

NATHAN MANKOVICH

CURRICULUM VITAE

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EDUCATION

- Ph.D. in Mathematics**, Colorado State University, Fort Collins, CO *Jan 2019- Mar 2023*
Advisor: Michael Kirby
Thesis: "Subspace Averaging for Computer Vision and Bioinformatics"
- M.S. in Mathematics**, Colorado State University, Fort Collins, CO *Aug 2017-Dec 2019*
Advisor: Michael Kirby
Thesis: "Methods for Network Generation and Spectral Feature Selection: Especially on Gene Expression Data"
- B.S. in Mathematics**, Colorado College, Colorado Springs, CO *Aug 2013-May 2017*
Advisor: Michael Penn
Thesis: "Using Commutative Algebra to Examine a Rogers-Ramanujan Identity"
Study abroad: Budapest Semesters in Mathematics (Fall 2015)

WORK EXPERIENCE

- Post Doctoral Researcher** *March 2023-present*
University of Valencia, Valencia, Spain
A member of the Image and Signal Processing Group (ISP) and diving into the field of earth system science by utilizing geometric and topological characteristics to understand underlying dynamical and causal relations between multimodal earth science data. Specific lines of investigation include Koopman mode decomposition, Riemannian manifolds (e.g., flag manifolds), and causality. Under the supervision of Gustau Camps-Valls.
- Graduate Research Assistant** *Jan 2019-March 2023*
Colorado State University, Fort Collins, CO
Leveraging subspace learning and network theory in conjunction with supervised classification and unsupervised clustering machine learning methods to analyze multi-omics datasets. Collaborative research with CSU students and faculty in mathematics and computer science for the Defense Advanced Research Projects Agency (DARPA) (2019 to 2020) and ZOETIS (2020 to 2023). Code: Pathway Analysis and Module Refinement. Under the supervision of Michael Kirby.
- PhD Intern** *Summer 2020, Summer 2021*
Pacific Northwest National Labs, Remote
Investigations into the geometric properties of the feature space of prototypical networks and few shot models in general. The project continued as a part time position Winter 2020/2021. Building approximate rationally invariant neural networks by learning on Fourier ring descriptors- rotationally invariant feature representations for images. Under the mentorship of Henry Kvinge and Tegan Emerson.
- Probability Researcher** *Summer 2016*
Colorado College, Colorado Springs, CO
Demonstrated the utility of APPL (A Probability Programming Language) by using its commands to write a program that generated 400 families of distributions.
- Geospatial Big Data Solutioneer Intern** *Summer 2015*
Digital Globe, Thorton, CO
Designed a workflow for large-scale orchard spatial analysis with California almond orchards.

Implemented the system on high-resolution Digital Globe imagery using the Geo Big Data platform to run algorithms for feature identification, extraction, analysis, and visualization at scale. Mentored by Jordan Reed.

Peer Tutor

2015-2017

Colorado College, Colorado Springs, CO

Tutoring students in mathematics courses from pre-calculus and calculus to proof-based courses like abstract algebra and real analysis and even computer science courses.

Lab Technician

2013-2017

Colorado College, Colorado Springs, CO

Introduced the Aerial Mapping Initiative (AMI) which builds and operates unmanned aerial vehicles to create high-resolution digital elevation models and raster data for geological, ecological, and environmental remote sensing projects. Student assistant for classes with labs using GIS (Geographic Information Systems). Monitoring and maintaining computer labs on campus.

Lab Technician

Summer 2013

National Institute of Standards and Technology, Boulder, CO

Built a circuit board, designed using Altium. Organized LabVIEW programs that operate various terahertz lab equipment. Acquired Machining Shop Certification at CU Boulder. Updated lab computers to Windows 7 and reinstalled scientific programs.

Summer High School Internship Program (SHIP)

Summer 2012

National Institute of Standards and Technology, Boulder, CO

Student intern collecting data for jet fuel density measurements using a vibrating tube densimeter. Introduced to programming with LabVIEW and the thermodynamic properties database, REFPROP.

PUBLICATIONS AND PREPRINTS

1. **Nathan Mankovich**, Kai-Hendrik Cohrs, Homer Durand, Vasileios Sitokonstantinou, Tristan Williams, Gustau Camps-Valls. Dimensionality reduction for remote sensing data analysis: A systematic review of methods and applications. *arXiv preprint*, 2025.
2. Robert CJ Wills, et al. Forced Component Estimation Statistical Method Intercomparison Project (ForceSMIP). *preprint*, 2025.
3. **Nathan Mankovich**, Ignacio Santamaria, Gustau Camps-Valls, Tolga Birdal. A flag decomposition for hierarchical datasets. *CVPR*, 2025.
4. **Nathan Mankovich**, Shahine Bouabid, Peer Nowack, Deborah Bassotto, Gustau Camps-Valls. Analyzing climate scenarios using dynamic mode decomposition with control. *EDS*, 2025.
5. Homer Durand, Gherardo Varando, **Nathan Mankovich** and Gustau Camps-Valls. Out-of-distribution robustness for multivariate analysis via causal regularisation. *AISStats*, 2025.
6. John Jasper, **Nathan Mankovich**, Dustin Mixon. Optimal codes in the Stiefel manifold. *arXiv preprint*, 2024.
7. David Aristoff, Jeremy Copperman, **Nathan Mankovich**, and Alexander Davies. Featurizing Koopman mode decomposition for robust forecasting. *The Journal of Chemical Physics*, 2024.
8. **Nathan Mankovich**, Homer Durand, Emiliano Diaz, Gherardo Varando, Gustau Camps-Valls. Recovering latent confounders from high-dimensional proxy variables. *arXiv preprint*, 2024.
9. **Nathan Mankovich** and Tolga Birdal. Fun with flags: Robust principal directions via flag manifolds. *Proceedings of CVPR*, 2024.
10. **Nathan Mankovich** and Tolga Birdal. Chordal averaging on flag manifolds and its applications. *Proceedings of ICCV*, 2023.

11. **Nathan Mankovich**, Helene Andrews-Polymenis, David Threadgill, and Michael Kirby. Module representatives for refining gene co-expression modules. *Physical Biology*, 2023.
12. **Nathan Mankovich**, Eric Kehoe, Amy Peterson, and Michael Kirby. Pathway expression analysis. *Scientific Reports*, 2022.
13. **Nathan Mankovich**, Emily King, Chris Peterson, and Michael Kirby. The flag median and FlagIRLS. *Proceedings of CVPR*, 2022.
14. Benjamin Jarman, **Nathan Mankovich**, and Jacob Moorman. Randomized extended Kaczmarz is a limit point of sketch-and-project. *arXiv:2110.05605*, 2021.
15. Melissa Jay, **Nathan Mankovich**, and Elanore Campbell. Searching for a lost plane: A neighborhood-based probabilistic model. *UMAP Journal*, 2015.

RESEARCH PRESENTATIONS

A Flag Decomposition for Hierarchical Datasets	2025
CVPR, Nashville, USA	<i>Poster</i>
Physics-aware kernel Koopman operators	2025
USMILE Seminar	<i>Virtual presentation</i>
Physics-aware kernel Koopman operator estimation for consistent nonlinear mode decomposition	2025
European Geosciences Union Conference	<i>Virtual presentation</i>
Flag manifolds in modern data analysis	2025
Yao Group Seminar, Remote	<i>Presentation</i>
A Flag Representation for Hierarchical Datasets	2024
AI4CS Workshop, Valencia, Spain	<i>Presentation</i>
FlagRep: A Stiefel-coordinate Flag Representation for Hierarchical Datasets	2024
ECCV Workshop, Milan, Italy	<i>Poster</i>
Dynamic Mode Decomposition With Control for Climate Analyses: Opportunities for Attribution	2024
XAIDA, Remote	<i>Presentation</i>
Fun with Flags: Robust Principal Directions via Flag Manifolds	2024
CVPR, Seattle, USA	<i>Poster</i>
Stiefel Packings for Coherent Communications	2024
Optimal Point Distributions and Related Fields, ICERM, Providence, USA	<i>Presentation</i>
Analyzing Climate Scenarios Using Dynamic Mode Decomposition With Control	2024
European Geosciences Union Conference, Vienna, Austria	<i>Presentation</i>
Dynamics, Data and Deep Learning Workshop, Bristol, United Kingdom	<i>Presentation</i>
Fun With Flags: Robust Averages and Principal Directions	2024
Invited Talk, Universidad de Cantabria, Santander, Spain	<i>Presentation</i>
Averaging and Dimensionality Reduction using Flag Manifolds	2024
Joint Mathematics Meetings, San Francisco, USA	<i>Presentation</i>
Graph-Based Dimensionality Reduction and Clustering for Earth and Life Sciences	2023
Learning on Graphs Meetup, Madrid, Spain	<i>Presentation</i>
Chordal Averaging on Flag Manifolds and Its Applications	2023
ICCV, Paris, France	<i>Presentation & Poster</i>

Recovering Latent Confounders from High-dimensional Proxy Variables	2023
First the Friday Talk, University of Valencia, Valencia, Spain	<i>Presentation</i>
Chordal Distance Averages on the Grassmann and Flag Manifolds	2023
Invited Talk, Imperial College of London, London, UK	<i>Presentation</i>
Grassmannian Averages of Synthetic Datasets	2023
The 24th Midrasa Mathematicae, Israel Institute for Advanced Studies, Jerusalem, Israel	<i>Poster</i>
The Applications of Chordal Flag Averages	2023
First The Friday Talk, University of Valencia, Valencia, Spain	<i>Presentation</i>
Chordal Distance Averaging on Flag Manifolds and its Applications	2023
Topology Seminar, CSU, Fort Collins, USA	<i>Presentation</i>
Central Prototypes on Manifolds of Subspaces and Feature Analysis Using Graphs	2022
Greenslopes Seminar, CSU, Fort Collins, USA	<i>Presentation</i>
Subspace Averaging for Computer Vision and Bioinformatics	2022
Michael Penn Patreon Seminar	<i>Virtual presentation</i>
The Flag Median and FlagIRLS	2022
CVPR, New Orleans, USA	<i>Poster</i>
Pathway Expression Analysis	2022
q-bio, CSU, Fort Collins, USA	<i>Poster</i>
FRD-NNs and Lessons Learned at PNNL	2021
Greenslopes Seminar, CSU, Fort Collins, USA	<i>Virtual presentation</i>
Geometric Median of Subspaces	2020
Front Range Applied Math Student Conference, University of Colorado, Denver, USA	<i>Presentation</i>
Detecting Biomarkers for Influenza	2019
Rocky Mountain Virology Club Meeting, CSU, Fort Collins, USA	<i>Poster</i>

TEACHING EXPERIENCE

Advances in Dimensionality Reduction	Fall 2023, Spring 2025, Fall 2025
Math 161 - Calculus II (Online)	Spring 2020
Math 340 - Ordinary Differential Equations (Online)	Fall 2020
Math 160 - Calculus I	Fall 2017, Spring 2018, Fall 2018, Fall 2019

HONORS & AWARDS

ELLIS Society Member	present
Neurips Top Reviewer	2025
Colorado College Sophie Germain Award	2017
INFORMS Award in the Mathematical Contest in Modeling	2015

SERVICE

Reviewer at <i>JMLR</i> , <i>Neurips</i> , <i>PAMI</i> , <i>Geoscientific Model Development</i>	2024-2025
Webmaster and Liaison for <i>CSU SIAM Graduate Chapter</i>	2021-2023

SKILLS

Programming	Python, Matlab, R
Languages	English (Native), Spanish (Fluent)
Typesetting	Latex, Word
Misc	GitHub, Linux, VSCode, Slurm, VIM