

Neriman Tokcan

CONTACT INFORMATION

415 Main St, Cambridge webpage: <https://nerimantokcan.com>
The Eli and Edythe L. Broad E-mails: ntokcan@broadinstitute.org
Institute of MIT and Harvard, ntokcan@mit.edu
Cambridge, MA 02142

RESEARCH INTERESTS

My research focuses on formulating novel, mathematically sound theoretical frameworks to perform **analysis of multi-modal, high-dimensional data** while preserving the integrity of their structure. I work on compression, noise elimination, and dimension reduction methods for **higher-order tensors** and the development of ML/AI tools. My expertise is at the intersection of **algebraic geometry, multi-linear algebra, combinatorics, and representation theory**. I explore applications in data science, bioinformatics, and cancer genomics.

APPOINTMENTS

Broad Institute of MIT and Harvard, Cambridge MA September 2019-present

Supervisors: Caroline Uhler, Todd Golub, Aviv Regev
Eric and Wendy Schmidt Center Postdoctoral Fellow, September 2021- present
Computational Postdoctoral Associate
– Golub Lab, September 2020- present
– Regev Lab, September 2019 - August 2021

Institute for Pure and Applied Mathematics (IPAM), UCLA Spring 2021

Fellow for the Tensor Methods and Emerging Applications to the Physical and Data Sciences
Spring Semester Program

University of Michigan (UMICH), Ann Arbor, MI August 2017-September 2019

Postdoctoral Assistant Professor of Mathematics
Postdoctoral Researcher at the Biomedical and Clinical Informatics Lab, Department of Computational Medicine and Bioinformatics
Supervisors: Harm Derksen, Kayvan Najarian

EDUCATION

University of Illinois at Urbana-Champaign (UIUC), Urbana IL August 2017

Dissertation Title: “Relative Waring Rank of Binary Forms”
Advisor: Bruce Reznick

University of Illinois at Urbana-Champaign (UIUC), Urbana IL August 2012

M.S. in Mathematics

Cukurova University, Adana Turkey June 2009

B.S. in Mathematics

PUBLICATIONS

1. T. Biancalani, G. Scalia, L. Buffoni, R. Avasthi, Z. Lu, A. Sanger, N. Tokcan, C. R. Vanderburg, A. Segerstolpe, M. Zhang, I. Avraham-Davidi, S. Vickovic, M. Nitzan, S. Ma, J. Buenrostro, N. B. Brown, D. Fanelli, X. Zhuang, E. Z. Macosko and A. Regev, *Deep learning and alignment of spatially-resolved whole transcriptomes of single cells in the mouse brain with Tangram*, *Nature Methods* (2021), <https://doi.org/10.1038/s41592-021-01264-7>.
2. L. Hernandez, R. Kim, N. Tokcan, H. Derksen, B.E. Biesterveld, A. Croteau, A. M. Williams, M. Mathis, K. Najarian, and J. Gryak, *Multimodal Tensor-Based Method for Integrative and Continuous Patient Monitoring During Postoperative Cardiac Care*, *Artificial Intelligence in Medicine* **113** (2021), 102032, <https://doi.org/10.1016/j.artmed.2021.102032>.
3. N. Tokcan, J. Gryak, K. Najarian, and H. Derksen, *Algebraic Methods for Tensor Data*, *SIAM Journal on Applied Algebra and Geometry*, **5** (2021), no.1, 1-27, <https://epubs.siam.org/doi/10.1137/19M1272494>.
4. M. R. Mathis, M. Engoren, S. Kheterpal, K. Gunnerson, A. Williams, B. Biesterveld, A. Croteau, K. Ward, H. Alam, H. Derksen, G. Liu, R. Kim, N. Tokcan, K. Najarian, J. Gryak, *Early Detection of Postoperative Deterioration in Cardiac Surgery Patients using Electronic Health Record and Waveform Data: A Machine Learning Approach*, *Anesthesia and Analgesia* **132**, no. 5, pp. 999-1003 (2021).
5. C. Monical, N. Tokcan, A. Yong, *Newton polytopes in algebraic combinatorics*, *Selecta Mathematica (N.S.)* **25** (2019), no. 5, <https://doi.org/10.1007/s00029-019-0513-8>.
6. B. Reznick and N. Tokcan, *Binary forms with three different relative ranks*, *Proceedings of the American Mathematical Society* **145** (2017), 5169-5177, <https://doi.org/10.1090/proc/13666>.
7. N. Tokcan, *On the Waring rank of binary forms*, *Linear Algebra and Its Applications* **524** (2017), 250-262, <https://doi.org/10.1016/j.laa.2017.03.007>.
8. R. Mancuso, R. Pellizzoni, N. Tokcan, M. Caccamo, *WCET Derivation Under Single Core Equivalence With Explicit Memory Budget Assignment*, *Proceedings of the 29th Euromicro Conference on Real-Time Systems (ECRTS 2017)*, Dubrovnik, Croatia, pp. 3:1-3:23, <https://doi.org/10.4230/LIPIcs.ECRTS.2017.3>
9. Relative Waring Rank of Binary Forms, Ph.D. thesis, available online at <https://www.ideals.illinois.edu/handle/2142/98327>.

PATENTS

Tensor Amplification-Based Data Processing

Patent no: US20210338171A1

Application no: 17/167,140.0

Publication date: 2021-11-04

Inventors: Harm Derksen, Neriman Tokcan, Kayvan Najarian, Jonathan Gryak

GRANTS

Michigan Precision Health Scholars Award, 2018-2020

University of Michigan, Ann Arbor

Project: *A Novel Tensor Similarity Score for the Classification of Cardiac Index*

Funding: USD 240,000

Role: PI

Award Nr.: U063159

HONORS,
FELLOWSHIPS,
AWARDS

Junior Leader for the Simons Semester, Fall 2022
Institute of Mathematics of the Polish Academy of Sciences
–*AGATES program: Algebraic Geometry with Applications to Tensors and Secants*

Travel Award, SIAM Conference on Mathematics of Data Science (MDS22), 08/2022

Early Career Travel Award, SIAM Conference on Applied Algebraic Geometry, 08/2021

Fellowship at the Institute for Pure and Applied Mathematics, UCLA (March-June 2021)
–*Program on Tensor Methods and Emerging Applications to the Physical and Data Sciences*

Irving Reiner Memorial Award in Algebra, UIUC, 2017

Campus Research Board Award, UIUC, Spring 2017

AMS Graduate Student Travel Grant to the Joint Mathematics Meetings, 2016

Nominated for Departmental TA Instructional Award, UIUC, Fall 2016

Finalist for Departmental TA Instructional Award, UIUC, Fall 2015

List of Teachers Ranked as Excellent by students, UIUC, Fall 2014, Spring 2015, Summer 2015, Fall 2015, Spring 2016(with outstanding rating)

Doctoral fellowship, Council of Higher Education of Turkey, 2011

Doctoral fellowship, Republic of Turkey Ministry of National Education, 2011-2017

Doctoral fellowship, Scientific and Technological Research Council of Turkey (TUBITAK), 2009

Ranked first among the Department of Mathematics graduates, Cukurova University, 2009

Ranked first among the College of Sciences and Letters graduates, Cukurova University, 2009

High Honor Award, Cukurova University, each semester 2006-2009

SELECTED
CONFERENCES,
SEMINARS,
PRESENTATIONS

Tensor Methods and Emerging Applications to the Physical and Data Sciences
Reunion Conference, UCLA, 12/2022
talk title: Tensor methods and applications in genomics

University of Trento, Italy, Department of Mathematics seminar, 12/2022
talk title: Non-negative consensus tensor factorization and applications

Algebraic Geometry with Applications to Tensors and Secants(AGATES) workshop
Poland, Warsaw, 11/2022
Multiple lectures on: Tensor methods and applications in data science

Oxford Applied Topology Seminar, England, 11/2022
talk title: Tensor-based frameworks for genomics

SIAM Conference on Mathematics of Data Science, San Diego, 09/2022
talk title: *Tensor-Based Frameworks in Cancer Genomics*

Combinatorial, Computational, and Applied Algebraic Geometry (CCAAGS'22), Seattle, 06/2022
poster title: *Tensor Methods for Cancer Genomics*

Seminar Series on Single-Cell Discussion, online, 05/2022
Broad Institute, Dana Farber Cancer Institute, MIT, and Harvard
organizers: Dana Silverbush and Erin M. Parry
talk title: *Spatial transcriptomics approaches for tumor microenvironment analysis*

MIT MGB AI Cures Conference, Boston, 04/2022
poster title: *Tensor based framework for the analysis of tumor microenvironment*

Mini-workshop on Algebraic Statistics, Harvard Statistics Department, 04/2022
talk title: *Algebraic Tools for Tensor Analysis*

Department of Mathematics Seminar, UMASS Boston, 02/2022
talk title: *Tensor methods for multimodal data*

Division of Applied Math Seminar, Brown University, 02/2022
talk title: *Tensor-based frameworks for multimodal data analysis*

AlToGeLiS: Seminar-online 12/2021
talk title: *Tensor decomposition for multi-modal data analysis*

Broad Institute of MIT and Harvard, Cancer Program, 10/2021
talk title: *Tensor-based frameworks for the analysis of tumor microenvironments*

Topics in Algebra, Topology, Etc., Research Seminar, Boise State University, 10/2021
talk title: *Tensor-based frameworks for multimodal data analysis*

SIAM Conference on Applied Algebraic Geometry, 08/2021
talk title: *Algebraic Methods for Tensor Data*

Institute for Advanced and Pure and Applied Mathematics, 06/2021
talk title: *Kernelization of Tensor-Based Models*

University of Illinois at Urbana-Champaign, Teaching and Diversity Seminar, March 2021
panel title: *Life After UIUC*

Broad Institute, Cancer Data Science Platform, 01/2021
talk title: *Tensor Methods for Cancer Genomics Data*

U-M Precision Health Symposium, 05/2019
talk title: *Tensor Methods for Biomedical Data Analysis*

Broad Institute of MIT and Harvard, Cambridge, MA, 04/2019
talk title: *Tensors for multi-dimensional data analysis*

Joint Mathematics and Computer Science Department Seminar, Boston University,
Boston, MA, 03/2019
talk title: *Tensor amplification and applications in multi-dimensional data analysis*

AMS Joint Mathematics Meetings, Ann Arbor, 10/2018
talk title: *Tensor decomposition and applications in Computational Medicine*

UMICH Michigan Institute for Clinical and Health Research (MICHR), 10/2018
talk title: *Tensor Analysis for Biomedical Data Processing*

Military Health System Research Symposium, Kissimmee, FL, 08/2018
poster title: *A Novel Tensor Similarity Score for the Classification of Cardiac Index from ECG Signals*

UMICH Biomedical and Clinical Informatics Lab, Department of Computational Medicine and Bioinformatics, 05/2018
talk title: *Tensors for Data Analysis*

UMICH Combinatorics Seminar, Ann Arbor, 04/2018
talk title : *Newton Polytopes in Algebraic Combinatorics*

UMICH Biomedical and Clinical Informatics Lab, Department of Computational Medicine and Bioinformatics, Fall 2017
Series of talks on tensor decomposition and applications
Audience: Interdisciplinary audience composed of industry practitioners, clinicians and academicians

Midwest Algebraic Geometry Graduate Conference, University of Illinois at Chicago, 04/2017
talk title : *A Lower Bound for the Waring Rank*

AMS Joint Mathematics Meetings, Atlanta, 2017
talk title: *Relative Ranks of Binary Forms*

ALGECOM – Algebra, Geometry and Combinatorics Day, Purdue University, 10/2016
poster title: *Waring’s problem for binary forms*

Summer School on Real Algebraic Geometry and Optimization, Georgia Tech University, 07/2016
talk title: *Binary Forms with Three Different Relative Ranks*

UIUC Women in Mathematics Seminar, 05/2015
talk title: *Length of Binary Forms*

OTHER RESEARCH EXPERIENCE

Research Assistant, Illinois Coordinated Science Laboratory, UIUC, Summer 2016
Supervisor: Negar Kiyavash, Department of Electrical and Computer Engineering
Topics: Graph deanonymization, graph matching, privacy of social graphs

Research Assistant, Department of Mathematics, UIUC, Summer 2014, 2015
Advisor: Bruce Reznick
Topics: Sum of Squares Optimization, Hilbert’s 17th problem, the Waring problem for binary forms

Research Assistant, Department of Mathematics, UIUC, Summer 2013
Supervisor: Maarten Bergvelt
Topics: Symmetric Polynomials and Representation Theory

TEACHING EXPERIENCE

Instructor, UMICH

Math 214, Applied Linear Algebra Fall 2018
Classic lecture format, 70 students
<http://www.math.lsa.umich.edu/courses/214/>

Math 217, Linear Algebra Fall 2107
IBL (Inquiry Based Learning) teaching format, 18 students
<http://www.math.lsa.umich.edu/ibl/217.html>

Teaching Assistant, UIUC

Calculus Fall 2013
Calculus I Fall 2014, Fall 2015
Calculus for Business I Spring 2014, Spring 2015

- Led group discussion sections for 30–35 undergraduate students in an active learning setting
- Created and graded course assessments to ensure students understood the course material and stayed on track
- Integrated multimedia approaches and used instructional technology
- Recognized on the List of Teachers Ranked as Excellent by students

Merit Program for Emerging Scholars, UIUC

Merit Workshop for Partial Differential Equations, Spring 2016

- Taught Introduction to Partial Differential Equations for 10 undergraduate students with high academic potential who are members of groups, such as ethnic minorities and women, who tend to be underrepresented in STEM
- Wrote challenging problems to encourage critical thinking
- Designed in-class activities to promote class discussion and active participation
- Recognized on the List of Teachers Ranked as Excellent by students with ICES score 5.0 out of 5.0

Instructor, UIUC

Calculus, Summer 2015

- Delivered lectures in an active learning format for 30 undergraduate students
- Designed the syllabus and all of the course material; lectures, worksheets, quizzes, exams
- Created online homeworks
- Provided immediate objective feedback
- Recognized on the List of Teachers Ranked as Excellent by students

ADVISING, MENTORING EXPERIENCE & CERTIFICATES

UROP Research Mentor, MIT, Fall 2022

Mentoring a junior undergraduate student majoring in computer science & molecular biology.
Topic: Spatial Transcriptomics Analysis for Cancer Genomics

Broad Summer Research Program, Broad Institute, Summer 2021

Mentored an undergraduate student majoring in Computational Biology (Brown University) with interest in machine learning applications in cancer genomics.

Topic: Computational methods for spatial transcriptomics and integrative analysis of the tumor microenvironment of Classical Hodgkin Lymphoma

Undergraduate Mentoring, Broad Institute, Fall 2020

Mentored a senior undergraduate student majoring in Mathematics with interest in data science and biology (Carleton College, MN).

Topic: Computational methods for the analysis and visualization of spatially resolved RNA-seq data

UROP Research Mentor, UMICH, Fall 2018

The Undergraduate Research Opportunity Program (UROP) offers research experience for undergraduates by connecting students with University of Michigan faculty and postdocs.

Project title: Tensors for Data Analysis

Certificate of Recognition, Broad Institute of MIT and Harvard, Summer 2021

This certificate was given to recognize the commitment and dedication as a mentor for the 2021 Broad Summer Research Program.

CIMER Research Mentor Training Program, Certificate of Completion, Summer 2021
I completed CIMER(Center for the Improvement of Mentored Experiences in Research) Mentoring Program focusing on mentoring undergraduate students in the areas of genomics/biology.

Teaching Assistant Mentor, Department of Mathematics, UIUC, Fall 2016

- Guided several graduate teaching assistants
- Observed their teaching in class
- Discussed feedback forms
- Helped my mentees improve their teaching skills

Project Manager in Illinois Geometry Lab, UIUC, Fall 2014

- Managed a team of 4 undergraduate students (majoring in mathematics and engineering) on the computational project “Elliptesque and hyperbolesque curves”
- Supervised progress on the project and provided both mathematical and technical support to the undergraduate student members
- Assigned responsibilities and organized regular meetings

SERVICES

Special Session co-organizer, 2023 Joint Mathematics Meetings, Boston

Title: Applications of Tensors in Computer Science

Date: January 5-6, 2022

Organizers: Neriman Tokcan, Harm Derksen, Benjamin Lovitz

Minisymposium co-organizer, September 2022, San Diego

SIAM Conference on Mathematics of Data Science

Title: Multilinear Algebra and Tensors for Data Science

Organizers: Neriman Tokcan, Harm Derksen

Co-organiser of a new international consortium:

AlToGeLiS: Algebra, Topology, Geometry, and the Life Sciences

Journal Reviewer, 2020-present

iScience: Cell Press

Linear and Multilinear Algebra

Book Reviews

Springer Nature, October 2019

Topic: Linear Algebra for advanced undergraduate level and graduate level

Faculty Host for American Mathematical Society Sectional Meeting, Ann Arbor, MI, October 20-21 2018

Publication Coordinator, Biomedical and Clinical Informatics Lab, UMICH, 2018

Graduate admission committee member, Department of Mathematics, UMICH, Fall 2017

Co-Organizer of the Teaching Assistant Training Program, UIUC, Fall 2016

- Assisted in organizing Math TA training for both incoming and current teaching assistants
- Organized two workshops for Math TA orientation: “Practice teaching for new TAs” and “Maximizing learning opportunities in a multi-cultural classroom”

Teaching Evaluator for Teaching Assistant Orientation, UIUC, Fall 2016

- Observed teaching demonstrations of incoming graduate students
- Made recommendations on teaching and grading assignments for the semester

COLLABORATORS,
MENTORS

Todd Golub

Core Institute Member, Chief Scientific
Officer, Director of the Broad Institute
of MIT and Harvard
Professor of Pediatrics
Harvard Medical School
golub@broadinstitute.org

Caroline Uhler

Associate Professor
Department of Electrical Engineering and
Computer Science and Institute for Data,
Systems and Society, MIT
cuhler@mit.edu

Bruce Reznick (Ph.D. advisor)

Professor of Mathematics
University of Illinois at Urbana-Champaign
reznick@illinois.edu

Harm Derksen

Professor of Mathematics
Northeastern University
ha.derksen@northeastern.edu

Aviv Regev

Chair of the Faculty and Core Member
Broad Institute of MIT and Harvard
Executive Vice President of Genentech
Research and Early Development
aregev@broadinstitute.org