Martin Lotz **Curriculum Vitae**

Personal Details

Martin Andreas Lotz

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Education

ETH Zürich (Swiss Federal Institute of Technology)
Diploma in Mathematics (Dipl. Math. ETH), 2001.
Advisor: Prof. János Makowsky and Prof. Robert Stärk (Computer Science)
Thesis: *On the algebraic complexity of some families of coloured Tutte polynomials.*

University of Paderborn, Germany
Ph.D. (Dr. rer. nat.) in Mathematics, summa cum laude, 2005.
Advisor: Prof. Peter Bürgisser.
Dissertation: *On Numerical Invariants in Algebraic Complexity Theory.*

Current Position

University of Warwick
Associate Professor since September 2018

Fellow of the **Alan Turing Institute** since 2021

Previous Positions

The University of Manchester
Lecturer in Numerical Analysis October 2012 - August 2018

The University of Edinburgh
Research Fellow, October 2010-September 2012, supported by the Leverhulme Trust and a Seggie Brown Fellowship.

University of Oxford
Research Fellow at the Computing Laboratory, July 2008-September 2010, supported by DFG Grant LO 1580/1-1 by the German Research Foundation.

Previous employment
Research Fellow at City University of Hong Kong (2005-2008). Teaching assistant at Uni Paderborn and ETH Zürich.
Scientific Consultant in fintech and IT security (Roman Consulting, Vincorex, TeRank, SME Capital).

Research and teaching interests

My current research interests are in using geometric methods to study robustness in machine learning, the estimation of information measures, probabilistic dimensionality reduction, compressive sensing, optimization, and topological data analysis. Most recently I have been involved in a Knowledge Transfer Partnership (KTP), funded by Innovate UK, applying modern classification methods based on large language models and changepoint detection methods to the problem of forecasting credit risk. Previous research interests include computational geometry and graph polynomials. Besides my foundational work, I have been involved in interdisciplinary collaborations in areas such as genomic data analysis.

Recent Grants and Funding

"Towards Incidence Combinatorics in O-minimal Structures: Theory and Generalizations"
Stellenbosch-Warwick Joint Seed Fund, £9,000
8/2025-7/2027

"SensorViz – a visualisation toolbox and gallery for communicating spatial sensor data stream information to planners, policy makers and the public"
Interdisciplinary Research Spotlights: Research Development Fund, £14,515
1/2025-12/2025

"Multimodal Catalogue Search For Second Hand Apparel Valuations"
Innovate UK scheme "Collaborative AI Solutions to improve productivity in key sectors" with Kelp Technologies and Andreas Kyprianou (CAMaCS, Warwick) £217,668
3/2024-3/2025

"Representation Learning on Graphs at Scale"
With Alan Turing Institute, Oxford University and GCHQ, £224,258
10/2023-4/2025

Knowledge Transfer Partnership (KTP) between Warwick University and SME Analytics and Technology Ltd for 24 months (2022), with Marya Bazzi £183,364
3/2023-3/2025

EPSRC Fellowship "Probabilistic and Topological methods in Real Algebraic Geometry and Computational Complexity" for hosting a postdoctoral researcher for three years (2022), £368,920

EPSRC Grant "Stochastic Perturbation Theory in Machine Learning" (2021), £76,216.

Work in preparation

1. *Robustness of Deep Learning and the Geometry of Pfaffian Sets*
   In preparation, with P. Lezeau and A. Natarajan

Publications

1. *Representation Learning on Graphs at Scale via Geometric Patch Alignment.*
   Submitted, 2025
   (with M. La Vecchia and M. Cucuringu)

2. *CL-FinTrans: A Hierarchical Contrastive Learning Framework for Multi-Modal Financial Transaction Representation.*
   Submitted, 2025
   (with P. Aluffi and M. Bazzi)

3. *Categorising SME Bank Transactions with Machine Learning and Synthetic Data Generation*
   Submitted, 2025
   (with P. Aluffi, M. Bazzi, K. Kennedy, M. Arderne and D. Rodrigues)

4. *Performance-Efficiency Trade-off for Fashion Image Retrieval*
   To appear in ECAI (European Conference on Artificial Intelligence), 2025
   (with J. Hurtado, H. Ni, D. Sap and C. Mattison)

5. *A Neural Difference-of-Entropies Estimator for Mutual Information.*
   To appear in ECAI (European Conference on Artificial Intelligence), 2025
   (with H. Ni)

6. *Partitioning Theorems for Sets of Semi-Pfaffian Sets with Applications.*
   Forum of Mathematics, Sigma, 2025
   (with A. Natarajan and N. Vorobjov)

7. *Sharp Phase Transitions in Euclidean Integral Geometry.*
   Geometric and Functional Analysis, 2024
   (with J. A. Tropp)

8. *Dimensionality reduction for k-distance applied to persistent homology.*
   Journal of Applied and Computational Topology, 2022.
   (with S. Arya, J.-D. Boissonnat and K. Dutta)

9. *Molecular subtype, biological sex and age shape melanoma tumour evolution.*
   British Journal of Dermatology, 2020.
   (with T. Budden, S. Furney and A. Virós)

10. *Wilkinson's Bus: weak condition numbers, with an application to singular polynomial eigenvalue problems.*
    Foundations of Computational Mathematics, 2020.
    (with V. Noferini).

11. *Concentration of the Intrinsic Volumes of a Convex Body.*
    Geometric Aspects of Functional Analysis – Israel Seminar (GAFA) 2017-2019
    Lecture Notes in Mathematics 2266, 2020.
    (with M. B. McCoy, I. Nourdin, G. Peccati, J. A. Tropp)

12. *Effective condition number bounds for convex regularization.*
    IEEE Transactions on Information Theory 66.4: 2501-2516, 2020.
    (with D. Amelunxen and J. Walvin)

13. *Persistent homology for low-complexity models.*
    Proceedings of the Royal Society A, 475.2230, 2019.

14. *On the Error in Phase Transition Computations for Compressed Sensing.*
    IEEE Transactions on Information Theory 65.10: 6620-6632, 2019.
    (with S. Daei, F. Haddadi, A. Amini)

15. *Intrinsic volumes of polyhedral cones: a combinatorial perspective.*
    Discrete & Computational Geometry 58.2: 371-409, 2017.
    (with D. Amelunxen)

16. *Average-case complexity without the black swan.*
    Journal of Complexity 41: 82-101, 2017.
    (with D. Amelunxen)

17. *Gordon's Inequality and Condition Numbers in Convex Optimization.*
    Preprint, 2015.
    (with D. Amelunxen)

18. *On the Volume of Tubular Neighbourhoods of Real Algebraic Varieties.*
    Proceedings of the AMS 143.5, pp. 1875-1889, 2015.

19. *Living on the edge: phase transitions in convex problems with random data.*
    Information and Inference 3(3), pp. 224-294, 2014.
    (with D. Amelunxen, M. McCoy and J. Tropp)

20. *Adversarial Smoothed Analysis.*
    Journal of Complexity 26, pp. 255-262, 2010.
    (with F. Cucker and R. Hauser)

21. *Coverage Processes on Spheres and Condition Numbers of Linear Programming.*
    Annals of Probability 38(2), pp. 570-604, 2010.
    (with P. Bürgisser and F. Cucker)

22. *The probability that a slightly perturbed numerical analysis problem is difficult.*
Mathematics of Computation 77, pp. 1559-1583, 2008.
(with P. Bürgisser and F. Cucker)

23. *The Complexity of Computing the Hilbert Polynomial of Smooth Equidimensional Complex Projective Varieties.*
Foundations of Computational Mathematics 7 (1), pp. 51-86, 2007.
(with P. Bürgisser)

24. *General formulas for the smoothed analysis of condition numbers.*
Comptes rendus de l'Académie des sciences Paris, Ser. I 343, pp. 145-150, 2006
(with P. Bürgisser and F. Cucker)

25. *Smoothed analysis of complex conic condition numbers.*
Journal de Mathématiques Pures et Appliquées 86, pp. 293-309, 2006.
(with P. Bürgisser and F. Cucker)

26. *Counting Complexity Classes for Numeric Computations. III: Complex Projective Sets.*
Foundations of Computational Mathematics 5 (4), pp. 351-387, 2005.
(with P. Bürgisser und F. Cucker)

27. *The Complexity of Computing the Euler Characteristic of Complex Varieties.*
Comptes rendus de l'Académie des sciences Paris, Ser. I 339, pp. 370-376, 2004.
(with P. Bürgisser und F. Cucker)

28. *Lower bounds on the bounded coefficient complexity of bilinear maps.*
Journal of the ACM 51 (3), pp. 464-482, 2004.
(with P. Bürgisser)

29. *On the algebraic complexity of some families of coloured Tutte polynomials.*
Advances in Applied Mathematics 32 (1-2), pp. 327-349, 2004.
(with J. Makowsky)

30. *Lower bounds on the bounded coefficient complexity of bilinear maps.*
Proceedings 43rd FOCS, pp. 658-668, November 16-19, 2002, Vancouver.
(with P. Bürgisser)

Thesis

On Numerical Invariants in Algebraic Complexity Theory.
Ph.D. Thesis at Department of Mathematics, University of Paderborn, July 2005.
Supervised by Prof. P. Bürgisser.

On the algebraic complexity of some families of coloured Tutte polynomials.
Diploma Thesis at Department of Mathematics, ETH Zürich, April 2001.
Supervised by Prof. R. Stärk and Prof. J. Makowsky.

Recent seminar and colloquium talks

Colloquium and invited seminar talks at Konstanz (2022), SISSA (Trieste) (2021), Oxford (2018 and 2013), Cambridge (2017 and 2019), Cardiff (2017), Sheffield (2017), Hong Kong University (2016), RWTH Aachen (2015), Paris-Sud (2014), TU Berlin (2014, 2019, 2020), Tokyo University (2013)

Selected Invited Conference Talks

Invited speaker at all Foundations of Computational Mathematics conferences since 2002, in workshops on Complexity Theory, Computational Algebraic Geometry, and Optimization.

Invited speaker at various SIAM Annual Meetings, SIAM Conference on Optimization, and Strathclyde Numerical Analysis Biennale.

Geometric Probability in Optimization and Complexity
Geometry in Complexity and Computations, University of Konstanz, 2022.

Wilkinson's Bus: weak condition numbers, with an application to singular polynomial eigenvalue problems
SIAM Algebraic Geometry, Berne, 2019.

Average-case analysis without the black swan
Discretization in Geometry and Dynamics, Döllnsee-Schorfheide, 2018.

Effective condition number bounds in convex regularization
Algebra meets numerics: condition and complexity, TU Berlin, 2017.

Invited Research Visits

Invited participant in the Turing interest group "Low-dimensional structure in data and graphs: models, analysis, and algorithms", 2020-2022.

Invited participant at a special programme "Approximation, sampling and compression in data science" at the Newton Institute, Cambridge, January-July 2019.

Invited participant at a special trimester "Mathematics of Signal Processing" at the Hausdorff Research Institute for Mathematics, Bonn, January-April 2016.

Externally funded research visits of at least one week to Hong Kong (2011, 2014, 2015, 2016), RWTH Aachen (July 2015), TU Berlin (May 2014), and Caltech (June 2013).

Teaching

University of Warwick

Designed, developed and delivered the new course **Mathematics of Machine Learning** (2019-2023).
Contents: statistical learning theory, optimization, deep learning.
Course page: http://homepages.warwick.ac.uk/staff/Martin.Lotz/courses/learning/
A textbook based on the lecture notes ($\sim$ 250 pages) is in preparation.

Simulation and Machine Learning in Finance (2023).
At Warwick Business School.

Methods of Mathematical Modelling 3 (2023)
New module. Contents: continuous optimization theory and elements of machine learning.

Introduction to Topology (Term 1 2018 and 2019)
Course page: http://homepages.warwick.ac.uk/staff/Martin.Lotz/courses/topology/

Topology of Data (Term 2 2020/2021).

The University of Manchester (2012-2018)

Designed, developed and delivered a new third year course Convex Optimization with a view towards applications in machine learning. The lecture notes are presented as Jupyter notebooks combining theory and Python code.
Course page: `www.math36061.org`

Teaching the course Numerical Analysis I and the MSc level course Scientific Computing, an introduction to C++ programming based on various projects.
Various tutorial, lab and supervision classes.

The University of Edinburgh (2010-2012)
Teaching the course Differential Equations and Modeling, supervision of three MSc. students in the Operations Research programme.

Other
Helped out with teaching and supervision in Oxford, Paderborn and ETH Zürich.

Students and Postdocs

Pietro Aluffi (PhD student since 2025).

Marco La Vecchia (Postdoc, 2023-2-25).

Brandi Jess (KTP Associate, 2023-2025).

Abhiram Natarajan (Postdoc funded by EPSRC, 2021-2024).

Tsz Fung Yu (PhD student in Mathematics, since 2022)
Deep Learning for the Numerical Solution of PDE

Haoran Ni (PhD student on the Mathematics of Systems Center for Doctoral Training, since 2020)
Numerical Estimation of Information Measures

Jake Walvin (PhD student at Manchester, 2013-2018)
Phase transitions for general convex regularization.

Stephen Elsworth (co-supervised PhD student, 2016-2019, with Sabisu)
Analysis and clustering of industrial time series.

Amit Arfan (co-supervised PhD student, 2017-2021)
Reinforcement learning and Markov processes.

Elliot Brendel (Visiting student from ENSTA ParisTech, May-August 2016)
Randomized linear algebra.

Joannés Chambon (Visiting student from ENSTA ParisTech, May-August 2017)
GPU accelerated algorithms for cosparse signal recovery.

Dennis Amelunxen (Postdoc, August 2013-July 2014)

Supervision of many third year, MMath and MSc. projects in Warwick, Manchester, Edinburgh and Oxford, on topics such as protein folding, topology of data, matrix completion, tensor computations, compressive sensing, multi-period portfolio optimization and financial volatility. Supervision of several LMS-funded URSS summer research projects.

Organisation

Warwick - Alan Turing Institute Collaboration - MIRaW (Mathematical Interdisciplinary Research at Warwick) days, Warwick University (2020)

Sessions at International Conference on Continuous Optimization, Tokyo (2016)

Workshop on Compressive Sensing in Tomography, Manchester (November 2015)

Session at Stochastic Processes and Applications, Oxford (July 2015)

Complexity Questions in Optimization in Edinburgh (April 2011)

Service

Member of the Editorial Board of journal Information and Inference (Oxford Uni-

versity Press) (since 2021)

Member of the Advisory Board of the Warwick Mathematics Institute (since 2020)

PhD examiner at Warwick, Oxford, Manchester and SUNY.

Faculty advisor of Warwick SIAM Student Chapter (since 2019)

External Examiner at the University of Birmingham (since 2019)

Secretary to the Second Year Exam board (since 2019)

In charge of academic aspects of departmental computing (since 2018)

Presentations at Department Open Days

Year 4 Senior Tutor (Manchester, 2017-2018)

Programme director for the Computer Science with Mathematics joint honours programme (Manchester, 2015-2017)

Internal and external PhD examiner (Manchester, Bogotá, New York, Oxford)

Organiser of yearly student information events for the Numerical Analysis pathway (Manchester).

Academic advisor/tutor to more than 50 students.

Regular refereeing activity (among others, for Foundations of Computational Mathematics, Annals of Statistics, Information and Inference, SIAM Journal on Optimization, Mathematical Programming).

Reviewed research funding proposals for research councils in Portugal, Ireland, Hong Kong and Poland.

Outreach

Co-organising a Maths Club and a Chess Club at St. Augustine's Primary School, Kenilworth (since 2022).

Talks at Warwick AI Society (Deep Learning for Protein Folding).

Talks at the Warwick Maths Society (2018 and 2019) on "Surprises in High Dimensions".

Talk at the Galois Group in Manchester (2017) on "Surprises in High Dimensions".

Represented the School of Mathematics (Manchester) at the Big Bang Fair 2017 in Birmingham.

Knowledge and Technology Transfer

Academic Supervisor for a Knowledge Transfer Partnership (KTP) between Warwick University and SME Technology and Analytics (since 2022).

Supervision of MathSys PhD student with BT Research (since 2020).

Supervision of MMath project with SME Captital (London), 2020.

Co-supervision of PhD student (Steven Elsworth) as part of a KTP with Sabisu (Manchester).

Professional memberships	Member of the AMS, DMV, SIAM Fellow of the Higher Education Academy (UK)
Language skills	English (fluent at native level) German and Spanish (native) Nationality: German and British
Other	Experience in software development (C++, Python), machine learning tools (PyTorch, Tensorflow), scientific computing tools (R, MATLAB, Julia, Rust, Sage, among others) and GPU Computing (CUDA)