

Dr. Philipp Christian Petersen

Curriculum Vitae

University of Oxford
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Education

- 03.06.2016 **Ph.D.**, *Technische Universität Berlin.*
- 25.03.2013 **Master of Science in Mathematics**, *Technische Universität Berlin.*
- 14.01.2011 **Bachelor of Science in Mathematics**, *Technische Universität Berlin.*
- 15.06.2006 **Abitur**, *Humboldt Gymnasium Tegel, Berlin.*

Employment History

- 07/2018 - 06/2019 **Post-doc**, *University of Oxford, Mathematical Institute.*
- 04/2013–06/2018 **Post-doc**, *Technische Universität Berlin, SFB/TRR 109 "Discretization in Geometry and Dynamics".*
- 04/2013–06/2016 **Scientific assistant**, *Technische Universität Berlin, SFB/TRR 109 "Discretization in Geometry and Dynamics".*
- 06/2012–04/2013 **Student assistant**, *Technische Universität Berlin, Applied Functional Analysis Group.*
- 06/2011–06/2012 **Student assistant**, *Landesbank Berlin - LBB, Pricing and Modelling.*

Awards

- 2017 BiMoS PhD Award
- 2017 Dr Klaus Körper Preis of the GAMM
- 2014 GAMM Junior 2014

Organisation of Conferences and Seminars

- 07/2019 Organiser of the minisymposium: "Theoretical Foundations of Deep Learning" during the ICIAM in Valencia
- 02/2019 Organiser of the minisymposium: "Mathematics of Deep Learning" during the Annual Meeting of the GAMM in Vienna
- 12/2017 Organiser of the MATHEON conference "Compressed Sensing and its Applications" at TU Berlin
- 05/2017 Organiser of the MATHEON conference "Wavelet and Tensor Methods for Partial Differential Equations" at TU Berlin

- 2016–2018 Coordination of the colloquium of the Modelling, Numerics, and Differential Equations Group at TU Berlin
- 2014–2017 Coordination of the seminar "Applied functional analysis" at TU Berlin
 - 12/2015 Local coordinator of the 2. MATHEON conference "Compressed Sensing and its Applications" at TU Berlin.
 - 04/2014 Local coordinator of the joint GAMM ANLA-MSIP workshop on "Matrix Computations for Sparse Recovery" at TU Berlin
 - 12/2013 Local coordinator of the MATHEON conference "Compressed Sensing and its Applications" at TU Berlin
- 06/2013–01/2018 Administration of the webpage of the GAMM Mathematical Signal and Image Processing activity group

Membership in Professional Societies

- American Mathematical Society (AMS)
- Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)
- GAMM Activity Group on Mathematical Signal- and Image Processing
- Berlin Mathematical School (BMS)
- Berlin International Graduate School in Model and Simulation Based Research (BIMoS)

List of Publications

Articles

- [1] J. Ma and P. Petersen, Linear independence of compactly supported separable shearlet systems, *Journal of Mathematical Analysis and Applications*, 428 (1), 238–257, 2015
- [2] P. Petersen, Shearlet approximation of functions with discontinuous derivatives, *Journal of Approximation Theory*, 207, 127–138, 2016
- [3] G. Kutyniok and P. Petersen, Classification of edges using compactly supported shearlets, *Applied and Computational Harmonic Analysis*, 42(2), 245–293, 2017
- [4] G. Kutyniok, V. Mehrmann, and P. Petersen, Regularization and Numerical Solution of the Inverse Scattering Problem using Shearlet Frames, *Journal of Inverse and Ill-Posed Problems*, 25(3), 287–309, 2017
- [5] C. Lessig, P. Petersen, and M. Schäfer, Bendlets: A Second-Order Shearlet Transform with Bent Elements, *Applied and Computational Harmonic Analysis*, 46(2), 384–399, 2019.
- [6] P. Petersen, F. Voigtlaender, Optimal approximation of piecewise smooth functions using deep ReLU neural networks, *Neural Networks*, 108, 296–330, 2018.
- [7] H. Bölcskei, P. Grohs, G. Kutyniok, and P. Petersen, Optimally Sparse Approximation with Deep Neural Networks, *SIAM Journal on Mathematics of Data Science*, in Press

Preprints

- [8] P. Grohs, G. Kutyniok, J. Ma, and P. Petersen, Anisotropic multiscale systems on bounded domains, *arXiv:1510.04538v1*, 2015
- [9] P. Petersen, M. Raslan, Approximation properties of shearlet frames for Sobolev spaces, *arXiv:1712.01047*, 2017

- [10] P. Petersen, M. Raslan, F. Voigtlaender, Topological properties of the set of functions generated by neural networks of fixed size, *arXiv:1806.08459*, 2018
- [11] P. Petersen, F. Voigtlaender, Equivalence of approximation by convolutional neural networks and fully-connected networks, *arXiv:1809.00973*, 2018
- [12] P. Petersen and E. Süli, Gamma-convergence of a shearlet-based Ginzburg–Landau energy, *arXiv:1810.12835*, 2018
- [13] H. Andrade-Loarca, G. Kutyniok, O. Öktem, P. Petersen, *Extraction of digital wavefront sets using applied harmonic analysis and deep neural networks*, submitted, 2019
- [14] J.A.A. Opschoor, P. Petersen, Ch. Schwab, *Deep ReLU Networks and High-Order Finite Element Methods*, submitted, 2019

Conference Proceedings

- H. Bölcskei, P. Grohs, G. Kutyniok, and P. Petersen, Memory-optimal neural network approximation, *Proc. of SPIE (Wavelets and Sparsity XVII)*, San Diego, USA, 2017

Monographs

- P. Petersen, Shearlets on Bounded Domains and Analysis of Singularities Using Compactly Supported Shearlets, PhD thesis, Technische Universität Berlin, 2016
- P. Petersen, Applications of Shearlet Frames for a Sparsity Promoting Regularization of the Inverse Scattering Problem, Master thesis, Technische Universität Berlin, 2013
- P. Petersen, Nonnegative Completions of Block Operators, Bachelor thesis, Technische Universität Berlin, 2011

List of Invited Talks

2019

- **Special Session on "Neural Networks and Sparse Representations" at the SPIE Meeting "Wavelets and Sparsity XVIII"**, San Diego, USA, 11.-15.08.2019
- **Third International Conference on Mathematics of Data Science (MathoDS 3)**, City University of Hong Kong, Hong Kong, 19.-23.06.2019
- **Neural Network Approximation at AT19**, Nashville, Tennessee, 19.-22.05.2019
- **Scientific computation using machine-learning algorithms: Recent mathematical advances and applications**, University of Nottingham, UK, 25-26.04.2019
- **Hot Topic Workshop on "Scientific Machine Learning"**, Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University, USA, 28.-30.01.2019
- **JMM 2019 Special Session on Low Complexity Models in Data Analysis and Machine Learning**, Baltimore, USA, 18.01.2019

2018

- **Zurich Colloquium in Applied and Computational Mathematics**, ETH Zürich, Zürich, Switzerland, 19.09.2018
- **PDE-CDT Summer School**, University of Oxford, United Kingdom, 03.-06.09.2018
- **Interplay of tensor structured formats with advanced PDE discretizations**, ESI Vienna, Austria, 11.-15.08.2018
- **Analysis seminar**, KU Eichstätt-Ingolstadt, Germany, 30.05.2018
- **Oberwolfach workshop**, "Applied Harmonic Analysis and Data Processing", Mathematisches Forschungsinstitut Oberwolfach, Germany, 25.03.2018

- **IAS Workshop on Mathematics of Deep Learning**, Hong Kong University of Science and Technology, Hong Kong, 9-12.01.2018

2017

- **Workshop on Mathematics of Deep Learning 2017**, Weierstrass Institute for Applied Analysis and Stochastics, Germany, 13–15.09.2017
- **Reliable Methods of Mathematical Modeling**, HU Berlin, Germany, 31.07–04.08. 2017
- **International Workshop on Computational Harmonic Analysis**, Nankai University, Tianjin, China, 15.-18.06.2017
- **RTG π^3 Seminar**, Universität Bremen, Germany, 29.03.2017

2016

- **NuHAG seminar**, University of Vienna, Austria, 16.11.2016
- **Analysis seminar**, Harbin Institute of Technology, Harbin, China, 05.08.2016
- **Minisymposium**, "Geometry and Non-Linear Approximation", Tønsberg, Norway, 27.06.2016
- **Oberseminar zur Numerik**, Philipps-Universität Marburg, Germany, 15.06.2016

2015

- **DMV15-minisymposium**, "Applied and Computational Harmonic Analysis", Universität Hamburg, Germany, 23.09.2015
- **Oberwolfach workshop**, "Applied Harmonic Analysis and Sparse Approximation", Mathematisches Forschungsinstitut Oberwolfach, Germany, 21.08.2015
- **1. BIMoS Day**, "Compressed Sensing", TU Berlin, Germany, 04.05.2015
- **Oberwolfach workshop**, "New Discretization Methods for the Numerical Approximation of PDEs" Mathematisches Forschungsinstitut Oberwolfach, Germany, 11.01.2015

2014

- **Zurich Colloquium in Applied and Computational Mathematics**, ETH Zürich, Zürich, Switzerland, 12.11.2014
- **Analysis seminar**, Brandenburgische Technische Hochschule Cottbus, Germany, 06.10.2014

Research Visits

- 11/2018 **ETH Zürich**, with *Prof. Dr Christoph Schwab*, (1 week).
- 11/2016 **University of Vienna**, with *Prof. Dr Philipp Grohs*, (1 week).
- 08/2016 **Harbin Institute of Technology**, with *Prof. Dr Jianwei Ma*, (1 month).
- 11/2014 **ETH Zürich**, with *Prof. Dr Philipp Grohs*, (1 week).
- 10/2014 **Technische Universität München**, with *Prof. Dr Massimo Fornasier*, (2 months).