Curriculum Vitæ: Andreas Heinecke

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Academic positions

2015–present	**Assistant Professor (Mathematical and Computational Science)**
	Science Division
	Yale-NUS College, Singapore
2016–present	Assistant Professor of Mathematics (Courtesy Appointment)
	Department of Mathematics
	National University of Singapore, Singapore
2013–2015	Research Fellow
	Department of Mathematics and Centre for Wavelets and Information Processing
	National University of Singapore, Singapore

Educational background

Dec 2012	**PhD degree in Mathematics**
	University of Missouri–Columbia, USA
Oct 2007	**Diplom degree in Mathematics**
	Technische Universität Dresden, Germany
Sep 2005–Feb 2006	Socrates–Erasmus Fellowship
	National Technical University of Athens, Greece

Research interests and expertise

My research spans from the analysis of mathematical structures to their use in solving applied problems. My expertise is in mathematical signal processing, in particular in applied and computational harmonic analysis, such as in frame theory and wavelet analysis. Further, my work is on the use of these methods in building mathematical and statistical models for concrete applications and on algorithms to solve such models, e.g., via Bayesian inference.

The starting point of my research has been the analysis and design of representation systems, called frames, that enable useful transformations of data and signals. Data acquired from nature or created by humans tend to be structured. A central idea is that for various classes of data, specific transformations may translate structural properties into sparse representations, which is key to solving many practical problems. Music recognition applications, for instance, are able to identify noisy samples of audio signals only after time-frequency transformation. My work on wavelet systems in particular concerns the existence and construction of non-tensor product multivariate dual MRA-wavelet frames. In scientific and engineering applications, suitable representations can then be used to build models that are structurally constrained to have few degrees of freedom relative to their ambient dimension. This paradigm allows the efficient approximation of specific solutions to such models via specially devised algorithms, as for instance in my work on the deconvolution of JRES NMR spectroscopy data for the large-scale study of metabolites.

Publications

Submitted

- A. Natarajan, M. De Iorio, A. Heinecke, E. Mayer and S. Glenn, *Repulsion and cohesion in Bayesian distance clustering* (submitted May 2021). arxiv.org/abs/2107.05414

Refereed journal articles <small>(authors by contribution)</small>

- A. Heinecke, L. Ye, M. De Iorio and T. Ebbels, *Bayesian deconvolution and quantification from J-resolved NMR spectroscopy,* Bayesian Anaysis, 16(2) (2021), 425–458. doi: 10.1214/20-BA1208

- A. Heinecke, M. Tallarita and M. De Iorio, *Bayesian splines versus fractional polynomials in network meta-analysis,* BMC Medical Research Methodology, 20(1):261 (2020), doi: 10.1186/s12874-020-01113-9

- A. Heinecke, J. Ho and W. Hwang, *Refinement and universal approximation via sparsely connected ReLU convolution nets,* IEEE Signal Processing Letters, 99:1-1 (2020), 1175–1179. doi: 10.1109/LSP.2020.3005051

- N. Le Bert, U.S. Gill, M. Hong, K. Kunasegaran, D.Z.M. Tan, R. Ahmad, Y. Cheng, C.A. Dutertre, A. Heinecke, L. Rivino, A. Tan, N.K. Hansi, M. Zhang, S. Xi, Y. Chong, S. Pflanz, E.W. Newell, P.T.F. Kennedy, A. Bertoletti, *Effects of Hepatitis B surface antigen on virus-specific and global T cells in patients with chronic HBV infection,* Gastroenterology, 159(2) (2020), 652–664. doi: 10.1053/j.gastro.2020.04.019

- W. Hwang and A. Heinecke, *Un-rectifying non-linear networks for signal representation,* IEEE Transactions on Signal Processing, 68 (2019), 196–210. doi: 10.1109/TSP.2019.2957607

Refereed journal articles <small>(authors in alphabetical order as customary in mathematics journals)</small>

- Z. Fan, A. Heinecke and Z. Shen, *Duality for frames,* Journal of Fourier Analysis and Applications, 22(1) (2016), 71–136. doi: 10.1007/s00041-015-9415-0 (Contributed equally to all parts, under lead of Z. Shen.)

- P. Casazza, A. Heinecke, K. Kornelson, Y. Wang and Z. Zhou, *Necessary and sufficient conditions to perform Spectral Tetris,* Linear Algebra and its Applications, 438(5) (2013), 2239–2255. doi: 10.1016/j.laa.2012.10.030

- P. Casazza, M. Fickus, A. Heinecke, Y. Wang and Z. Zhou, *Spectral Tetris fusion frame constructions,* Journal of Fourier Analysis and Applications, 18(4) (2012) 828–851. doi: 10.1007/s00041-012-9225-6

- P. Casazza, A. Heinecke, F. Krahmer and G. Kutyniok, *Optimally sparse frames,* IEEE Transactions on Information Theory, 57 (2011), 7279–7287. doi: 10.1109/TIT.2011.2160521

- R. Calderbank, P. Casazza, A. Heinecke, G. Kutyniok and A. Pezeshki, *Sparse fusion frames: existence and construction,* Advances in Computational Mathematics, 35(1) (2011), 1–31. doi: 10.1007/s10444-010-9162-3

Conferences, talks and tutorials

- ISBA 2021 World Meeting of the International Society for Bayesian Analysis (7/2021) (Session: Advances in Bayesian Methods for Bioinformatics and Healthcare Problems)

- International Workshop on Frames, Wavelets, Approximation Methods and Applications, Palermo, Italy (9/2019)

- Summer Course on Mathematical Data Analysis, Academia Sinica Institute of Mathematics, Taipei, Taiwan (1 week invited lectures/tutorials, 7/2019)

- Summer Course on Mathematical Signal Processing and Data Analysis, Academia Sinica Institute of Mathematics, Taipei, Taiwan (1 week invited lectures/tutorials, 8/2018)

- Department of Mathematics and Computer Science Colloquium, Chulalongkorn University, Bangkok, Thailand (2/2018)

- Workshop on Spline Approximation and its Applications on Carl de Boor's 80th Birthday, Institute for Mathematical Sciences, National University of Singapore, Singapore (12/2017)

- International Conference on Subdivision, Geometric and Algebraic Methods, Isogeometric Analysis and Refinability in Italy, Gaeta, Italy (9/2017)

- Summer Course on Mathematical Signal Processing and Data Analysis, Academia Sinica Institute of Mathematics, Taipei, Taiwan (1 week invited lectures/tutorials, 8/2017)

- NCTS Seminar on Applied Mathematics, National Center for Theoretical Sciences, National Taiwan University, Taipei, Taiwan (6/2017)

- Data Sciences: Bridging Mathematics, Physics and Biology (Conference Session on Frame Theory and Sparse Representation for Complex Data), Institute for Mathematical Sciences, National University of Singapore, Singapore (6/2017)

- Summer Course on Mathematical Signal and Data Analysis, Academia Sinica Institute of Mathematics, Taipei, Taiwan (1 week invited lectures/tutorials, 7/2016)

- 15th International Conference on Approximation Theory, San Antonio, USA (5/2016)

- Mathematical Biology Colloquium, Chinese Academy of Sciences, Beijing, China (12/2015)

- International Conference on Wavelets and Applications, Euler International Mathematical Institute, St. Petersburg, Russia (6/2015)

- International Summer School on Wavelet Frames and Signal Processing, Chinese Academy of Sciences, Beijing, China (2 weeks invited lectures/tutorials, 7/2014)

- NUS Applied and Computational Mathematics Seminar, Singapore (2/2013)

- SPIE Optics and Photonics Conference, San Diego, USA (8/2011)

- SAMPTA 9th International Conference on Sampling Theory and Applications, Singapore (5/2011)

Teaching activities

- Undergraduate thesis advising at Yale-NUS College
  - Brian Huang (senior thesis on phaseless reconstruction in medical imaging; went on to medical school)
  - Abhinav Venkatesh Natarajan (award for most outstanding senior thesis in Mathematical, Computational and Statistical Sciences,now graduate school at Cambridge)
  - Jung Yoonju (now analyst at AMASIA)
  - Peeranat Tokaeo (now graduate programme in computer science at University of British Columbia)
  - Zhu Xinyu

- Yale-NUS College
  - Calculus (Spring 2021; 22 students)
  - Quantitative Reasoning (Fall 2020/21; 50 students)
  - Foundations of Applied Mathematics (Spring 2019/20; 20 students total)
  - Introduction to Mathematical Analysis (Fall 2015/16/17/18/21; 55 students total)
  - Scientific Inquiry II (Fall 2018; 18 students)
  - Applied Harmonic Analysis (Fall 2016/17; 7 students total)
  - Mathematical Methods for Physical Scientists (Spring 2016/17; 14 students total)
  - Advanced Calculus (Analysis on Manifolds, Spring 2016/17; 3 students)

- National University of Singapore
  - Graduate Analysis I (Abstract Measure and Integration, Fall 2013, 30 students)

- University of Missouri–Columbia

· Advanced Calculus I (Spring 2012, 25 students)

· Calculus for Social and Natural Sciences (Fall 2011, 25 students)

· College Algebra (Spring/Fall 2009, 50 students)

Professional service

- Peer review for mathematical journals
    · Linear Algebra and its Applications
    · SIAM Journal on Mathematical Analysis
    · Applied and Computational Harmonic Analysis
    · Journal of Fourier Analysis and Applications
    · Journal of Approximation Theory
    · Constructive Approximation
    · Bulletin of the Malaysian Mathematical Sciences Society
    · International Journal of Wavelets, Multiresolution and Information Processing