Randomized Greedy Sensor Selection: Leveraging Weak Submodularity,” *IEEE Transactions on Automatic Control*, Jan. 2021.
2. **Hashemi, A.** and Vikalo, H., “Evolutionary Self-Expressive Models for Subspace Clustering,” *IEEE Journal of Selected Topics in Signal Processing*, vol. 12, no. 6, pp. 1534–1546, Dec. 2018.
3. **Hashemi, A.** and Vikalo, H., “Accelerated Orthogonal Least-Squares for Large-Scale Sparse Reconstruction,” *Digital Signal Processing*, vol. 82, pp. 91–105, Nov. 2018.
4. **Hashemi, A.**, Zhu, B., Vikalo, H., “Sparse Tensor Decomposition for Haplotype Assembly of Diploids and Polyploids,” *BMC Genomics*, vol. 19, no. 4, pp. 1–15, Mar. 2018.

### Conference Papers

1. Ghasemi, M., **Hashemi, A.**, Topcu, U., Vikalo, H., “Online Learning with Implicit Exploration in Episodic Markov Decision Processes,” *American Control Conference (ACC)*, 2021.
2. Savas, Y., **Hashemi, A.**, Vinod, AP., Sadler, BM., Topcu, U., “Physical-Layer Security via Distributed Beam-forming in the Presence of Adversaries with Unknown Locations,” *International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2021.
3. Chen, Y., **Hashemi, A.**, Vikalo, H., “Decentralized Optimization on Time-Varying Directed Graphs under Communication Constraints,” *International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2021.
4. **Hashemi, A.**, Vikalo, H., de Veciana, G., “On the Performance-Complexity Tradeoff in Stochastic Greedy Weak Submodular Optimization,” *International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2021.
5. Ghasemi, M., **Hashemi, A.**, Vikalo, H., Topcu, U., “Identifying Low-Dimensional Structures in Markov Chains: A Nonnegative Matrix Factorization Approach,” *American Control Conference (ACC)*, 2020.
6. Ghasemi\*, M., **Hashemi\***, A., Vikalo, H., Topcu, U., “On Submodularity of Quadratic Observation Selection in Constrained Networked Sensing Systems,” *American Control Conference (ACC)*, 2019.
7. Shafipour, R., **Hashemi, A.**, Mateos, G., Vikalo, H., “Online Topology Inference from Streaming Stationary Graph Signals,” *Data Science Workshop (DSW)*, 2019.

8. **Hashemi, A.**, Ghasemi, M., Vikalo, H., Topcu, U., “Submodular Observation Selection and Information Gathering for Quadratic Models,” *International Conference on Machine Learning (ICML)*, June 2019.
9. **Hashemi, A.** and Vikalo, H., “Evolutionary Subspace Clustering: Discovering Structure In Self-expressive Time-series Data,” *International Conference on Acoustic, Speech and Signal Processing (ICASSP)*, 2019.
10. Consul, S., **Hashemi, A.**, Vikalo, H., “A MAP Framework for Support Recovery of Sparse Signals Using Orthogonal Least Squares,” *International Conference on Acoustic, Speech and Signal Processing (ICASSP)*, Brighton, 2019.
11. **Hashemi, A.**, Kilic, O.F., Vikalo, H., “Near-Optimal Distributed Estimation for a Network of Sensing Units Operating Under Communication Constraints,” *Conference on Decision and Control (CDC)*, 2018.
12. **Hashemi, A.**, Shafipour, R., Vikalo, H., Mateos, G., “A Novel Scheme for Support Identification and Iterative Sampling of Bandlimited Graph Signals,” *Global Conference on Signal and Information Processing (GlobalSIP)*, 2018.
13. **Hashemi, A.**, Ghasemi, M., Vikalo, H., Topcu, U., “A Randomized Greedy Algorithm for Near-Optimal Sensor Scheduling in Large-Scale Sensor Networks,” *American Control Conference (ACC)*, 2018 (**Best student paper award finalist**).
14. **Hashemi, A.**, Shafipour, R., Vikalo, H., Mateos, G., “Sampling and Reconstruction of Graph Signals via Weak Submodularity and Semidefinite Relaxation,” *International Conference on Acoustic, Speech and Signal Processing (ICASSP)*, 2018.
15. **Hashemi, A.**, Zhu, B., Vikalo, H., “Sparse Tensor Decomposition for Haplotype Assembly of Diploids and Polyploids,” *International Workshop on Computational Network Biology: Modeling, Analysis, Control (CNB-MAC)*, 2017.
16. **Hashemi, A.** and Vikalo, H., “Sparse Recovery via Branch and Bound Least-Squares,” *International Conference on Acoustic, Speech and Signal Processing (ICASSP)*, 2017.
17. **Hashemi, A.** and Vikalo, H., “Sparse Linear Regression via Generalized Orthogonal Least-Squares,” *Global Conference on Signal and Information Processing (GlobalSIP)*, 2016.

## PROFESSIONAL MEMBERSHIPS AND SERVICES

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### Technical Program Committees

- 2020 IEEE International Workshop on Signal Processing Advances in Wireless Communications
- 2019 International Multi-Conference on Computing in the Global Information Technology
- 2019 International Conference on Mobile, Hybrid, and Online Learning
- 2018 International Conference on Advanced Engineering Computing and Applications in Sciences
- 2018 International Multi-Conference on Computing in the Global Information Technology

### Memberships

- Institute of Electrical and Electronics Engineers (IEEE), Signal Processing Society 2016 – present
- Member of Society for Industrial and Applied Mathematics (SIAM) 2016 – present

### Journal Reviews

- IEEE Signal Processing Magazine 2020
- IEEE Transactions on Signal Processing 2016 – 2020
- IEEE Signal Processing Letters 2016
- IEEE Transactions on Signal and Information Processing over Networks 2018

- IEEE Transactions on Cybernetics 2020
- IEEE Journal of Selected Areas in Information Theory 2019
- SIAM Journal on Scientific Computing 2021
- Elsevier Signal Processing 2019
- IET Signal Processing 2017
- IEEE Access 2019
- Nature Scientific Reports 2018
- PLOS One 2018
- Taylor and Francis Journal on Forensic Sciences Research 2018

### Conference Reviews

- International Conference on Artificial Intelligence and Statistics (AISTATS) 2021
- International Conference on Machine Learning (ICML) 2020 & 2021
- Conference on Neural Information Processing Systems (NeurIPS) 2020
- American Control Conference (ACC) 2020 & 2021
- International Symposium on Information Theory (ISIT) 2020
- International Workshop on Signal Processing Advances in Wireless Communications (SPAWC) 2020
- Conference on Decision and Control (CDC) 2018

### REFERENCES

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| <ul style="list-style-type: none"> <li>• Haris Vikalo<br/>Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:hvikalo@ece.utexas.edu">hvikalo@ece.utexas.edu</a></li> </ul>                 | <ul style="list-style-type: none"> <li>• Rachel Ward<br/>Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:rward@math.utexas.edu">rward@math.utexas.edu</a></li> </ul>                    |
| <ul style="list-style-type: none"> <li>• Ufuk Topcu<br/>Associate Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:utopcu@utexas.edu">utopcu@utexas.edu</a></li> </ul>                   | <ul style="list-style-type: none"> <li>• Inderjit Dhillon<br/>Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:inderjit@cs.utexas.edu">inderjit@cs.utexas.edu</a></li> </ul>             |
| <ul style="list-style-type: none"> <li>• Sujay Sanghavi<br/>Associate Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:sanghavi@mail.utexas.edu">sanghavi@mail.utexas.edu</a></li> </ul> | <ul style="list-style-type: none"> <li>• Gustavo de Veciana<br/>Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:gustavo@ece.utexas.edu">gustavo@ece.utexas.edu</a></li> </ul>           |
| <ul style="list-style-type: none"> <li>• Gonzalo Mateos<br/>Associate Professor<br/>University of Rochester<br/>Email: <a href="mailto:gmateosb@ur.rochester.edu">gmateosb@ur.rochester.edu</a></li> </ul>     | <ul style="list-style-type: none"> <li>• Alex Dimakis<br/>Associate Professor<br/>University of Texas at Austin<br/>Email: <a href="mailto:dimakis@austin.utexas.edu">dimakis@austin.utexas.edu</a></li> </ul> |