

Dr. Philipp Christian Petersen

Curriculum Vitae

Universität Wien
Institut für Mathematik
Oskar Morgenstern Platz 1
1090 Wien

✉ pc.petersen.pp@gmail.com

🌐 www.pc-petersen.eu

Education

- 03.06.2016 **PhD**, *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

- 10/2019 - **Assistant Professor**, *Universität Wien, Mathematisches Institut*.
- 06/2018 - 07/2019 **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

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*, 1(1), 8–45, 2019.
- [8] P. Petersen, M. Raslan, Approximation properties of shearlet frames for Sobolev spaces, *Advances in Computational Mathematics*, 45(3), 1581–1606, 2019.
- [9] I. Gühring, G. Kutyniok, P. Petersen, Error bounds for approximations with deep ReLU neural networks in $W^{s,p}$ norms, *Analysis and Applications*, in Press.
- [10] P. Petersen, F. Voigtlaender, Equivalence of approximation by convolutional neural networks and fully-connected networks, *Proceedings of the AMS*, in Press.
- [11] J.A.A. Opschoor, P. Petersen, Ch. Schwab, Deep ReLU Networks and High-Order Finite Element Methods, *Analysis and Applications*, in Press
- [12] H. Andrade-Loarca, G. Kutyniok, O. Öktem, P. Petersen, Extraction of digital wavefront sets using applied harmonic analysis and deep neural networks, *SIAM Journal on Imaging Sciences*, 12(4), 1936–1966, 2019
- [13] P. Grohs, G. Kutyniok, J. Ma, and P. Petersen, Anisotropic multiscale systems on bounded domains, *Advances in Computational Mathematics*, in Press
- [14] P. Petersen, M. Raslan, F. Voigtlaender, Topological properties of the set of functions generated by neural networks of fixed size, *Foundations of Computational Mathematics*, in Press

Preprints

- [15] P. Petersen and E. Süli, Gamma-convergence of a shearlet-based Ginzburg–Landau energy, *arXiv:1810.12835*, 2018
- [16] G. Kutyniok, P. Petersen, M. Raslan, R. Schneider, A Theoretical Analysis of Deep Neural Networks and Parametric PDEs, *arXiv:1904.00377*, 2019
- [17] F. Laakmann, P. Petersen, Efficient Approximation of Solutions of Parametric Linear Transport Equations by ReLU DNNs, <https://arxiv.org/abs/2001.11441>, 2020

Conference Proceedings

- P. Petersen, Mones Raslan, F. Voigtlaender, The Structure of Spaces of Neural Network Functions, *Proc. of SPIE (Wavelets and Sparsity XVIII)*, San Diego, USA, 2019

- I. Gühring, G. Kutyniok, P. Petersen, Error bounds for approximations with deep ReLU neural networks in Sobolev norms, *Signal Processing with Adaptive Sparse Structured Representations (SPARS) Workshop*, Toulouse, France, 2019
- F. Voigtlaender, P. Petersen, Approximation in $L^p(\mu)$ with deep ReLU neural networks, *Proc. of Intl. Conf. on Sampling Theory and Applications (SampTA)*, Bordeaux, France, 2019
- P. Petersen, M. Raslan, F. Voigtlaender, Unfavorable structural properties of the set of neural networks with fixed architecture, *Proc. of Intl. Conf. on Sampling Theory and Applications (SampTA)*, Bordeaux, France, 2019
- 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

Organisation of Conferences and Seminars

- 03/2020 Organiser of the Session "Uncertainty Quantification" at the Annual Meeting of the GAMM in Kassel.
- 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
- 2013–2018 Administration of the webpage of the GAMM Mathematical Signal and Image Processing activity group

List of Invited Talks

2020

- **Computational Harmonic Analysis and Compressive Sensing at FoCM 2020**, Vancouver, Canada, 18.-20.06.2020
- **Computational Uncertainty Quantification: Mathematical Foundations, Methodology & Data**, Vienna, 25.-29.05.2020
- **SIAM Conference on Mathematics of Data Science (MDS20)**, Cincinnati, May 5 - 8.2020

2019

- **Mathematics of Data Science Workshop**, Berlin, Germany, 24.-25.10.2019
- **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
- **Analysis Seminar**, TU Dresden, Germany, 09.05.2019
- **Analysis Seminar**, Warwick University, UK, 03.05.2019
- **Computational Mathematics Seminar**, EPFL, Switzerland, 09.04.2019
- **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

- 04/2019 **Ecole Polytechnique Federale de Lausanne**, *with Prof. Dr Annalisa Buffa*, (1 week).
- 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).

Membership in Professional Societies

- American Mathematical Society (AMS)
- Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)
- GAMM Activity Group on "Mathematical Signal- and Image Processing"
- GAMM Activity Group on "Computational and Mathematical Methods in Data Science"