

# Marie-Charlotte Brandenburg

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## Curriculum Vitæ

KTH Royal Institute of Technology  
Department of Mathematics  
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## Professional Experience

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- 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. Advisor: Rainer Sinn. Research Group: Non-linear Algebra (Bernd Sturmfels).
- 2019 – 2020    **Ph.D. Student**, Berlin Mathematical School and Freie Universität Berlin.  
Ph.D. Advisor: Rainer Sinn. Research Group: Discrete Methods in Algebraic Geometry (Christian Haase).
- 2016 – 2017    **Data Analyst, Business Intelligence**, Minodes GmbH.

## Education

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

## Extended Research Visits

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- 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 Best Ways to Slice a Polytope**, with Jesús A. de Loera and Chiara Meroni. Accepted in *Mathematics of Computation*, 2024. [arXiv:2304.14239](https://arxiv.org/abs/2304.14239)
- 2024 **Intersection Bodies of Polytopes: Translations and Convexity**, with Chiara Meroni. *Journal of Algebraic Combinatorics*, May 2024. [doi:10.1007/s10801-024-01328-9](https://doi.org/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](https://doi.org/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](https://doi.org/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](https://doi.org/10.1007/s44007-022-00038-7)
- 2023 **Multivariate Volume, Ehrhart and  $h^*$ -Polynomials of Polytopes**, with Sophia Elia and Leon Zhang. *Journal of Symbolic Computation*, 114:209–230, January 2023. [doi:10.1016/j.jsc.2022.04.011](https://doi.org/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](https://doi.org/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](https://doi.org/10.1088/1755-1315/833/1/012107)

### Preprints

- 2024 **The Real Tropical Geometry of Neural Networks**, with Georg Loho and Guido Montúfar. [arXiv:2403.11871](https://arxiv.org/abs/2403.11871)
- 2024 **Quotients of M-convex sets and M-convex functions**, with Georg Loho and Ben Smith. [arXiv:2403.07751](https://arxiv.org/abs/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](https://doi.org/10.22429/Euc2022.016)

## Non-Reviewed Publications

- 2024                    **Separating points by piecewise 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](https://doi.org/10.4171/OWR/2024/3)
- 2023                    **Slices of Polytopes**, with Chiara Meroni. *NSF Research Highlights*, May 2023. [url:mathinstitutes.org/highlights/slices-of-polytopes](https://url.mathinstitutes.org/highlights/slices-of-polytopes)

## Seminar and Conference Talks

### Invited Conference Talks

- 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 **Colloquium 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 Polytopes*.

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

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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

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### 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](https://polytopia.eu)) for communicating polyhedral geometry to a general audience.