Marie-Charlotte Brandenburg

Curriculum Vitæ

KTH Royal Institute of Technology
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Professional Experience

Feb. 2024 – today	**Postdoctoral Researcher,** KTH Royal Institute of Technology. Research Group: Combinatorics (Katharina Jochemko), and part of the Wallenberg AI, Autonomous Systems and Software Program (WASP).
Jan. 2023 – Jan. 2024	**Postdoctoral Researcher,** Max Planck Institute for Mathematics in the Sciences. Research Group: Mathematical Machine Learning (Guido Montúfar), and part of the project "Combinatorial and Implicit Approaches to Deep Learning" of the DFG priority program Theoretical Foundations of Deep Learning.
2020 – 2022	**Ph.D. Student,** Max Planck Institute for Mathematics in the Sciences. Ph.D. Adivsor: Rainer Sinn. Research Group: Non-linear Algebra (Bernd Sturmfels).
2019 – 2020	**Ph.D. Student,** Berlin Mathematical School and Freie Universität Berlin. Ph.D. Adivsor: Rainer Sinn. Research Group: Discrete Methods in Algebraic Geometry (Christian Haase).
2016 – 2017	**Data Analyst, Business Intelligence,** Minodes GmbH.

Education

2023	**Dr. rer. nat. Mathematics,** Max Planck Institute for Mathematics in the Sciences. Thesis title: *Tropical Positivity and Semialgebraic Sets from Polytopes*. Ph.D. Adivsor: Rainer Sinn.
2019	**M.Sc. Mathematics,** Freie Universität Berlin.
2016	**B.Sc. Mathematics,** Freie Universität Berlin.

Extended Research Visits

March 2023	**Institute for Computational and Experimental Research in Mathematics (ICERM)**, Providence, RI, USA. Invited participant of the semester program *Discrete Optimization*.

October 2022	**University of Twente**, Enschede, Netherlands. Visitor of the research group *Mathematics of Operations Research*.
November 2021	**Hausdorff Research Institute for Mathematics (HIM)**, Bonn, Germany. Invited participant of the trimester program *Discrete Optimization*.
Jan – Feb. 2019	**Simons Institute for the Theory of Computing**, Berkeley, CA, USA. Invited participant of the semester program *Geometry of Polynomials*.

Publications

Journal Publications

2024	**The Real Tropical Geometry of Neural Networks for Binary Classification**, with Georg Loho and Guido Montúfar. *Transactions of Machine Learning*, September 2024. `openreview:I7JWf8XA2w`
2024	**The Best Ways to Slice a Polytope**, with Jesús A. de Loera and Chiara Meroni. *Mathematics of Computation*, 2024. `doi:10.1090/mcom/4006`
2024	**Intersection Bodies of Polytopes: Translations and Convexity**, with Chiara Meroni. *Journal of Algebraic Combinatorics*, 60:127-143, August 2024. `doi:10.1007/s10801-024-01328-9`
2024	**Combinatorics of Correlated Equilibria**, with Benjamin Hollering and Irem Portakal. *Experimental Mathematics*, April 2024. `doi:10.1080/10586458.2024.2340000`
2023	**Tropical Positivity and Determinantal Varieties**, with Georg Loho and Rainer Sinn. *Algebraic Combinatorics*, 6(4):999-1040, August 2023. `doi:10.5802/alco.286`
2023	**Competitive equilibrium always exists for combinatorial auctions with graphical pricing schemes**, with Christian Haase and Ngoc Mai Tran. *La Matematica (Official Journal of the Association for Women in Mathematics)*, 2:1–30, March 2023. `doi:10.1007/s44007-022-00038-7`
2023	**Multivariate Volume, Ehrhart and h^*-Polynomials of Polytropes**, with Sophia Elia and Leon Zhang. *Journal of Symbolic Computation*, 114:209–230, January 2023. `doi:10.1016/j.jsc.2022.04.011`
2022	**Intersection Bodies of Polytopes**, with Katalin Berlow, Chiara Meroni and Isabelle Shankar. *Contributions to Algebra and Geometry*, 63(2):419–439, June 2022. `doi:10.1007/s13366-022-00621-7`
2021	**Investigation of hydro-mechanica processes in fluid-saturated fractured rock based on numerical model generation**, with Nele Pollmann, Julia Gallas, Lucas Witte and Tobias Backers. *IOP Conference Series: Earth and Environmental Science*, 833(1):012107, August 2021. `doi:10.1088/1755-1315/833/1/012107`

Preprints

2024	**Veronese polytopes: Extending the framework of cyclic polytopes**, with Roland Púček. `arXiv:2411.13702`
2024	**Decomposition Polyhedra of Piecewise Linear Functions**, with Moritz Grillo and Christoph Hertrich.. `arXiv:2410.04907`
2024	**Quotients of M-convex sets and M-convex functions**, with Georg Loho and Ben Smith. `arXiv:2403.07751`

Published Conference Contributions

2022   **Extended Abstract: Competitive equilibrium always exists for combinatorial auctions with graphical pricing schemes**, with Christian Haase and Ngoc Mai Tran. In: L.F. Tabera Alonso (ed.), *Discrete Mathematics Days 2022*, pp. 64 – 70, June 2022. [doi:10.22429/Euc2022.016](doi:10.22429/Euc2022.016)

Non-Reviewed Publications

2024   **Separating points by pieceweise linear functions: The real tropical geometry of neural networks.** In: *Oberwolfach Report No. 03/2024*, pp. 9–10, January 2024. [doi:10.4171/OWR/2024/3](doi:10.4171/OWR/2024/3)

2023   **Slices of Polytopes**, with Chiara Meroni. *NSF Research Highlights*, May 2023. url:mathinstitutes.org/highlights/slices-of-polytopes

Seminar and Conference Talks

Invited Conference Talks

September 2024   **Integral Structures in Geometry and Representation Theory (Session: Experimental Methods in Algebra, Geometry and Number Theory)**, Universität Paderborn, Germany. Talk: *Correlated equilibrium polytopes – from game theory to combinatorics to varieties and back.*

July 2024   **Women in Combinatorics Virtual Conference**, online. Talk: *How to Slice a Polytope.*

January 2024   **MFO Workshop Discrete Geometry**, Mathematisches Forschungsinstitut Oberwolfach, Germany. Talk: *Separating Points by Hyperplanes – Discrete and Real Tropical Geometry of Neural Networks.*

February 2023   **Tropical Geometry in Applications**, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Talk: *Tropical Geometry and Neural Networks.*

September 2022   **Geometry meets Combinatorics**, Universität Bielefeld, Germany. Talk: *Tropical Positivity and Determinantal Varieties.*

July 2022   **Matroids, Ordered Structures, and Arrangements in Combinatorics**, University of Manchester, England. Talk: *Tropical Positivity and Determinantal Varieties.*

March 2022   **Combinatorial Coworkspace**, Kleinwalsertal, Austria. Talk: *Intersection Bodies of Polytopes.*

March 2022   **Discrete and Convex Day**, Freie Universität Berlin, Germany. Talk: *The Positive Tropicalization of Low Rank Matrices.*

March 2022   **Mini-Symposium on Lattice Polytopes**, KTH Royal Institute of Technology in Stockholm, Sweden and University of Nottingham, England (online). Talk: *Competitive Equilibrium and Lattice Polytopes.*

Contributed Conference Talks

March 2024	**Combinatorial Coworkspace**, Kleinwalsertal, Austria. Talk: *Separating Points by Hyperplanes – Discrete and Real Tropical Geometry of Neural Networks.*
November 2023	**Annual Meeting of the DFG Priority Program Theoretical Foundations of Deep Learning**, Ludwig-Maximilians-Universität München, Germany. Talk: *Combinatorial and Algebraic Approaches to Deep Learning.*
July 2022	**Discrete Mathematics Days**, University of Cantabria, Santander, Spain. Talk: *Competitive Equilibrium Always Exists.*
June 2022	**VII Encuentro Colombiano de Combinatoria (ECCO)**, Universidad de los Andes, Pontificia Universidad Javeriana, and Universidad Sergio Arboleda in Bogotá, Colombia. Talk: *The Positive Tropicalization of Low Rank Matrices.*
December 2021	**Conference for Women in Algebra and Symbolic Computation II**, Technische Universität Kaiserslautern, Germany. Talk: *Intersection Bodies of Polytopes.*

Research Seminar Talks

March 2024	**Combinatorics Seminar**, KTH Royal Institute of Technology, Stockholm, Sweden. Talk: *The Best Ways to Slice a Polytope.*
February 2024	**Applied Combinatorics, Algebra, Topology and Statistics Seminar**, KTH Royal Institute of Technology, Stockholm, Sweden. Talk: *Separating Points by Hyperplanes – Real Tropical Geometry of Neural Networks.*
November 2023	**Research Seminar Discrete Geometry**, Freie Universität Berlin, Germany. Talk: *The Best Ways to Slice a Polytope.*
June 2023	**Research Seminar Nonlinear Algebra**, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Talk: *The Best Ways to Slice a Polytope.*
May 2023	**Postdoc and Graduate Student Seminar**, Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, RI, USA. Talk: *Competitive Equilibrium and Lattice Polytopes.*
October 2022	**Mathematical Operations Research Seminar**, University of Twente, Netherlands. Talk: *Competitive Equilibrium and Lattice Polytopes.*
August 2022	**Copenhagen-Jerusalem Combinatorics Seminar**, University of Copenhagen, Denmark and Hebrew University of Jerusalem, Israel (online). Talk: *Tropical Positivity and Determinantal Varieties.*
May 2022	**Research Seminar Algebra**, Friedrich-Schiller-Universität Jena, Germany. Talk: *The Positive Tropicalization of Low Rank Matrices.*
May 2022	**Research Seminar Algebra and Geometry**, Universität Osnabrück, Germany. Talk: *The Positive Tropicalization of Low Rank Matrices.*
March 2022	**Research Seminar Discrete Mathematics and Geometry**, Technische Universität Berlin, Germany (online). Talk: *Competitive Equilibrium and Lattice Polytopes.*
February 2022	**Colloqium of the Graduate School "Facets of Complexity"**, Freie Universität Berlin, Germany (online). Talk: *Intersection Bodies of Polytopes.*
November 2021	**Research Seminar Nonlinear Algebra**, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Talk: *Intersection Bodies of Polytopes.*

May 2021	**Research Seminar Nonlinear Algebra**, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany. Talk: *The Positive Tropicalization of Low Rank Matrices.*
July 2020	**Research Seminar Discrete Geometry**, Freie Universität Berlin, Germany (online). Talk: *Multivariate Volume, Ehrhart and h^*-Polynomials of Polytropes.*
October 2019	**Research Seminar Algebra and Geometry**, Otto-von-Guericke-Universität Magdeburg, Germany. Talk: *Competitive Equilibrium and Lattice Polytopes.*
December 2018	**Colloquium of the Graduate School "Facets of Complexity"**, Freie Universität Berlin, Germany. Talk: *Product-Mix Auctions, Competitive Equilibrium and Lattice Polytopes.*

Poster Presentations

December 2019	**Conference for Women in Algebra and Symbolic Computation I**, Technische Universität Kaiserslautern, Germany. Talk: *Multivariate Volume, Ehrhart and h^*-Polynomials of Polytropes.*

Teaching

Summer 2020	**Linear Algebra II**. Teaching Assistant for a class for first-year math students at Freie Universität Berlin, Germany.
Winter 2019/2020	**Panorama der Mathematik**. Teaching Assistant for a class for first-year math teachers in training at Freie Universität Berlin, Germany.
Summer 2018	**Geometry**. Teaching Assistant for a class for advanced bachelor and early master students at Freie Universität Berlin, Germany.

Organization and Service

Journal and Conference Proceedings Reviews

Advances in Geometry, FPSAC, Linear and Multilinear Algebra, Scientific Reports, SIAM Journal on Optimization.

Conference and Seminar Organization

October 2023	**Chow Lectures.** Conference at the Max Planck Institute for Mathematics in the Sciences in Leipzig (MPI MiS), with a lecture series by June Huh. Co-organized with Christian Haase and Mario Kummer.
September 2023	**Hodge and K-Theory meet Combinatorics**. Workshop at Bernoulli Center for Fundamental Studies at EPFL in Lausanne, Switzerland, with lecture series by Alex Fink and Omid Amini. Co-organized with Johannes Hofscheier and Leonid Monin.
Summer 2022	**Nonlinear Algebra Seminar.** Research Seminar of the Nonlinear Algebra Group at MPI MiS.

Spring 2022	**AlToGeLiS Seminar**. Seminar series on applied algebra, topology, geometry and combinatorics between MPI MiS, EPFL, KTH, MIT, and the University of Oxford. Co-coordinated from MPI MiS together with Chiara Meroni and Anna-Laura Sattelberger.
December 2019	**MATH+ Algebraic Geometry+ Research Retreat**. Workshop within the Berlin MATH+ Thematic Einstein Semester on Varieties, Polyhedra, and Computation. Co-organized with Lena Walter.

Outreach

2018 – 2019	**Polytopia**. Development of an online platform (polytopia.eu) for communicating polyhedral geometry to a general audience.