Paul Breiding | Curriculum Vitae

Universität Osnabrück, FB Mathematik/Informatik, Albrechtstr. 28a, D-49076 Osnabrück

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born 12th of May 1988, german citizenship

Universität Osnabrück
Professor for Mathematical Methods in Data Science *Since 04/2022*

Max-Plack-Institute for Mathematics in the Sciences Leipzig
Head of Emmy Noether Research Group: *04/2021 – 03/2022*
Numerical and Probabilistic Nonlinear Algebra

University of Kassel
Substitute Professor for Computeralgebra *11/2020 – 03/2021*

Akademie der Wissenschaften und der Literatur Mainz
Speaker of the Junge Akademie | Mainz *02/2022 – 02/2023*

Akademie der Wissenschaften und der Literatur Mainz
Member of the Junge Akademie | Mainz *04/2020 – 03/2024*

Parental leave
7 months *10/2019 – 11/2019 and 04/2020 – 10/2020*

Technische Universität Berlin
Postdoctoral researcher in the algorithmic algebra research group *04/2019 – 10/2020*

Max-Plack-Institute for Mathematics in the Sciences Leipzig
Postdoctoral researcher in the nonlinear algebra research group *10/2017 – 03/2019*

Technische Universität Berlin
PhD student with Prof. Dr. Bürgisser *12/2013 – 09/2017*
Date of thesis defense: July 25, 2017. Evaluation 'summa cum laude'.

Simons Institute for the Theory of Computing
Visiting graduate student *08/2014 – 10/2014*
Algorithms and Complexity in Algebraic Geometry

Education

Georg-August-Universität Göttingen
Master of Science *10/2011 – 11/2013*
Evaluation: excellent.

Universidad de Sevilla
Undergraduate studies, part of the Erasmus exchange program *02/2011 – 09/2011*

Georg-August Universität Göttingen
Bachelor of Science *10/2008 – 09/2011*

Languages

German: *fluent, native*

English: *fluent*

Awards

SIAG/AG Early Career Prize
Awarded by the SIAM Activity Group on Algebraic Geometry *2021*

External Funding

Kähler Package for the Zonoid Algebra
Granted by the Deutsche Forschungsgemeinschaft, €164.822 *2024*

Maßnahme "Digitalisierung sicher gestalten"
Granted by MWK Niedersachsen, €49.780 *2022*
with T. Römer

Maßnahme "Unterstützung der Digitalisierung der Lehre für die Digitalisierungsprofessuren"
Granted by MWK Niedersachsen, €104.125 *2022*
with T. Römer

BIRS Workshop on Random Algebraic Geometry
Granted by the Banff International Research Station *2022*
with S. Petrović and G. Smith

Geometry in Complexity and Computation Conference
Granted by Foundation Compositio *2021*
with K. Kohn

Numerical and Probabilistic Nonlinear Algebra
Granted by the Deutsche Forschungsgemeinschaft, €1.132.600 *2020*
Emmy Noether Research Group

Academic Leadership

Metric Algebraic Geometry **Organizer**
ICERM *02/2027 – 05/2027*
Semester program

Conference on Applied Algebra **Organizer**
Universität Osnabrück *09/2023*

Metric Algebraic Geometry **Organizer**
Oberwolfach Seminar *05/2023*

Random Algebraic Geometry **Organizer**
BIRS Workshop, financial support by the Banff International Research Station *04/2023*

Stochastic Geometry **Organizer**
Universität Osnabrück *11/2022*

Geometry in Complexity and Computations **Organizer**
Universität Konstanz, financial support by Foundation Compositio *09/2022*
(including an Abel prize winner as speaker)

Podiumsdiskussion zur Diversität in der Wissenschaft **Organizer**
Akademie der Wissenschaft und der Literatur Mainz *04/2022*

The 1st East German Tensor Day **Organizer**
Max-Planck Institute for Complex Technical Systems *09/2021*

Minisymposium on Random Algebraic Geometry **Organizer**
SIAM Conference on Applied Algebraic Geometry *08/2021*

Minisymposium on Convex Bodies in Real Geometry **Organizer**
SIAM Conference on Applied Algebraic Geometry *08/2021*

Workshop on Software and Applications of Numerical Nonlinear Algebra **Organizer**
Max-Planck Institute for Mathematics in the Sciences *06/2021*

Minisymposium on Random Geometry and Topology **Organizer**
SIAM Conference on Applied Algebraic Geometry *07/2019*

Minisymposium on Numerical Methods in Algebraic Geometry **Organizer**
SIAM Conference on Applied Algebraic Geometry *07/2019*

Summer School on Randomness and Learning in Nonlinear Algebra **Organizer**
Max-Planck Institute for Mathematics in the Sciences *07/2019*

Workshop on Random Algebraic Geometry **Organizer**
SISSA *11/2018*

Max-Planck Day (Presentation of MPI MiS to a general audience) **Organizer**
Munich *09/2018*

Summer School on Numerical Computing in Algebraic Geometry **Organizer**
Max-Planck Institute for Mathematics in the Sciences *08/2018*

Publications

Journal articles

[1] C. Beltrán, P. Breiding, and N. Vannieuwenhoven. The average condition number of most tensor rank decomposition problems is infinite. *Foundations of Computational Mathematics (2022).*

[2] C. Beltrán, P. Breiding, and N. Vannieuwenhoven. Pencil-based algorithms for tensor rank decomposition are not stable. *SIAM J. Matrix Anal. and Appl. (2019).*

[3] V. Borovik and P. Breiding. A short proof for the parameter continuation theorem. *Journal of Symbolic Computation (2025).*

[4] V. Borovik, P. Breiding, J. del Pino, M. Michałek, and O. Zilberberg. Khovanskii bases for semimixed systems of polynomial equations - a case of approximating stationary nonlinear Newtonian dynamics. *J. Mathématiques Pures et Appliquées (2023).*

[5] P. Breiding. An algebraic geometry perspective on topological data analysis. *SIAM News (2020).*

[6] P. Breiding. The expected number of eigenvalues of a real gaussian tensor. *SIAM J. Appl. Algebra Geometry (2017).*

[7] P. Breiding. How many eigenvalues of a random symmetric tensor are real? *Trans. Amer. Math. Soc.(2019).*

[8] P. Breiding and P. Bürgisser. Distribution of the eigenvalues of a random system of homogeneous polynomials. *Linear Algebra and its Applications (2016).*

[9] P. Breiding, P. Bürgisser, A. Lerario, and L. Mathis. The zonoid algebra, generalized mixed volumes, and random determinants. *Adv. in Math. 402 (2022).*

[10] P. Breiding, T. Çelik, T. Duff, A. Heaton, A. Maraj, A. Sattelberger, L. Venturello, and O. Yürük. Nonlinear algebra and applications. *Numerical Algebra, Optimization and Control (2021).*

[11] P. Breiding, T. Duff, L. Gustafsson, F. Rydell, and E. Shehu. Line multiview ideals. *Communications in Algebra (2024).*

[12] P. Breiding and S. Eggleston. Reach of segre-veronese manifolds. *Acta Univ. Sapientiae Math (to appear).*

[13] P. Breiding, S. Eggleston, and A. Rosana. Typical ranks of random order-three tensors. *International Mathematical Research Notices (2025).*

[14] P. Breiding, S. Fairchild, P. Santarsiero, and E. Shehu. Average degree of the essential variety. *La Matematica (2023).*

[15] P. Breiding, F. Gesmundo, M. Michalek, and N. Vannieuwenhoven. Algebraic compressed sensing. *Applied and Computational Harmonic Analysis (2023).*

[16] P. Breiding, R. Hodges, C. Ikenmeyer, and M. Michalek. Equations for GL invariant families of polynomials. *Vietnam Journal of Mathematics (2022).*

[17] P. Breiding, H. Keneshlou, and A. Lerario. Quantitative singularity theory for random polynomials. *International Mathematical Research Notices (2020).*

[18] P. Breiding, K. Kozhasov, and A. Lerario. On the geometry of the set of symmetric matrices with repeated eigenvalues. *Arnold Math J.*

[19] P. Breiding, K. Kozhasov, and A. Lerario. Random spectrahedra. *SIAM J. Optim. (2019).*

[20] P. Breiding, J. Lindberg, G. Ong, and L. Sommer. Real circles tangent to 3 conics. *Le Matematiche (2023).*

[21] P. Breiding and O. Marigliano. Random points on an algebraic manifold. *SIAM J. Mathematics of Data Science (2020).*

[22] P. Breiding, K. Ranestad, and M. Weinstein. Critical curvature of algebraic surfaces in three-space. *Acta Univ. Sapientiae Math (to appear).*

[23] P. Breiding, K. Rose, and S. Timme. Certifying zeros of polynomial systems using interval arithmetic. *Trans. Math. Software (2023).*

[24] P. Breiding, F. Rydell, E. Shehu, and A. Torres. Line multiview varieties. *SIAM J. Appl. Algebra Geometry (2023).*

[25] P. Breiding and P. Santarsiero. Degree of the subspace variety. *Collectanea Mathematica (to appear).*

[26] P. Breiding, F. Sottile, and J. Woodcock. Euclidean distance degree and mixed volume. *Foundations of Computational Mathematics (2021).*

[27] P. Breiding, B. Sturmfels, S. Kalisnik Verovsek, and M. Weinstein. Learning algebraic varieties from samples. *Revista Matemática Complutense (2018).*

[28] P. Breiding, B. Sturmfels, and S. Timme. 3264 conics in a second. *Not. Amer. Math. Soc. (2020). Article is featured on the title page.*

[29] P. Breiding, B. Sturmfels, and K. Wang. Computing arrangements of hypersurfaces. *Journal of Software and Algebra (to appear).*

[30] P. Breiding and N. Vannieuwenhoven. The condition number of join decompositions. *SIAM J. Matrix Anal. and Appl. (2018).*

[31] P. Breiding and N. Vannieuwenhoven. The condition number of Riemannian approximation problems. *SIAM J. Optim. (2021).*

[32] P. Breiding and N. Vannieuwenhoven. Convergence analysis of Riemannian Gauss-Newton methods and its connection with the geometric condition number. *Applied Mathematics Letters (2018).*

[33] P. Breiding and N. Vannieuwenhoven. On the average condition number of tensor rank decompositions. *IMA J. Num. Anal. (2019).*

[34] P. Breiding and N. Vannieuwenhoven. A Riemannian trust region method for the canonical tensor rank approximation problem. *SIAM J. Optim. (2018).*

[35] P. Breiding and N. Vannieuwenhoven. Sensitivity of low-rank matrix recovery. *Numerische Math. (2022).*

[36] N. Dewaele, P. Breiding, and N. Vannieuwenhoven. The condition number of many tensor decompositions is invariant under Tucker compression. *Numerical Algorithms (2023).*

[37] N. Dewaele, P. Breiding, and N. Vannieuwenhoven. Three decompositions of symmetric tensors have similar condition numbers. *Linear Algebra and its Applications (2023).*

Preprints

[38] D. Bates, P. Breiding, T. Chen, J. Hauenstein, A. Leykin, and F. Sottile. Numerical nonlinear algebra. *arXiv:2302.08585.*

[39] P. Blagojević, P. Breiding, and A. Heaton. Facet volumes of polytopes. *arXiv:2112.08437.*

[40] P. Breiding. An efficient randomized homotopy method to approximate eigenpairs of tensors. *arXiv1512.03284.*

[41] P. Breiding, M. Michałek, L. Monin, and S. Telen. The algebraic degree of coupled oscillators. *arXiv:2208.08179.*

Software

[42] P. Breiding and S. Timme. Homotopycontinuation.jl: A package for homotopy continuation in Julia. juliahomotopycontinuation.org. github.com/JuliaHomotopyContinuation. Open Source software.

Homotopy Continuation.jl

Lecture notes

[43] P. Breiding and S. Fairchild. *Mathematical Methods in Data Science.* Unpublished work in progress. `https://pbrdng.github.io/MathData.pdf`.

[44] P. Breiding, K. Kohn, and B. Sturmfels. *Metric Algebraic Geometry.* Oberwolfach Seminars, Birkhäuser, Basel, 2024. `https://link.springer.com/content/pdf/10.1007/978-3-031-51462-3.pdf`.

Theses

[45] P. Breiding. On a p-adic newton method. Master's thesis, Georg-August Universität Göttingen, 2013. Grade: 1.0. First supervisor: Preda Mihailescu. Second supervisor: Peter Bürgisser.

[46] P. Breiding. *Numerical and Statistical Aspects of Tensor Decompositions.* PhD thesis, TU Berlin, 2017. Grade: summa cum laude. First supervisor: Peter Bürgisser. Second supervisor: Felipe Cucker.