Afshin **Abdi**

PH.D. CANDIDATE · GEORGIA TECH

251 10th street NW, Atlanta, GA 30318, USA

(+1) 404-333-1040 | abdi@ece.gatech.edu

afshinabdi | NetTrim | LinkedIn | Google Scholar

Dynamic and motivated researcher and professional with extensive experience in managing and working on projects from concept to completion. Skills include analytical thinking, creative problem solving, and computer programming. Have expertise and research/work experience in the areas of

Machine Learning · Optimization · Distributed Training · Signal & Image Processing · Data Science

Education

Georgia Institute of Technology   Atlanta, GA
PH.D. IN ELECTRICAL AND COMPUTER ENGINEERING (EXPECTED JUNE, 2020)   GPA 4.0/4.0
   Thesis: *Distributed Learning and Inference in Deep Models*

Sharif University of Technology   Iran
M.SC. IN ELECTRICAL ENGINEERING, COMMUNICATION   GPA 18.07/20

Sharif University of Technology   Iran
B.SC. IN ELECTRICAL ENGINEERING, COMMUNICATION   GPA 18.6/20

Research Experience

Georgia Institute of Technology   Atlanta, GA
GRADUATE RESEARCH ASSISTANT   2014–present

- Distributed Training and Inference of Deep Neural Networks (2017–present)
- Federated Learning over Wireless Edge Networks (2019–present)
- Deep Learning for Coding and Communication (2018–present)
- Deep Model Compression (2017–present)
- Compressed Sensing and Signal Processing in Biology (2016–present)
- (Universal) Data Compression (2014–2016)

University of Tehran   Iran
RESEARCHER   2011–2013

- Distributed Source Coding
- Functional Compression in Sensor Networks

Work Experience

ProcessMiner   Atlanta, GA
DATA SCIENCE INTERN   May–July, 2018

I developed and evaluated various algorithms for processing and cleaning data, causality analysis and finding the most significant parameters in controlling the quality of the final product in paper mill industry. The algorithms were implemented in Python, and tested and successfully evaluated on real data by the industry experts. The outcomes of the algorithm were used to simplify and improve the quality control of the products in the manufacturing process.

Kavosh co.   Iran

CO-FOUNDER AND PRODUCT DEVELOPER   *2012–2013*

> We designed and developed numerous products for automatic traffic monitoring and road inspection, and delivered various services based on the computer vision and signal processing, such as
> - 3D imaging and inspection of road surface in real-time (using CUDA and C++),
> - Automatic traffic monitoring, including license plate recognition and OCR, and instantaneous and average speed measurement of each car (using C++ and C#).

Beena   *Iran*

R&D MANAGER FOR ALGORITHM DEVELOPMENT AND COMPUTER VISION   *2010–2011*

> Lead a successful team of researchers and engineers, and worked on various projects from concept to production for automatic real-time inspection of trains and railways. Developed algorithms based on joint laser-camera imaging, computer vision, and 3D reconstruction for parameter measurement and anomaly detection, using MATLAB, C++, Embedded C++, and LabView. Examples of the developed products include *WheelView*, *LazerView*, and *BrakeView*.

Teaching Experience

Course Development
UNIVERSITY OF TEHRAN   *2011*

> Participated in Developing *Real-Time Digital Signal Processing Laboratory Using TI Processors*.

Instructor
UNIVERSITY OF TEHRAN   *2012–2013*

> Instructor of "*A Short Course on Real-Time Digital Signal Processing Using TI DSP Processors*".

Teaching Assistant
SHARIF UNIVERSITY OF TECHNOLOGY

> Teaching Assistant for the courses *Adaptive Filters*, *DSP Processors*, *Digital Signal Processing Lab*, *Differential Equations*, and *Communication systems I*.

Teaching Assistant
GEORGIA TECH

> Teaching Assistant for the course *Introduction to Signal Processing*.

Honors and Awards

Student Travel Award, AAAI conference on Artificial Intelligence, 2020   *New York, NY*
CSIP Outstanding Research Award, Georgia Tech, 2019   *Atlanta, GA*
Colonel Oscar P. Cleaver Award, Top Score in Ph.D. Preliminary Exam, Georgia Tech, 2013   *Atlanta, GA*
Gold medal, 13th Iran's National Mathematics Olympiad   *Iran*
Silver medal, 12th Iran's National Mathematics Olympiad   *Iran*
Selected (top 50), 6th Iran's National Informatics Olympiad   *Iran*
Rank #6, Iran's National Universities Entrance Exam for M.Sc. in Mathematics   *Iran*
Rank #2, Iran's National Universities Entrance Exam for M.Sc. in Computer Science   *Iran*
Rank #8, Iran's National Universities Entrance Exam for M.Sc. in Communications   *Iran*
Rank #3, Top B.Sc. Students in Electrical Engineering at Sharif University of Technology   *Iran*

Publications

❯ Machine Learning: Algorithms and Applications

1. A. Abdi and F. Fekri, "Indirect stochastic gradient quantization and its application in distributed deep learning," in *AAAI conference on Artificial Intelligence*, 2020, **20% acceptance rate**
2. A. Abdi and F. Fekri, "Quantized compressive sampling of stochastic gradients for efficient communication in distributed deep learning," in *AAAI conference on Artificial Intelligence*, 2020, **20% acceptance rate**
3. A. Aghasi, A. Abdi, and J. Romberg, "Fast convex pruning of deep neural networks," *SIAM Journal on the Mathematics of Data Science*, 2020

4. A. Abdi and F. Fekri, "Reducing communication overhead via ceo in distributed training," in *IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2019

5. Y. M. Saidutta, A. Abdi, and F. Fekri, "Joint source-channel coding for gaussian sources over AWGN channels using variational autoencoders," in *IEEE International Symposium on Information Theory*, July 2019

6. Y. M. Saidutta, A. Abdi, and F. Fekri, "M to 1 joint source-channel coding of gaussian sources via dichotomy of the input space based on deep learning," in *Data Compression Conference (DCC)*, 2019

7. Y. M. Saidutta, A. Abdi, and F. Fekri, "Joint source-channel coding of gaussian sources over AWGN channels via manifold variational autoencoders," in *Annual Allerton Conference on Communication, Control, and Computing*, 2019

8. A. Abdi and F. Fekri, "Nested dithered quantization for communication reduction in distributed training," *arXiv preprint arXiv:1904.01197*, 2019

9. A. Aghasi, A. Abdi, N. Nguyen, and J. Romberg, "Net-trim: Convex pruning of deep neural networks with performance guarantee," in *Advances in Neural Information Processing Systems*, 2017, **presented as Spotlight, 3% acceptance rate**

10. A. Abdi, and F. Fekri, "RePurpose: Restructuring and Pruning of Deep Models for Parallel Distributed Inference," *submitted to International Conference on Machine Learning (ICML)*, 2020

11. A. Abdi, Y. M. Saidutta, and F. Fekri, "Analog Compression and Communication for Federated Learning over Wireless MAC," *submitted to IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2020

12. Y. M. Saidutta, A. Abdi, and F. Fekri, "VAE for Joint Source-Channel Coding of Distributed Gaussian Sources over AWGN MAC," *submitted to IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2020

13. A. Abdi, and F. Fekri, "A Convex Optimization Framework for Model Compression with Performance Guarantee," *in Process*

❯ Signal Processing, Compressed Sensing and Applications in Biology

1. H. Zhang, A. Abdi, and F. Fekri, "Recovering noisy-pseudo-sparse signals from linear measurements via ℓ_∞," in *Annual Allerton Conference on Communication, Control, and Computing*, 2019

2. H. Zhang, A. Abdi, and F. Fekri, "Compressive sensing with a multiple convex sets domain," in *IEEE International Symposium on Information Theory*, July 2019

3. H. Zhang, A. Abdi, and F. Fekri, "Analysis of sparse-integer measurement matrices in compressive sensing," in *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2019

4. H. Zhang, A. Abdi, and F. Fekri, "Sparse recovery of sign vectors under uncertain sensing matrices," in *IEEE Information Theory Workshop*, 2018

5. H. Zhang, A. Abdi, and F. Fekri, "Compressive sensing with energy constraint," in *IEEE Information Theory Workshop*, 2017

6. H. Zhang, A. Abdi, and F. Fekri, "Recovery of sign vectors in quadratic compressed sensing," in *IEEE Information Theory Workshop*, 2017

7. A. Abdi and F. Fekri, "Optimal sensor selection in the presence of noise and interference," in *IEEE International Symposium on Information Theory*, 2017

8. H. Zhang, A. Abdi, F. Fekri, and H. Esmaeilzadeh, "Error correction for approximate computing," in *Annual Allerton Conference on Communication, Control, and Computing*, 2016

9. A. Abdi, A. Einolghozati, and F. Fekri, "Quantization in molecular signal sensing via biological agents," *IEEE Transactions on Molecular, Biological and Multi-Scale Communications*, vol. 3, no. 2, 2017

10. A. Abdi, A. Einolghozati, and F. Fekri, "Computing framework in biological cells via stochastic methods," in *IEEE Information Theory Workshop*, 2017

11. A. Einolghozati, J. Zou, A. Abdi, and F. Fekri, "Micro-RNA profile detection via factor graphs," in *IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2016

12. H. Zhang, A. Abdi, and F. Fekri, "Non-Parametric Structure Learning in Graphical Models from Indirect Observations," *in Process*

❯ Data Compression

1. A. Payani, A. Abdi, X. Tian, F. Fekri, and M. Mohandes, "Advances in seismic data compression via learning from data: Compression for seismic data acquisition," *IEEE Signal Processing Magazine*, vol. 35, no. 2, March 2018

2. X. Tian, A. Abdi, E. Liu, and F. Fekri, "Seismic signal compression through delay compensated and entropy constrained dictionary learning," in *IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2018

3. X. Tian, A. Abdi, E. Liu, and F. Fekri, "Memory-assisted seismic signal compression based on dictionary learning and sparse coding," in *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, 2017

4. A. Payani, A. Abdi, and F. Fekri, "Memory-assisted compression of seismic data: Tackling a large alphabet-size problem by statistical methods," in *SEG's International Exposition*, 2017

5. A. Abdi and F. Fekri, "Mixture source identification in non-stationary data streams with applications in compression," in *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2017

6. A. Abdi, A. Payani, and F. Fekri, "Learning dictionary for efficient signal compression," in *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2017

7. A. Payani, A. Abdi, and F. Fekri, "Near optimal representative subset selection from short sequences generated by a stationary source," in *IEEE International Workshop on Signal Processing Advances in Wireless Communications*, 2016

8. A. Abdi and F. Fekri, "Source identification and compression of mixture data from finite observations," in *IEEE Information Theory Workshop*, 2015

9. F. Fekri, M. Sardari, A. Beirami, L. Huang, A. Abdi, "Packet-level clustering for memory-assisted compression of network traffic,", US **Patent**, App. 15/191,280

Selected Projects

> **Machine Learning: Algorithms and Applications**

Distributed and Parallel Training of Deep Neural Networks   *Gerogia Tech*

Ph.D. Research   *2017–present*

   Developed and analyzed novel algorithms to mitigate communication bottleneck in distributed training from three different perspectives: *Information Theory and CEO*, *Matrix Factorization*, and *Compressive Sampling*. Implemented and evaluated using Python and Tensorflow.

Distributed Model Inference   *Georgia Tech*

Ph.D. Research   *2019–present*

   Developed and analyzed techniques for efficient training and inference of distributed multimodal/multi-input deep models over a (wireless) sensor network, using Python and Tensorflow.

Federated Learning in Wireless Edge Networks   *Georgia Tech*

Ph.D. Research   *2019–present*

   Proposed a novel communication and distributed learning algorithm that satisfies the edge network's constraints, such as unreliable transmissions and limited power, while preserving data privacy and benefiting from the characteristics of wireless communication channel such as over-the-air computations.

Deep Model Compression   *Georgia Tech*

Ph.D. Research   *2017–present*

   We proposed *Net-Trim*, a fast layer-wise convex optimization framework, to prune trained deep neural networks. We analyzed the sample complexity of the method, and mathematically proved the consistency between the original and the pruned deep models. [O Github]

Applications of Deep Learning in Coding and Communication   *Georgia Tech*

Ph.D. Research   *2018–present*

   We argued that the m to k joint source-channel coding can be considered as a projection of input m-dimensional data onto a k dimensional manifold in $\mathbb{R}^m$. Exploiting the manifold nature of the coding problems, we have developed novel neural network architectures and devised information theoretic/VAE-based cost functions for training using Python and Tensorflow.

> **Signal Processing, Compressed Sensing and Applications in Biology**

Compressed Sensing with Side-Information in Biology   *Georgia Tech*

Graduate Research   *2016–present*

   Proposed and evaluated novel algorithms to estimate the micro-RNAs' concentrations or discover their abnormal behavior through measurements from a small group of cheap biosensors, where we have utilized the side-information about the micro-RNAs' behavior, such as sparsity, bounded variations (expressed through ℓ_2 or ℓ_∞ norms), and causality, to improve the estimation accuracy.

Optimum Sensor Selection   *Georgia Tech*

Graduate Research   *2017*

   Developed and evaluated a novel optimization technique to select the optimum set of sensors from a library of sensors in the presence of noise and interference, using MATLAB and cvx.

Quantization and Rate-Distortion in Biology
GRADUATE RESEARCH

Georgia Tech

2016–2017

Developed algorithms for the optimal quantization and analyzed its distortion in sensing and estimation of the concentration of molecular signals in the synthetic biological agents equipped with ligand receptors.

Causality Analysis in Time-Series Signals
INTERNSHIP

ProcessMiner

2018

Developed and evaluated various algorithms for cleaning, processing and causality analysis of time-series signals in Python.

Approximate Computing
GRADUATE RESEARCH

Georgia Tech

2014

We proposed a novel approach to improve the accuracy of distributed approximate computation via exploiting the correlation and using error correction coding techniques.

› Information Theory, Compression and Communication

In-Field Seismic Signal Compression
GRADUATE. RESEARCH

Georgia Tech

2014

Developed and analyzed various techniques for efficient compression of seismic signals based on minimum-entropy and sparse dictionary learning, one-bit re-sampling, and exploiting memory from previous transmissions.

Universal Data Compression
GRADUATE RESEARCH

Georgia Tech

2014

We analyzed how using information from past compressed data can significantly improve the compression gain, especially for short blocks of data, such as network packets. We developed efficient methods to exploit that knowledge using C++ and MATLAB.

Extracurricular Activity

Reviewer - Conferences

IEEE International Symposium on Information Theory, IEEE Information Theory Workshop, IEEE Wireless Communications and Networking Conference, International Conference on Machine Learning (ICML), Neural Information Processing Systems (NeurIPS), AAAI Conference on Artificial Intelligence, IEEE workshop on Signal Processing Advances in Wireless Communications (SPAWC)

Reviewer - Journals

IEEE Trans. on NanoBioScienc, IEEE Trans. on Signal Processing, IEEE Communications Letters

Membership

IEEE student member, AAAI student member