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 mathematics of data science. My recent work is on applications to cryogenic electron-microscopy (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*

· Teach applied mathematics classes

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*

- Taught MAT 321 - Numerical Methods.
  Upper-level undergraduate course in Numerical Analysis.
  Course quality rated 4.8/5 by students
  Course website: `https://ma-gilles.github.io/mat321/mat321.html`

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

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. ——, *Cryo-em heterogeneity analysis using regularized covariance estimation and kernel regression*, bioRxiv, (2024)
2. M. A. Gilles and A. Singer, *A molecular prior distribution for bayesian inference based on wilson statistics*, arXiv preprint arXiv:2202.09388, (2022)
3. E. Verbeke, M. A. Gilles, T. Bendory, and A. Singer, *Self fourier shell correlation: properties and application to cryo-ET*, In review
4. 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
5. 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
6. 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
7. 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/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