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*

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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 June 2017 - August 2017
Research Intern *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) June 2013 - August 2013
Undergraduate Researcher *Piscataway, NJ*

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

TEACHING EXPERIENCE

Princeton University January 2023 - May 2023
Instructor *Princeton, NJ*

- (Fall 2025) - MAT 321/APC 321: Numerical Analysis and Scientific Computing
- (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 September 2014 - July 2019
Teaching Assistant *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

- Matias Andia, Princeton Undergraduate (B.A., Mathematics, 2027). Summer research "Tensor factorization methods for density estimation"
- Iniabasi Ekpenyong, Princeton Undergraduate (B.A., Computer Science, 2026). Summer research "Neural network-based solutions to high-dimensional PDEs"

· 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 examplar 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. Luke Evans, Lars Dingeldein, Roberto Covino, Marc Aurèle Gilles, Erik Thiede, and Pilar Cossio. Counting particles could give wrong probabilities in cryo-electron microscopy. *bioRxiv*, pages 2025–03, 2025
2. Marc Aurèle Gilles and Amit Singer. Cryo-EM heterogeneity analysis using regularized covariance estimation and kernel regression. *Proceedings of the National Academy of Sciences*, 122(9):e2419140122, 2025
3. Andy Zhang, Oscar Mickelin, Joe Kileel, Eric J Verbeke, Nicholas F Marshall, Marc Aurèle Gilles, and Amit Singer. Moment-based metrics for molecules computable from cryogenic electron microscopy images. *Biological Imaging*, 4:e3, 2024
4. Marc Aurèle Gilles and Amit Singer. A molecular prior distribution for bayesian inference based on wilson statistics. *Computer methods and programs in biomedicine*, 221:106830, 2022
5. Eric J Verbeke, Marc Aurèle Gilles, Tamir Bendory, and Amit Singer. Self fourier shell correlation: properties and application to cryo-et. *Communications Biology*, 7(1):101, 2024
6. Marc Aurèle Gilles and Alex Townsend. Continuous analogues of Krylov subspace methods for differential operators. *SIAM Journal on Numerical Analysis*, 57(2):899–924, 2019
7. Marc Aurèle Gilles, Christopher Earls, and David Bindel. A subspace pursuit method to infer refractivity in the marine atmospheric boundary layer. *IEEE Transactions on Geoscience and Remote Sensing*, 57(8):5606–5617, 2019
8. Marc Aurèle Gilles, Youssef Nashed, Ming Du, Chris Jacobsen, and Stefan Wild. 3D X-ray imaging of continuous objects beyond the depth of focus limit. *Optica*, 5(9):1078–1086, 2018
9. Marc Aurèle Gilles and Alexander Vladimirsky. Evasive path planning under surveillance uncertainty. *Dynamic Games and Applications*, 2018

TALKS AND PRESENTATIONS

· Reconstructing conformational states and inferring conformational densities in cryo-EM, Biophysical Society Annual Meetings, CryoEM Subgroup, Los Angeles, USA, 2025
· Reconstructing Conformational States & Densities in CryoEM with RECOVAR, OpenEye CUP XXIV, Santa Fe, USA, 2025
· Reconstructing Distributions of Molecules from Cryo-EM Datasets, PACM/CSML joint Colloquium, Princeton, USA, 2025
· Reconstructing Distributions of Molecules from Cryo-EM Datasets, Computational Microscopy Reunion Conference 2, Los Angeles, USA, 2025

- 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/recovar`
- 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