

Damek Davis

Contact

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Google Scholar

Interests

I am broadly interested in the mathematics of data science, particularly the interplay of optimization, signal processing, statistics, and machine learning.

Positions

2022–	Associate Professor (with tenure) <i>Operations Research and Information Engineering</i>	Cornell University
2016–2022	Assistant Professor <i>Operations Research and Information Engineering</i>	Cornell University
Sept-Dec 2022	Senior Fellow <i>Program on Computational Microscopy</i>	Institute for Pure and Applied Mathematics
Aug-Oct 2017	Visiting Research Scientist <i>Program on Bridging Continuous and Discrete Optimization</i>	Simons Institute for the Theory of Computing
2015–2016	NSF Mathematics Postdoctoral Fellow	University of California, Los Angeles

Education

2010-2015	Ph.D. in Mathematics Thesis: <i>On the Design and Analysis of Operator-Splitting Schemes</i> Committee: Wotao Yin (chair), Stefano Soatto (co-chair), Stan Osher, Lieven Vandenbergh	University of California, Los Angeles
2006-2010	B.S. summa cum laude Majoring in Mathematics	University of California, Irvine

Honors and Awards

2023	SIAM Activity Group on Optimization Best Paper Prize SIAM
2020	NSF CAREER Award Budget: \$454,000
2020	Sloan Research Fellowship in Mathematics Budget: \$75,000
2019	Young Researchers Prize INFORMS Optimization Society
2019	Finalist: Best Paper Prize for Young Researchers in Continuous Optimization (One of Four) ICCOPT
2018	A. W. Tucker Dissertation Prize Finalist (One of Two) Mathematical Optimization Society

2015	NSF Mathematics Postdoctoral Fellowship Budget: \$150,000
2015	Dissertation Prize Pacific Journal of Mathematics
2014	Student Paper Prize INFORMS Optimization Society
2010	NSF Graduate Research Fellowship Title: <i>Generalized Washnitzer and Dagger Algebras and a More General p-Adic Cohomology Theory in Rigid Analysis</i>
2009	Elected to Phi Beta Kappa (Junior Year)

Funding

2020	NSF CAREER Award Budget: \$454,000
2020	Sloan Research Fellowship in Mathematics Budget: \$75,000
2015	NSF Mathematics Postdoctoral Fellowship Budget: \$150,000

Publications

Preprints

- [1] *Asymptotic normality and optimality in nonsmooth stochastic approximation*
Damek Davis, Dmitry Drusvyatskiy, and Liwei Jiang
arXiv preprint arXiv:arXiv:2301.06632 (2023) Under submission at *Annals of Statistics*.
- [2] *Active manifolds, stratifications, and convergence to local minima in nonsmooth optimization*
Damek Davis, Dmitry Drusvyatskiy, and Liwei Jiang
arXiv preprint arXiv:2108.11832 (2022) Under submission at *Journal of AMS*.
- [3] *A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth*
Damek Davis and Liwei Jiang
arXiv preprint arXiv:2205.00064 (2022) Under submission at *Foundations of Computational Mathematics*.
- [4] *Clustering a Mixture of Gaussians with Unknown Covariance*
Damek Davis, Mateo Díaz, and Kaizheng Wang
arXiv preprint arXiv:2110.01602 (2021) Under submission at *Annals of Statistics*.
- [5] *Stochastic optimization over proximally smooth sets*
Damek Davis, Dmitry Drusvyatskiy, and Zhan Shi
arXiv preprint arXiv:2002.06309 (2020) Under revision at *SIAM Journal on Optimization*.

Articles in peer-reviewed journals

- [1] *A superlinearly convergent subgradient method for sharp semismooth problems*
Damek Davis and Vasileios Charisopoulos
arXiv preprint arXiv:2201.04611 (2023).

- [2] *Escaping Strict Saddle Points of the Moreau Envelope in Nonsmooth Optimization*
 Damek Davis, Mateo Díaz, and Dmitriy Drusvyatskiy
 SIAM Journal on Optimization 32.3 (2022) pp. 1958–1983.
- [3] *Low-Rank Matrix Recovery with Composite Optimization: Good Conditioning and Rapid Convergence*
 Vasileios Charisopoulos, Yudong Chen, Damek Davis, Mateo Díaz, Lijun Ding, and Dmitriy Drusvyatskiy
 Foundations of Computational Mathematics (2021).
- [4] *Variance reduction for root-finding problems*
 Damek Davis
 Mathematical Programming Series A (2021).
- [5] *Conservative and semismooth derivatives are equivalent for semialgebraic maps*
 Damek Davis and Dmitriy Drusvyatskiy
 Set-Valued and Variational Analysis (2021) pp. 1–11. Springer.
- [6] *Proximal Methods Avoid Active Strict Saddles of Weakly Convex Functions*
 Damek Davis and Dmitriy Drusvyatskiy
 Foundations of Computational Mathematics (2021).
- [7] *From Low Probability to High Confidence in Stochastic Convex Optimization*
 Damek Davis, Dmitriy Drusvyatskiy, Lin Xiao, and Junyu Zhang
 Journal of Machine Learning Research 22.49 (2021) pp. 1–38.
- [8] *Composite optimization for robust rank one bilinear sensing*
 Vasileios Charisopoulos, Damek Davis, Mateo Díaz, and Dmitriy Drusvyatskiy
 Information and Inference: A Journal of the IMA (2020).
- [9] *Graphical convergence of subgradients in nonconvex optimization and learning*
 Damek Davis and Dmitriy Drusvyatskiy
 Mathematics of Operations Research (Learning Theory) (2020).
- [10] *The nonsmooth landscape of phase retrieval*
 Damek Davis, Dmitriy Drusvyatskiy, and Courtney Paquette
 IMA Journal of Numerical Analysis 40.4 (Jan. 2020) pp. 2652–2695.
- [11] *Stochastic model-based minimization of weakly convex functions*
 Damek Davis and Dmitriy Drusvyatskiy
 SIAM Journal on Optimization 29.1 (2019) pp. 207–239.
- [12] *Stochastic algorithms with geometric step decay converge linearly on sharp functions*
 Damek Davis, Dmitriy Drusvyatskiy, and Vasileios Charisopoulos
 arXiv preprint arXiv:1907.09547 (2019).
- [13] *Stochastic subgradient method converges on tame functions*
 Damek Davis, Dmitriy Drusvyatskiy, Sham Kakade, and Jason D Lee
 Foundations of Computational Mathematics (Jan. 2019).
- [14] *Proximally Guided Stochastic Subgradient Method for Nonsmooth, Nonconvex Problems*
 Damek Davis and Benjamin Grimmer
 SIAM Journal on Optimization 29.3 (2019) pp. 1908–1930. SIAM.
- [15] *Trimmed Statistical Estimation via Variance Reduction*
 Aleksandr Aravkin and Damek Davis
 Mathematics of Operations Research (2018).
- [16] *Forward-Backward-Half Forward Algorithm with non Self-Adjoint Linear Operators for Solving Monotone Inclusions*
 Luis M Briceño-Arias and Damek Davis
 SIAM Journal on Optimization 28.4 (2018) pp. 2839–2871.
- [17] *Subgradient methods for sharp weakly convex functions*
 Damek Davis, Dmitriy Drusvyatskiy, Kellie J MacPhee, and Courtney Paquette
 Journal of Optimization Theory and Applications 179.3 (2018) pp. 962–982. Springer.

- [18] *A Three-Operator Splitting Scheme and its Optimization Applications*
 Damek Davis and Wotao Yin
Set-Valued and Variational Analysis 25.4 (Dec. 2017) pp. 829–858.
- [19] *Faster convergence rates of relaxed Peaceman-Rachford and ADMM under regularity assumptions.*
 Damek Davis and Wotao Yin
Mathematics of Operations Research 42.3 (2017) pp. 783–805.
- [20] *Beating level-set methods for 3D seismic data interpolation: a primal-dual alternating approach*
 Rajiv Kumar, Oscar López, Damek Davis, Aleksandr Y. Aravkin, and Felix J. Herrmann
IEEE Transactions on Computational Imaging (2017).
- [21] *Convergence Rate Analysis of Primal-Dual Splitting Schemes*
 Damek Davis
SIAM Journal on Optimization 25.3 (2015) pp. 1912–1943.
- [22] *Convergence Rate Analysis of the Forward-Douglas-Rachford Splitting Scheme*
 Damek Davis
SIAM Journal on Optimization 25.3 (2015) pp. 1760–1786.
- [23] *Tactical Scheduling for Precision Air Traffic Operations: Past Research and Current Problems*
 Douglas R. Isaacson, Alexander V. Sadovsky, and Damek Davis
Journal of Aerospace Information Systems 11.4 (2014) pp. 234–257. *American Institute of Aeronautics and Astronautics*.
- [24] *Efficient Computation of Separation-Compliant Speed Advisories for Air Traffic Arriving in Terminal Airspace*
 Alexander V. Sadovsky, Damek Davis, and Douglas R. Isaacson
Journal of Dynamic Systems, Measurement, and Control 136.4 (2014) p. 041027. *American Society of Mechanical Engineers*.
- [25] *Separation-compliant, optimal routing and control of scheduled arrivals in a terminal airspace*
 Alexander V. Sadovsky, Damek Davis, and Douglas R. Isaacson
Transportation Research Part C: Emerging Technologies 37 (2013) pp. 157–176.
- [26] *Factorial and Noetherian subrings of power series rings*
 Damek Davis and Daqing Wan
Proceedings of the American Mathematical Society 139.3 (2011) pp. 823–834.

Articles in peer-reviewed conferences

- [1] *A gradient sampling method with complexity guarantees for Lipschitz functions in high and low dimensions*
 Damek Davis, Dmitriy Drusvyatskiy, Yin Tat Lee, Swati Padmanabhan, and Guanghao Ye
Neural Information Processing Systems (ORAL, \approx top 1%), 2022.
- [2] *High probability guarantees for stochastic convex optimization*
 Damek Davis and Dmitriy Drusvyatskiy
Proceedings of Thirty Third Conference on Learning Theory, 2020.
- [3] *Global Convergence of the EM Algorithm for Mixtures of Two Component Linear Regression*
 Jeongyeol Kwon, Wei Qian, Constantine Caramanis, Yudong Chen, and Damek Davis
Proceedings of the Thirty-Second Conference on Learning Theory, 2019.
- [4] *The Sound of APALM Clapping: Faster Nonsmooth Nonconvex Optimization with Stochastic Asynchronous PALM*
 Damek Davis, Brent Edmunds, and Madeleine Udell
Neural Information Processing Systems, 2016.

- [5] *Multi-View Feature Engineering and Learning*
Jingming Dong, Nikolaos Karianakis, Damek Davis, Joshua Hernandez, Jonathan Balzer, and Stefano Soatto
The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2015.
- [6] *Asymmetric Sparse Kernel Approximations for Large-scale Visual Search*
Damek Davis, Jonathan Balzer, and Stefano Soatto
The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2014.

Book chapters

- [1] Convergence rate analysis of several splitting schemes
Damek Davis and Wotao Yin
Splitting Methods in Communication and Imaging, Science and Engineering, 2016.

Lecture notes

- [1] Lecture Notes for Mathematical Programming I (ORIE 6300)
Damek Davis
URL: <https://people.orie.cornell.edu/dsd95/ORIE6300Fall12019notes.pdf>

Newletters

- [1] Subgradient methods under weak convexity and tame geometry
Damek Davis and Dmitriy Drusvyatskiy
SIAG/OPT Views and News vol. 28.1 (2020) pp. 1–10.
URL: <https://people.orie.cornell.edu/dsd95/ViewsAndNews-28-1.pdf>
- [2] Convergence Rate Analysis of Several Splitting Schemes
Damek Davis
INFORMS OS Today vol. 5.1 (2015) pp. 20–25.
URL: <https://people.orie.cornell.edu/dsd95/OSToday0515.pdf>

Invited Talks

- June 2023 **A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth** Paris, France
Continuous Optimization Workshop, Foundations of Computational Mathematics 2023
- June 2023 **A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth** Seattle, Washington
SIAM conference on optimization
- June 2023 **Stochastic model-based minimization of weakly convex functions** Seattle, Washington
SIAM conference on optimization (prize lecture)
- April 2023 **Leveraging “partial” smoothness for faster convergence in nonsmooth optimization** Seattle, Washington
Distinguished Seminar in Optimization & Data, University of Washington
- February 2023 **Leveraging “partial” smoothness for faster convergence in nonsmooth optimization** Pasadena, California
CMX Lunch Seminar, Caltech
- Fall 2022 **Leveraging “partial” smoothness for faster convergence in nonsmooth optimization** Los Angeles, California
Level Set Seminar, UCLA

Fall 2022	Leveraging ``partial'' smoothness for faster convergence in nonsmooth optimization Seminar, IPAM workshop on computational microscopy	Los Angeles, California
Fall 2022	Leveraging ``partial'' smoothness for faster convergence in nonsmooth optimization Seminar, UCLA Department of Computer Science	Los Angeles
Fall 2022	Leveraging "partial" smoothness for faster convergence in nonsmooth optimization ISL seminar, Stanford	Palo Alto, California
Fall 2022	Leveraging ``partial'' smoothness for faster convergence in nonsmooth optimization Seminar, Northwestern University Department of Statistics and Data Science	Evanston, Illinois
Nov 2022	A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth OPTML++ seminar, MIT	Virtual
July 2022	A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth International Conference on Continuous Optimization	Lehigh, Pennsylvania
May 2022	Avoiding saddle points in nonsmooth optimization Workshop on Robustness and Resilience in Stochastic Optimization and Statistical Learning: Mathematical Foundations Ettore Majorana Foundation And Centre For Scientific Culture	Erice, Italy
February 2022	Avoiding saddle points in nonsmooth optimization Theoretical Computer Science Seminar, University at Illinois, Chicago	Virtual
Dec 2021	Plenary Talk: Avoiding saddle points in nonsmooth optimization OPT2021 NeurIPS Workshop	Virtual
Nov 2021	Avoiding saddle points in nonsmooth optimization One World Optimization Seminar	Virtual
July 2021	Avoiding saddle points in nonsmooth optimization SIAM Optimization Conference	Virtual
Nov 2020	Nonconvex Optimization for Estimation and Learning: Dynamics, Conditioning, and Nonsmoothness CRM Applied Math Seminar, McGill University	Montreal, Quebec, Canada
June 2020	Proximal methods avoid active strict saddles of weakly convex functions Foundations of Computational Mathematics (Cancelled due to COVID)	Vancouver, Canada
May 2020	Stochastic Algorithms with Geometric Step Decay Converge Linearly on Sharp Functions SIAM Mathematics of Data Science (sessions cancelled due to COVID)	Cincinnati, Ohio
Nov 2019	Stochastic model-based minimization of weakly convex functions INFORMS Optimization Society Young Researchers Award Presentation	Seattle, Washington
Nov 2019	Low-rank matrix recovery with composite optimization: good conditioning and rapid convergence INFORMS Annual Meeting	Seattle, Washington
Nov 2019	Stochastic subgradient method converges on tame functions INFORMS Annual Meeting	Seattle, Washington

August 2019	Stochastic subgradient method converges on tame functions Germany ICCOPT Best Paper Prize for Young Researchers in Continuous Optimization Finalist	Berlin,
April 2019	Nonsmooth and nonconvex optimization under statistical assumptions Princeton, New Jersey Operations Research and Financial Engineering Optimization Seminar, Princeton University	
Sept 2018	Stochastic Methods for Non-smooth Non-convex Optimization Champaign, Illinois Annual Allerton Conference on Communication, Control, and Computing	Urbana-
Aug 2018	Algorithmic Foundations of Huge-Scale Nonsmooth, NonConvex Optimization with Applications in Data Science AFOSR Optimization and Discrete Math Program Review	Arlington, Virginia
Aug 2018	Stochastic Methods for Non-smooth Non-convex Optimization Pennsylvania TRIPODS/MOPTA Conference	Lehigh,
July 2018	Convergence rates of stochastic methods for nonsmooth nonconvex problems International Symposium on Mathematical Programming (ISMP) (cancelled due to illness)	Bordeaux, France
June 2018	Stochastic Methods for Non-smooth Non-convex Optimization Washington DIMACS Workshop on ADMM and Proximal Splitting Methods in Optimization (cancelled due to illness)	Seattle,
May 2018	Stochastic Methods for Non-smooth Non-convex Optimization Washington West Coast Optimization Meeting	Seattle,
April 2018	Recent progress on nonsmooth nonconvex optimization under statistical assumptions Operations Research Center Seminar, MIT	Cambridge, Massachusetts
Nov 2017	Proximally Guided Stochastic Subgradient Method for Nonsmooth, Non-convex Problems INFORMS Annual Meeting	Houston, Texas
July 2017	Trimmed Statistical Estimation via Variance Reduction Canada EUROPT continuous optimization working group of EURO (The Association of European Operational Research Societies)	Montreal, Quebec,
July 2017	A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning Google Brain Seminar	New York, New York
May 2017	A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning Applied Mathematics Colloquium, UCLA	Los Angeles, California
May 2017	A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning SIAM Optimization Conference	Vancouver, Canada
July 2016	Fast Algorithms for Robust Machine Learning Google Internal Seminar	New York, New York

June 2016	SMART: The Stochastic Monotone Aggregated Root-Finding Algorithm Waikoloa, Hawaii INFORMS International Meeting
May 2016	A Three-Operator Splitting Scheme and its Optimization Applications Al- buquerque, New Mexico SIAM Conference on Imaging Science
Feb 2016	SMART: The Stochastic Monotone Aggregated Root-Finding Algorithm Madison, Wisconsin Systems, Information, Learning and Optimization (SILO) Seminar, University of Wisconsin, Madison
Oct 2015	A Three-Operator Splitting Scheme and its Optimization Applications Seattle, Washington TOPS Optimization Seminar, University of Washington
July 2015	A Three-Operator Splitting Scheme and its Optimization Applications Pitts- burg, Pennsylvania International Symposium on Mathematical Programming (ISMP)
June 2015	Decentralized Optimization via Operator Splitting Murray Hill, New Jersey Bell Labs Prize Innovathon @ Alcatel-Lucent
May 2015	A Three-Operator Splitting Scheme and its Optimization Applications Stanford, California Linear Algebra and Optimization Seminar, Stanford University
Feb 2015	The Design and Analysis of Large-scale Operator-splitting Schemes Madi- son, Wisconsin Wisconsin Institute for Discovery Colloquium, University of Wisconsin, Madi- son
Jan 2015	The Design and Analysis of Large-scale Operator-splitting Schemes Wa- terloo, Ontario, Canada Combinatorics and Optimization Seminar, University of Waterloo

Service

Editorial

2022-	Associate Editor Mathematical Programming
2023-	Associate Editor Foundations of Computational Mathematics

Conference/Workshop/Seminar organization

2022-	Stream co-chair for Nonsmooth Optimization International Conference on Continuous Optimization	Lehigh University
2020-	Cluster co-chair for Continuous Optimization International Symposium on Mathematical Programing	Beijing, China
2019-2020	Track co-chair for Optimization in Data Science INFORMS Optimization Society 2020 Meeting	Clemson University
2016	OPT2016 Program Committee Member Neural Information Processing Systems	Barcelona, Spain

Departmental Service

2021	ORIE Director Reappointment Committee Operations Research and Information Engineering	Cornell University
2018-2019	COR-OPT Optimization Seminar Operations Research and Information Engineering	Cornell University
2018-2020, 2022	Graduate Admissions Committee Operations Research and Information Engineering	Cornell University
2016, 2021, 2022	Masters of Engineering Admissions Committee Operations Research and Information Engineering	Cornell University
2017-2018	Colloquium Co-organizer Center for Applied Math	Cornell University
2016, 2020	Colloquium Co-organizer Operations Research and Information Engineering	Cornell University

Reviews

2020, 2021	Proposal Reviewer NSF Division of Mathematical Sciences
2014-	Article Reviewer <i>Mathematical Programming Series A/B,</i> <i>SIAM Journal on Optimization,</i> <i>Foundations of Computational Mathematics,</i> <i>Mathematics of Operations Research,</i> <i>Transactions of the American Mathematical Society,</i> <i>Set-Valued and Variational Analysis,</i> <i>Journal of Optimization Theory and Applications,</i> <i>IEEE Transactions on Automatic Control,</i> <i>IEEE Signal Processing Magazine</i>

Teaching

Courses

Spring 2022	ORIE 4740 Statistical Data Mining Dept: Operations Research and Information Engineering	Cornell University
Fall 2021	ORIE 7391 Selected Topics in Mathematical Programming Dept: Operations Research and Information Engineering	Cornell University
Spring 2021	ORIE 6340 Mathematics of Data Science Dept: Operations Research and Information Engineering Course materials available at the following link: https://www.dropbox.com/sh/bvxav1pc2nr5n6x/AABn7gEfuYY7qD_ZxUQzJwpmad1=0	Cornell University
Fall 2020	ORIE 3300 Optimization I Dept: Operations Research and Information Engineering	Cornell University
Fall 2020	Engineering 1050 Dept: Operations Research and Information Engineering	Cornell University
Spring 2020	ORIE 4740 Statistical Data Mining Dept: Operations Research and Information Engineering	Cornell University

Fall 2019	ORIE 6300 Mathematical Programming I Dept: Operations Research and Information Engineering Lecture notes available at the following link: https://people.orie.cornell.edu/dsd95/ORIE6300Fall12019notes.pdf	Cornell University
Fall 2018	ORIE 3300 Optimization I Dept: Operations Research and Information Engineering	Cornell University
Spring 2018	Math 2940 Linear Algebra for Engineers Dept: Mathematics	Cornell University
Spring 2017	ORIE 4350 Introduction to Game Theory Dept: Operations Research and Information Engineering	Cornell University
Fall 2016	ORIE 6300 Mathematical Programming I Dept: Operations Research and Information Engineering	Cornell University

Advising

Current PhD Students

2021–	Tao Jiang <i>Operations Research and Information Engineering</i> Status: Q Exam Passed	Cornell University
2020–	Liwei Jiang <i>Operations Research and Information Engineering</i> Status: Q Exam Passed	Cornell University

Former PhD Students

2018–2023	Vasileios Charisopoulos <i>Operations Research and Information Engineering</i> Status: Degree Obtained Next Position: Postdoc (w/ Becca Willet)	Cornell University
2016–2021	Mateo Diaz <i>Computational and Applied Mathematics</i> Status: Degree Obtained Next Positions: Postdoc (w/ V. Chandrasekaran and J. Tropp) Asst. Prof. at Johns Hopkins (Applied Math)	Cornell University
2017–2021	Benjamin Grimmer <i>Operations Research and Information Engineering</i> (Co-adviser: J. Renegar (primary)) Status: Degree Obtained Next Position: Asst. Prof. at Johns Hopkins (Applied Math)	Cornell University

Doctoral Supervising Committee Member:

Si Yi (Cathy) Meng (ORIE), Song (Sam) Zhou (ORIE), Qinru Shi (CAM), Calvin Wylie (ORIE), Miaolan Xie (ORIE), Tonghua Tian (ORIE)

Former MEng Students (ORIE Capstone Project)

2016–2017	Kendrick Cancio, Karen Cronk, Alexis Rouge Carrassat Co-adviser: D. Shmoys Industry Sponsor: MITRE	Cornell University
Fall 2017	Henry Zhou, Juan Duran-Vara, Elijah Huang Putnam Investments Co-adviser: J. Renegar	Cornell University
2017-2018	Anne Ng, Antong Su, Charlotte Wang, Umut Yildiz Industry Sponsor: Equifax	Cornell University
2018-2019	Chenxin Guo, Dajun Luo, Liyang Du, Zuolin Shen Industry Sponsor: Equifax	Cornell University
2019-2020	Percy Zhao, Iris Zhao, Foster Zhen, Betsy Fu Industry Sponsor: Equifax	Cornell University
2020-2021	Yixiao He, Xiaoxiang Ma, Yuke Wu, Jiaqi Zhang Industry Sponsor: Pitney Bowes	Cornell University