Alec Dunton

Education

2017–2021 (Expected) **PhD, Applied Mathematics**, *University of Colorado Boulder*, 3.97/4.0.
Advisor: Alireza Doostan
Dissertation (In Progress): Data and model reduction techniques for large-scale applications
Course Highlights: Functional & Numerical Analysis; Advanced & Randomized Algorithms
Honors & Awards: 2020 HPEC Graph Challenge Team Champion, SIAM Student Travel Award, Graduate School Student Travel Grant, UGGS Student Travel Grant

2012–2016 **BS, Mathematics**, *Harvey Mudd College*, Claremont, CA, 3.80/4.0.
Advisor: Andrew Bernoff
Senior Thesis: Topological data analysis for systems of coupled oscillators
Course Highlights: Time Series Analysis, Principles of Computer Science, Dynamical Systems
Honors & Awards: Stavros Busenberg Prize in Applied Mathematics, Outstanding Student Presenter at AMS-MAA Joint Mathematics Meeting 2016, Honors in Mathematics & Graduation with Distinction, Murphy Fellowship (Northwestern University - declined)

PhD Thesis Work

subjects *model reduction, matrix sketching, mixed precision computing, graph clustering*

advisor Alireza Doostan

summary The first project of my thesis was centered on the development and large-scale implementation of pass-efficient matrix algorithms for lossy data compression with applications to simulation data. I have since completed a project in mixed precision algorithms for computing matrix interpolative decompositions with application to model reduction in particle laden turbulence. My ongoing projects include: (1) a general framework for deterministic matrix sketching for online low-rank approximation of simulation data; (2) the derivation and implementation of matrix-based compression algorithms in a task-based parallelism environment in collaboration with members of the Predictive Science Academic Alliance Program (PSAAP-II) team at Stanford University; (3) scalable, distributed matrix sketching algorithms for graph clustering in collaboration with Lawrence Livermore National Laboratory.

Other Research

subjects *nonlinear dimensionality reduction, multi-fidelity Gaussian process regression, topological data analysis*

summary Other ongoing and previous projects include (1) using kernel PCA and convolutional autoencoders to compress data from large-scale simulations; (2) taking advantage of existing linear algebraic analyses of multi-fidelity models to prove convergence of multi-fidelity Gaussian process regression (Co-kriging); (3) utilizing topological data analysis techniques, particularly persistent homology, to identify clusters in networks of coupled oscillators and train models to predict the movement of stock indices.

Experience

Academia

2017– **Research Assistant**, *University of Colorado Boulder*, Boulder, CO.

Funding Research Project: Low-rank approximation methods for compression of turbulent flow data. PSAAP-II Campaign, Stanford University. Funded by DOE Grant DE-NA-0002373, Award DE-SC0006402, NSF Grant CMMI-145460.

2017 **Teaching Assistant**, *University of Colorado Boulder*, Boulder, CO.

Course Taught: Calculus II (APPM 1360)
Responsibilities: Writing quizzes, grading written homework, proctoring and grading exams

2016 **Undergraduate Research Fellow**, *Harvey Mudd College*, Remote.

Project: Persistent homology of financial time series data
During this summer research project I worked under Professor Weiqing Gu in the Big Data research group at Harvey Mudd College. My work was again funded by the Rose Hills Foundation Undergraduate Research Fellowship, and focused on the application of techniques from topological data analysis and machine learning to financial time series data.

2015 **Undergraduate Research Fellow**, *Harvey Mudd College*, St. Paul, MN..

Project: Topological data analysis for systems of coupled oscillators
This Summer REU was an introduction to the mathematical study of coupled oscillators, namely the Kuramoto model. I worked on using topological data analysis to infer network topology from simulation data. The fellowship grant of 5000 dollars which I received to fund this experience came from the Rose Hills Foundation, an organization which supports undergraduate research for students in the greater Los Angeles area.

2014–2016 **Math Grader & Tutor**, *Harvey Mudd College*, Claremont, CA.

Courses Tutored & Graded: Fourier Series/Boundary Value Problems (PHYS115), Partial Differential Equations (MATH180)
Courses Graded: Dynamical Systems (MATH181)

Government

2020 **Data Science Summer Institute**, *Lawrence Livermore National Lab*, Remote.

Project: Scaling graph clustering with distributed matrix sketching
Mentor: Ben Priest
Responsible for conducting basic research in graph clustering and matrix sketching
Implemented matrix sketches in C++ and Python
Submitted paper to the HPEC Graph Challenge
Attended seminars on various topics in data science
Studied problem in neuroimaging; used convolutional autoencoder for binary classification.

2019 **Computing Graduate Intern**, *Lawrence Livermore National Lab*, Livermore, CA.

Project: Variable precision computing
Mentor: Alyson Fox
Responsible for conducting basic research in variable precision computing
Developed novel algorithms for computing matrix interpolative decompositions
Conducted error analysis and studied both probabilistic and deterministic bounds

Industry

2014 **Data Engineering Intern**, *Intuit*, Mountain View, CA.

Worked on the IDEA Team: Intuit Data Engineering and Analytics
Assigned to the Web Software Development Kit project
Participated in the innovation university intern program
Helped design and present a tool to help business owners predict future cash flows

Languages

French — Three years of coursework in undergraduate.

Spanish — Three years of coursework in high school.

Skills

languages — MATLAB (primary), Python (primary), Julia (lots), C++ (some)

other — LaTeX, monte carlo simulation, statistics, algorithms, machine learning, topological data analysis, randomized algorithms for numerical linear algebra applications

Publications

- **A. Dunton**, A. Doostan. *Single-pass autoencoders for online data compression.* In preparation. 2021.
- **A. Dunton**, A. Doostan. *Online self-expressive basis updates for low-rank approximation.* In preparation. 2021.
- H. Pacella, **A. Dunton**, A. Doostan, G. Iaccarino. *In situ compression for large-scale simulations using interpolative decomposition methods.* In preparation. 2021.
- **A. Dunton**, A. Doostan. *Determinstic sketches for low-rank approximation of simulation data.* In preparation. 2021.
- **A. Dunton**, A. Fox. *Mixed precision matrix interpolative decompositions with application to model reduction.* In preparation. 2021.
- B. Priest, **A. Dunton**, G. Sanders. *Scaling graph clustering with distributed sketches.* HPEC Graph Challenge. 2020.
- **A. Dunton**, L. Jofre, A. Doostan, G. Iaccarino. *Pass-efficient methods for compression of high-dimensional particle-laden turbulent flow data.* Journal of Computational Physics. 2020.

Talks & Presentations

- B. Priest, **A. Dunton**, G. Sanders. *Scaling graph clustering with distributed sketches. Summer SLAM! Special Edition. Livermore Lab Foundation. Virtual talk. 2020.*
- B. Priest, **A. Dunton**, G. Sanders. *Scaling graph clustering with distributed sketches. Summer SLAM! Lawrence Livermore National Laboratory. Virtual talk. 2020.*
- **A. Dunton**, A. Fox. *Mixed precision algorithms for deterministic feature selection.* 16^{th} Copper Mountain Conference on Iterative Methods. Mini-symposium talk (cancelled due to pandemic). 2020.
- H. Pacella, **A. Dunton**, A. Doostan, G. Iaccarino. *In situ data compression for large-scale computational fluid dynamics simulations via interpolative decomposition methods.* APS. 2019.
- **A. Dunton**, L. Jofre, A. Doostan, G. Iaccarino. *Pass-efficient matrix algorithms for lossy data compression.* SIAM Conference on Computational ScienGianlucace & Engineering. Mini-symposium talk. 2019.

- **A. Dunton**, L. Jofre, A. Doostan, G. Iaccarino. *Pass-efficient compression of high-dimensional particle-laden turbulent flow data*. Predictive Simulation Academic Alliance Program II Review - Stanford. Talk. 2018.
- **A. Dunton**, L. Jofre, A. Doostan, G. Iaccarino. *Matrix decomposition algorithms for large-scale data compression*. SIAM Conference on Uncertainty Quantification. Mini-symposium talk. 2018.
- **A. Dunton**, L. Jofre, A. Doostan, G. Iaccarino. *Pass-efficient methods for compression of high-dimensional particle-laden turbulent flow data*. IMA Workshop on Integrating Machine Learning and Predictive Simulation. Poster. 2018.
- **A. Dunton**. *Topological data analysis for systems of coupled oscillators*. Talk & Poster. Harvey Mudd College. 2016.
- E. Datta, **A. Dunton**, H. Fremont. *The topology of systems of coupled oscillators*. AMS-MAA Joint Mathematics Meeting. Poster. Seattle, WA. 2016.

Organizational Memberships

- SIAM CU Boulder Student Chapter (2017-Present)