# Neriman Tokcan- Detailed CV


## Contact Information

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University of Massachusetts Boston

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## Research Interests

My research focuses on formulating novel, 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, and computational biology. I explore various applications in data science, bioinformatics, and cancer genomics.

My primary focus centers on modeling the tumor microenvironment of Classical Hodgkin's lymphoma utilizing spatial and single-cell RNA-sequencing data. The objective is to gain a deeper understanding of the intricate interactions within the tumor microenvironment and to identify key pathways that play a crucial role in the disease. By pinpointing potential targets for immuno-therapy, the goal is to develop more effective and targeted treatments for Classical Hodgkin's lymphoma. This project is a collaborative effort between UMass Boston, Broad Institute of MIT and Harvard, Massachusetts General Hospital, and Dana-Farber Cancer Institute.

## Appointments

**University of Massachusetts Boston** 01/2023 - present

Assistant Professor of Applied Mathematics

**Broad Institute of MIT and Harvard**, Cambridge MA 09/2019 - 01/2023

Supervisors: Caroline Uhler, Todd Golub, Aviv Regev
Research focus: Deep learning methods for spatially resolved transcriptome analysis; high-dimensional tensor frameworks to model tumor microenvironments.

Eric and Wendy Schmidt Center Postdoctoral Fellow, 09/2021 - 01/2023
https://www.broadinstitute.org/ewsc

Computational Postdoctoral Associate

- Golub Lab, 09/2020 - 01/2023
  https://golublab.broadinstitute.org/
- Regev Lab, 09/2019 - 08/2021
  https://www.broadinstitute.org/regev-lab

**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** 08/2017 - 09/2019

Supervisors: Harm Derksen, Kayvan Najarian
Research focus: Algebraic tools for multimodal data analysis; clinical decision support platforms to

predict complications and recovery trends for patients following cardiac surgery.

- Postdoctoral Assistant Professor of Mathematics
- Postdoctoral Researcher at the Biomedical and Clinical Informatics Lab, Department of Computational Medicine and Bioinfomatics
  `https://najarianlab.ccmb.med.umich.edu/`

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## Education

**University of Illinois at Urbana-Champaign (UIUC)**, Urbana IL 08/2017

Ph.D. in Mathematics

Advisor: Bruce Reznick

Research focus: decomposition of homogeneous polynomials, algebraic geometry tools for symmetric tensor decomposition, Newton polytopes in algebraic combinatorics

Dissertation Title: *"Relative Waring Rank of Binary Forms"*

**University of Illinois at Urbana-Champaign (UIUC)**, Urbana IL 08/2012

M.S. in Mathematics

**Cukurova University,** Adana Turkey 06/2009

B.S. in Mathematics

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## Peer Reviewed Conference and Journal Papers

### In Submission

1. Daniel Chafamo, Vignesh Shanmugam, Neriman Tokcan, *Robust Bayesian Tensor Factorization with Zero-Inflated Poisson Model and Consensus Aggregation*, under submission (2023).
2. Vignesh Shanmugam, Neriman Tokcan, Daniel Chafamo, Sean Sullivan, Mehdi Borji, Naeem Nadaf, Irving Barrera, Dylan Cable, Jackson Weir, Abner Louissaint Jr., Scott Rodig, Margaret Shipp, Fei Chen, Todd Golub, *Genome-scale high-resolution spatial mapping of Hodgkin lymphoma reveals microenvironmental dependencies*, under submission (2023).

### Published

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

SIAM Travel Award, SIAM Conference on Applied Algebraic Geometry (AG23), 07/2023

SIAM Early Career Travel Award, SIAM Conference on Optimization (OP23), 06/2023

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 (AG21), 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

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## Invited Talks and Posters

### Invited Talks

ICERM workshop on "Connecting Higher-Order Statistics and Symmetric Tensors"
Brown University, 01/2024
Talk title: TBA

Tensor Methods and Emerging Applications to the Physical and Data Sciences
Core Participant Reunion Conference UCLA, 12/2023
Talk title: TBA

Workshop on "Algebraic Statistics for Ecological and Biological Systems"
The Institute for Mathematical and Statistical Innovation, University of Chicago, 10/2023
Talk title: TBA

Workshop on "Algebraic Statistics and Our Changing World: New Methods for New Challenges"
The Institute for Mathematical and Statistical Innovation, University of Chicago, 09/2023
**Talk title**: Multimodal Methods for Cancer Genomic Data

10th International Congress on Industrial and Applied Mathematics (ICIAM)
Tokyo, Japan, 08/2023
Talk title: *A probabilistic nonnegative tensor factorization for tumor microenvironment analysis*

SIAM Conference on Applied Algebraic Geometry (AG23)
Eindhoven, Netherlands, 07/2023
Talk title: *Cancer Classification and Pathway Discovery Using Non-Negative Tensor Factorization*

SIAM Conference on Optimization (OP23)
Seattle, 06/2023
Talk title: *A Non-Negative Probabilistic Tensor Decomposition and Applications in Cancer Genomics*

The 36th New England Statistics Symposium (NESS 2023)
Boston University, 05/2023
Talk title:*Non-negative tensor factorization methods and applications*

NSF-Simons Center for Quantitative Biology Seminar
Harvard University & Harvard Medical School, 05/2023
Talk title: *Cancer Classification and Pathway Discovery Using Non-Negative Tensor Factorization*

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

AGATES Workshop on "Algebraic Geometry with Applications to Tensors and Secants"
Poland, Warsaw, 11/2022
Talk title: *Non-negative tensor decompositions and applications in cancer genomics*

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*

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

Mini-workshop on Algebraic Statistics, Harvard Statistics Department
Boston, 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 Mathematics 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*

Cancer Program Seminar
Broad Institute of MIT and Harvard, 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 (AG21)
online, 08/2021
Talk title: *Algebraic Methods for Tensor Data*

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

Teaching and Diversity Seminar
University of Illinois at Urbana-Champaign, 03/2021
Panel title: *Life After UIUC*

Cancer Data Science Platform Seminar
Broad Institute of MIT and Harvard, 01/2021
Talk title: *Tensor Methods for Cancer Genomics Data*

Precision Health Symposium
University of Michigan Ann Arbor, 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, 03/2019
Talk title: *Tensor amplification and applications in multi-dimensional data analysis*

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

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

Biomedical and Clinical Informatics Lab Seminar
University of Michigan Ann Arbor , 05/2018
Talk title: *Tensors for Data Analysis*

Combinatorics Seminar
University of Michigan Ann Arbor, 04/2018
Talk title : *Newton Polytopes in Algebraic Combinatorics*

UMICH Biomedical and Clinical Informatics Lab Seminar
University of Michigan Ann Arbor, 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 2017
Atlanta, 01/2017
Talk title: *Relative Ranks of Binary Forms*

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

Women in Mathematics Seminar
University of Illinois at Urbana-Champaign, 05/2015
Talk title: *Length of Binary Forms*

## Posters

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

MIT-Mass General Brigham (MGB) AI Cures Conference
Boston, 04/2022
Poster title: *Tensor based framework for the analysis of tumor microenvironment*

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*

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

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## 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

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## Teaching Experience

**Instructor, UMass Boston**
Math 345, Probability and Statistics — Spring 2023
Classic lecture format, 25 students

**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

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## 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

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## Services

Co-organizer and chair for special sessions
SIAM Conference on Applied Algebraic Geometry
Eindhoven, Netherlands, 07/2023
Session titles: *Tensors in Applications I-IV*

Program committee member
36th New The 36th New England Statistics Symposium (NESS 2023)
Boston, 05/2023

Organizer and chair for the Invited Sessions
The 36th New England Statistics Symposium (NESS 2023)
Boston, 05/2023

Session titles: *Tensor Methods in High-dimensional Statistics* &
*Tensor Methods for Modern Data Science*

Special Session co-organizer
2023 Joint Mathematics Meetings
Boston, 01/2023
Session title: *Applications of Tensors in Computer Science*

Minisymposium co-organizer and chair
SIAM Conference on Mathematics of Data Science
San Diego, 09/2022
Minisymposium title: *Multilinear Algebra and Tensors for Data Science*

Co-organiser of a new international consortium:
AlToGeLiS: Algebra, Topology, Geometry, and the Life Sciences

Journal Reviewer, 2020-present
iScience: Cell Press
Linear and Multilienar 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