Robin John Armstrong

Contact Information

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Education

Cornell University August 2021 – May 2026 (expected)
PhD, Applied Mathematics. Advisor: Anil Damle, Dept. of Computer Science. *Ithaca, NY*

Cornell University August 2021 – May 2024
MS, Applied Mathematics. Advisor: Anil Damle, Dept. of Computer Science. *Ithaca, NY*

University of Massachusetts Amherst September 2017 – May 2021
BS, Mathematics (Summa Cum Laude). *Amherst, MA*

Research Interests

Data assimilation, computational methods for geoscience, numerical linear algebra, covariance estimation.

Publications and Preprints

- Robin Armstrong and Ian Grooms, "Data Assimilation With An Integral-Form Ensemble Square-Root Filter," *Journal of Computational Physics*, 2025, 543, 114413.
- Robin Armstrong and Anil Damle, "Collect, Commit, Expand: Efficient CPQR-Based Column Selection for Extremely Wide Matrices," *arXiv preprints*, arXiv:2501.18035, 2025.
  Under review in the *SIAM Journal on Scientific Computing*.
- Robin Armstrong, Alex Buzali, and Anil Damle, "Structure-Aware Analyses and Algorithms for Interpolative Decompositions," *SIAM Journal on Scientific Computing*, 2025, 47 (3), A1527-A1554.

Software

CCEQR.jl

https://github.com/robin-armstrong/CCEQR.jl

- Julia package providing a highly efficient variant of the column-pivoted QR (CPQR) factorization for matrices with far more columns than rows.
- Algorithm documented in R. Armstrong and A. Damle, "Collect, Commit, Expand: Efficient CPQR-Based Column Selection for Extremely Wide Matrices," *arXiv preprints*, arXiv:2501.18035, 2025.

Data Assimilation Research Testbed (DART)

https://github.com/NCAR/DART

- A community software project for prototyping and testing ensemble data assimilation methodologies with Earth system models.
- Contributed a Fortran interface to the Marine Biogeochemistry Library (MARBL); see https://github.com/NCAR/DART/tree/main/models/MARBL_column.

Presentations

- 15$^{\text{th}}$ AIMS Conference on Dynamical Systems, Differential Equations, and Applications, July 2026, Athens, Greece (Upcoming).
  Title TBA, in "Innovations in Data Assimilation: Theory, Algorithms, and Application."
- 27$^{\text{th}}$ Conference of the International Linear Algebra Society, May 2026, Blacksburg, VA (Upcoming).
  Title TBA, in "Hierarchical Low-Rank Approximations: Algorithms and Applications."
- AGU Annual Meeting, December 2025, New Orleans, LA (Upcoming).
  "Localizing High-Dimensional Covariance Estimates with Hierarchical Rank Structure."

- SIAM NNP Section Conference, November 2025, State College, PA.
  "Estimating High-Dimensional Covariance Matrices with Hierarchical Rank Structure."
- SIAM Conference on Mathematical and Computational Issues in Geosciences, October 2025, Baton Rouge, LA.
  "Estimating High-Dimensional Covariance Matrices with Hierarchical Rank Structure."
- SIAM Conference on Computational Science and Engineering, March 2025, Fort Worth, TX.
  "A Quadrature Technique for Efficient Kalman Filtering with Model-Space Covariance Localization."
- 11$^{\text{th}}$ International Symposium on Data Assimilation, October 2025, Melbourne, Australia.
  "Localizing High-Dimensional Covariance Estimates with Hierarchical Rank Structure."
- 26$^{\text{th}}$ Conference of the International Linear Algebra Society, June 2025, Kaohsiung, Taiwan.
  "Identifying and Estimating Dynamical Covariance Matrices with Hierarchical Rank Structure."
- Householder Symposium XXII, June 2025, Ithaca, NY (Poster).
  "Collect, Commit, Expand: an Efficient Strategy for Column Subset Selection on Extremely Wide Matrices."
- SIAM Conference on Applications of Dynamical Systems, May 2025, Denver, CO.
  "A Quadrature Technique for Efficient Kalman Filtering with Model-Space Covariance Localization."
- International Symposium on Data Assimilation, March 2024, Online.
  "An Integral-Form Ensemble Square-Root Filter with Efficient and Precise Model-Space Localization."
- American Meteorological Society Annual Meeting, January 2025, New Orleans, LA.
  "A Quadrature Technique for Ensemble Kalman Filtering with Efficient and Precise Covariance Localization."
- Mid-Atlantic Numerical Analysis Day, November 2024, Philadelphia, PA.
  "Collect, Commit, Expand: A Strategy for Faster CPQR-Based Column Selection on Short, Wide Matrices."
- SIAM NNP Section Conference, November 2024, Henrietta, NY.
  "Collect, Commit, Expand: A Strategy for Faster CPQR-Based Column Selection on Short, Wide Matrices."
- Student Colloquium in Applied Mathematics, October 2024, Cornell University, Ithaca, NY.
  "Lessons From a Difficult Eigenvalue Problem."
- JCSDA Science Cookies Series, July 2024, Boulder, CO.
  "A Quadrature Technique for Model-Space Localization."
- Data Assimilation Research Centre Seminar Series, May 2024, University of Reading, Reading, UK (Remote).
  "A Quadrature Method for Ensemble Kalman Filtering with Model Space Localization."
- AGU Ocean Sciences Meeting, February 2024, New Orleans, LA.
  "MARBL-DART: An Ensemble System for Biogeochemical Data Assimilation and Parameter Estimation."
- Teaching Seminar, October 2022, Cornell University, Ithaca, NY.
  "The Challenges of Mathematical Language."

Research Experience

Graduate Student Researcher January 2022 - Present

Cornell University, Center for Applied Mathematics *Ithaca, NY*

- Conducting reserach in efficient numerical computation for data assimilation. Research published in the SIAM Journal on Scientific Computing, and under review in the Journal of Computational Physics.
- Project focuses:
  - Efficient ensemble data assimilation with model-space localization (see Armstrong and Grooms, 2025).
  - Forecast covariance matrix estimation with novel localization techniques (in progress).
  - Fast algorithms for large-scale matrix computations (see Armstrong and Damle 2025, Armstrong et al. 2025).

Visitor, NSF National Center for Atmospheric Research May 2024 - July 2024

MMM Visiting Scholar Program *Boulder, CO*

- Began ongoing work to implement a novel ensemble square-root filtering algorithm in the Joint Effort for Data Assimilation with the Model for Prediction Across Scales (MPAS-JEDI). This algorithm was developed by myself and Ian Grooms in our preprint "Data Assimilation with an Integral-Form Ensemble Square-Root Filter," currently under review in the Journal of Computational Physics.

- Results to presented at the American Meteorological Society 2025 annual meeting.
- Supervisor: Chris Snyder (MMM).

Visitor, NSF National Center for Atmospheric Research August 2023 - February 2024
CISL and CGD Visiting Scholar Programs *Remote*

- Finished development of MARBL-DART that was initiated during the summer 2023 internship.
- Presented work at the AGU Ocean Sciences 2024 meeting.
- Supervisors: Moha Gharamti (CISL) and Dan Amrhein (CGD/CISL).

Intern, NSF National Center for Atmospheric Research May 2023 - August 2023
Summer Internships in Parallel Computational Science (SIParCS) *Boulder, CO*

- Began development of MARBL-DART, an ensemble data assimilation system for optimizing the parameters of the Marine Biogeochemistry Library (MARBL) using the Data Assimilation Research Testbed (DART).
- Participated in weekly professional development sessions covering topics in science communication, proposal writing, and diversity, equity, and inclusion (DEI).
- Supervisors: Moha Gharamti (CISL) and Dan Amrhein (CGD/CISL).

Mentorship and Teaching

Research Mentor December 2025 - Present
Cornell University *Ithaca, NY*

- Mentoring a master's student (formally an undergraduate at Cornell) in research on scientific computing and low-rank approximation. Developing novel theory to quantify singular subspace estimation errors in the randomized singular value decomposition under new error metrics.
- Weekly meetings with my mentee to answer questions, share ideas, and set project direction.
- Work is intended to result in a publication in the SIAM Journal on Matrix Analysis and Appplications.

Teaching Assistant August 2020 - May 2023
Cornell University and University of Massachusetts Amherst *Ithaca, NY and Remote*

- At Cornell University: MATH 2940, Linear Algebra for Engineers (Fall 2021, Fall 2022), MATH 1106, Modeling with Calculus for the Life Sciences (Spring 2022), MATH 4130, Honors Introduction to Analysis I (Spring 2023).
- At UMass Amherst: MATH 300, Fundamental Concepts of Mathematics (Fall 2020).

Service

- Chair for contributed talk session at the 2025 SIAM Conference on Applications of Dynamical Systems.
- Co-chair for 2026 ISDA online session "Math and Methods."