

MARC AURÈLE GILLES

ma-gilles.github.io

Princeton University, Fine Hall ◊ Washington Road, Princeton NJ 08544

French citizen ◊ US permanent resident

RESEARCH RESUME

My research focuses on numerical linear algebra, computational imaging, and applications to cryogenic electron-microscopy (cryo-EM). I build tools to analyze large, high-dimensional and noisy datasets arising in cryo-EM.

EDUCATION

Cornell University September 2014 - May 2019
Ph.D. in Applied Mathematics *Ithaca, NY*
Advised by Prof. Alex Townsend
Thesis title: At the intersection of differential equations and optimization: inverse problems, path planning and Krylov subspaces.

Rutgers University January 2012 - May 2014
B.A. in Mathematics *New Brunswick, NJ*
Summa Cum Laude
Minor in Economics

Raritan Valley Community College September 2010 - January 2012
Concentration in Economics *Branchburg, NJ*

PROFESSIONAL EXPERIENCE

Princeton University, Department of Mathematics September 2024 - Present
Assistant Professor of Mathematics *Princeton, NJ*

Princeton University, PACM September 2021 - September 2024
Postdoctoral Research Associate *Princeton, NJ*

- Advised by Prof. Amit Singer.
- Researched algorithms for reconstruction of protein structures by cryo-EM.
- Developed computational priors for Bayesian inference of protein structure and methods for covariance estimation of inferred potentials.
- Developed computational methods for heterogeneity analysis in cryo-EM.

Facebook Reality Labs July 2019 - September 2021
Research Scientist *Redmond, WA*

- Researched core technologies for augmented and virtual reality.
- Developed efficient algorithms for precise calibration, processing, and state estimation for novel sensors and imaging technologies.
- Invented and patented novel sensors for augmented reality.
- Led the optimal design of hardware components.
- Mentored and managed two Ph.D. interns on research projects.

Facebook Reality Labs June 2018 - August 2018
Research Intern *Redmond, WA*

- Designed novel computer vision and optimization algorithms for eye tracking and calibration.
- Implemented algorithms in C++ using OpenCV and Eigen.
- Worked alongside mechanical engineers and optical scientists to build experimental setups.
- Conceived and conducted user studies.

Argonne National Laboratory

Research Intern

June 2017 - August 2017

Lemont, IL

- Designed algorithms to perform 3D image reconstruction of nanometer-scale objects from X-ray measurements.
- Solved inverse problems with tens of millions of unknowns using supercomputers with tens of thousands of cores.
- Wrote high performance, massively parallel code in C using MPI and MKL.
- Collaborated with a team of physicists, engineers, and mathematicians.

Center for Discrete Mathematics And Theoretical Computer Science (DIMACS)

Undergraduate Researcher

June 2013 - August 2013

Piscataway, NJ

- Developed computational imaging tools for biomedical applications under the supervision of Prof. Schliep.

TEACHING EXPERIENCE

Princeton University

Instructor

January 2023 - May 2023

Princeton, NJ

- (Spring 2025) - MAT 204 : Advanced Linear Algebra with Applications
- (Fall 2024) - Mathematics Junior Seminar: The Top 10 Algorithms of the 20th Century
- (Fall 2024) - MAT 321/APC 321: Numerical Analysis and Scientific Computing
- (Spring 2023) MAT 321/APC 321: Numerical Methods

Cornell University

Teaching Assistant

September 2014 - July 2019

Ithaca, NY

- Prepared and held recitations
- Held office hours
- Wrote and graded exams.
- Classes taught:
INFO 2950 - Introduction to Data Science (Head TA)
CS4780/5780 - Machine Learning for Intelligent Systems
CS 1112 - Introduction to Computing Using MATLAB
MATH 1910 - Calculus for engineers
MATH 1920 - Multivariable Calculus for engineers
MATH 1110 - Calculus I

ADVISING

- Won-Jae Chang (co-advised with Amit Singer). Princeton Undergraduate (B.A., economics, 2024). PACM certificate - project on “Efficient algorithms for Ewald sphere correction in cryo-EM”

HONORS AND PRIZES

- McGraw Center’s exemplar mentor award for graduate students and postdocs (2024)
- SIAM Student Travel Award (3×) in 2017 and 2018, 2023
- NSF Mathematical Sciences Graduate Internship in 2017
- Lawrence Corwin Memorial Math Prize in 2014
- Stanley E. Brasefield Mathematics Scholarship in 2013

JOURNAL PUBLICATIONS

1. M. A. GILLES AND A. SINGER, *Cryo-em heterogeneity analysis using regularized covariance estimation and kernel regression*, Proceedings of the National Academy of Sciences, (to appear)
2. A. ZHANG, O. MICKELIN, J. KILEEL, E. J. VERBEKE, N. F. MARSHALL, M. A. GILLES, AND A. SINGER, *Moment-based metrics for molecules computable from cryogenic electron microscopy images*, Biological Imaging, 4 (2024), p. e3
3. M. A. GILLES AND A. SINGER, *A molecular prior distribution for bayesian inference based on wilson statistics*, Computer methods and programs in biomedicine, 221 (2022), p. 106830
4. E. J. VERBEKE, M. A. GILLES, T. BENDORY, AND A. SINGER, *Self fourier shell correlation: properties and application to cryo-et*, Communications Biology, 7 (2024), p. 101
5. M. A. GILLES AND A. TOWNSEND, *Continuous analogues of Krylov subspace methods for differential operators*, SIAM Journal on Numerical Analysis, 57 (2019), pp. 899–924
6. M. A. GILLES, C. EARLS, AND D. BINDEL, *A subspace pursuit method to infer refractivity in the marine atmospheric boundary layer*, IEEE Transactions on Geoscience and Remote Sensing, 57 (2019), pp. 5606–5617
7. M. A. GILLES, Y. NASHED, M. DU, C. JACOBSEN, AND S. WILD, *3D X-ray imaging of continuous objects beyond the depth of focus limit*, Optica, 5 (2018), pp. 1078–1086
8. M. A. GILLES AND A. VLADIMIRSKY, *Evasive path planning under surveillance uncertainty*, Dynamic Games and Applications, (2018)

TALKS AND PRESENTATIONS

- RECOVAR: A Bayesian framework for cryo-EM heterogeneity analysis (Selected poster talk), Gordon Research Conference, Barcelona, Spain, 2024
- RECOVAR: A Bayesian framework for cryo-EM heterogeneity analysis, Gordon Research Seminar, Barcelona, Spain, 2024
- Reconstructing flexible proteins from cryo-EM datasets, SIAM ALA, Sorbonne Université, 2024
- Reconstructing flexible proteins from massive microscopy datasets, Applied Mathematics Seminar, Yale University, New Haven, 2024
- Reconstructing flexible proteins from massive microscopy datasets, Applied Mathematics Seminar (online), University of Texas at Austin, 2024
- A Bayesian framework for cryo-EM heterogeneity analysis, CCM-CCB seminar, Flatiron Institute, NYC, 2023
- A Bayesian framework for cryo-EM heterogeneity analysis, Cryo-EM One World seminar series (online)

- Cryo-EM heterogeneity analysis by regularized covariance estimation, IAS, Gottingen, 2023
- Cryo-EM heterogeneity analysis by regularized covariance estimation, ICIAM, Tokyo, 2023
- Cryo-EM heterogeneity analysis by regularized covariance estimation, Cryo-EM summer workshop, Flatiron Institute, New York, 2023
- High Dimensional Covariance Estimation in Cryo-EM, SIAM MDS, San Diego, 2022
- Heterogeneity analysis in cryo-EM, IPAM seminar, Los Angeles, 2022
- Near Real-Time Heterogeneity Analysis by Sketched Covariance, GRC Three Dimensional Microscopy, Barcelona, Spain, 2022 (Selected Poster Presentation)
- A Molecular Prior Distribution for Bayesian Inference Based on Wilson Statistics, Cryo-EM seminar, Flatiron Institute, NY (online), 2022
- Computing with subspaces generated by differential operators, IDeAS seminar, Princeton University, 2021
- 3D X-ray imaging beyond the depth of focus limit, SIAM Conference on Imaging Science, 2018
- Continuous analogues of Krylov methods for differential operators, SIAM Conference on Applied Linear Algebra, 2018
- Continuous analogues of Krylov methods for differential operators, Scientific Computing and Numerics seminar, Cornell University, 2018
- Adversarial path planning, Scientific Computing and Numerics seminar, Cornell University, 2017
- A Subspace Pursuit Method to Invert the Refractivity Profile within the Marine Atmospheric Boundary Layer (Poster), SIAM Conference on Computational Science and Engineering, 2017

ORGANIZED EVENTS

- Co-organized “Advances of regularization techniques in iterative reconstruction” minisymposium at SIAM Conference on Imaging Science (2018)
- Organized Applied Mathematics student-invited speaker series at Cornell University (2017-2019)

SOFTWARE

- RECOVAR [1]: <https://github.com/ma-gilles/recover>
- C++ companion library to [7]: github.com/eikonal-equation/Stationary_SEG
- MATLAB companion libraries to [4] : chebfun.org/examples/ode-linear/Krylov.html
- Python companion library https://github.com/ma-gilles/wilson_prior

TECHNICAL SKILLS

Computer Languages	Python, MATLAB, Julia, C++, C
Libraries	PyTorch, JAX, OpenCV, Eigen, MPI
Others	Github, Mercurial, Linux