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)** *Operations Research and Information Engineering*	Cornell University
2016–2022	**Assistant Professor** *Operations Research and Information Engineering*	Cornell University
Sept-Dec 2022	**Senior Fellow** *Program on Computational Microscopy*	Institute for Pure and Applied Mathematics
Aug-Oct 2017	**Visiting Research Scientist** *Program on Bridging Continuous and Discrete Optimization*	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: *On the Design and Analysis of Operator-Splitting Schemes* Committee: Wotao Yin (chair), Stefano Soatto (co-chair), Stan Osher, Lieven Vandenberghe	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: *Generalized Washnitzer and Dagger Algebras and a More General p-Adic Cohomology Theory in Rigid Analysis*

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, Dmitriy 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, Dmitriy 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, Dmitriy Drusvyatskiy, and Zhan Shi
arXiv preprint arXiv:2002.06309 *(2020) Under revision at SIAM Journal on Optimization.*

[6] *Stochastic algorithms with geometric step decay converge linearly on sharp functions*
Damek Davis, Dmitriy Drusvyatskiy, and Vasileios Charisopoulos
arXiv preprint arXiv:1907.09547 *(2019) Under revision at Mathematical Programming.*

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 subgradient method converges on tame functions*
Damek Davis, Dmitriy Drusvyatskiy, Sham Kakade, and Jason D Lee
Foundations of Computational Mathematics *(Jan. 2019).*

[13] *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.*

[14] *Trimmed Statistical Estimation via Variance Reduction*
Aleksandr Aravkin and Damek Davis
Mathematics of Operations Research *(2018).*

[15] *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.*

[16] *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.*

[17] *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.*

[18] *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.*

[19] *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).*

[20] *Convergence Rate Analysis of Primal-Dual Splitting Schemes*
Damek Davis
SIAM Journal on Optimization *25.3 (2015) pp. 1912–1943.*

[21] *Convergence Rate Analysis of the Forward-Douglas-Rachford Splitting Scheme*
Damek Davis
SIAM Journal on Optimization *25.3 (2015) pp. 1760–1786.*

[22] *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.*

[23] *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.*

[24] *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.*

[25] *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/ORIE6300Fall2019notes.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

Spring 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** Los Angeles, California
Seminar, IPAM workshop on computational microscopy

Fall 2022 **Leveraging ``partial'' smoothness for faster convergence in nonsmooth optimization** Los Angeles
Seminar, UCLA Department of Computer Science

Fall 2022 **Leveraging "partial" smoothness for faster convergence in nonsmooth optimization** Palo Alto, California
ISL seminar, Stanford

Fall 2022 **Leveraging ``partial'' smoothness for faster convergence in nonsmooth optimization** Evanston, Illinois
Seminar, Northwestern University Department of Statistics and Data Science

Nov 2022 **A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth** Virtual
OPTML++ seminar, MIT

July 2022 **A nearly linearly convergent first-order method for nonsmooth functions with quadratic growth** Lehigh, Pennsylvannia
International Conference on Continuous Optimization

May 2022 **Avoiding saddle points in nonsmooth optimization** Erice, Italy
Workshop on Robustness and Resilience in Stochastic Optimization and Statistical Learning: Mathematical Foundations
Ettore Majorana Foundation And Centre For Scientific Culture

February 2022 **Avoiding saddle points in nonsmooth optimization** Virtual
Theoretical Computer Science Seminar, University at Illinois, Chicago

Dec 2021 **Plenary Talk: Avoiding saddle points in nonsmooth optimization** Virtual
OPT2021 NeurIPS Workshop

Nov 2021 **Avoiding saddle points in nonsmooth optimization** Virtual
One World Optimization Seminar

July 2021 **Avoiding saddle points in nonsmooth optimization** Virtual
SIAM Optimization Conference

Nov 2020 **Nonconvex Optimization for Estimation and Learning: Dynamics, Conditioning, and Nonsmoothness** Montreal, Quebec, Canada
CRM Applied Math Seminar, McGill University

June 2020 **Proximal methods avoid active strict saddles of weakly convex functions** Vancouver, Canda
Foundations of Computational Mathematics (Cancelled due to COVID)

May 2020 **Stochastic Algorithms with Geometric Step Decay Converge Linearly on Sharp Functions** Cincinnati, Ohio
SIAM Mathematics of Data Science (sessions cancelled due to COVID)

Nov 2019 **Stochastic model-based minimization of weakly convex functions** Seattle, Washington
INFORMS Optimization Society Young Researchers Award Presentation

Nov 2019 **Low-rank matrix recovery with composite optimization: good conditioning and rapid convergence** Seattle, Washington
INFORMS Annual Meeting

Nov 2019 **Stochastic subgradient method converges on tame functions** Seattle, Washington
INFORMS Annual Meeting

August 2019 **Stochastic subgradient method converges on tame functions** Berlin, Germany
ICCOPT Best Paper Prize for Young Researchers in Continuous Optimization Finalist

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** Urbana-Champaign, Illinois
Annual Allerton Conference on Communication, Control, and Computing

Aug 2018 **Algorithmic Foundations of Huge-Scale Nonsmooth, NonConvex Optimization with Applications in Data Science** Arlington, Virginia
AFOSR Optimization and Discrete Math Program Review

Aug 2018 **Stochastic Methods for Non-smooth Non-convex Optimization** Lehigh, Pennsylvania
TRIPODS/MOPTA Conference

July 2018 **Convergence rates of stochastic methods for nonsmooth nonconvex problems** Bordeaux, France
International Symposium on Mathematical Programming (ISMP) (cancelled due to Illness)

June 2018 **Stochastic Methods for Non-smooth Non-convex Optimization** Seattle, Washington
DIMACS Workshop on ADMM and Proximal Splitting Methods in Optimization (cancelled due to Illness)

May 2018 **Stochastic Methods for Non-smooth Non-convex Optimization** Seattle, Washington
West Coast Optimization Meeting

April 2018 **Recent progress on nonsmooth nonconvex optimization under statistical assumptions** Cambridge, Massachusetts
Operations Research Center Seminar, MIT

Nov 2017 **Proximally Guided Stochastic Subgradient Method for Nonsmooth, Nonconvex Problems** Houston, Texas
INFORMS Annual Meeting

July 2017 **Trimmed Statistical Estimation via Variance Reduction** Montreal, Quebec, Canada
EUROPT continuous optimization working group of EURO (The Association of European Operational Research Societies)

July 2017 **A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning** New York, New York
Google Brain Seminar

May 2017 **A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning** Los Angeles, California
Applied Mathematics Colloquium, UCLA

May 2017 **A SMART Stochastic Algorithm for Nonconvex Optimization with Applications to Robust Machine Learning** Vancouver, Canada
SIAM Optimization Conference

July 2016 **Fast Algorithms for Robust Machine Learning** New York, New York
Google Internal Seminar

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** Albuquerque, 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** Pittsburg, 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** Madison, Wisconsin
Wisconsin Institute for Discovery Colloquium, University of Wisconsin, Madison

Jan 2015 **The Design and Analysis of Large-scale Operator-splitting Schemes** Waterloo, Ontario, Canada
Combinatorics and Optimization Seminar, University of Waterloo

Service

Editorial

2022- **Associate Editor**
Mathematical Programming

Conference/Workshop/Seminar organization

2022- **Stream co-chair for Nonsmooth Optimization** Lehigh University
International Conference on Continuous Optimization

2020- **Cluster co-chair for Continuous Optimization** Beijing, China
International Symposium on Mathematical Programing

2019-2020 **Track co-chair for Optimization in Data Science** Clemson University
INFORMS Optimization Society 2020 Meeting

2016 **OPT2016 Program Committee Member** Barcelona, Spain
Neural Information Processing Systems

Departmental Service

2021 **ORIE Director Reappointment Committee** Cornell University
Operations Research and Information Engineering

2018-2019 **COR-OPT Optimization Seminar** Cornell University
Operations Research and Information Engineering

2018-2020, 2022 **Graduate Admissions Committee** Cornell University
Operations Research and Information Engineering

2016, 2021, 2022 **Masters of Engineering Admissions Committee** Cornell University
Operations Research and Information Engineering

2017-2018 **Colloquium Co-organizer** Cornell University
Center for Applied Math

2016, 2020 **Colloquium Co-organizer** Cornell University
Operations Research and Information Engineering

Reviews

2020, 2021 **Proposal Reviewer**
NSF Division of Mathematical Sciences

2014- **Article Reviewer**
Mathematical Programming Series A/B,
SIAM Journal on Optimization,
Foundations of Computational Mathematics,
Mathematics of Operations Research,
Transactions of the American Mathematical Society,
Set-Valued and Variational Analysis,
Journal of Optimization Theory and Applications,
IEEE Transactions on Automatic Control,
IEEE Signal Processing Magazine

Teaching

Courses

Spring 2022 **ORIE 4740 Statistical Data Mining** Cornell University
Dept: Operations Research and Information Engineering

Fall 2021 **ORIE 7391 Selected Topics in Mathematical Programming** Cornell University
Dept: Operations Research and Information Engineering

Spring 2021 **ORIE 6340 Mathematics of Data Science** Cornell University
Dept: Operations Research and Information Engineering
Course materials available at the following link:
`https://www.dropbox.com/sh/bvxav1pc2nr5n6x/AABn7gEfuYY7qD_ZxUQzJwpma?dl=0`

Fall 2020 **ORIE 3300 Optimization I** Cornell University
Dept: Operations Research and Information Engineering

Fall 2020 **Engineering 1050** Cornell University
Dept: Operations Research and Information Engineering

Spring 2020 **ORIE 4740 Statistical Data Mining** Cornell University
Dept: Operations Research and Information Engineering

Fall 2019 **ORIE 6300 Mathematical Programming I** Cornell University
Dept: Operations Research and Information Engineering
Lecture notes available at the following link:
`https://people.orie.cornell.edu/dsd95/ORIE6300Fall2019notes.pdf`

Fall 2018 **ORIE 3300 Optimization I** Cornell University
Dept: Operations Research and Information Engineering

Spring 2018 **Math 2940 Linear Algebra for Engineers** Cornell University
Dept: Mathematics

Spring 2017 **ORIE 4350 Introduction to Game Theory** Cornell University
Dept: Operations Research and Information Engineering

Fall 2016 **ORIE 6300 Mathematical Programming I** Cornell University
Dept: Operations Research and Information Engineering

Advising

Current PhD Students

2021– **Tao Jiang** Cornell University
Operations Research and Information Engineering
Status: Q Exam Passed

2020– **Liwei Jiang** Cornell University
Operations Research and Information Engineering
Status: Q Exam Passed

2018– **Vasileios Charisopoulos** Cornell University
Operations Research and Information Engineering
Status: A Exam Passed

Former PhD Students

2016–2021 **Mateo Diaz** Cornell University
Computational and Applied Mathematics
Status: Degree Obtained
Thesis: *Complexity, conditioning, and saddle avoidance in nonsmooth optimization*
Next Positions: Postdoc (w/ V. Chandrasekaran and J. Tropp)
Asst. Prof. at Johns Hopkins (Applied Math)

2017–2021 **Benjamin Grimmer** Cornell University
Operations Research and Information Engineering
(Co-adviser: J. Renegar (primary))
Status: Degree Obtained
Thesis: *Some Extensions On The Reach Of First-Order Optimization Theory*
Next Position: Asst. Prof. at Johns Hopkins (Applied Math)

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** Cornell University
Co-adviser: D. Shmoys
Industry Sponsor: MITRE

Fall 2017 **Henry Zhou, Juan Duran-Vara, Elijah Huang** Cornell University
Putnam Investments
Co-adviser: J. Renegar

2017-2018 **Anne Ng, Antong Su, Charlotte Wang, Umut Yildiz** Cornell University
Industry Sponsor: Equifax

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