

# Caroline J. Klivans

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## Research Interests

Algebraic, Geometric, and Topological Combinatorics: simplicial complexes, matroids, hyperplane arrangements, polytopes, combinatorial Laplacians, quasisymmetric functions, chip-firing models.

## Appointments

Professor, Brown University  
Division of Applied Mathematics (2024 – )

Deputy Director, ICERM  
Institute for Computational and Experimental Research in Mathematics (2020 – present)

Affiliated Faculty, BTPC  
Brown Theoretical Physics Center (2020 – present)

## Education

Ph.D. Massachusetts Institute of Technology (2003)  
Applied Mathematics Department, Advisor: Richard Stanley  
Thesis: Combinatorial Properties of Shifted Complexes

B.A. Cornell University (1999)  
Mathematics Department, Advisor: Louis Billera

## Previous Appointments

Associate Professor, Brown University  
Division of Applied Mathematics (2018 – 2024)

Associate Director, ICERM  
Institute for Computational and Experimental Research in Mathematics (2015 – 2020)

Research Member, MSRI  
Semester program: Geometric and Topological Combinatorics (Fall 2017)

Visitor, ICERM  
Semester program: Topology in Motion (Fall 2016)

Adjunct Professor, Lecturer, Senior Lecturer Brown University  
Division of Applied Mathematics and Department of Computer Science  
(2011 – 2015, 2015 – 2016, 2016 – 2018)

Research Scholar and Senior Lecturer, The University of Chicago  
Departments of Mathematics and Computer Science (2008 – 2011)

Visiting Scholar of Mathematics, Cornell University (2009 – 2010)

L.E. Dickson Instructor and VIGRE postdoctoral fellow, The University of Chicago  
Departments of Mathematics and Computer Science (2004 – 2008)

Instructor, Cornell University  
Computing and Information Science (Spring 2004)

Postdoctoral Fellow, MSRI  
Special semester in Discrete and Computational Geometry (Fall 2003)

## Publications

### Submitted

S. Brauner, G. Doepalen-Barry, S. Kara, C. Klivans, L. Schneider. A Three-Regime Theorem for Flow-Firing.

*Submitted for Journal Publication.* <https://arxiv.org/abs/2303.02526>

C. Klivans, P. Liscio. Move and Configuration Posets.

*Submitted for Journal Publication.* <https://arxiv.org/abs/2202.02821>

M. Calkins, S.J. Gates, C. Klivans. Supersymmetry and representation theory in low dimensions.

*In revision for Notices of the American Mathematical Society.* <https://arxiv.org/pdf/2012.09211>

### Published

Y. Baryshnikov, C. Klivans, N. Kosar, On the topology of no  $k$ -equal spaces.

*Advances in Applied Mathematics* 2023

<https://arxiv.org/abs/1708.00032>

K. Iga, C. Klivans, J. Kostiuk and C. Yuen. Eigenvalues and Critical Groups of Adinkras.

*Advances in Applied Mathematics* vol. 143, 2023.

<https://arxiv.org/abs/2202.02821>

C. Klivans and N. Saldanha, Domino tilings and flips in dimensions 4 and higher.

*Algebraic Combinatorics* vol. 5, no. 1, 2022

<https://arxiv.org/abs/2007.08474>

P. Felzenszwalb, C. Klivans, A. Paul, Clustering with semidefinite programming and fixed point iteration.

*Journal of Machine Learning Research* 23 (190) 2022.

<https://arxiv.org/pdf/2012.09202>

C. Klivans and P. Liscio, Confluence in labeled chip-firing.

*Journal of Combinatorial Theory Series A* vol. 186 2022.

*Extended abstract appeared at FPSAC 2020.*

J. Freire, C. Klivans, P. Milet, N. Saldanha, On the connectivity of three dimensional tilings.

*Transactions of the American Mathematical Society*, 2021.

P. Felzenszwalb, C. Klivans, A. Paul. Iterated linear optimization.

*Quarterly of Applied Mathematics*, 2021.

P. Felzenszwalb and C. Klivans, Flow-firing processes.

*Journal of Combinatorial Theory A*, vol. 177, 2021.

Book: C. Klivans, The Mathematics of Chip-firing,

*Publisher: CRC Press.* 2019.

G. Benkart, C. Klivans, V. Reiner, Chip firing on Dynkin diagrams and McKay quivers.

*Mathematische Zeitschrift*, 290, 2018.

A. Duval, C. Klivans and J. Martin, The Partitionability Conjecture.

*The Notices of the American Mathematical Society*, 64(2), 2017.

O. Bernardi and C. Klivans, Directed rooted simplicial forests.

*The Electronic Journal of Combinatorics*, 23(4), 2016.

- J. Guzman, C. Klivans, Chip-firing on general invertible matrices.  
*SIAM Journal on Discrete Mathematics*, 30(2), 2016.
- A. Duval, B. Goeckner, C. Klivans, J. Martin, A non-partitionable Cohen-Macaulay simplicial complex.  
*Advances in Mathematics*, Vol. 299, 2016.
- R. Ehrenborg, C. Klivans, and N. Reading, Coxeter arrangements in three dimensions.  
*Beitrage zur Algebra und Geometrie / Contributions to Algebra and Geometry*, 2016.
- F. Breuer, C. Klivans, Scheduling Problems.  
*Journal of Combinatorial Theory, Series A* Vol. 139, 2016.
- A. Duval, C. Klivans, and J. Martin, Simplicial and Cellular Trees.  
IMA Volume Book Chapter in *Recent Trends in Combinatorics*, 2015.
- J. Guzman, C. Klivans, Chip-firing and energy minimization on M-matrices.  
*Journal of Combinatorial Theory, Series A*, vol. 132, 2015.
- J. Steenbergen, C. Klivans, and S. Mukherjee, A Cheeger-Type Inequality on Simplicial Complexes.  
*Advances in Applied Mathematics* vol. 56, 2014.
- A. Duval, C. Klivans, and J. Martin, Cuts and flows of cell complexes.  
*Journal of Algebraic Combinatorics* 1-31, 2014.  
Extended abstract appeared in FPSAC (Formal Power Series and Algebraic Combinatorics) 2013.
- A. Duval, C. Klivans, and J. Martin, Critical groups for simplicial complexes.  
*Annals of Combinatorics* vol. 17, Issue 1, 2013.  
Extended abstract appeared in FPSAC (Formal Power Series and Algebraic Combinatorics) 2011.
- C. Klivans, E. Swartz, Projection volumes of hyperplane arrangements.  
*Discrete and Computational Geometry* vol. 46, No. 3, 2011.
- M. Drton, C. Klivans, A geometric interpretation for the coefficients of the characteristic polynomial of a reflection arrangement.  
*Proceedings of the American Mathematical Society*, vol. 138, 2010.
- A. Duval, C. Klivans, and J. Martin, Cellular spanning trees and Laplacians of cubical complexes.  
*Advances in Applied Mathematics, Special issue in tribute to Dennis Stanton*, vol. 46, 2011.
- R. Basri, P. Felzenszwalb, R. Girshick, D. Jacobs, and C. Klivans, Visibility Constraints on Features of 3D Objects.  
*IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* 2009.
- A. Duval, C. Klivans, and J. Martin, Simplicial spanning trees and generalized matrix-tree theorems.  
*Transactions of the American Mathematical Society*, vol. 361, 2009.
- C. Klivans, K. Nyman, and B. Tenner, Relations on generalized degree sequences.  
*Discrete Mathematics* vol. 30, Issue 13, 2009.
- C. Klivans, Shifted matroid complexes.  
*Preprint*.
- C. Klivans and V. Reiner, Shifted set families, degree sequences, and plethysm.  
*The Electronic Journal of Combinatorics*, vol. 15, no.1, 2008.
- C. Klivans, Threshold graphs, shifted Complexes, and graphical Complexes.  
*Discrete Mathematics*, vol. 307, no. 21, 2007.

F. Ardila, C. Klivans, and L. Williams, The positive Bergman complex of an oriented matroid.  
*European Journal of Combinatorics*, vol. 27, no. 4, 2006.

F. Ardila and C. Klivans, The Bergman complex of a matroid and phylogenetic trees.  
*Journal of Combinatorial Theory, Series B*, vol. 96, Issue 1, 2006.

Extended abstract appeared in FPSAC (Formal Power Series and Algebraic Combinatorics) 2004.

C. Klivans, Obstructions to shiftedness.  
*Discrete and Computational Geometry* vol. 33, no. 3, 2005.

C. Klivans, Combinatorial properties of shifted complexes.  
Ph.D. Thesis, MIT June 2003.

C. Klivans, Mobile robotics navigation.  
DIMACS Technical Report Summer 1998.

## Teaching

### **Brown University**

Operations Research APMA 1210, Fall 2020, 2021

Statistical Inference, APMA 1650, Fall 2011, 2012, 2013, 2014, 2015, 2019

Statistical Inference, APMA 1655, Fall 2015, 2016, 2018

Introduction to Discrete Structures and Probability, CS 22, Spring 2012 – 2019

Graph Theory (GISP), Fall 2015

Combinatorial Theory, APMA 2822C, Spring 2020, Fall 2022

### **The University of Chicago**

Abstract Algebra (Regular and honors sequences) Winter 2006, 2007, 2008, Spring 2008, 2011

Discrete Mathematics (Undergraduate and graduate versions) Autumn 2004, 2005, 2006, 2007, 2008

Mathematical Methods for the Physical Sciences Winter 2005

Combinatorics and Complexity in Game Theory (Topics in theoretical computer science) Spring 2005

Hyperplane Arrangements (REU program) Summer 2005

Graph Theory Spring 2011

### **Cornell University**

Information Modeling (School of computing and information sciences) Spring 2004

Discrete Structures (Department of Computer Science) Spring 2010

### **MIT (Teaching Assistant)**

Calculus Spring 2003

Principles of Discrete Applied Mathematics Autumn 2002

## Advising

### **PhD thesis advisor**

Yifan Guo (current, first year)

Ethan Partida (current)

Nicholas Arosemena (current)

Terresa Chambers (current)

Patrick Liscio (graduated 2022) Quantitative Researcher, Jane Street

Alexander McDonough (graduated 2021) Kresner Assistant Professor, UC Davis

### **Postdoctoral mentoring**

Sarah Brauner, Prager Assistant Professor and NSF postdoctoral fellow, 2024 –  
Andrew Vander Werf, RTG postdoctoral fellow, 2023 –  
Nidhi Kaihnsa, Prager Assistant Professor, 2020 – 2023.  
Chi Ho Yuen, Croucher postdoctoral fellow, 2019 – 2021.

### **Undergraduate research advisor - Brown University**

Cassie Ding, Tropical Geometry (2023-2024)  
Tracy Chin, A Computational Commutative Algebra Approach to Tilings (2019)  
Daniel Kunin, Visualizations for Statistics (Summer, Fall 2016)  
Harjasleen Malvai, Chip-firing (2014-2015), UTRA (Summer 2015)  
Alex St. Laurent, Simplicial Chip-firing (Summer 2012)

### **Masters thesis advisor**

Negar Mirsattari, Properties of Degree Sequences of  $k$ -Uniform Hypergraphs  
The University of Chicago, 2010.

### **Ph.D. thesis committee member**

Andres Santamaria-Galvis, On partitionability and shellability of relative simplicial complexes  
University of Primorska, Slovenia, 2022.  
Chi Ho Yuen, Geometric Bijections of Graphs and regular matroids  
Georgia Institute of Technology, 2018.  
Ningning Ma, Tropicalization of the dimer model and cluster integrable systems  
Brown University, 2015.  
Elliot Krop, Enumerating Matchings in Regular Graphs  
University of Illinois - Chicago, 2007.

### **Brown University Undergraduate Advising**

Concentration advisor, APMA, APMA-CS  
Sophomore advisor  
Freshman advisor

## **Professional Activities**

Organizer & co-founder, Brown Combinatorics Seminar  
2019 – present.

Executive Committee, Initiative to Maximize Student Development (IMSD)  
2022 – present.

Executive Committee, Association for Women in Mathematics (AWM)  
Spring 2022 – Spring 2026.

Inaugural Cohort, Faculty Leadership Program, Brown University  
2022 – 2023.

Campus Advisory Board, Data Science Initiative (DSI)  
Fall 2021 – Fall 2024.

Editorial Board, Algebraic Combinatorics (ALCO)  
2021 – present.

Scientific Program Committee, Encuentro Colombiano de Combinatoria (ECCO) 2024

Project Leader, Research Community in Algebraic Combinatorics, ICERM  
Fall 2021 – Spring 2022.

Member, StemJazz Network  
2020 – present.

Chair: American Mathematical Society (AMS) David P. Robbins Prize Committee.  
Appointed 2021, had to step down after one of my own papers was nominated.

Co-organizer: Special Session on Applied Combinatorics  
AMS Regional Meeting, Boston, MA, March 2020 (virtual)

Co-organizer: Special Session on Algebraic, Geometric and Topological Combinatorics  
AMS Regional Meeting, UT El Paso, September 2020 (virtual) and September 2022 (in-person)

Participant: MSRI African Diaspora Joint Mathematics Workshop 2019

Committee Member: AWM Policy and Advocacy Committee (2019 – 2022)

Co-organizer: Special Session on Chip-firing and Divisor Theory  
AMS Regional Meeting, Hartford, CT, April 2019

Program Co-Chair: Formal Power Series and Algebraic Combinatorics, FPSAC 2018

Co-organizer: Special Session on Chip-firing and Divisors on Graphs and Complexes  
AMS Regional Meeting, Minneapolis, MN, October 2016

Organizing Committee Member:  
Formal Power Series and Algebraic Combinatorics, FPSAC 2014  
Stanley@70: A Celebration of Combinatorics in honor of Richard Stanley 2014

Program Committee Member:  
Formal Power Series and Algebraic Combinatorics, FPSAC 2010 & 2014

AWM Selection Committee Member for the Alice T. Schafer Prize

Panelist and Participant for various women and URM in STEM events

Co-organizer: Special Session on Geometric Combinatorics  
AMS Regional Meeting, DePaul University, October 2007

Member of The Women in the Physical Sciences Dean's Committee  
University of Chicago (2005 – 2011)

Faculty Sponsor: AWM Student Chapter  
University of Chicago (2005 – 2011)

Organizer, Zeilberger Miniconference, MIT 2003

Reviewer for many mathematical journals and the National Science Foundation

## Awards and Honors

National Institute of Health (NIH) NIGMS grant 1T32GM144926-01A1, Initiative to Maximize Student Development (IMSD) Role: Committee member, Dates: February 1, 2023 – January 31, 2028, Award Amount: \$3,297,130.

National Science Foundation Research and Training Grant (NSF RTG Grant) Mathematics of Information, Data, and Applications to Science (MIDAS) Role: co-PI, Dates: September 1, 2021 – August 31, 2026, Award Amount: \$2,491,556.

Top Influential Mathematicians of 2010-2020, ranked #11, Academic Influence, 2020.

National Science Foundation Mathematics Institutes Award, Institute for Computational and Experimental Research in Mathematics (ICERM) Role: co-I, Dates: September 1, 2020 – August 31, 2025, Award Amount: \$23,532,919.

National Science Foundation (NSF) Conference Grant, Celebration of Combinatorics Stanley(at)70, Role: Co-PI, Dates: June 23-27 2014, Award Amount: \$25,000.

Brown University Brazil Initiative Grant, Collaborations in Applied Mathematics. Role: PI, Dates: November 2013 – November 2016, Award amount: \$19,576.

Association for Women in Mathematics, National Science Foundation (AWM-NSF) Travel Grant. Role: PI, Date: 2013, Award amount \$1,742.

Association for Women in Mathematics, National Science Foundation (AWM-NSF) Travel Grant. Role: PI, Date: 2009, Award amount \$1,010.

National Science Foundation VIGRE Postdoctoral Fellowship, 2004 – 2008.

National Science Foundation Graduate Fellowship, 1999 – 2002.

Alice T. Schafer AWM National Mathematics Prize, 1999.

Summer Research Assistant, DIMACS 1999  
(Center for Discrete Math and Theoretical Computer Science)  
Project: Mobile Robotics Navigation, Advisor: Sven Dickinson

REU Student, DIMACS 1998  
Advisors: Sven Dickinson and Diane Souvaine

President, Undergraduate Math Club, Cornell University (1997-1999);  
Rensselaer Medal Award 1995;  
Andrew's Leaper, Carnegie Mellon University 1994.

## Accepted Invited Talks

2024 BIRS workshop, Algebraic and Enumerative Combinatorics, Banff, Canada  
IPAM workshop, Statistical Mechanics Beyond 2D, UCLA, CA

2023 Matroids and Tropical Combinatorics, London, UK (series of 4 lectures)  
BIRS workshop, Algebraic aspects of matroid theory, Banff, Canada  
Triangle Lectures, Raleigh, NC (plenary speaker)  
EDGE Colloquium, Brown University

2022 Combinatorics Seminar, Michigan State University  
AMS Invited address, El Paso, Texas  
ECCO, Encuentro Colombiano de Combinatoria, Bogota, Colombia (series of 4 lectures)

2021 Research Communities in Algebraic Combinatorics, ICERM  
MPS Conference on High-Dimensional Expanders, Simons Foundation, NYC, NY

- 2020 Discrete Math Seminar, UMass, Amherst, MA **postponed**  
 Combinatorics Seminar, University of Miami, Miami FL  
 ECCO 2020, Bogota, Colombia **postponed** (plenary speaker)  
 AMS Invited address, El Paso, Texas **postponed**
- 2019 Dynamical Systems Seminar, PUC-Rio, Rio de Janeiro, Brazil  
 Colloquium, Math department, Providence College, Providence, RI  
 FPSAC 2019, Ljubljana, Slovenia (plenary speaker)  
 Combinatorics Seminar, MIT/Harvard, Cambridge, MA  
 JMM special session, Baltimore, MD
- 2018 Discrete Math Days of the Northeast, University of New England, Biddeford, ME  
 AMS Special Session Algebraic, Geometric, and Topological Methods in Combinatorics, Boston MA  
 Combinatorics Seminar, Brandeis, MA  
 CombinaTexas 2018, Texas A&M University, College Station, TX
- 2017 Colloquium, Math department, UC-Berkeley, Berkeley, CA  
 Combinatorics Seminar, UC-Davis, Davis, CA  
 Combinatorics Seminar, UC-Berkeley, Berkeley, CA  
 MSRI workshop, Geometric and topological combinatorics: Modern techniques, Berkeley, CA  
 Combinatorics Seminar, University of Washington, Seattle, WA  
 MSRI workshop, Connections for Women: Geometric and Topological Combinatorics, Berkeley, CA  
 Theoretical Biology Seminar, Penn State University, State College, PA  
 Discrete Geometry and Combinatorics Seminar, Cornell University, Ithaca, NY  
 Combinatorics & Geometry/Topology Seminar, Binghamton University, Binghamton, NY
- 2106 ICERM workshop, Stochastic Topology and Thermodynamic Limits, Providence, RI  
 Workshop and Special Session, Combinatorics, at the crossroads of Algebra, Geometry, and Topology, Northeastern University, Boston, MA  
 FPSAC 2016 (28th International Conference), Vancouver, BC  
 Combinatorial algebra meets algebraic combinatorics, University of Western Ontario, London, ON  
 Applied Algebra Seminar, York University, Toronto, ON
- 2015 CRM, Perspectives in Lie Theory, Combinatorics & Algebraic Topology of Configurations, Pisa, Italy  
 Discrete Math Seminar, Brown University / ICERM  
 AMS Special Session on Enumerative, Algebraic and Geometric Combinatorics, Chicago IL  
 Colloquium, Mathematics Department, Dartmouth College  
 Applied Math DUG, Brown University  
 BIRS Workshop, Sandpile Groups, Oaxaca, Mexico  
 Combinatorics Seminar, MIT
- 2014 Mathematics Department Seminar, PUC-Rio, Rio de Janeiro, Brazil  
 Stanley@70, Conference in honor of Richard P. Stanley's 70th birthday, MIT  
 Colloquium, Mathematics Department, George Mason University  
 AMS Special Session on Topological Combinatorics, Washington University, St. Louis



- 2013 AIM workshop, Generalizations of Chip-Firing and The Critical Group, Palo Alto  
 CIRM workshop, Combinatorial Geometries: matroids, oriented matroids and applications, Luminy, France  
 Applied mathematics seminar, Wentworth Institute of Technology, Boston, MA  
 Discrete Math Seminar, Brown University, Providence, RI
- 2012 Applied Math & Math DUG, Brown University, Providence, RI  
 Lefschetz Center for Dynamical Systems Seminar, Brown University, Providence, RI  
 Combinatorics Seminar, MIT, Cambridge, MA
- 2011 Discrete Math Seminar, Brown University  
 Mathematics Department Colloquium, Wellesley University  
 AMS Special Session on Species and Hopf Algebraic Combinatorics, Cornell University  
 Geometry/Topology Seminar, University of Chicago  
 Computer Science Theory Seminar, University of Chicago  
 Mathematics Department Colloquium, University of Nebraska  
 Algebraic Combinatorixx, Banff  
 Special Session on Polyhedra, MAA Mathfest, Lexington KY
- 2010 Discrete Geometry and Combinatorics Seminar, Cornell University  
 Combinatorics and Computer Science Seminar, University of Illinois -Chicago  
 Workshop on Quasisymmetric Functions, Banff
- 2009 Combinatorics Seminar, SUNY-Binghamton  
 Combinatorial Geometry Workshop, IPAM  
 Mathematics Department Colloquium (Oliver Club), Cornell University  
 Discrete Geometry and Combinatorics Seminar, Cornell University  
 Special Session on Matroids in Algebra and Geometry, AMS regional meeting, SFSU  
 Algebra Seminar, IMPA, Rio de Janeiro  
 Analysis Seminar, PUC-Rio, Rio de Janeiro  
 Theoretical Computer Science Seminar, University of Chicago
- 2008 Special Session on Combinatorial Representation Theory, AMS regional meeting, Vancouver, BC  
 Lou Billera's Birthday Conference, Cornell University  
 Special Session on Combinatorial Representation Theory, Topological Combinatorics, and Interactions between them, AMS regional meeting, Indiana University  
 Combinatorics Seminar, University of Washington
- 2007 Combinatorics Seminar, University of Illinois - Chicago  
 Combinatorics Seminar, MIT  
 Combinatorics Seminar, SUNY - Binghamton  
 Discrete Geometry and Combinatorics Seminar, Cornell

- 2006 Special Session on Geometric Combinatorics, AMS regional meeting, University of Cincinnati  
 Applied Mathematics Seminar, Illinois Institute of Technology  
 Combinatorics Seminar, University of Minnesota  
 Combinatorics Seminar, University of Kansas
- 2005 Special Session on Algebraic and Geometric Combinatorics, AMS regional meeting, Bard College  
 Combinatorics Seminar, University of Illinois - Chicago  
 Special Session on Curvature in Group Theory and Combinatorics, AMS regional meeting, UCSB  
 Combinatorics Seminar, Indiana University  
 Topology Seminar, University of Chicago
- 2004 Combinatorics Seminar, University of Illinois - Chicago  
 Richard Stanley's Birthday Conference, MIT  
 Combinatorics Seminar, MIT  
 Combinatorics Seminar, University of Michigan  
 Geometry Seminar, Courant Institute  
 Discrete Geometry and Combinatorics Seminar, Cornell University  
 Combinatorics Seminar, SUNY - Binghamton
- 2003 Combinatorics Seminar, University of California - Davis  
 Bay Area Discrete Math Day, San Francisco State University  
 Special Session on Topological Combinatorics, AMS regional meeting, SUNY - Binghamton  
 Combinatorics Seminar, University of California - Berkeley  
 Combinatorics Seminar, SUNY - Binghamton  
 Combinatorics Seminar, University of Washington - Seattle
- 1998-2003 Applied Mathematics Student Seminar (SPAMS) (4 talks), MIT  
 Pure Mathematics Student Seminar (Puma Grass), MIT  
 Graph Theoretic Methods in Computer Vision, DIMACS Workshop  
 Graph Theory and Combinatorial Optimization, DREI 98, DIMACS  
 Cornell Math Club