

Reinhard Heckel

Associate Professor, Technical University of Munich

Adjunct Associate Professor, Rice University

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Google scholar citations/h-index: 4182/33 (Jan, 2024)

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Research interests

Machine learning, signal and information processing, optimization, and statistics.

Current focus is on i) developing algorithms and theory for deep learning, in particular for solving medical image reconstruction problems with deep learning, ii) developing mathematical and empirical foundations of machine learning, in particular how to learn robust models, and iii) DNA data storage and DNA as digital information technology.

Education

08/2010 - **ETH Zurich**, Zurich, Switzerland.

10/2014 Ph.D. in Electrical Engineering, **ETH medal for outstanding thesis**
Advisor: Prof. Helmut Bölcskei

10/2005 - **University of Ulm**, Ulm, Germany.

05/2010 Diploma (equiv. M.S. degree) in Electrical Engineering, **with Honors**.

Academic experience

12/2023 - **Technical University of Munich**, Munich, Germany.

present Associate Professor at the Department of Electrical and Computer Engineering
- Academic director of the TUM Venture Lab for AI
- Core member of the Munich Data Science Institute
- Principal Investigator in the Munich School of Machine Learning
- Fellow of the Konrad Zuse School of Excellence in Reliable AI

06/2019 - **Technical University of Munich**, Munich, Germany.

12/2023 Assistant Professor at the Department of Electrical and Computer Engineering
Rudolf Mössbauer Tenure Track Professor, TUM Institute of Advanced Studies

06/2019 - **Rice University**, Houston, TX.

present Adjunct Assistant Professor at the Department of Electrical and Computer Engineering

08/2017 - **Rice University**, Houston, TX.

05/2019 Assistant Professor at the Department of Electrical and Computer Engineering

09/2022 **Stanford University**, Stanford, CA.

Visiting Scholar at the Center for Artificial Intelligence in Medicine and Imaging, Stanford School of Medicine

01/2016 - **University of California Berkeley**, Berkeley, CA.

07/2017 Postdoc at the Department of Electrical Engineering and Computer Sciences, with Prof. Kannan Ramchandran and Prof. Martin Wainwright

12/2014 - **IBM Research**, Zurich, Switzerland.

12/2015 Researcher at the Department of Cognitive Computing & Computational Sciences

- 08/2013 - **Stanford University**, Stanford, CA.
- 12/2013 Visiting PhD student at the Statistics Department with Prof. Emmanuel Candès
- 08/2010 - **ETH Zurich**, Zurich, Switzerland.
- 11/2014 Research and teaching assistant at Prof. Bölcskei's Chair for Mathematical Information Science

Awards

- Capital magazine's 40 under 40, 2022
- Young scientist honour from the Werner-von-Siemens-Ring foundation, 2022
- Outstanding Reviewer Award, NeurIPS, 2021
- Runner up (second place) in the 2021 AAPM (American Association of Physicists in Medicine) Grand Challenge: "Deep Learning for Inverse Problems: Sparse-View Computed Tomography Image Reconstruction"
- Featured in the BBC Future series "The Genius Behind": This is how to store human knowledge for eternity, 2015
- ETH Zurich medal for outstanding Ph.D. thesis, 2015
- IBM first patent application invention achievement award, 2015
- Early Postdoc.Mobility fellowship from the Swiss National Science Foundation, 2014
- Best student paper award at the Int. Workshop on Comp. Systems Biology, 2012

Funding

European funding:

- EU Pathfinder project, "DNA Data AppliXns (DiDAX): Computational, Chemical and Biotechnology Solutions to Improved DNA Data Storage: from In-Product Information and Cryptography to Long-Term Archiving", awarded as co-PI, 600,000 Euro (652,347 USD). Running 2023-2027.
- DFG project "Deep Learning for imaging non-static objects", awarded 2023 as single PI, EUR 315,073. Running: 2023-2026.
- DAAD project for research abroad "Robust deep learning for image reconstruction", awarded as single PI, 28,052 Euro (30,080 USD). Running 2021-2022.
- BMBF project "6G life", awarded as co PI, Individual part: 576,058 Euro (665,580 USD). Grant lead by Prof. Fitzek and Prof. Boche, and includes 50 PIs from TU Dresden and TUM. Running 2021-2025.
- DFG project "Solving linear inverse problems with end-to-end neural networks: expressivity, generalization, and robustness", awarded 2021 as co PI; Individual part: 209,400 Euro (249,523 USD). Co-PI: Felix Krahmer. Running: 2021-2024.
- DFG project "Theory of un-trained neural networks for image recovery", awarded 2021 as single PI. 294,000 Euro (356,628 USD). Running 2021-2024.
- "6G Future Lab Bavaria", awarded 2021 as co-PI. Individual part: 210,000 Euro (252,305 USD). Grant lead by Prof. Kellerer and includes 13 PIs from TUM. Running 2021-2024.

- EU project “DNA-Fast light driven data technology with multiplexed optical encoding and readout”, awarded 2020 as co-PI. Individual part: 324,780 Euro (388,558 USD). Grant includes 6 PIs from 6 Universities and in addition three companies are involved. Running 2021-2024.

US funding:

- NIH “Polycyclic aromatic hydrocarbons: Ultrasensitive detection, early life exposures-clinical outcomes (preterm births, chronic lung disease, and neurocognitive deficits), prevention, and remediation”, awarded 2019 as co-PI. Individual part: 276,064 USD. Grant includes 10 PIs. Running 2020-2025.
- NSF IIS Small “Actively learning from the crowd”, awarded 2018 as a single PI: 474,322 USD. Running 2018-2023.

Teaching

At TUM

- Summer 2021, 2022, and 2023: Deep learning for inverse problems
- Winter 2019, 2020, 2021, 2022, 2023: Machine learning and optimization
- Summer 2019, 2020, 2021, and 2022: Introduction to machine learning
- Summer 2023: Seminar on foundation models
- Winter 2022: Seminar on diffusion models
- Summer 2022: Seminar on machine learning for molecules
- Winter 2021: Seminar on the foundations of modern machine learning practice
- Winter 2020: Seminar on the foundations and robustness of deep learning
- Summer 2020: Seminar on the foundation of deep learning in imaging science

At Rice

- Fall 2017, Spring 2019: Optimization for data science
- Fall 2018: Introduction to machine learning
- Spring 2018: Deep networks for inference and estimation, jointly taught with Richard Baraniuk

Mentoring and student supervision

PhD supervision

- Michael Girsch, PhD student at TUM, November 2023 - now
- Franziska Weindel, PhD student at TUM, January 2023 - now
- Kang Lin, PhD student at TUM, December 2022 - now
- Anselm Krainovic, PhD student at TUM, June 2022 - now
- Simon Wiedemann, PhD student at TUM, December 2021 - now
- Youssef Mansour, PhD student at TUM, September 2021-now
- Tobit Klug, PhD student at TUM, September 2020 - now

Alumni / former group members

- Mohammad Zalbagi Darestani, PhD student at Rice, November 2018 - April 2023. Next position: Research engineer at a machine learning startup in Boston.
- Fatih Furkan Yilmaz, PhD student at Rice, August 2017 - August 2022. Next position: Research scientist at Amazon.
- Zhenwai Dai, PhD student at Rice, co-advised with Anshumali Shrivastava, August 2018 - July 2022. Next position: Research scientist at Amazon.
- Daniel LeJeune, PhD student at Rice, guest doctoral candidate at TUM in the Winter 2021-2022 Semester. Next position: Postdoctoral researcher at Stanford.

Service

Academic service

- Area Chair NeurIPS 2022, 2023
- Area Chair ICML 2022, 2023, 2024
- Area Chair ICLR 2022, 2023, 2024
- Co-founded and am co-chair for the NeurIPS 2019, 2020, 2021, and 2024 workshop “Deep Learning and Inverse Problems”. The workshop is attracting 60+ submissions and 150+ participants each year.
- Guest Editor for the IEEE Journal of Selected Areas in Information Theory, for the issue ‘deep learning and inverse problems’
- Technical Area Chair for Adaptive Systems, Machine Learning, Data Analytics at the 2022 Asilomar conference
- Technical Area Chair for Adaptive Systems, Machine Learning, Data Analytics at the 2019 Asilomar conference
- Advisory committee for the BMBF Programm Mathematics for Innovations in 2019 and 2022
- Journal reviewing: Amongst others, I reviewed for some of the top multidisciplinary journals (Nature, Nature Biotechnology, Nature Communications), for top journals in machine learning and statistics (Journal of Machine Learning Research, Annals of Statistics), and for top engineering journals (IEEE Transactions on Information Theory, Image Processing, and Signal Processing)
- Conference reviewing: Amongst others, I reviewed for the top Maschine Learning Conferences (International Conference on Machine Learning, Neural Information Processing Systems, International Conference on Learning Representations, and the International Conference on Artificial Intelligence and Statistics), and the leading conferences in information theory and signal processing (IEEE International Symposium on Information Theory, IEEE International Conference on Acoustics, Speech, and Signal Processing).

Service at the Technical University of Munich

- Member of the Examination Board of the Master’s in Robotics, Cognition, Intelligence
- Deputy of the director for the Master’s in Communications Engineering
- Member of the Admissions Board of the Master’s in Electrical Engineering and the Master’s in Communications Engineering

Service at Rice University

- Founded, acquired \$20,000 funding for, and co-running (with students from ECE, CS, and Stats) a weekly machine learning lunch seminar that averages more than 70 participants per week (2018-2019)
- Member of the graduate committee
- Member of the ECE search committee for the faculty search in “Embedded Machine Learning”

Member in PhD and Master committees

- Eva Gil San Antonio, PhD in Electrical Engineering, Université Côte d’Azur, 2023
- Beliz Gunel, PhD in Electrical Engineering, Stanford University, 2022
- Jan Macdonald, PhD in Mathematics, TU Berlin, 2022
- Jorio Cocola, PhD in Mathematics, Northeastern University, 2022
- Antkowiak Philipp, PhD in Chemical Engineering, ETH Zurich, 2021
- Ivan Olefir, PhD in ECE, Technical University of Munich, 2021
- Rodrigo Perez, PhD in ECE, Technical University of Munich, 2021
- Jangwon Kim, PhD in Bioengineering, Rice University, 2020
- Souptik Barua, PhD in ECE, Rice University, 2019
- Babhru Joshi, PhD in Applied Mathematics, Rice University, 2019
- Chris Metzler, PhD in ECE, Rice University, 2018
- CJ Barberan, Masters in ECE, Rice University, 2019
- Oscar Leong, Master in Applied Mathematics, Rice University, 2018
- Akash Kumar Maity, Masters in ECE Rice University, 2018
- Qiang Zhang, Masters in Applied Mathematics, Rice University, 2018

Publications

5 representative papers marked with *

Preprints

- P1 J. F. Kunz, S. Ruschke, and **R. Heckel**
Implicit Neural Networks with Fourier-Feature Inputs for Free-breathing Cardiac MRI Reconstruction
arXiv:2305.06822, May 2023.
- P2 D. LeJeune, J. Liu, **R. Heckel**
Monotonic risk relationships under distribution shifts for regularized risk minimization
arXiv:2210.11589, Oct. 2022.
- P3 F. F. Yilmaz and **R. Heckel**
Test-time recalibration of conformal predictors under distribution shifts based on unlabeled examples
arXiv:2210.04166, Oct. 2022.

Long papers in highly selective conferences

- L1 A. Krainovic, M. Soltanolkotabi, **R. Heckel**
Learning Provably Robust Estimators for Inverse Problems via Jittering
NeurIPS 2023.
- L2 T. Klug, D. Atik, **R. Heckel**
Analyzing the Sample Complexity of Self-Supervised Image Reconstruction Methods
NeurIPS 2023.
- L3 Y. Mansour and **R. Heckel**
Zero-Shot Noise2Noise: Efficient Image Denoising without any Data
CVPR 2023.
- L4 T. Klug and **R. Heckel**
Scaling laws for deep learning based image reconstruction
ICLR 2023.
- L5 M. Zalbagi Darestani, Jiayu Liu, **R. Heckel**
Test-time training can close the natural distribution shift performance gap in deep learning based compressed sensing
ICML 2022.
- L6 **R. Heckel**
Provable continual learning via sketched Jacobian approximations
AISTATS 2022.
- L7 K. Donhauser, A. Tifrea, M. Aerni, **R. Heckel**, F. Yang
Interpolation can hurt robust generalization even when there is no noise
NeurIPS 2021.
- *L8 M. Zalbagi Darestani, A. Chaudhari, and **R. Heckel**
Measuring robustness in deep learning based compressive sensing
ICML 2021 (**long talk**, top 3% of submissions).
- L9 Z. Fabian, **R. Heckel**, and M. Soltanolkotabi
Data augmentation for deep learning based accelerated MRI reconstruction with limited data
ICML 2021.
- L10 **R. Heckel** and F. F. Yilmaz
Early stopping in deep networks: Double descent and how to eliminate it
ICLR 2021
- L11 Z. Dai, A. Desai, **R. Heckel**, A. Shrivastava
Active sampling count sketch (ASCS) for online sparse estimation of a trillion scale covariance matrix
SIGMOD 2021
- L12 **R. Heckel** and M. Soltanolkotabi
Compressive sensing with un-trained neural networks: Gradient descent finds the

smoothest approximation
ICML 2020

- *L13 **R. Heckel** and M. Soltanolkotabi
Denoising and regularization via exploiting the structural bias of convolutional generators
ICLR 2020
- *L14 **R. Heckel** and P. Hand
Deep decoder: Concise image representations from untrained non-convolutional networks
ICLR 2019
- L15 D. LeJeune, R. Baraniuk, and **R. Heckel**
Adaptive estimation for approximate k-nearest-neighbor computations
AISTATS 2019
- L16 **R. Heckel**, M. Simchowitz, K. Ramchandran, and M. Wainwright
Approximate ranking from pairwise comparisons
AISTATS 2018
- L17 **R. Heckel** and K. Ramchandran
The sample complexity of online one-class collaborative filtering
ICML 2017
- L18 **R. Heckel**, M. Vlachos, T. Parnell, and C. Dünner
Scalable and interpretable product recommendations via overlapping co-clustering
ICDE 2017
- L19 **R. Heckel** and M. Vlachos, “Private and right-protected big data publication: An analysis
SIAM Data Mining 2017

Journal articles

- J1 A. L. Gimpel, W. J. Stark, **R. Heckel**, R. N. Grass
A digital twin for DNA data storage based on comprehensive quantification of errors and biases
Nature Communications, 2023.
- J2 J. Scarlett, **R. Heckel**, MRD Rodrigues, P. Hand, Y. C. Eldar, , A.G. Marques
Theoretical perspectives on deep learning methods in inverse problems
IEEE Journal on Selected Areas in Information Theory, 2023.
- J3 S. Rey, S. Segarra, **R. Heckel**, A.G. Marques
Untrained Graph Neural Networks for Denoising
IEEE Transactions on Signal Processing, 2022.
- J4 A. Doricchi, C. Platnich, A. Gimpel, F. Horn, M. Earle, G. Lanzavecchia, A. Cortajarena, L. Liz-Marzán, Na Liu, **R. Heckel**, R. Grass, R. Krahne, U. Keyser, D. Garoli
Emerging approaches to DNA data storage: Challenges and prospects
ACS Nano, 2022.

- J5 L. Meiser, A. Gimpel, T. Deshpande, G. Libort, W. Chen, **R. Heckel**, B. Nguyen, K. Strauss, W. Stark, R. Grass
Information decay and enzymatic information recovery for DNA data storage
Nature Communications Biology, 2022.
- J6 M. Zalbagi Darestani and **R. Heckel**
Accelerated MRI with un-trained neural networks
IEEE Transactions on Computational Imaging, 2021.
- J7 W. Huang, **R. Heckel**, P. Hand, V. Voroninski,
A provably convergent scheme for compressive sensing under random generative priors
Journal of Fourier Analysis and Applications, 2021.
- J8 I. Shomorony and **R. Heckel**
DNA-based storage: Models and fundamental limits
IEEE Trans. Inf. Theory, 2021.
- * J9 P. L. Antkowiak, J. Lietard, M. Zalbagi Darestani, M. Somoza, W. J. Stark, **R. Heckel***, R. N. Grass*
Low cost DNA data storage using photolithographic synthesis and advanced information reconstruction and error correction
Nature Communications, 2020 (*=corresponding authors), **featured as Editor’s high-light**.
- J10 L. C. Meiser, J. Koch, P. L. Antkowiak, W. J. Stark, **R. Heckel**, R. N. Grass
DNA synthesis for true random number generation
Nature Communications, 2020.
- J11 **R. Heckel**, W. Huang, P. Hand, V. Voroninski,
Deep denoising: Rate-optimal recovery of structured signals with a deep prior
Information and Inference: A Journal of the IMA, 2020.
- J12 E. Bostan, **R. Heckel**, M. Chen, M. Kellman, L. Waller
Deep Phase Decoder: Self-calibrating phase microscopy with an untrained deep neural network
Optica, 2020.
- J13 R. Grass, **R. Heckel**, C. Dessimoz, W. J. Stark,
Genomic encryption of digital data stored in synthetic DNA
Angewandte Chemie International Edition, 2020.
- J14 L. Meiser, P. Antkowiak, J. Koch, W. Chen, A. X. Kohll, W. J. Stark, **R. Heckel*** R. N. Grass* (*=corresponding authors)
Reading and writing digital data in DNA
Nature Protocols, 2019, **featured on the cover of the January 2020 issue**.
- J15 **R. Heckel**, G. Mikutis, and R. N. Grass
A Characterization of the DNA Data Storage Channel
Scientific Reports, 2019.

- J16 W. Chen, A. Kohll, B. Nguyen, J. Koch, **R. Heckel**, W. J. Stark, L. Ceze, K. Strauss, R. N. Grass
Combining data longevity with high storage capacity—layer-by-layer DNA encapsulated in magnetic nanoparticles
Advanced Functional Materials, 2019.
- * J17 **R. Heckel**, N. B. Shah, K. Ramchandran, and M. J. Wainwright
Active ranking from pairwise comparisons and when parametric assumptions don't help
Annals of Statistics, 2019.
- J18 **R. Heckel**
An archive written in DNA
Nature Biotechnology, 2018.
- J19 M. Vlachos, C. Duenner, **R. Heckel**, V.G. Vassiliadis, T. Parnell, K. Atasu
Addressing interpretability and cold-start in matrix factorization for recommender systems
IEEE Trans. on Knowl. and Data Eng., 2018.
- J20 N. Antipa, G. Kuo, **R. Heckel**, B. Mildenhall, E. Bostan, R. Ng, L. Waller
DiffuserCam: Lensless single-exposure 3D imaging
Optica, 2018.
- J21 **R. Heckel** and M. Soltanolkotabi
Generalized line spectral estimation via convex optimization
IEEE Trans. Inf. Theory, 2018.
- J22 **R. Heckel**, M. Tschannen, and H. Bölcskei
Dimensionality-reduced subspace clustering
Information and Inference: A Journal of the IMA, 2017.
- J23 M. Vlachos, V.G. Vassiliadis, **R. Heckel**, A. Labbi
Toward interpretable predictive models in B2B recommender systems
IBM Journal of Research and Development, 2016.
- J24 **R. Heckel**, V. I. Morgenshtern, M. Soltanolkotabi
Super-resolution radar
Information and Inference: A Journal of the IMA, 2016.
- J25 **R. Heckel** and H. Bölcskei
Robust subspace clustering via thresholding
IEEE Trans. Inf. Theory, 2015.
- J26 D. Paunescu, C. A. Mora, L. Querci, **R. Heckel**, M. Puddu, B. Hattendorf, D. Günther, and R. N. Grass
Detecting and number counting of single engineered nanoparticles by digital particle polymerase chain reaction
ACS Nano, 2015, **selected by ACS as Editors Choice**.

- J27 R. Grass, **R. Heckel**, M. Puddu, D. Paunescu, and W. J. Stark
Robust chemical preservation of digital information on DNA in silica with error-correcting codes
Angewandte Chemie International Edition, 2015, **featured in Nature as research highlight, press coverage by BBC, CNN, and IEEE Spectrum.**
- J28 **R. Heckel** and H. Bölcskei
Identification of sparse linear operators
IEEE Trans. Inf. Theory, 2013.
- J29 **R. Heckel**, S. Schober, and M. Bossert
Harmonic analysis of Boolean networks: Determinative power and perturbations
EURASIP J. Bioinform. Syst. Biol., 2013.
- J30 J. Klotz, **R. Heckel**, and S. Schober,
Bounds on the average sensitivity of nested canalizing functions
PLoS ONE, 2013.
- J31 S. Schober, D. Kracht, **R. Heckel**, and M. Bossert
Detecting controlling nodes of Boolean regulatory networks
EURASIP J. Bioinform. Syst. Biol., 2011.

Refereed conference proceedings

- C1 K. Lin and **R. Heckel**
Vision transformers enable fast and robust accelerated MRI
Medical Imaging with Deep Learning (MIDL), 2022.
- C2 F. F. Yilmaz and **R. Heckel**
Regularization-wise double descent: Why it occurs and how to eliminate it
ISIT, 2022.
- C3 Frederik Fraaz, **R. Heckel**
Accelerated magnetic resonance imaging with flow-based priors
ISMRM, 2022.
- C4 K. Levick, **R. Heckel**, I. Shomorony
Achieving the capacity of a DNA storage channel with linear coding schemes
Annual Conference on Information Sciences and Systems (CISS), 2022.
- C5 M. Zalbagi Darestani and **R. Heckel**
Can un-trained networks compete with trained ones for accelerated MRI?
ISMRM, oral presentation, 2021.
- C6 D. Van Veen, A. Desai, **R. Heckel**, A. Chaudhari
Using untrained convolutional neural networks to accelerate MRI in 2D and 3D
ISMRM, 2021.
- C7 S. Shin, **R. Heckel**, I. Shomorony
Capacity of the erasure shuffling channel
ICASSP, 2020.

- C8 **R. Heckel**
Signal recovery with un-trained convolutional neural networks
NeurIPS medical imaging workshop, 2019.
- C9 Z. Dai and **R. Heckel**
Channel Normalization in Convolutional Neural Network avoids Vanishing Gradients
ICML Deep Phenomena Workshop, 2019
- C10 I. Shomorony and **R. Heckel**
Capacity Results for the Noisy Shuffling Channel
ISIT, 2019
- C11 F. Ong, **R. Heckel**, K. Ramchandran
A fast and robust paradigm for Fourier compressed sensing based on coded sampling
ICASSP, 2019
- C12 C. Metzler, A. Mousavi, **R. Heckel**, R. Baraniuk
Unsupervised learning with Stein’s unbiased risk estimator
International Biomedical and Astronomical Signal Processing (BASP) Frontiers workshop, 2019, **best contribution award**.
- C13 **R. Heckel**^{*}, I. Shomorony^{*}, K. Ramchandran, and D. Tse
Fundamental limits of DNA storage systems
ISIT, 2017 (^{*} equal contribution).
- C14 **R. Heckel** and M. Soltanolkotabi
Generalized line spectral estimation for radar and localization
CoSeRa, 2016, **invited paper**.
- C15 **R. Heckel**
Super-resolution MIMO radar
ISIT, 2016.
- C16 **R. Heckel**, M. Tschannen, and H. Bölcskei
Subspace clustering of dimensionality reduced data
ISIT, 2014.
- C17 A. Jung, **R. Heckel**, H. Bölcskei, and F. Hlawatsch
Compressive nonparametric graphical model selection for time series
ICASSP, 2014.
- C18 **R. Heckel**, E. Agustsson, and H. Bölcskei
Neighborhood selection for thresholding based subspace clustering
ICASSP, 2014.
- C19 **R. Heckel** and H. Bölcskei
Noisy subspace clustering via thresholding
ISIT, 2013.
- C20 **R. Heckel** and H. Bölcskei
Subspace clustering via thresholding and spectral clustering
ICASSP, 2013.

- C21 **R. Heckel** and H. Bölcskei
Joint sparsity with different measurement matrices
Allerton, 2012, **invited paper**.
- C22 **R. Heckel**, S. Schober, and M. Bossert
Determinative power and tolerance to perturbations in Boolean networks
WCSB, 2012, **best student paper award**.
- C23 **R. Heckel** and H. Bölcskei
Compressive identification of linear operators
ISIT, 2011.
- C24 S. Schober, **R. Heckel**, and D. Kracht
Spectral properties of a Boolean model of the E. coli genetic network and its implication on network inference
WCSB, 2010.
- C25 **R. Heckel**, S. Schober, and M. Bossert
On random Boolean threshold networks
SCC, 2010.
- C26 **R. Heckel** and S. Schober
A Boolean genetic regulatory network created by whole genome duplication
WCSB, 2009.

Patents

- P1 **R. Heckel**, V. Vasileiadis, and M. Vlachos, “Method and system for identifying dependent components”, US Patent 20,160,063,392, 2016.
- P2 **R. Heckel** and M. Vlachos, “The obfuscation and protection of data rights”, US Patent 9,916,472, 2015.

Books and Book Chapters

- B1 I. Shomorony and **R. Heckel** “Information-theoretic foundations of DNA data storage”, *Foundations and Trends in Communications and Information Theory*, 2022.
- B2 **R. Heckel**, “Super-resolution radar imaging via convex optimization”, Chapter in “Compressed Sensing based Radar Signal Processing”, 2019.

Invited talks

- 45. 2023 "Robust deep learning based imaging", Mathematical Information Science Workshop, Paris
- 44. 2023 "Unpacking Data Needs for Deep Learning based Imaging", USC
- 43. 2023 “Uncertainty Quantification under Distribution Shifts”, London Symposium on Information Theory
- 42. 2023 “Robust deep learning based imaging”, University of Bonn.
- 41. 2023 “Robust deep learning based imaging", Imperial College London.

40. 2023 “Distributionally robust deep learning based image reconstruction”, Information Theory and Data Science Workshop, National University of Singapore.
39. 2023 “Distributionally robust deep learning based image reconstruction”, Workshop on Seeking Low-dimensionality in Deep Neural Networks (SLOWDNN), MBZUAI, Abu Dhabi.
38. 2022 “The role of data and models for deep-learning based image reconstruction”, Workshop on “Multi-Modal Imaging with Deep Learning and Modeling” at the Institute for Pure & Applied Mathematics (IPAM), UCLA.
37. 2022 “Robustness of Deep Learning-Based Signal Reconstruction: Partial Results and Open Directions”, Oberwolfach Workshop on “Mathematical Foundations of Robust and Generalizable Learning”
36. 2022 “The role of data and models for deep-learning based image reconstruction”, Stanford School of Medicine.
35. 2022 “The role of data and models for deep-learning based image reconstruction”, ECE colloquium, UC Riverside
34. 2022 “Measuring and enhancing robustness in deep learning based imaging”, Exceptional seminar, Paris Artificial Intelligence for Society, Telecom Paris
33. 2022 “Measuring and enhancing robustness in deep learning based imaging”, Minisymposium at the International Conference for Inverse Problems on Deep Learning for Inverse Problems
32. 2021 “Measuring robustness in deep learning based compressive sensing”, Inverse Problems Seminar, University College London
31. 2021 “Measuring robustness in deep learning based compressive sensing”, Machine Learning for Algorithms Workshop of the Foundations of Data Science Institute (FODSI)
30. 2021 “Low cost DNA data storage with noisy synthesis and advanced error correction”, JPEG DNA Workshop
29. 2020 “Tutorial on Deep networks for inverse problems”, IEEE European School of Information Theory
28. 2020 “Image recovery with untrained convolutional neural networks”, Stanford SCIEN Colloquium
27. 2020 “Provable Image Recovery with Untrained Convolutional Neural Networks”, One World Mathematics of Information, Data, and Signals Seminar.
26. 2020 “Image recovery and recognition via exploiting the structural bias of neural networks”, Math FLDS / CPS seminar, University of Southern California (USC)
25. 2019 “Denoising and regularization via exploiting the structural bias of convolutional generators”, Berkeley, Computational Imaging Lunch
24. 2019 “Denoising and regularization via exploiting the structural bias of convolutional generators”, Stanford, Information Systems Lab Colloquium
23. 2019 “Image recovery and restoration with neural networks and robust storage of information on DNA”, ETH, Institute for Chemical and Bioengineering Seminar

22. 2019 “Denoising and regularization with untrained neural networks”, Asilomar Conference on Signals, Systems, and Computers
21. 2019 “Denoising and regularization via exploiting the structural bias of convolutional generators”, Allerton Conference on Communication, Control, and Computing
20. 2019 “Deep Decoder: Concise image representations from untrained networks”, Math+X symposium on inverse problems and deep learning in space exploration
19. 2019 “Regularizing inverse problems with untrained neural networks”, Machine Learning in Solid Earth Geoscience Workshop, Los Alamos
18. 2019 “Deep Decoder: Concise image representations from untrained networks”, Information Theory and Applications Workshop, San Diego
17. 2019 “Deep Decoder: Concise image representations from untrained networks”, University of Washington, Machine learning seminar
16. 2018 “Deep Decoder: Concise image representations from untrained networks”, UIUC, Coordinate Science Lab, SINE Seminar
15. 2018 “Deep Decoder: Concise image representations from untrained networks”, Winedale workshop, Windedale, Texas
14. 2018 “Deep Decoder: Concise image representations from untrained networks”, Rice University, CAAM colloquium
13. 2018 “Robust storage of information in DNA molecules”, Microsoft Research Redmond
12. 2018 “Robust storage of information in DNA molecules”, EPFL, IC talk
11. 2018 “Robust storage of information in DNA molecules”, Berkeley, Berkeley Laboratory for Information and System Sciences (BLISS) Seminar
10. 2018 “Approximate ranking from pairwise comparisons”, Information Theory and Applications Workshop
9. 2017 “Robust preservation of digital information on DNA with error-correcting codes”, UT Austin, DNA23 conference
8. 2017 “Robustness and complexity tradeoffs in inference and learning”, Rice University
7. 2017 “Robustness and complexity tradeoffs in inference and learning”, Cornell
6. 2017 “Collection and preserving information efficiently and reliably”, Cornell Tech
5. 2017 “Algorithms and theory for efficient data collection, information extraction, and preservation”, TU Munich
4. 2017 “Super-resolution and resolution limits of computational imaging systems”, Berkeley, Computational Imaging Lunch
3. 2017 “Active ranking from pairwise comparisons and when parametric models don’t help”, Berkeley, Berkeley Laboratory for Information and System Sciences (BLISS) Seminar

2. 2017 “Active ranking from pairwise comparisons and when parametric models don’t help”, Information Theory and Applications Workshop
1. 2016 “Super-resolution radar”, USC

Press coverage

- Jan. 2021 We appeared in the German TV series Galileo for our work on DNA storage, see [video](#).
- Nov. 2020 Invited article in the German newspaper “Frankfurter Allgemeine” on DNA as an information technology ([article](#)).
- Aug. 2020 We stored the first Series of the German TV show “Biohackers” for Netflix on DNA. This was one of the first commercial applications of DNA storage, and received wide press coverage by the German media including the newspaper FAZ, a 8-minute feature in the German TV show “Gut zu wissen” (see [video](#)), and a number of blogs such as <https://blocksandfiles.com> and www.golem.de.
- Oct. 2018 We stored Massive Attack’s music album Mezzanine on DNA. This was the first commercial application of DNA storage and received press coverage by **Weired** “Massive Attack are releasing an album in a new format: DNA”, and **Fortune** “Scientists are coding an electronic music masterpiece into DNA so it can last forever”, amongst others.
- Nov. 2015 BBC featured a video about us and the DNA storage project in the science news series “the genius behind”, the video was broadcasted at BBC worlds news, the channel with the largest audience of any channel: <http://www.bbc.com/future/story/20151122-this-is-how-to-store-human-knowledge-for-eternity>.
- Jan. 2015 Our work on robust DNA data storage was featured in Nature as research highlight and received press coverage by BBC, CNN, and IEEE Spectrum