Robert M. Gower

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modern optimization **adaptive methods** **stochastic optimization** **machine learning** **randomized numerical linear algebra**

Profile

I work on the mathematics of modern optimization: why methods such as Adam, Muon, Polyak step-sizes, and non-Euclidean gradient descent work, fail, and sometimes come up with new methods. My current research sits between optimization theory and machine-learning practice, with a focus on simple algorithms that exploit structure. Previously, I worked on randomized numerical linear algebra, automatic differentiation, and quasi-Newton methods.

Appointments and Education

11/2021–present	**Research Scientist** , Center for Computational Mathematics, Flatiron Institute New York, NY
06/2021–11/2021	**Visiting Scientist** , Google Research New York, NY
01/2020–08/2020	**Visiting Scientist** , Facebook Research New York, NY
09/2017–06/2021	**Assistant Professor** , Telecom Paris, Institut Polytechnique de Paris Paris, France
08/2016–09/2017	**Laureate Fellow** , Fondation Sciences Mathematiques de Paris, ENS and Inria Paris, France
09/2012–06/2016	**Ph.D.** , Optimization and Operations Research, University of Edinburgh Thesis: *Sketch and Project: Randomized Iterative Methods for Linear Systems and Inverting Matrices*
05/2011–08/2012	**Analyst in Risk and Validation** , Itaú Unibanco São Paulo, Brazil
03/2009–04/2011	**M.Sc.** , Applied Mathematics, University of Campinas Thesis: *Hessian Matrices via Automatic Differentiation*
03/2005–03/2009	**B.Sc.** , Applied and Computational Mathematics, University of Campinas Brazil

Prizes, Honors, and Funding

- ICLR 2026 Outstanding Paper Honorable Mention for *The Polar Express: Optimal Matrix Sign Methods and Their Application to the Muon Algorithm.*
- **Reviewing rewards**: NeurIPS 2026 Top Reviewer; ICML 2026 Gold Reviewer; NeurIPS 2025 Top Reviewer; ICML 2021 Best Reviewer (top 10%); NeurIPS 2020 Top 10% Reviewer; ICML 2019 Top 5% Reviewer.
- Thomas Jefferson Fund grant, “Matrix equations for big data compression”, $20k, 2019.
- CIFRE Facebook Research funding, $72k, 2019.
- Leslie Fox Prize for Numerical Analysis, 2nd place, 2017.
- Fondation Sciences Mathematiques de Paris Fellowship at Inria/ENS, 122k EUR, 2016.
- Best Talk Prize, Irish SIAM student meeting, 2014.

- University of Edinburgh Ph.D. scholarship, 85.1k GBP, 2012.

People and Mentoring

- Nidham Gazagnadou, Ph.D. student, 2018–2021; now Research Scientist at Sony AI.
- Rui Yuan, Ph.D. student, 2019–2023; now AI Research Scientist at Stellantis.
- Samy Jelassi, intern, 2017; Ph.D. at Princeton.
- Si Yi Meng (Cathy), intern, 2022 and 2023.
- Fabian Schaipp, guest researcher, 2022 and 2023.
- Slavomir Hanzely, intern, 2022; now Researcher at CISPA.
- Aaron Mishkin, intern, 2023; now Postdoc at EPFL.
- David Persson, Flatiron Fellow, 2024–present.
- Michael Crawshaw, intern, 2025; joining Flatiron as a Fellow in 2026.
- Tetiana Parshakova, Flatiron Fellow, 2025–present.

Selected Invited Talks

Over 45 talks at conferences, workshops, and seminars; the full list is in `talks.bib`.

2026	**Non-Euclidean Gradient Descent Operates at the Edge of Stability**. ICML oral, Seoul	
2026	**An Exploration of Non-Euclidean Gradient Descent: Muon and its Many Variants**. SIAM Conference on Optimization (OP26), Edinburgh	
2026	**The Polar Express: Optimal Matrix Sign Methods and Their Application to the Muon Algorithm**. ICLR oral (recording); ICERM, Brown University (recording); IMPA, Rio de Janeiro (recording).	
2025	**In Search of Adam's Secret Sauce**. NeurIPS oral, San Diego	recording/link
2021	**New Viewpoints, Variants and Convergence Theory for Stochastic Polyak Step-sizes**. MTL MLOpt seminar	recording/link
2019	**SGD: General Analysis and Improved Rates**. ICML oral, Long Beach	recording/link
2018	**Tracking the Gradients Using the Hessian**. AISTATS semi-plenary oral, Lanzarote	
2018	**Séminaire Parisien d'Optimisation**. Institut Henri Poincaré, Paris	
2017	**Randomized Iterative Methods for Linear Systems**. 18th IMA Leslie Fox Prize meeting (2nd place), Glasgow	

Teaching

I have given over 360 hours of lectures on optimization, numerical analysis, and machine learning. Prior to that, as a graduate student at the University of Edinburgh, I gave over 350 hours of tutorials and lectures.

- 2019–2020: *Machine Learning in High Dimensions*, graduate course, Telecom Paris.
- 2017–2020: *Optimization and Numerical Analysis*, undergraduate course, Telecom Paris.
- 2017–2020: *Optimization for Data Science*, Data Science Master's, Institut Polytechnique de Paris.
- 2019: *Stochastic Optimization for Machine Learning*, African Master's of Machine Intelligence at AIMS, Rwanda.
- 2017–2019: Summer school lectures on stochastic optimization for machine learning at Yerevan State University and the University of Novi Sad.
- 2010–2015: Over 350 hours of tutorials and lectures at the University of Edinburgh, including linear algebra, calculus, financial mathematics, operations research, optimization theory, proofs, and problem solving.

Service

Editorial work and reviewing for:

Action Editor, *Transactions of Machine Learning Research* (TMLR)

Editorial Board Reviewers, *Journal of Machine Learning Research* (JMLR)

Area Chair / Meta-Reviewer, *International Conference on Machine Learning* (ICML), 2025

Area Chair, *Conference on Neural Information Processing Systems* (NeurIPS), 2021 and 2022

Senior Program Committee, *International Joint Conference on Artificial Intelligence* (IJCAI), 2020

Reviewer, *Conference on Neural Information Processing Systems* (NeurIPS)

International Conference on Machine Learning (ICML)

Journal of Machine Learning Research (JMLR)

Proceedings of the IEEE

IEEE Transactions on Signal Processing

SIAM Journal on Scientific Computing (SISC)

SIAM Journal on Optimization (SIOPT)

Optimization Methods and Software, Taylor & Francis

Computational and Applied Mathematics, Springer

Mathematical Programming, Springer Computation

BIT Numerical Mathematics, Springer

Numerical Algorithms, Springer

Publications

All entries below are generated directly from `../rob_papers.bib`.

[1] N. Amsel, D. Persson, C. Musco, and R. M. Gower. "The Polar Express: Optimal Matrix Sign Methods and Their Application to the Muon Algorithm". In: *International Conference on Learning Representations (ICLR)*. Oral presentation; Outstanding Paper Honorable Mention. 2026. arXiv: 2505.16932 [cs.LG]. URL: https://openreview.net/forum?id=yRtgZ1K8hO.

[2] M. Crawshaw, C. Modi, M. Liu, and R. M. Gower. "An Exploration of Non-Euclidean Gradient Descent: Muon and its Many Variants". In: *International Conference on Machine Learning (ICML)*. 2026. arXiv: 2510.09827 [cs.LG]. URL: https://arxiv.org/abs/2510.09827.

[3] N. Ghosh, T. Parshakova, and R. M. Gower. *PoLoRA: A Preconditioned Orthogonalized LoRA Optimizer*. 2026. arXiv: 2607.17620 [cs.LG]. URL: https://arxiv.org/abs/2607.17620.

[4] R. M. Gower, G. Garrigos, N. Loizou, D. Oikonomou, K. Mishchenko, and F. Schaipp. "Analysis of an Idealized Stochastic Polyak Method and its Application to Black-Box Model Distillation". In: *Transactions on Machine Learning Research (TMLR)* (2026). arXiv: 2504.01898 [cs.LG]. URL: https://openreview.net/forum?id=lNRBJekTFX.

[5] R. Islamov, M. Crawshaw, J. Cohen, and R. M. Gower. "Non-Euclidean Gradient Descent Operates at the Edge of Stability". In: *International Conference on Machine Learning (ICML)*. Oral presentation. 2026. arXiv: 2603.05002 [cs.LG]. URL: https://arxiv.org/abs/2603.05002.

[6] D. Oikonomou, M. Buchholz, Y.-M. Pun, R. M. Gower, and N. Loizou. "Taking the Road Less Scheduled with Adaptive Polyak Steps". In: *Conference on Neural Information Processing Systems (NeurIPS)*. 2026. arXiv: 2511.07767 [cs.LG]. URL: https://arxiv.org/abs/2511.07767.

[7] T. Parshakova, A. Khaled, M. Crawshaw, G. Garrigos, and R. M. Gower. "Muon Does Not Converge on Convex Lipschitz Functions". In: *Conference on Neural Information Processing Systems (NeurIPS)*. 2026. arXiv: 2605.08980 [cs.LG]. URL: https://arxiv.org/abs/2605.08980.

[8] F. Schaipp, R. M. Gower, and A. B. Taylor. "Step-Size Stability in Stochastic Optimization: A Theoretical Perspective". In: *International Conference on Machine Learning (ICML)*. 2026. arXiv: 2602.09842 [math.OC]. URL: https://arxiv.org/abs/2602.09842.

[9] D. Cai, R. M. Gower, D. M. Blei, and L. K. Saul. "Fisher Meets Feynman: Score-Based Variational Inference with a Product of Experts". In: *Conference on Neural Information Processing Systems (NeurIPS)*. Spotlight presentation. 2025. arXiv: 2510.21598 [stat.ML]. URL: https://arxiv.org/abs/2510.21598.

[10] A. Mishkin, A. Bietti, and R. M. Gower. "Level Set Teleportation: An Optimization Perspective". In: *International Conference on Artificial Intelligence and Statistics (AISTATS)*. Vol. 258. Proceedings of Machine Learning Research. PMLR, 2025, pp. 5059–5067. arXiv: 2403.03362. URL: https://proceedings.mlr.press/v258/mishkin25a.html.

[11] A. Orvieto and R. M. Gower. "In Search of Adam's Secret Sauce". In: *Conference on Neural Information Processing Systems (NeurIPS)*. Oral presentation. 2025. arXiv: 2505.21829 [cs.LG]. URL: https://openreview.net/forum?id=CH72XyZs4y.

[12] F. Schaipp, G. Garrigos, U. Şimşekli, and R. M. Gower. "Tracking the Median of Gradients with a Stochastic Proximal Point Method". In: *Transactions on Machine Learning Research (TMLR)* (2025). arXiv: 2402.12828 [cs.LG]. URL: https://openreview.net/forum?id=WMxLEgYGxu.

[13] D. Cai, C. Modi, C. C. Margossian, R. M. Gower, D. M. Blei, and L. K. Saul. "EigenVI: Score-Based Variational Inference with Orthogonal Function Expansions". In: *Conference on Neural Information Processing Systems (NeurIPS)*. Vol. 37. Spotlight presentation. 2024. arXiv: 2410.24054. URL: https://openreview.net/forum?id=thUf6ZBlPp.

[14] D. Cai, C. Modi, L. Pillaud-Vivien, C. Margossian, R. M. Gower, D. M. Blei, and L. K. Saul. "Batch and Match: Black-Box Variational Inference with a Score-Based Divergence". In: *International Conference on Machine Learning (ICML)*. Vol. 235. Proceedings of Machine Learning Research. Spotlight presentation. PMLR, 2024, pp. 5258–5297. arXiv: 2402.14758. URL: https://proceedings.mlr.press/v235/cai24b.html.

[15] R. M. Gower, D. A. Lorenz, and M. Winkler. "A Bregman-Kaczmarz Method for Nonlinear Systems of Equations". In: *Computational Optimization and Applications (COAP)* 87.3 (2024), pp. 1059–1098. DOI: 10.1007/s10589-023-00541-9. arXiv: 2303.08549. URL: https://doi.org/10.1007/s10589-023-00541-9.

[16] Y. Li, R. Yuan, C. Fan, M. Schmidt, S. Horváth, R. M. Gower, and M. Takáč. *Enhancing Policy Gradient with the Polyak Step-Size Adaptation*. 2024. arXiv: 2404.07525 [cs.LG]. URL: https://arxiv.org/abs/2404.07525.

[17] A. Mishkin, A. Khaled, Y. Wang, A. Defazio, and R. M. Gower. "Directional Smoothness and Gradient Methods: Convergence and Adaptivity". In: *Conference on Neural Information Processing Systems (NeurIPS)*. Vol. 37. 2024. arXiv: 2403.04081. URL: https://proceedings.neurips.cc/paper_files/paper/2024/hash/1ac83203e88eb6cf6b30642f0239b932-Abstract-Conference.html.

[18] F. Schaipp, R. Ohana, M. Eickenberg, A. Defazio, and R. M. Gower. "MoMo: Momentum Models for Adaptive Learning Rates". In: *International Conference on Machine Learning (ICML)*. Vol. 235. Proceedings of Machine Learning Research. PMLR, 2024, pp. 43542–43570. arXiv: 2305.07583. URL: https://proceedings.mlr.press/v235/schaipp24a.html.

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[22] A. Khaled, O. Sebbouh, N. Loizou, R. M. Gower, and P. Richtárik. "Unified Analysis of Stochastic Gradient Methods for Composite Convex and Smooth Optimization". In: *Journal of Optimization Theory and Applications (JOTA)* 199.2 (2023), pp. 499–540. DOI: 10.1007/s10957-023-02297-y. arXiv: 2006.11573. URL: https://doi.org/10.1007/s10957-023-02297-y.

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[25] C. Modi, R. M. Gower, C. Margossian, Y. Yao, D. Blei, and L. Saul. "Variational Inference with Gaussian Score Matching". In: *Conference on Neural Information Processing Systems (NeurIPS)*. Ed. by A. Oh, T. Naumann, A. Globerson, K. Saenko, M. Hardt, and S. Levine. Vol. 36. Curran Associates, Inc., 2023, pp. 29935–29950. URL: https://proceedings.neurips.cc/paper_files/paper/2023/file/5f9453c4848b89d4d8c5d6041f5fb9ec-Paper-Conference.pdf.

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