

# Nadav Cohen\*

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## Research Interests

Machine Learning, Deep Learning Theory, Non-Convex Optimization, Tensor Analysis

## Education

**2012-2017:** Ph.D. (direct track), School of Computer Science and Engineering, The Hebrew University of Jerusalem

- Advisor: Prof. Amnon Shashua
- Thesis: Analysis and Design of Convolutional Networks via Hierarchical Tensor Decompositions
- GPA: 99.4/100.0

**2008-2012:** B.Sc. Mathematics and B.Sc. Electrical Engineering, Technion — Israel Institute of Technology

- GPA: 98.3/100.0 (rank 1 of 1827 in Technion class 2012)
- Member of the Technion Excellence Program for Distinguished Undergraduates

## Academic Appointments

**2019-present:** Asst. Professor (Senior Lecturer), School of Computer Science, Tel Aviv University

**2017-2019:** Postdoctoral member, School of Mathematics, Institute for Advanced Study

- Host: Prof. Sanjeev Arora, Prof. Elad Hazan
- Research Area: Deep Learning Theory

## Industry Positions

**2017-present:** Co-founder and Chief Scientist, Imubit

**2007-2017:** Chief Technology Officer, Cigol Digital Systems (acquired by Mellanox Technologies)

**2004-2007:** FPGA Engineer, Cyber Security Center, Israel Defense Forces

## Honors and Awards

Google Research Scholar Award (2021)

European Laboratory for Learning and Intelligent Systems (ELLIS) Scholarship (2020)

Google Gift for Machine Learning Research (2020)

Hans Wiener Prize for outstanding doctoral thesis (2018)

Zuckerman Postdoctoral Fellowship (2017)

Rothschild Postdoctoral Fellowship (2017)

Final Prize for Machine Learning Research (2017)

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\* Updated on June 6, 2022

TheMarker (Israeli business newspaper) “40 under 40” list (2017)  
Google Doctoral Fellowship in Machine Learning (2015)  
The Hebrew University of Jerusalem Faculty of Science dean’s honors list (2013)  
Summa cum laude graduate of Technion B.Sc. Mathematics (2012)  
Summa cum laude graduate of Technion B.Sc. Electrical Engineering (2012)  
Maxim Bychkov prize for outstanding achievements in B.Sc. Mathematics (2012)  
Technion Excellence Program for Distinguished Undergraduates (2008-2012)  
Technion president’s honors list (2008-2012)  
Technion Faculty of Mathematics award for outstanding undergraduate achievements (2011)  
Elias-Perlmutter prize for outstanding achievements in B.Sc. Electrical Engineering (2011)  
Israel Defense Forces award for outstanding R&D of classified cyber security system (2008)  
Israel Defense Forces award for outstanding R&D of classified cyber security system (2007)  
Israel Defense Forces Cyber Security Center award for excellence in R&D (2006)

## Publications

### Conference Proceedings

† Noam Razin, Asaf Maman and Nadav Cohen. ‘Implicit Regularization in Hierarchical Tensor Factorization and Deep Convolutional Neural Networks’. *International Conference on Machine Learning (ICML) 2022*.

Edo Cohen-Karlik, Avichai Ben David, Nadav Cohen and Amir Globerson. ‘On the Implicit Bias of Gradient Descent for Temporal Extrapolation’. *Conference on Artificial Intelligence and Statistics (AISTATS) 2022*.

† Omer Elkabetz and Nadav Cohen. ‘Continuous vs. Discrete Optimization of Deep Neural Networks’. *Conference on Neural Information Processing Systems (NeurIPS) 2021, Spotlight Track (top 3%)*.

† Noam Razin, Asaf Maman and Nadav Cohen. ‘Implicit Regularization in Tensor Factorization’. *International Conference on Machine Learning (ICML) 2021*.

† Noam Razin and Nadav Cohen. ‘Implicit Regularization in Deep Learning May Not Be Explainable by Norms’. *Conference on Neural Information Processing Systems (NeurIPS) 2020*.

‡ Sanjeev Arora, Nadav Cohen, Wei Hu and Yuping Luo (alphabetical order). ‘Implicit Regularization in Deep Matrix Factorization’. *Conference on Neural Information Processing Systems (NeurIPS) 2019, Spotlight Track (top 3%)*.

‡ Sanjeev Arora, Nadav Cohen, Noah Golowich and Wei Hu (alphabetical order). ‘A Convergence Analysis of Gradient Descent for Deep Linear Neural Networks’. *International Conference on Learning Representations (ICLR) 2019*.

Assaf Shocher, Nadav Cohen and Michal Irani. ‘“Zero-Shot” Super-Resolution Using Deep Internal Learning’. *Conference on Computer Vision and Pattern Recognition (CVPR) 2018*.

‡ Sanjeev Arora, Nadav Cohen and Elad Hazan (alphabetical order). ‘On the Optimization of

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† Supervised student paper

‡ Primary authorship

Deep Networks: Implicit Acceleration by Overparameterization'. *International Conference on Machine Learning (ICML) 2018*.

‡ Nadav Cohen, Ronen Tamari and Amnon Shashua. 'Boosting Dilated Convolutional Networks with Mixed Tensor Decompositions'. *International Conference on Learning Representations (ICLR) 2018, Oral Track (top 1%)*.

Yoav Levine, David Yakira, Nadav Cohen and Amnon Shashua. 'Deep Learning and Quantum Entanglement: Fundamental Connections with Implications to Network Design'. *International Conference on Learning Representations (ICLR) 2018*.

‡ Nadav Cohen and Amnon Shashua. 'Inductive Bias of Deep Convolutional Networks through Pooling Geometry'. *International Conference on Learning Representations (ICLR) 2017*.

‡ Nadav Cohen and Amnon Shashua. 'Convolutional Rectifier Networks as Generalized Tensor Decompositions'. *International Conference on Machine Learning (ICML) 2016*.

‡ Nadav Cohen, Or Sharir and Amnon Shashua. 'On the Expressive Power of Deep Learning: A Tensor Analysis'. *Conference on Learning Theory (COLT) 2016*.

‡ Nadav Cohen, Or Sharir and Amnon Shashua. 'Deep SimNets'. *Conference on Computer Vision and Pattern Recognition (CVPR) 2016*.

## Journals

Yoav Levine, Or Sharir, Nadav Cohen and Amnon Shashua. 'Quantum Entanglement in Deep Learning Architectures'. *Physical Review Letters (PRL)*.

## Book Chapters

Yoav Levine, Or Sharir, Nadav Cohen and Amnon Shashua. 'Bridging Many-Body Quantum Physics and Deep Learning via Tensor Networks'. *Mathematics of Deep Learning*, Cambridge University Press.

Yoav Levine, Noam Wies, Or Sharir, Nadav Cohen and Amnon Shashua. 'Tensors for Deep Learning Theory: Analyzing Deep Learning Architectures via Tensorization'. *Tensors for Data Processing: Theory, Methods and Applications*, Academic Press.

## Invited Papers, Workshops and Preprints

‡ Nadav Cohen, Or Sharir, Yoav Levine, Ronen Tamari, David Yakira and Amnon Shashua. 'Analysis and Design of Convolutional Networks via Hierarchical Tensor Decompositions'. *Intel Collaborative Research Institute Special Issue on Deep Learning Theory*.

Or Sharir, Ronen Tamari, Nadav Cohen and Amnon Shashua. 'Tensorial Mixture Models'. *arXiv preprint*.

‡ Nadav Cohen and Amnon Shashua. 'SimNets: A Generalization of Convolutional Networks'. *Conference on Neural Information Processing Systems (NeurIPS) 2014, Workshop on Deep Learning and Representation Learning*.

## Research Funding

Tel Aviv University Center for Artificial Intelligence and Data Science (2022-present)

Israel Science Foundation, grant 1780/21 (2021-present)

Google Research Scholar Award (2021)

Google Gift for Machine Learning Research (2020)

Amnon and Anat Shashua (2020)  
Yandex Initiative in Machine Learning (2019-present)  
Len Blavatnik and the Blavatnik Family Foundation (2019-present)

## Advised Students

Noam Razin, Ph.D. (2019-present)  
Yotam Alexander, Ph.D. (2021-present)  
Nimrod De La Vega, M.Sc. (2022-present)  
Tom Verbin, M.Sc. (2022-present)  
Itamar Menuchin, M.Sc. (2021-present)  
Asaf Maman, M.Sc. (2020-2022)  
Omer Elkabetz, M.Sc. (2020-2022)

## Outreach

Advisory Board Member, Artificial Intelligence in Education Program, Israel Ministry of Education (2020-present)  
Chairman, Industrial Affiliates Program, School of Computer Science, Tel Aviv University (2019-present)

## Teaching

Teacher, Workshop in Deep Learning, School of Computer Science, Tel Aviv University (2021-present)  
Lecturer, Foundations of Deep Learning, School of Computer Science, Tel Aviv University (2020-present)  
Lecturer, Introduction to Machine Learning, School of Computer Science, Tel Aviv University (2020-present)  
Teacher, Advanced Seminar in Machine Learning, School of Computer Science, Tel Aviv University (2019-present)  
Joint lecturer, Advanced Practical Machine Learning, School of Computer Science and Engineering, The Hebrew University of Jerusalem (2016-2017)  
Teacher, Advanced Seminar in Deep Learning, School of Computer Science and Engineering, The Hebrew University of Jerusalem (2015-2017)  
Teaching assistant, Computer Vision, School of Computer Science and Engineering, The Hebrew University of Jerusalem (2013-2016)

## Invited Conference and Workshop Talks

### 2022

*International Conference on Machine Learning (ICML), Workshop on Continuous Time Perspectives in Machine Learning.* Baltimore, MD, USA.

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§ Declined due to schedule conflict

|| Canceled due to COVID-19

*Schloss Dagstuhl – Leibniz Center for Informatics, Seminar on Tensor Computations: Applications and Optimization.* Wadern, Germany.

*Workshop on New Interactions Between Statistics and Optimization.* Banff, Canada.

*Workshop on Mathematics of Data Science.* Bonn, Germany.

*AI Week.* Virtual.

*Meeting for Youth in High-Dimensions: Recent Progress in Machine Learning, High-Dimensional Statistics and Inference.* Trieste, Italy.<sup>§</sup>

## 2021

*Conference on Neural Information Processing Systems (NeurIPS) 2021, Workshop on Quantum Tensor Networks in Machine Learning.* Virtual.

*Conference on Algorithmic Learning Theory (ALT) 2021, Mentorship Workshop.* Virtual.

*Oberwolfach Research Institute for Mathematics, Workshop on Applied Harmonic Analysis and Data Science.* Oberwolfach, Germany.

*Workshop on Tensor Methods and their Applications in the Physical and Data Sciences.* Virtual.

*AI Week.* Virtual.

## 2020

*Conference on Neural Information Processing Systems (NeurIPS) 2020, Workshop on Quantum Tensor Networks in Machine Learning.* Virtual.

*Simons Institute for the Theory of Computing Workshop on Learning and Testing in High Dimensions.* Virtual.

*One World Seminar Series on the Mathematics of Machine Learning.* Virtual.

*Workshop on Theory of Deep Learning.* Holetown, Barbados.

*Tel Aviv University Annual Summit for Ambassadors to Israel.* Tel-Aviv, Israel.<sup>§</sup>

*Workshop on Mathematics of Data Science.* Bonn, Germany.<sup>||</sup>

*Summer School and Workshop on the Foundations of Graph and Deep Learning.* Baltimore, MD, USA.<sup>§</sup>

Keynote. *International Joint Conference on Artificial Intelligence (IJCAI), Workshop on Tensor Network Representations in Machine Learning.* Yokohama, Japan.<sup>§</sup>

Keynote. *Israel Machine Vision Conference (IMVC).* Tel-Aviv, Israel.

## 2019

*Simons Institute for the Theory of Computing Workshop on Frontiers of Deep Learning.* Berkeley, CA, USA.

*Workshop on Theoretical Physics for Machine Learning.* Aspen, CO, USA.<sup>§</sup>

*Society for Industrial and Applied Mathematics (SIAM) Conference on Computational Science and Engineering (CSE), Minisymposium on Low-Rank Tensor Methods and Deep Learning.* Spokane, WA, USA.<sup>§</sup>

*Institute of Electrical and Electronics Engineers (IEEE) International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP).* Guadeloupe, West Indies.<sup>§</sup>

*Institute for Computational and Experimental Research in Mathematics (ICERM), Workshop on Theory and Practice in Machine Learning and Computer Vision.* Providence, RI, USA.

*Workshop on Mathematics of Deep Learning.* Berlin, Germany. §

*International Congress on Industrial and Applied Mathematics (ICIAM), Minisymposium on Theoretical Foundations of Deep Learning.* Valencia, Spain. §

*International Conference on Sampling Theory and Applications (SAMPTA), Special Session on Deep Learning.* Bordeaux, France. §

*International Conference on Approximation Theory (AT), Minisymposium on Neural Network Approximation.* Nashville, TN, USA. §

*Workshop on Theory of Deep Learning.* Istanbul, Turkey. §

*AI and Big Data Day.* Lviv, Ukraine. §

*Institute of Science and Technology (IST) Austria, Workshop on the Theory of Deep Learning.* Vienna, Austria. §

*African Institute for Mathematical Sciences (AIMS), Spring School on Mathematics of Data Science.* Cape Town, South Africa. §

*Workshop on AI and Tensor Factorization for Physical, Chemical, and Biological Systems.* Santa Fe, NM, USA. §

Keynote. *Israel Machine Vision Conference (IMVC).* Tel-Aviv, Israel. §

*Interdisciplinary Workshop on Quantum Computing.* Jerusalem, Israel. §

*Workshop on Quantum Computing and Quantum Chemistry: Theory, Platforms, and Practical Applications.* Tel Aviv, Israel.

*Israel's Homeland Security (iHLS) Conference on Quantum Technologies for Security.* Rishon LeZion, Israel.

*AI Week.* Tel Aviv, Israel.

## 2018

*Symposium on the Mathematical Theory of Deep Neural Networks.* Princeton, NJ, USA.

*Oberwolfach Research Institute for Mathematics, Workshop on Applied Harmonic Analysis and Data Processing.* Oberwolfach, Germany.

*Workshop on Physics and Machine Learning.* New York City, NY, USA.

*Institute of Electrical and Electronics Engineers (IEEE) Conference on Decision and Control (CDC), Workshop on the Intersections of Machine Learning and Parameter Estimation in Control.* Miami Beach, FL, USA. §

*Workshop on Machine Learning and Physics.* Beijing, China. §

*Deep Learning Summer Course.* Hsinchu City, Taiwan. §

*Summer School on Machine Learning.* Yerevan, Armenia. §

Keynote. *Israel Machine Vision Conference (IMVC).* Tel-Aviv, Israel. §

## 2017

*Conference on Computer Vision and Pattern Recognition (CVPR), Workshop on Tensor Methods in Computer Vision.* Honolulu, HI, USA.

*International Conference on Computer Vision (ICCV), Workshop on Matrix and Tensor Factorization Methods in Computer Vision.* Venice, Italy. §

*Workshop on Mathematics of Deep Learning.* Berlin, Germany.

*Workshop on Physics and Machine Learning.* New York City, NY, USA.

*Association for the Advancement of Artificial Intelligence (AAAI) Spring Symposium Series, Science of Intelligence: Computational Principles of Natural and Artificial Intelligence.* Palo Alto, CA, USA.

*Conference on Applied Inverse Problems (AIP), Minisymposium on Deep Neural Networks: Theory and Application.* Hangzhou, China.

*GAMM Annual Meeting, Minisymposium on Nonlinear Approximations for High-Dimensional Problems.* Weimar, Germany.

## 2016

*Conference on Neural Information Processing Systems (NeurIPS), Workshop on Learning with Tensors: Why Now and How.* Barcelona, Spain.

## Service

### Organizer

*Conference on the Mathematical Theory of Deep Neural Networks (DeepMath) 2020*

*Conference on Neural Information Processing Systems (NeurIPS) 2020, Workshop on Quantum Tensor Networks in Machine Learning*

### Session Chair

*Conference on Neural Information Processing Systems (NeurIPS)*

### Action Editor

*Transactions on Machine Learning Research (TMLR)*

### Area Chair

*Conference on Neural Information Processing Systems (NeurIPS)*

*International Conference on Machine Learning (ICML)*

### Reviewer

*Conference on Neural Information Processing Systems (NeurIPS)*

*International Conference on Machine Learning (ICML)*

*Conference on Learning Theory (COLT)*

*Conference on Computer Vision and Pattern Recognition (CVPR)*

*International Conference on Learning Representations (ICLR)*

*Journal of Machine Learning Research (JMLR)*

*Springer Machine Learning*

*IEEE Transactions on Pattern Analysis and Machine Intelligence*

*SIAM Journal on Mathematics of Data Science*

*IEEE Transactions on Knowledge and Data Engineering*

*IEEE Journal on Selected Areas in Information Theory*

*Physical Review Letters (PRL)*

*Physical Review B (PRB)*