Tolga Ergen

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Research Interests

Machine learning, deep learning, optimization

Education

Stanford University — *Stanford, CA*

PH.D. IN ELECTRICAL ENGINEERING, CGPA: **4.11 / 4.00** — *Sep 2018 – 2023*

- Advisor: Mert Pilanci
- Thesis: Convex optimization for neural networks

Bilkent University — *Ankara, Turkey*

M.S. IN ELECTRICAL AND ELECTRONICS ENGINEERING, CGPA: **4.00 / 4.00** — *Sep 2016 – July 2018*

- Advisor: Suleyman Serdar Kozat
- Thesis: Online learning with recurrent neural networks

Bilkent University — *Ankara, Turkey*

B.S. IN ELECTRICAL AND ELECTRONICS ENGINEERING, CGPA: **3.97 / 4.00** — *Sep 2011 – July 2016*

- Graduated as the **3rd** in class

Industrial & Academic Experience

LG AI Research — *Ann Arbor, MI*

RESEARCH SCIENTIST — *July 2023 – Present*

- Improving optimization, efficiency, and understanding of Large Language Models

Google Research — *Mountain View, CA*

RESEARCH INTERN — *Jun 2022 – Sep 2022*

- Hosts: Harsh Mehta and Behnam Neyshabur
- Improving optimization and understanding of transformer networks through convex optimization theory

Salesforce Research — *Palo Alto, CA*

RESEARCH INTERN — *Jun 2021 – Sep 2021*

- Host: Yu Bai
- Gradient based methods for uncertainty quantification under unknown distribution shift

Stanford University — *Stanford, CA*

TEACHING ASSISTANT — *2018-Present*

- EE-269: Signal Processing for Machine Learning — Sep 2019 – Dec 2019
- EE-270: Large Scale Matrix Computation, Optimization and Learning — Jan 2020- Mar 2020
- EE-364B: Convex Optimization II — Apr 2020 – Jun 2020
- EE-269: Signal Processing for Machine Learning — Sep 2020 – Dec 2020
- EE-270: Large Scale Matrix Computation, Optimization and Learning — Jan 2021 – Mar 2021
- EE-364B: Convex Optimization II — Mar 2021 – Jun 2021
- EE-364B: Convex Optimization II — Mar 2022 – Jun 2022

Bilkent University — *Ankara, Turkey*

TEACHING ASSISTANT — *2016-2018*

- EEE-424: Digital Signal Processing — Sep 2016 – Jan 2017
- EEE-102: Introduction to Digital Circuit Design — Feb 2017 – Jun 2017
- EEE-424: Digital Signal Processing — Sep 2017 – Jan 2018
- EEE-424: Digital Signal Processing — Feb 2018 – Jun 2018

Academic Service

REVIEWER

- NeurIPS, ICML, ICLR, IEEE Transactions on Neural Networks and Learning Systems (TNNLS) and IEEE Signal Processing Letters (SPL)

Havelsan Inc., CCCS — *Ankara, Turkey*

UNDERGRADUATE INTERN — *Aug 2015 – Sep 2015*

- Modelling sound propagation and design of a wireless communication system using Snap modules

Aselsan Inc., REHIS *Ankara, Turkey*

Undergraduate Intern *Aug 2014 – Sep 2014*

- Design and implementation of an audio radar warning system based on Virtex-5 FPGA

Honors & Awards

2022	Awarded Adobe Research Fellowship	*Stanford, CA*
2021	Received NeurIPS 2021 Outstanding Reviewer Award given to **the top 8% of reviewers**	*Stanford, CA*
2021	International Conference on Acoustics, Speech, & Signal Processing (ICASSP), **best paper award**	*Stanford, CA*
2020	Conference on the Mathematical Theory of Deep Neural Networks (DeepMath), **best poster award**	*Stanford, CA*
2018	Stanford University Departmental Fellowship: Full tuition waiver & stipend during the first year of PhD	*Stanford, CA*
2017	Bilkent University Graduate Research Conference (GRC), **best oral presentation award** in signal processing	*Ankara, Turkey*
2016	TUBITAK Scholarship for the M.S. studies based on a weighted ALES (National GRE) and GPA score list	*Ankara, Turkey*
2016	Full Scholarship from Bilkent University during M.S. Studies	*Ankara, Turkey*
2016	Bilkent University Academic Excellence Award	*Ankara, Turkey*
2016	Bilkent University High Honor Student during B.S. Studies	*Ankara, Turkey*
2015	Received the **13th rank** among 0.2M university graduates in ALES (National GRE)	*Ankara, Turkey*
2011	Bilkent University Full Scholarship for the B.S. degree in the EEE Department	*Ankara, Turkey*
2011	Received the **178th rank** among 2M high school graduates in University Entrance Examinations	*Ankara, Turkey*

Publications

Journal Articles

Convex Geometry and Duality of Over-parameterized Neural Networks
T. Ergen, M. Pilanci
Journal of Machine Learning Research (***JMLR***) (2021)

A Novel Distributed Anomaly Detection Algorithm based on Support Vector Machines
T. Ergen, S. S. Kozat
Elsevier Digital Signal Processing (2020)

Unsupervised Anomaly Detection with LSTM Neural Networks
T. Ergen, S. S. Kozat
IEEE Transactions on Neural Networks and Learning Systems (2019)

Energy-Efficient LSTM Networks for Online Learning
T. Ergen, Ali H Mirza, S. S. Kozat
IEEE Transactions on Neural Networks and Learning Systems (2019)

Team-optimal Online Estimation of Dynamic Parameters over Distributed Tree Networks
O. F. Kilic, T. Ergen, M. Sayin, S. S. Kozat
Elsevier Signal Processing (2019)

Online Training of LSTM Networks in Distributed Systems for Variable Length Data Sequences
T. Ergen, S. S. Kozat
IEEE Transactions on Neural Networks and Learning Systems (2017)

Efficient Online Learning Algorithms based on LSTM Neural Networks
T. Ergen, S. S. Kozat
IEEE Transactions on Neural Networks and Learning Systems (2017)

Preprints

Convexifying Transformers: Improving optimization and understanding of transformer networks
T. Ergen, B. Neyshabur, H. Mehta
Under Review (2022)

Scaling Convex Neural Networks with Burer-Monteiro Factorization
A. Sahiner, T. Ergen, B. Ozturkler, J. Pauly, M. Mardani, M. Pilanci
Under Review (2022)

Two-Layer Neural Networks as Sparse Mixtures of Convex Models: Polynomial-Time Convex Optimization Formulations of Neural Networks with Piecewise Linear Activations
T. Ergen, M. Pilanci

Under Review (2021)

Conference & Workshop Papers

Globally Optimal Training of Neural Networks with Threshold Activation Functions
T. Ergen, H. Gulluk, J. Lacotte, M. Pilanci
*International Conference on Learning Representations (**ICLR**)* (2023)

Path Regularization: A Convexity and Sparsity Inducing Regularization for Parallel ReLU Networks
T. Ergen, M. Pilanci
*Neural Information Processing Systems (**NeurIPS**)* (2023)

Fixing the NTK: From Neural Network Linearizations to Exact Convex Programs
R. Dwaraknath, T. Ergen, M. Pilanci
*Neural Information Processing Systems (**NeurIPS**)* (2023)

Parallel Deep Neural Networks Have Zero Duality Gap
Y. Wang, T. Ergen, M. Pilanci
*International Conference on Learning Representations (**ICLR**)* (2023)

Unraveling Attention via Convex Duality: Analysis and Interpretations of Vision Transformers
A. Sahiner, T. Ergen, B. Ozturk, J. Pauly, M. Mardani, M. Pilanci
*International Conference on Machine Learning (**ICML**)* (2022)

Demystifying Batch Normalization in ReLU Networks: Equivalent Convex Optimization Models and Implicit Regularization
T. Ergen*, A. Sahiner*, B. Ozturk, J. Pauly, M. Mardani, M. Pilanci
*International Conference on Learning Representations (**ICLR**)* (2022)

Hidden Convexity of Wasserstein GANs: Interpretable Generative Models with Closed-Form Solutions
A. Sahiner*, T. Ergen*, B. Ozturk, B. Bartan, J. Pauly, M. Mardani, M. Pilanci
*International Conference on Learning Representations (**ICLR**)* (2022)

Revealing the Structure of Deep Neural Networks via Convex Duality
T. Ergen, M. Pilanci
*International Conference on Machine Learning (**ICML**)* (2021)

Global Optimality Beyond Two Layers: Training Deep ReLU Networks via Convex Programs
T. Ergen, M. Pilanci
*International Conference on Machine Learning (**ICML**)* (2021)

Implicit Convex Regularizers of CNN Architectures: Convex Optimization of Two- and Three-Layer Networks in Polynomial Time
T. Ergen, M. Pilanci
*International Conference on Learning Representations (**ICLR**)*-**(Spotlight Presentation)** (2021)

Vector-output ReLU Neural Network Problems are Copositive Programs: Convex Analysis of Two Layer Networks and Polynomial-time Algorithms
A. Sahiner, T. Ergen, J. Pauly, M. Pilanci
*International Conference on Learning Representations (**ICLR**)* (2021)

Exact and Relaxed Convex Formulations for Shallow Neural Autoregressive Models
V. Gupta, B. Bartan, T. Ergen, M. Pilanci
*IEEE International Conference on Acoustics, Speech and Signal Processing (**ICASSP**)*-**(Outstanding Paper Award)** (2021)

Neural Networks are Convex Regularizers: Exact Polynomial-time Convex Optimization Formulations for Two-layer Networks
M. Pilanci, T. Ergen
*International Conference on Machine Learning (**ICML**)* (2020)

Convex Geometry of Two-Layer ReLU Networks: Implicit Autoencoding and Interpretable Models
T. Ergen, M. Pilanci
*International Conference on Artificial Intelligence and Statistics (**AISTATS**)* (2020)

Convex Programs for Global Optimization of Convolutional Neural Networks in Polynomial-Time
T. Ergen, M. Pilanci
*NeurIPS Workshop on Optimization for Machine Learning (**OPTML**)* - **(Oral Presentation)** (2020)

Random Projections for Learning Non-convex Models
T. Ergen, M. Pilanci
NeurIPS Workshop on Beyond First Order Methods in Machine Learning (2019)

Convex Duality and Cutting Plane Methods for Over-parameterized Neural Networks
T. Ergen, M. Pilanci
*NeurIPS Workshop on Optimization for Machine Learning (**OPTML**)* (2019)

Convex Optimization for Shallow Neural Networks
T. Ergen, M. Pilanci
*Annual Allerton Conference on Communication, Control, and Computing (**Allerton**)* (2019)

A Highly Efficient Recurrent Neural Network Architecture for Data Regression
T. Ergen, E. Ceyani
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2018)

A Novel Anomaly Detection Approach Based on Neural Networks
T. Ergen, M. Kerpicci
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2018)

Computationally Efficient Online Regression via LSTM Neural Networks
T. Ergen, S. S. Kozat
European Signal Processing Conference (EUSIPCO) (2017)

An Efficient Bandit Algorithm for General Weight Assignments
K. Gokcesu, T. Ergen, S. Ciftci, S. S. Kozat
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2017)

Neural Networks Based Online Learning
T. Ergen, S. S. Kozat
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2017)

Novelty Detection Using Soft Partitioning and Hierarchical Models
T. Ergen, K. Gokcesu, M. Simsek, S. S. Kozat
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2017)

Online Distributed Nonlinear Regression via Neural Networks
T. Ergen, S. S. Kozat
*IEEE Signal Processing and Communications Applications Conference (**SIU**)* (2017)

Skills

Programming Python, Matlab, LaTeX, VHDL
Languages English, Turkish