Ali Mohammad Nezhad

Assistant Professor
Department of Statistics and Operations Research
University of North Carolina at Chapel Hill
Hanes 338, 318 Hanes Hall
Chapel Hill, NC 27599
alimn@unc.edu
https://alimn.stor.unc.edu/index.html

EDUCATION

Lehigh University — Bethlehem, PA
Ph.D. Industrial and Systems Engineering — Sept. 2013 - Aug. 2018
Dissertation: *Conic Optimization: Optimal Partition, Parametric, and Stability Analysis*
Academic advisor: *Tamás Terlaky*

Sharif University of Technology — Tehran, Iran
M.S.c Industrial Engineering — Sept. 2008 - Jan. 2011
Dissertation: *Two simulation optimization based artificial neural networks algorithms for constrained simulation optimization problems with stochastic constraints*
Academic advisor: *Hashem Mahlooji*

Golpayegan College of Engineering — Golpayegan, Iran
B.S.c Industrial Engineering — Sept. 2004 - Sept. 2008

PROFESSIONAL EXPERIENCE

University of North Carolina at Chapel Hill — Chapel Hill, NC
Assistant Professor, Department of Statistics and Operations Research — July 2023 - Present

Carnegie Mellon University — Pittsburgh, PA
Postdoctoral Research Associate, Department of Mathematical Sciences
Also affiliated with Hoskinson Center for Formal Mathematics — May 2022 - June 2023
Mentor: *Jeremy Avigad*

Purdue University — West Lafayette, IN
Golomb Visiting Assistant Professor, Department of Mathematics — Aug. 2019 - May 2022
Mentor: *Saugata Basu*

Lehigh University — Bethlehem, PA
Visiting Scholar, Department of Industrial and Systems Engineering — Jan. 2019 - Aug. 2019
Mentor: *Tamás Terlaky*

Purdue University — West Lafayette, IN
Postdoctoral Research Assistant, School of Industrial Engineering — Oct. 2018 - Jan. 2019

SAS Institute — Cary, NC
Operations Research Fellow, Optimization and Machine Learning group — Jun. 2017 - Aug. 2017

SAS Institute — Cary, NC
Operations Research Intern, Optimization and Machine Learning group — Jun. 2016 - Aug. 2016

RESEARCH INTERESTS

Continuous Optimization and Applications, Semidefinite and Polynomial Optimization, Computational Complexity, Applications of Algebraic Geometry and Algebraic Topology in Optimization and Machine Learning, Topological Data Analysis

HONORS AND AWARDS

- Van Hoesen Family Best Publication Award (Honorable mention), Industrial and Systems Engineering, Lehigh University — Apr. 2016
- Ranked 16st in the Nationwide Graduate Admission Test — May 2008
- Ranked 1st based on GPA, Golpayegan College of Engineering — Jun. 2008

BIBLIOGRAPHY AND SCHOLARSHIP

In Preperation

1. Basu S., **Mohammad-Nezhad A.** On the extension of Morse inequalities to semi-algebraic optimization
2. Basu S., Frick F., **Mohammad-Nezhad A.** On learning critical points in semi-algebraic optimization

Preprints (Under Review)

1. Basu S., **Mohammad-Nezhad A.** On the complexity of analyticity in semi-definite optimization. Submitted to Advances in Applied Mathematics (2023) (30 pages)
2. Basu S., **Mohammad-Nezhad A.** Improved effective Łojasiewicz inequality and applications. Submitted to the Forum of Mathematics, Sigma (2022) (29 pages)

Refereed Published Papers

1. Basu S., **Mohammad-Nezhad A.** On the central path of semidefinite optimization: Degree and worst-case convergence rate. SIAM Journal on Applied Algebra and Geometry (2022) 6:299-318 (20 pages)
2. Hauenstein J., **Mohammad-Nezhad A.**, Tang T., Terlaky T. On computing the nonlinearity interval in parametric semidefinite optimization. Mathematics of Operations Research (2022) (22 pages)
3. **Mohammad-Nezhad A.**, Terlaky T. On the sensitivity of the optimal partition for parametric second-order conic optimization. Mathematical Programming B (2021) 189:491-525 (35 pages)
4. He S., Hwang J., Martins J., Shahabsafa M., **Mohammad-Nezhad A.**, Lei W., Zuluaga L., Terlaky T. Mixed-integer Second-order Cone Optimization for Composite Discrete Ply-angle and Thickness Topology Optimization Problems. Optimization and Engineering (2021) 22:1589-1624 (36 pages)
5. **Mohammad-Nezhad A.**, Terlaky T. Parametric analysis of semidefinite optimization. Optimization (2020) 69:187-216 (30 pages)
6. **Mohammad-Nezhad A.**, Terlaky T. Quadratic convergence to the optimal solution of second-order conic optimization without strict complementarity. Optimization Methods and Software (2019) 34(5):960-990 (31 pages)

7. **Mohammad-Nezhad A.**, Terlaky T. On the identification of optimal partition for semidefinite optimization. INFOR: Information Systems and Operational Research (2019) 58:225-263 (39 pages)
8. **Mohammad-Nezhad A.**, Terlaky T. A rounding procedure for semidefinite optimization. Operations Research Letters (2019) 47:59-65 (7 pages)
9. Shahabsafa M., **Mohammad-Nezhad A.**, Terlaky T., Zuluaga L., He S., Hwang J., Martins J. A novel approach to discrete truss design problems using mixed integer neighborhood search. Structural and Multidisciplinary Optimization (2018) 58:2411-2429 (19 pages)
10. **Mohammad-Nezhad A.**, Terlaky T. A polynomial primal-dual affine scaling algorithm for symmetric conic optimization. Computational Optimization and Applications (2017) 66:577-600 (24 pages)
11. **Mohammad Nezhad A.**, Mahlooji H. An artificial neural network meta-model for constrained simulation optimization. Journal of the Operational Research Society (2014) 65:1232-1244 (13 pages)
12. **Mohammad Nezhad A.**, Manzour H, Salhi S. Lagrangian relaxation heuristics for the uncapacitated single-source multi-product facility location problem. International Journal of Production Economics (2013) 145:714-724 (11 pages)
13. **Mohammad Nezhad A.**, Aliakbari Shandiz R, Eshraghniaye Jahromi A H. A particle swarm-BFGS algorithm for nonlinear programming problems. Computers and Operations Research (2013) 40:963-972 (10 pages)
14. **Mohammad Nezhad A.**, Mahlooji H. A revised particle swarm optimization based discrete Lagrange multipliers method for nonlinear programming problems. Computers and Operations Research (2011) 38:1164-1174 (11 pages)

TALKS

Invited Talks

- Improved Effective Lojasiewicz inequality and applications, Jul. 2023, in Minisymposium on Computational Real Algebraic Geometry, Upcoming SIAM Conference on Applied Algebra and Geometry, Eindhoven University of Technology, Netherlands (Virtual)
- On the complexity of semidefinite and polynomial optimization: A real algebraic geometry approach, Feb. 2023, Department of Mathematics and Statistics, University of Maryland at Baltimore County
- On the complexity of semidefinite and polynomial optimization: A real algebraic geometry approach, Feb. 2023, Department of Industrial and Systems Engineering, Virginia Tech
- On the complexity of semidefinite and polynomial optimization: A real algebraic geometry approach, Jan. 2023, Department of Statistics and Operations Research, University of North Carolina at Chapel Hill
- On effective improved Lojasiewicz inequality, Jan. 2023, in Special Session on Polynomial systems, homotopy continuation, and applications, Joint Mathematics Meetings, Boston MA

- On the analytic reparametrization of the central path of semidefinite optimization, Mar. 2022, in Special Session on Computational and Applied Algebraic Geometry, AMS Spring Central Sectional Meeting, Purdue University (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Oct. 2021, Informs Annual Meeting (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Aug. 2021, SIAM Conference on Applied Algebraic Geometry (Virtual)
- Nonlinearity Intervals in Parametric Semidefinite Optimization, Jul. 2021, SIAM Conference on Optimization (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Jul. 2021, SIAM Conference on Optimization (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Apr. 2021, Guest Lecturer for the course "Real Algebraic Geometry", Department of Mathematics, Purdue University (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Nov. 2020, Informs Annual Meeting (Virtual)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, May 2020, Spring Western Sectional Meeting 2020, California State University Fresno (Cancelled due to COVID-19)
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Jan. 2020, Mini Real Algebraic Geometry Conference, Department of Mathematics, Purdue University
- On the identification of optimal partition and optimal solutions for semidefinite optimization, Aug. 2017, MOPTA, Lehigh University
- Numerical issues of the interior point methods, Dec. 2016, Guest Lecturer for the course "Computational methods of Optimization", Department of Industrial and Systems Engineering, Lehigh University
- A rounding procedure for second-order conic optimization, Aug. 2016, MOPTA, Lehigh University
- A rounding procedure for a maximally complementary solution of SDP, Nov. 2015, Informs Annual Meeting, Philadelphia PA

Contributed Talks

- Improved Effective Lojasiewicz inequality and applications, Jun. 2023, in Minisymposium on Algebro-geometric Aspects of Optimization, SIAM Conference on Optimization, Seattle WA
- Applications of Real Algebraic Geometry in Optimization, Oct. 2022, in Algebraic Methods in Semidefinite and Polynomial Optimization, Informs Annual Meeting, Indianapolis IN
- On the complexity of analyticity, a real algebraic geometry approach, Jul. 2022, ICCOPT 2022, Lehigh University
- On the Complexity of Analyticity, the central path of semidefinite optimization, Poster Session, Jun. 2022, Combinatorial, Computational, and Applied Algebraic Geometry, University of Washington, Seattle WA

- On the Complexity of Analyticity, the central path of semidefinite optimization, Poster Session, May 2022, Algebraic Statistics 2022, University of Hawai'i at Manoa, Honolulu HI
- Semidefinite optimization through the lens of real algebraic geometry, Apr. 2022, Bridge to Research Talk, Department of Mathematics, Purdue University
- On the analytic reparametrization of the central path of semidefinite optimization, Apr. 2022, in AMS Contributed Paper Session on Computer Science, Artificial Intelligence and Operations, Joint Mathematics Meetings 2022 (Virtual)
- On the analytic reparametrization of the central path of semidefinite optimization, Mar. 2022, Informs Optimization Society, Greenville SC
- On the central path of semidefinite optimization: Degree and worst-case convergence rate, Jun. 2021, Workshop on Real Algebraic Geometry and Algorithms for Geometric Constraint Systems, The Fields Institute (Virtual)
- Parametric analysis of linear conic optimization, Nov. 2018, Informs Annual Meeting, Phoenix AZ
- Parametric second-order and semidefinite optimization, Poster session, Oct. 2018, ICERM, Providence RI
- Parametric analysis of semidefinite and second-order cone optimization, Mar. 2018, Informs Optimization Society Conference, University of Colorado Denver
- Parametric second-order cone optimization, Oct. 2017, COR@L seminar, Lehigh University
- Parametric second-order cone optimization, Oct. 2017, Informs Annual Meeting, Houston TX
- Quadratic convergence of Newton's method to the optimal solution of second-order cone optimization, Oct. 2017, Informs Annual Meeting, Houston TX
- On the identification of optimal partition for second-order optimization, Poster session, May 2017, NemFest 2017, Atlanta GA
- On the identification of optimal partition for semidefinite optimization, Poster session, Nov. 2016, Informs Annual Meeting, Nashville TN
- Rounding procedures for a maximally complementary solution of second-order conic optimization, Nov. 2016, Informs Annual Meeting, Nashville TN
- Rounding procedures for a maximally complementary solution of second-order conic optimization, Sept. 2016, COR@L seminar, Lehigh University
- On the identification of optimal partition for semidefinite optimization, Mar. 2016, Informs Optimization Society Conference, Princeton University
- A rounding procedure for a maximally complementary solution of SDP, Nov. 2015, COR@L seminar, Lehigh University
- A polynomial primal-dual affine scaling algorithm for symmetric conic optimization, Jul. 2015, ISMP 2015, Pittsburgh PA
- A polynomial primal-dual affine scaling algorithm for symmetric conic optimization, Oct. 2014, COR@L seminar, Lehigh University

- Incorporating clique inequalities into a Lagrangian relaxation framework for a facility location problem, Nov. 2013, COR@L seminar, Lehigh University

CONFERENCES AND WORKSHOPS

- SIAM Conference on Applied Algebra and Geometry, Jul 10 - 14, 2023, Eindhoven University of Technology, Netherlands
- SIAM Conference on Optimization, May 31 - June 03, 2023, Seattle WA
- Joint Mathematics Meetings, Jan. 4-7, 2023, Boston MA
- Informs Annual Meeting, Oct. 16-19, 2022, Indianapolis IN
- International Conference On Continuous Optimization, Jul. 25-28, 2022, Lehigh University
- Combinatorial, Computational, and Applied Algebraic Geometry, Jun. 27 - Jul. 01, University of Washington Seattle WA
- Algebraic Statistics 2022, May 16-20, 2022, University of Hawai'i at Manoa, Honolulu HI
- Joint Mathematics Meetings, Apr. 6-9, 2022 (Virtual)
- Informs Optimization Society Conference, Mar. 13-15, 2022, Greenville SC
- AMS Spring Central Sectional Meeting, Mar. 26-27, 2022 (Virtual)
- Informs Annual Meeting, Oct. 24-27, 2021 (Virtual)
- SIAM Conference on Applied Algebraic Geometry, Aug. 16-20, 2021 (Virtual)
- SIAM Conference on Optimization, Jul. 20-23, 2021 (Virtual)
- Real Algebraic and Convex Geometry workshop, Jul. 29-30, 2021 (Virtual)
- Workshop on Real Algebraic Geometry and Algorithms for Geometric Constraint Systems, Jun. 14-18, 2021, The Fields Institute (Virtual)
- MEGA 2021, Jun. 7-11, 2021 (Virtual)
- Workshop on Distance Geometry, Semidefinite Programming and Applications, May 10-14, 2021, The Fields Institute (Virtual)
- AMS Spring Southeastern Sectional Meeting, Mar. 13-14, 2021 (Virtual)
- Joint Mathematics Meetings, Jan. 6-9, 2021 (Virtual)
- Informs Annual Meeting, Nov. 7-13, 2020 (Virtual)
- Workshop on Symmetry, Randomness, and Computations in Real Algebraic Geometry, Aug. 24-28, 2020, ICERM (Virtual)
- DIMACS Workshop on Polynomial Optimization, May 27-29, 2020 (Cancelled due to COVID-19)
- AMS Spring Central Sectional Meeting, Apr. 4-5, 2020, Purdue University (Cancelled due to COVID-19)

- Mini Real Algebraic Geometry Conference, Jan. 24, 2020, Department of Mathematics, Purdue University
- Workshop on Hyperbolic Polynomials and Hyperbolic Programming, Apr. 30 - May 3, Simons Institute, Berkeley CA
- AMS Short Course on Sum of Squares, Jan. 14-15, 2019, Baltimore MD
- Informs Annual Meeting, Nov. 4-7, 2018, Phoenix AZ
- Workshop on Optimization and Real Algebraic Geometry, Oct. 15-19, ICERM, Providence RI
- MOPTA 2018, Aug. 13-15, 2018, Lehigh University
- Summer School on Hyperbolic Polynomials, Sums of Squares and Optimization, Jun. 25-29, 2018, Georgia Institute of Technology
- Informs Optimization Society Conference, Mar. 23-25, 2018, University of Colorado Denver
- Informs Annual Meeting, Oct. 22-25, 2017, Houston TX
- MOPTA 2017, Aug. 16-18, 2017, Lehigh University
- NemFest 2017 (A celebration of Professors George Nemhauser and Arkadi Nemirovski), May 11-12, 2017, Atlanta GA
- Informs Annual Meeting, Nov. 13-16, 2016, Nashville TN
- MOPTA 2016, Aug. 17-19, 2016, Lehigh University
- Informs Optimization Society Conference, Mar. 17-19, 2016, Princeton University
- Informs Annual Meeting, Nov. 1-4, 2015, Philadelphia PA
- MOPTA 2015, Jul. 20-22, 2015, Lehigh University
- 22nd International Symposium on Mathematical Programming (ISMP), Jul. 12-17, 2015, Pittsburgh PA
- MOPTA 2014, Aug. 13-15, 2014, Lehigh University

MENTORING

Graduate

- PhD Committee member — Spring 2022 - Present
  - Pouya Sampourmahani (PhD Student), Industrial and Systems Engineering Department, Lehigh University

Undergraduate

- Undergraduate Program (SUAMI), Carnegie Mellon University — Summer 2022
  Project: *Simulation Optimization in Emerald Cloud Lab*
  - Janiece Jackson (Undergraduate Student), Department of Biological Sciences, Clemson University

– Layla Montemayor (Undergraduate Student), Department of Mathematics, University of Nebraska Lincoln

TEACHING EXPERIENCE

Teacher Development Certificate Level 1, Lehigh University — Feb. 2018

Instructor

- **University of North Carolina at Chapel Hill**
  - Discrete Mathematics for Data Science (STOR 315) — Fall 2023
- **Carnegie Mellon University**
  - Matrix Algebra with Applications (21-240) — Fall 2022
- **Purdue University**
  - Linear Algebra (MA265) — Spring 2022
  - Differential Equations and Partial Differential Equations for Engineering and the Sciences (MA303) — Fall 2021
  - Linear Algebra (MA265) — Spring 2021
  - Linear Algebra (MA265) — Fall 2020
  - Ordinary Differential Equations (MA266) — Summer 2020
  - Ordinary Differential Equations (MA266) — Spring 2020
  - Ordinary Differential Equations (MA266) — Fall 2019

Teaching Assistant

- **Lehigh University**
  - Optimization Methods and Software — Spring 2016
  - Stochastic Models and Applications — Spring 2015
  - Optimization Models and Applications — Fall 2014
  - Engineering Economics — Spring 2014
  - Game Theory — Fall 2013
  - Design of Experiments — Fall 2013
- **Sharif University, Iran**
  - Reliability Engineering — Spring 2010
- **University of Science and Culture, Iran**
  - Mathematical Optimization — Spring 2009
  - Linear Optimization — Fall 2008
- **Golpayegan College of Engineering, Iran**
  - Linear Optimization — Spring 2008

- Linear Optimization Spring 2007
- Multivariate Calculus Spring 2006

GRANTS

- Collaborative NSF CCF-2128702 (former PI and current co-PI, due to moving to CMU): On the Complexity of Semidefinite and Polynomial Optimization through the Lens of Real Algebraic Geometry (Effort = 75%). With Saugata Basu and Tamás Terlaky ($500,000) 2021 - 2024
- Travel grant for the SIAM Conference on Applied Algebraic Geometry, Eindhoven University of Technology, Netherlands Jul. 2023
- Travel grant for the Workshop on Real Number Complexity, Foundations of Computational Mathematics (FoCM) 2023, Paris, France Jun. 2023
- Travel grant for the workshop on Hyperbolic Polynomials and Hyperbolic Programming, Simons Institute, Berkeley CA Apr. 2019
- Travel grant for the workshop on Optimization and Real Algebraic Geometry, ICERM, Providence RI Oct. 2018
- Rossin Doctoral Fellowship, College of Engineering, Lehigh University Apr. 2016
- Deans Doctoral Assistantship, Lehigh University Sept. 2013

PROFESSIONAL SERVICES

Seminars and Conferences

- Organizer of the Optimization, Algebra, and Geometry seminar, Department of Mathematical Sciences, Carnegie Mellon University . . . . . 2022 - 2023
- Organizer of the Optimization and Real Algebraic Geometry seminar, Department of Mathematics, Purdue University . . . . . Spring 2022
- Organizer of "Topological and Algebraic Approaches for Optimization", Upcoming Joint Mathematics Meetings 2024, Seattle WA
- Organizer of "Algebro-geometric Aspects of Optimization", SIAM Conference on Optimization 2023, Seattle WA
- Organizer of "Complexity and Topology in Computational Algebraic Geometry", Joint Mathematics Meetings 2023, Boston MA
- Organizer of "Algebraic Methods in Polynomial and Semidefinite Optimization", Informs Annual Meeting 2022, Indianapolis IN
- Co-organizer (with Saugata Basu) of "Optimization, Complexity, and Real Algebraic Geometry", AMS Spring Central Sectional Meeting 2022 (Virtual)
- Co-organizer (with Saugata Basu) of "Algebraic Methods of Optimization", SIAM Conference on Applied Algebraic Geometry 2021 (Virtual)

- Organizer of "Recent Advances in Conic Optimization", SIAM Conference on Optimization 2021 (Virtual)
- Co-organizer (with Saugata Basu) of "Optimization and Real Algebraic Geometry", AMS Spring Southeastern Sectional Meeting 2021 (Virtual)
- Co-organizer (with Saugata Basu) of "Optimization and Algebraic Geometry", Joint Mathematics Meetings 2021 (Virtual)
- Co-organizer (with Jonathan Hauenstein) of "Optimization and Algebraic Geometry", AMS Spring Central Sectional Meeting 2020, Purdue University (Cancelled due to COVID-19)
- Organizer of "Perturbation Analysis of Conic Optimization", Informs Annual Meeting 2018, Phoenix AZ
- Organizer of "Conic Optimization and Integer Programming", MOPTA 2018, Lehigh University
- Organizer of "Conic Optimization", MOPTA 2017, Lehigh University
- Organizer of "Dynamic Optimization", MOPTA 2016, Lehigh University
- Organizer of "Convex and Conic Relaxations for Intractable Optimization Problems", MOPTA 2016, Lehigh University
- Organizer of "Conic optimization", MOPTA 2016, Lehigh University
- Organizer of "Polynomial Optimization and Interior Point Methods", MOPTA 2016, Lehigh University

Review Services . . . . . 2014 - Present

- Reviewer for Mathematics of Operations Research, Journal of Symbolic Computation, Mathematical Programming, Mathematical Programming Computation, SIAM Journal on Optimization, Journal of Optimization Theory and Applications, Computational Optimization and Applications, Optimization, Operations Research Letters, Optimization Letters, Optimization Methods and Software, Numerical Optimization

Membership

- Member of AMS, SIAM, MOS, and INFORMS societies . . . . . 2016 - Present

COMPUTER SKILLS

COR@L server administrator, Lehigh University . . . . . 2015 - 2018

Operating Systems

- Unix/Linux (Debian, Ubuntu, Arch Linux)

Version control systems

- Git

Programming Languages

- C/C++, Python, Cuda-GPU Computing, CPU-parallel Computing (OpenMP, MPI), MATLAB, Maple

Math Solvers

- Macaulay2, Gurobi, MOSEK, CPLEX, SeDuMi, SDPT3, SOS, CSDP, Ipopt

Linear Algebra

- CuBLAS, Intel Math Kernel Library

Mathematical Modeling

- GAMS, CVX, LINGO, AMPL