Boulos El Hilany

Curriculum Vitae

Institut für Analysis und Algebra,
TU Braunschweig, Universitätsplatz 2
38106 Braunschweig, Germany
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Employment and Education

May – August 2025 **visiting associate professor (Vertretungsprofessor)**, *Faculty of Mathematics, Otto von Guerike Universität Magdeburg*, Germany, Geometry Research Group.

Since May 2023 **Postdoc**, *Institut für Analysis und Algebra, TU Braunschweig*, Germany, Applied Algebra Group.
Mentor: Timo de Wolff

May 2021 – April 2023 **Walter Benjamin Programme fellow**, *Institut für Analysis und Algebra, TU Braunschweig*, Germany, Applied Algebra Group.
Mentor: Timo de Wolff

May 2020 – April 2021 **Postdoc**, *Johann Radon Institute for Computational and Applied Mathematics*, Linz, Austria, Symbolic Computations Group.
Mentor: Niels Lubbes

Dec. 2018 – April 2020 **Visiting Researcher**, *Institute for Mathematics in the Polish Academy of Sciences*, Warsaw, Poland, Algebraic Geometry Group.
Mentor: Zbigniew Jelonek

Dec. 2017 – Nov. 2018 **Visiting Researcher**, *Max Planck Institute for Mathematics*, Bonn, Germany.
Mentor: Gaetan Borot

May 2016 – Nov. 2017 **Postdoc**, *University of Tübingen*, Germany, Geometry Group.
Mentor: Johannes Rau

Oct. 2013 – Sept. 2016 **PhD Student**, *University of Savoy Mont Blanc*, Chambéry, France, Mathematics Laboratory (LAMA).
Advisor: Frédéric Bihan

Oct. 2012 – June 2013 **2nd Masters in pure mathematics; *Riemannian Geometry***, *Lebanese University, École Doctorale de Sciences et Technologies, Hadath*, Beirut, Lebanon.

Oct. 2011 – June 2012 **1st masters year in pure mathematics**, *Lebanese University, Faculty of Science 2, Fanar*, Beirut, Lebanon.

Oct. 2008 – June 2011 **Bachelor in pure mathematics**, *Lebanese University, Faculty of Science 2, Fanar*, Beirut, Lebanon.

Awards and Scholarships

2021 – 2023 **DFG Walter Benjamin Programme**, *Project title: "Classifying polynomial maps by means of polyhedral geometry"*, €187 400, Single PI.

Research Topics

- Topology of polynomial maps
- Real algebraic geometry
- Real Hurwitz theory
- Geometry of sparse polynomial systems
- Tropical and convex geometry

Publications

1. **The tropical non-properness set of a polynomial map**
   Discrete and Computational Geometry, 1432-0444, (2024),
   doi.org/10.1007/s00454-024-00684-4 ArXiv 2207.00989
2. **Coupler curves of moving graphs and counting realizations of rigid graphs**
   with Georg Grasegger and Niels Lubbes, Mathematics of Computations Vol. **93**, no. **345**, pp. 459–504, (2024),
   doi.org/10.1090/mcom/3886, ArXiv 2205.02612
3. **Computing the non-properness set of real polynomial maps in the plane**
   with Elias Tsigaridas, Vietnam Journal of Mathematics, (2023),
   doi.org/10.1007/s10013-023-00652-0, ArXiv 2101.05245
4. **Counting isolated points outside the image of a polynomial map**
   Advances in Geometry Vol. **22**, no. **3**, pp. 355-374, (2022),
   doi:10.1515/advgeom-2021-0042 ArXiv 1909.08339
5. **A note on generic polynomial maps having a fiber of maximal dimension**
   Colloquium Mathematicum Vol. **166**, pp. 129–136, (2021),
   doi.org/10.4064/cm8162-8-2020, ArXiv 1910.01333
6. **Signed counts of real simple rational functions**
   with Johannes Rau, Journal of Algebraic Combinatorics Vol. **52**, pp. 369–403, (2020),
   doi.org/10.1007/s10801-019-00906-6, ArXiv 1712.05639
7. **Constructing polynomial systems with many positive solutions using tropical geometry**
   Revista Matematica Complutense Vol. **31**, no. **2**, pp. 525–544, (2018),
   doi.org/10.1007/s13163-017-0254-1 ArXiv 1703.02272
8. **Characterization of circuits supporting polynomial systems with the maximal number of positive solutions**
   Journal of Discrete & Computational Geometry, Vol. **58**, No. **2**, pp. 355–370, (2017),
   doi.org/10.1007/s00454-017-9897-4 ArXiv 1603.01813
9. **A sharp bound on the number of real intersection points of a sparse plane curve with a line**
   with Frédéric Bihan, Journal of Symbolic Computations, Vol. **81**, pp. 88–96, (2017),
   doi.org/10.1016/j.jsc.2016.12.003 , ArXiv 1506.03309

Preprints

- **Around the topological classification problem of polynomial maps: A survey**
  see ArXiv 2501.03828
- **Improved fewnomial upper bounds from Wronskians and dessins d'enfant**
  with Sébastien Tavenas, see ArXiv 2409.01651

- **Stratification of projection maps from toric varieties**
  with Martin Helmer and Elias Tsigaridas, see ArXiv 2408.08991
- **Bounds on the infimum of polynomials over a generic semi-algebraic set using asymptotic critical values**
  with Elias Tsigaridas, see ArXiv 2407.17093
- **The polyhedral type of a polynomial map on the plane**
  with Kemal Rose, see ArXiv 2402.08993
- **The tropical discriminant of a polynomial map on a plane**
  see ArXiv 2202.05052
- **Describing the Jelonek set of polynomial maps via Newton polytopes**
  see ArXiv 1909.07016

Theses

1. **Tropical Geometry and Polynomial Systems**
   Doctorate, 2016
2. **Tropical Curves and Amoebas**
   Masters, 2013

Invited talks

Oct. 2024 **A tropical day**, *École polytechnique, Paris*.
The tropical non-properness set of a polynomial map.

Jul. 2024 **DIGO seminar**, *Frankfurt University, Frankfurt*.
The tropical non-properness set of a polynomial map.

July. 2024 **18th International Workshop on Real and Complex Singularities**, *University of Valencia, Spain*.
The polyhedral type of a complex polynomial map on the plane.

May. 2024 **BIRS workshop: Positive Solutions of Polynomial Systems Arising from Real-life Applications**, *University of Granada, Spain*.
Constructing polynomial systems with many positive solutions using tropical geometry

May. 2024 **GKŁW seminar**, *IMPAN, Warsaw, Poland (Virtual)*.
The polyhedral type of a complex polynomial map on the plane.

Jul. 2023 **SIAM conference AG23**, *TU Eindhoven, Netherlands*, Minisymposium talk.
The polyhedral type of a complex polynomial map on the plane.

Jun. 2023 **Colloquium**, *MIC Limerick, Ireland*, on-line.
Linear independence and modeling clay

Jun. 2023 **Oka Theory and Complex Geometry Conference**, *Sophus Lie center, Nordfjordeid, Norway*.
The polyhedral type of a complex polynomial map on the plane.

Dec. 2022 **GKŁW Conference**, *IMPAN, Warsaw, Poland*.
The bifurcation set of a tropical polynomial map

Nov. 2022 **Colloquium**, *TU Dortmund, Germany*.
Das charakteristische Polynom eines linearen Endomorphismus

Oct. 2022 **Real Algebraic Geometry Conference**, *CIRM Luminy, France*.
Coupler curves of moving graphs and counting realizations of rigid graphs

Sept. 2022 **DMV Annual Meeting 2022**, *Nonlinear Algebra in the Sciences Minisymposium*.
The tropical bifurcation set of a polynomial map on a plane

July. 2022 **Applied Analysis and Algebra meeting**, *Braunschweig and Osnabrück universities*.
The tropical bifurcation set of a polynomial map on a plane

Feb. 2022 **Latin American Real and Tropical Geometry Seminar**, *LAGARTOS*.
The tropical discriminant of a polynomial map on a plane

Oct. 2021 **Applied Algebra and Analysis online seminar**, *TU Braunschweig*.
An algorithm for counting realizations of minimally rigid graphs using intersection theory

Oct. 2021 **Workshop on Real Polynomials: Counting and Stability (on-line)**, *Oaxaca, Mexico*.
A polyherdal description for the non-properness set of a polynomial map

Sep. 2021 **Conference on Geometry: Theory and Applications 2021**, *Gozd Martuljek, Slovenia*.
An algorithm for counting realizations of minimally rigid graphs using intersection theory

July 2021 **MEGA 2021 (on-line)**, *UiT – The Arctic University of Norway*.
Computing efficiently the non-properness set of polynomial maps on the plane

July 2021 **Geometric Structures Research Seminar (on-line)**, *SISSA, Italy*.
Computing efficiently the non-properness set of polynomial maps on the plane

May 2021 **Ouragan Seminar (on-line)**, *Inria Paris, France*.
Computing efficiently the non-properness set of polynomial maps on the plane

March 2021 **Singularity Theory Seminar (on-line)**, *Universidade Federal do Ceará, Brazil*.
Computing efficiently the non-properness set of polynomial maps on the plane

Feb. 2021 **DFG Funding Opportunities workshop (non-scientific talk)**, *TU Braunschweig, Germany*.
How I obtained a grant

Oct. 2020 **Geometry team seminar (on-line)**, *LAMA, Université Savoie Mont Blanc, Chambéry*.
Counting isolated points outside the image of a polynomial map

Sep. 2020 **Applied Algebra and Analysis online seminar (on-line)**, *TU Braunschweig*.
Counting isolated points outside the image of a polynomial map

July 2020 **Discrete Mathematics Research Seminar (on-line)**, *RICAM, Linz*.
Counting isolated points outside the image of a polynomial map

June 2020 **Seminar in Real and Complex Geometry (on-line)**, *TAU University*.
Counting isolated points outside the image of a polynomial map

March 2020 **Colloquium**, *Innsbrück University, Austria*.
Discrete geometry and topological structures from polynomial equations.

Feb. – 2020 **Young Researchers Colloquium**, *IMPAN, Warsaw*.
On polynomial maps having fibers of maximal dimension

Dec. – 2019 **Gdańsk-Kraków-Łódź-Warszawa Seminar in Singularity Theory**, *Jagellonian University, Kraków*.
Describing the Jelonek set of polynomial maps via Newton polytopes

Oct. 2019 **Algebraic Geometry Seminar**, *MIMUW, Warsaw*.
Describing the Jelonek set of polynomial maps via Newton polytopes

Sep. 2019 **Einstein workshop on Real Applied Algebraic Geometry**, *TU Berlin*.
Describing the Jelonek set of polynomial maps via Newton polytopes

Jul. 2019 **SIAM conference on Applied Algebraic Geometry**, *Bern University*.
Characterizing circuits supporting polynomial systems having maximal number of positive solutions

June 2019 **Algebra group seminar**, *University of Tübingen*.
Describing the Jelonek set of polynomial maps via Newton polytopes

– 2019 **Geometry and Singularity Theory seminar**, *IMPAN, Warsaw*.
On polynomial maps having fibers of maximal dimension

– 2019 **Geometry and Singularity Theory seminar**, *IMPAN, Warsaw*.
Counting isolated points outside the image of a polynomial map

– 2019 **Geometry and Singularity Theory seminar**, *IMPAN, Warsaw*.
Constructing polynomial systems with many positive solutions using tropical geometry

Feb. 2018 **IMPANGA Seminar**, *IMPAN, Warsaw*.
Signed counts of real simple rational functions

June 2018 **6th Workshop on Combinatorics of Moduli Spaces, Cluster Algebras, and Topological Recursion**, *Steklov Mathematical Institute, Moscow.*.
Signed counts of real simple rational functions

May. 2018 **Düsseldorf Research Seminar in Pure Mathematics**, *Heinrich Heine University*.
Constructing polynomial systems with many positive solutions using tropical geometry

Oct. 2018 **ASGARD: Real algebraic geometry and tropical mathematics**, *Oslo University, Norway*.
Signed counts of real simple rational functions

Oct. 2018 **Working group on Grothendieck-Teichmüller groups**, *MPIM, Bonn, Germany*.
Belyii Theorem via dessins d'enfants

Sep. 2018 **Image Processing and Computer Vision conference**, *Tübingen University, Germany*.
The equations for the moduli space of n points on the line

June 2017 **Reading Group on Real Algebraic Geometry**, *Max Plank Institute MIS, Leipzig*.
Topology of real K3 surfaces

Feb. 2017 **Workshop on Tropical algebra and applications** , *Mittag Leffler Institute, Sweden*.
Constructing polynomial systems with many positive solutions using tropical geometry

Dec. 2017 **Algorithmic algebra group weekly seminar**, *TU Berlin, Germany*.
Signed counts of real simple rational functions

Aug. 2017 **Nonarchimedean and Tropical Geometry conference** , *Universität Regensburg, Germany*.
Constructing polynomial systems with many positive solutions using tropical geometry

July 2017 **Geometry group seminar** , *Tübingen University, Germany*.
Real Hurwitz numbers and simple rational functions

June 2017 **Geometry team seminar**, *LAMA, Université Savioe Mont Blanc, Chambéry.*.
Nombres de Hurwitz réels et fonctions rationnelles simples

March 2016 **Geometry group seminar**, *Universität des Saarlandes, Saarbrücken, Germany*.
Constructing polynomial systems with many positive solutions using tropical geometry

Further Conferences and Workshops

August 2024 **MEGA 2024**, MPI MIS, Leipzig, Germany.

August 2021 **SIAM AG 2021**, Texas A& M, USA.

April 2021 **(Polytop)ics: Recent advances on polytopes** , MPI MIS, Leipzig, Germany.

July 2021 **Tropical Moduli Spaces School**, Mittag Leffler Institute, Sweden.

Sep. 2019 **Curves and Surfaces, A History of Shapes**, Hotel Bellavista - Levico Terme, Italy.

June 2019 **Gdańsk-Kraków-Łódź-Warszawa Seminar in Singularity Theory**, IMPAN, Warsaw, Poland.

June 2019 **New Perspectives in Gromov-Witten Theory**, Institut de mathématiques de Jussieux, France.

July 2018 **Tropical Geometry in Europe**, Institut de mathématiques de Toulouse, France.

June 2018 **Random matrices, maps, and gauge theories**, ENS de Lyon, France.

Nov. 2017 **Young Researchers in String Mathematics**, MPI Für Mathematik, Bonn, Germany.

Sep. 2017 **Perspectives in Real Geometry**, CIRM, Marseilles, France.

May 2017 **Geometric aspects of singularities**, Université de Lille, France.

March 2017 **Tropical curve counts, Motivic integration and Nonarchimedean Geometry**, Universität Tübingen, Germany.

March 2017 **Workshop on Enumerative Geometry**, IHP, Paris, France.

Jan. 2016 **Singularity Workshop Meeting**, CIRM, Marseilles, France.

Jan. 2015 **Singularities and Tropical Geometry**, IMJ-PRG, Paris, France.

June 2015 **Algebraic Complexity Meeting**, ENS de Lyon, France.

June 2015 **MEGA 2015**, Povo center, Trento, Italy.

Feb. 2015 **Jeunes Chercheurs en Singularité**, CIRM, Marseilles, France.

Jan. 2014 **Tropical Geometry in its Complex and Symplectic Aspects**, Bernoulli Center, EPFL, Switzerland.

Organized Conferences and Workshops

July 2021 **Workshop on *Real Algebraic and Convex Geometry***, TU Braunschweig.
joint with Khazhgali Kozhasov and Timo de Wolff

July 2017 **Image Processing and Computer Vision**, Universität Tübingen, Germany.
joint with Domenico Monaco and Jonas Ziefle

July 2015 ***Colloque Inter'Actions***, Université Grenoble Alpes, France.
joint with Clément Charpentier, Benjamin Druart, Burak Ekici, Guillaume Idelon-Riton, Julien Korinman, Teddy Mignot, Pedro Montero, Charlotte Perrin, Federico Zertuche

Teaching

Apr. 2024– Jul. 2024 **Computational Algebraic Geometry**, *55 hrs*, TU Braunschweig, Germany, In English.

Oct. 2023– Feb. 2024 **Neural Networks and Machine Learning**, *30 hrs*, TU Braunschweig, Germany, In English.

Apr. – Jul. 2023 **Algebra for bachelor students in informatics**, *30 hrs*, TU Braunschweig, Germany, In German.

Oct. 2022 – Feb. 2023 **Discrete Mathematics lectures for bachelor students**, *30 hrs*, TU Braunschweig, Germany, In German.

Apr. – Sep. 2022 **Topology lectures for bachelor students**, *55 hrs*, TU Braunschweig, Germany, In German.

Sep. 2017 **Teaching assistant for refugees**, *15 hrs*, Universität Tübingen, Germany.

Université Savoie Mont Blanc, France

2015 – 2016 **Ramp-up math courses**, *20 hrs*, In French.

2015 – 2016 **Fourrier Series**, *25 hrs*.

2015 – 2016 **Linear Algebra I**, *15 hrs*.

2015 – 2016 **Calculus I**, *55 hrs*.

2014 – 2015 **Inferential Statistics**, *30 hrs*.

2014 – 2015 **Statistics and Probability**, *12 hrs*.

Students supervision

Bachelor theses:

- The Alexander polynomial,
- Tropical j-invariant

Committee

2024 – **Board member for Promoting Digital education through Global Interconnection**, TU Braunschweig.
https: ProDiGi

2023 – **Admission committee member for Financial and Business Mathematics**, TU Braunschweig.

2014–2015 **Committee representative for institutes' PhD students**, LAMA, University of Savoy.

Other Professional Activities

Refereeing

- ISSAC conference
- Journal für die Reine und Angewandte Mathematik

- Journal of Algebraic Combinatorics
- Journal of Algebra
- International Journal of Differential Equations
- Revista Matemática Complutense

Paper reviews for AMS: Mathematical reviews

Articles reviewed (**11** in total). Article No.: 3693663, 3717977, 3718078, 3860888, 3906126, 4016892, 3902912, 3913874, 4048722, 4330408, 4372667, 4447397, 4403222

Software skills

C++, Python, SAGE, Latex

Languages

Arabic	**Mothertongue**
Ukranian	**Mothertongue**
English	**Fluent**
Russian	**Fluent**
French	**Fluent**
German	**Fluent**
Polish	**Basic**