

Paul Breiding | Curriculum Vitae

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

✉ pbreiding@uni-osnabrueck.de • 🌐 paulbreiding.org • 📷 PBrdng

born 12th of May 1988, german citizenship

Universität Osnabrück

Professor for Mathematical Methods in Data Science

Since 04/2022

Max-Planck-Institute for Mathematics in the Sciences Leipzig

*Head of Emmy Noether Research Group:
Numerical and Probabilistic Nonlinear Algebra*

04/2021 – 03/2022

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-Planck-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

ICERM

Semester program

Organizer

02/2027 – 05/2027

Conference on Applied Algebra

Universität Osnabrück

Organizer

09/2023

Metric Algebraic Geometry

Oberwolfach Seminar

Organizer

05/2023

Random Algebraic Geometry

BIRS Workshop, financial support by the Banff International Research Station

Organizer

04/2023

Stochastic Geometry

Universität Osnabrück

Organizer

11/2022

Geometry in Complexity and Computations

Universität Konstanz, financial support by Foundation Compositio

(including an Abel prize winner as speaker)

Organizer

09/2022

Podiumsdiskussion zur Diversität in der Wissenschaft

Akademie der Wissenschaft und der Literatur Mainz

Organizer

04/2022

The 1st East German Tensor Day

Max-Planck Institute for Complex Technical Systems

Organizer

09/2021

Minisymposium on Random Algebraic Geometry

SIAM Conference on Applied Algebraic Geometry

Organizer

08/2021

Minisymposium on Convex Bodies in Real Geometry

SIAM Conference on Applied Algebraic Geometry

Organizer

08/2021

Workshop on Software and Applications of Numerical Nonlinear Algebra

Max-Planck Institute for Mathematics in the Sciences

Organizer

06/2021

Minisymposium on Random Geometry and Topology

SIAM Conference on Applied Algebraic Geometry

Organizer

07/2019

Minisymposium on Numerical Methods in Algebraic Geometry

SIAM Conference on Applied Algebraic Geometry

Organizer

07/2019

Summer School on Randomness and Learning in Nonlinear Algebra

Max-Planck Institute for Mathematics in the Sciences

Organizer

07/2019

Workshop on Random Algebraic Geometry
SISSA

Organizer
11/2018

Max-Planck Day (Presentation of MPI MiS to a general audience)
Munich

Organizer
09/2018

Summer School on Numerical Computing in Algebraic Geometry
Max-Planck Institute for Mathematics in the Sciences

Organizer
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, M. Michałek, L. Monin, and S. Telen. The algebraic degree of coupled oscillators. *Advances in Mathematics* (2025).
- [23] P. Breiding, K. Ranestad, and M. Weinstein. Critical curvature of algebraic surfaces in three-space. *Acta Univ. Sapientiae Math* (to appear).
- [24] P. Breiding, K. Rose, and S. Timme. Certifying zeros of polynomial systems using interval arithmetic. *Trans. Math. Software* (2023).
- [25] P. Breiding, F. Rydell, E. Shehu, and A. Torres. Line multiview varieties. *SIAM J. Appl. Algebra Geometry* (2023).
- [26] P. Breiding and P. Santarsiero. Degree of the subspace variety. *Collectanea Mathematica* (to appear).

- [27] P. Breiding, F. Sottile, and J. Woodcock. Euclidean distance degree and mixed volume. *Foundations of Computational Mathematics* (2021).
- [28] P. Breiding, B. Sturmfels, S. Kalisnik Verovsek, and M. Weinstein. Learning algebraic varieties from samples. *Revista Matemática Complutense* (2018).
- [29] P. Breiding, B. Sturmfels, and S. Timme. 3264 conics in a second. *Not. Amer. Math. Soc.* (2020). *Article is featured on the title page.*
- [30] P. Breiding, B. Sturmfels, and K. Wang. Computing arrangements of hypersurfaces. *Journal of Software and Algebra* (to appear).
- [31] P. Breiding and N. Vannieuwenhoven. The condition number of join decompositions. *SIAM J. Matrix Anal. and Appl.* (2018).
- [32] P. Breiding and N. Vannieuwenhoven. The condition number of Riemannian approximation problems. *SIAM J. Optim.* (2021).
- [33] P. Breiding and N. Vannieuwenhoven. Convergence analysis of Riemannian Gauss-Newton methods and its connection with the geometric condition number. *Applied Mathematics Letters* (2018).
- [34] P. Breiding and N. Vannieuwenhoven. On the average condition number of tensor rank decompositions. *IMA J. Num. Anal.* (2019).
- [35] P. Breiding and N. Vannieuwenhoven. A Riemannian trust region method for the canonical tensor rank approximation problem. *SIAM J. Optim.* (2018).
- [36] P. Breiding and N. Vannieuwenhoven. Sensitivity of low-rank matrix recovery. *Numerische Math.* (2022).
- [37] N. Dewaele, P. Breiding, and N. Vannieuwenhoven. The condition number of many tensor decompositions is invariant under Tucker compression. *Numerical Algorithms* (2023).
- [38] N. Dewaele, P. Breiding, and N. Vannieuwenhoven. Three decompositions of symmetric tensors have similar condition numbers. *Linear Algebra and its Applications* (2023).

Preprints.....

- [39] D. Bates, P. Breiding, T. Chen, J. Hauenstein, A. Leykin, and F. Sottile. Numerical nonlinear algebra. *arXiv:2302.08585*.
- [40] P. Blagojević, P. Breiding, and A. Heaton. Facet volumes of polytopes. *arXiv:2112.08437*.
- [41] P. Breiding. An efficient randomized homotopy method to approximate eigenpairs of tensors. *arXiv:1512.03284*.
- [42] P. Breiding, T. Brysiewicz, and H. Friedman. Homotopy iterators. *arXiv:2509.08084*.
- [43] P. Breiding, P. Bürgisser, A. Lerario, and L. Mathis. Probabilistic intersection theory in Riemannian homogeneous spaces. *arXiv:2502.08256*.
- [44] P. Breiding, J. Cobb, A. K. Englander, N. Farnsworth, J. D. Hauenstein, O. Henriksson, D. K. Johnson, J. L. Garcia, and D. Mundayur. Elimination without eliminating: Computing complements of real hypersurfaces using pseudo-witness sets. *arXiv:2601.04383*.
- [45] G. L. Marchetti, E. Connelly, P. Breiding, and K. Kohn. Critical points of degenerate metrics on algebraic varieties: A tale of overparametrization. *arXiv:2512.21029*.

Software.....

- [46] 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.....

- [47] P. Breiding and S. Fairchild. *Mathematical Methods in Data Science*. Unpublished work in progress. <https://pbrdng.github.io/MathData.pdf>.
- [48] 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.....

- [49] 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.
- [50] 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.