Joseph Geisz

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Education

- **PhD in Mathematics, Colorado State University, Fort Collins, CO**   In Progress
  - Course Work: Real Analysis, Abstract Algebra, Algebraic Topology, PDEs, Measure Theory, Mathematics of Radar, Differential Geometry, Discrete Differential Geometry, Fourier Analysis, Random Walks

- **M.S. in Applied Mathematics, University of Colorado, Boulder, CO**   May 2020
  - Thesis: A 3D Extension of the Sierpinski Relatives and an Analysis of Their Persistent Homology   (Supervisor: Dr. James Meiss)
  - Course Work: Numerical Analysis, Mathematical Statistics, Modeling in Applied Mathematics, Markov Processes, Dynamics on Networks, Computer Graphics, Computer Animation
  - GPA: 3.900/4.0

- **B.S. in Applied Mathematics, University of Colorado, Boulder, CO**   May 2020
  - Minors in Computer Science, Physics, and Spanish
  - Course Work: Applied Analysis, Electromagnetism, Chaos in Dynamical Systems, Algorithms, Numerical Analysis, Classical Mechanics, Computer Systems, Fourier Series & Boundary Value Problems, Complex Variables, Applied Probability, Discrete Applied Mathematics, Data Structures
  - GPA: 3.861/4.0

Work Experience

- **Research and Development Year Round Intern**   May 2024 - Present
  Sandia National Laboratories
  - Contributed to data curation for Undocumented Orphaned Wells research program
  - Worked on improving VoroClust, a persistent homology inspired clustering algorithm
  - Learned the mathematical formulation of Synthetic Aperture Radar (SAR) Imaging
  - Investigated applications of Machine Learning and Artificial Intelligence to Radar

- **Research Engineer**   Aug 2022 – May 2024
  Michigan Tech University, Great Lakes Research Center
  - Continued work on projects with former USGS employers
  - Wrote python package to easily analyze robotic operating system data from autonomous underwater vehicles (AUV)
  - Published Datasets, Code, and Journal Articles related to research projects

- **Computer Scientist**   Aug 2020 — Aug 2022
  U.S. Geological Survey, Great Lakes Science Center
  - Coded machine learning algorithms to analyze Great Lakes AUV data
  - Maintained a dataset of nearly 1petabyte of AUV data

- Created science products and presentations to study invasive species, benthic ecology, and lake substrate
- Coordinated and filmed underwater 360 videos for the National Parks Service

Teaching Experience

- Teaching Assistant CSU Mathematics   Aug – Dec 2026
  - MATH 340: Ordinary Differential Equations
- Teaching Assistant CSU Mathematics   Aug – Dec 2025
  - MATH 160: Calculus for Engineers
- Teaching Assistant CSU Mathematics   Aug – Dec 2024
  - MATH 340: Ordinary Differential Equations
- Teaching Assistant CSU Mathematics   Aug – Dec 2023
  - MATH 120: College Algebra
- Teaching Assistant CU Boulder Applied Mathematics   Aug 2019 – May 2020
  - APPM 1340/1345: Calculus 1A and 1B
- Course Assistant CU Boulder Applied Mathematics   Aug – Dec 2017
  - APPM 3310: Matrix Methods and Linear Algebra
- Course Assistant CU Boulder Applied Mathematics   Aug – Dec 2018
  - APPM 4350: Fourier Series and PDE's

Written Publications

1. Geisz, Joseph. 2025. "A Model of Flocking Using Sheaves". *Conference Proceedings: TAG-DS,* Topology Algebra and Geometry in Data Science.

2. Esselman, P. C., Moradi, S., Geisz, J., & Roussi, C. 2025. "A transferable approach for quantifying benthic fish sizes and densities in annotated underwater images." *Methods in Ecology and Evolution*, 16, 145–159. https://doi.org/10.1111/2041-210X.14453

3. Geisz, Joseph K., Phillipe A. Wernette, and Peter C. Esselman. 2024. "Classification of Lakebed Geologic Substrate in Autonomously Collected Benthic Imagery Using Machine Learning." *Remote Sensing* 16, no. 7: 1264. https://doi.org/10.3390/rs16071264

4. Geisz, Joseph. 2020. "A 3D Extension of the Sierpinski Relatives and an Analysis of their Persistent Homology." Order No. 27958282, University of Colorado at Boulder.

Dataset Publications

1. Down-looking Images of Lake Trout (Salvelinus namaycush) and Round Goby (Neogobius melanostomus) to Support Automated Biomass Estimation   Oct 2024
2. Autonomously Collected Benthic Imagery for Substrate Prediction, Lake Michigan 2020-2021   Jan 2024

Code Publications

1. FishScale: Estimating fish length, abundance, and biomass density   Oct 2024
2. LabelingGUIs: Graphical user interface for image labeling   Dec 2023

Research Projects

1. Pattern Analysis Lab – Understanding Diffusion Models	Aug 2025 - Present
2. VoroClust: Scalable Accurate Clustering for High Dimensional Data	Oct 2024 – Sept 2025
3. Consensus Dynamics and Sheaf Laplacians	Jan 2024 – Oct 2024
4. Synthetic Aperture Radar Passive Source Localization	Aug 2024 – May 2025
5. Classifying Benthic Substrate Type with Computer Vision, Stereo Imagery, and Machine Learning	May 2021 – May 2024
6. Identifying Toxic Stamp Sands in Benthic Images with Computer Vision and Machine Learning	Feb. 2021 – May 2024
7. Detecting Quagga and Zebra Mussels in Underwater Imagery using Machine Learning	Mar. 2021 – Aug 2023
8. Great Lakes National Parks 360 Degree Underwater Films	Aug. 2021 – Aug 2023
9. Topological Data Analysis and 3D Fractals, CU Applied Math	June 2019 – May 2020
10. Summer Research for Undergraduates Program: Finite Element Methods for Seismic Modeling, CU Computer Science	June – Aug. 2019
11. Neutral Vehicle and Geotab Data Analysis and Visualization	Jan. – May 2019
12. Topological Data Analysis: Using Topology to Detect Bifurcations, CU Applied Math	Aug. 2017 – Dec. 2018

Presentations

1. *A Model of Flocking Using Sheaves,* Topology Algebra and Geometry in Data Science Conference	Dec 2025
2. *3D Fractals,* CSU Math Day 2025	Nov 2025
3. *A Model of Flocking Using Sheaves,* Colorado State University Topology Seminar	Nov 2025
4. *Math for Statisticians: Topology,* Colorado State University Greenslopes Seminar	Oct 2025
5. *"Fish Math" – How I used math and stats in my job even though my title wasn't mathematician,* Colorado State University Greenslopes Seminar	Mar 2025
6. *Consensus on Higher Order Networks,* Colorado State University Topology Seminar	Oct 2024
7. *Artificial Intelligence Applied to Radar: Summer Internship,* Colorado State University Inverse Problems, Data Science, and Applied Math Seminar	Sept 2024
8. *Toward a Spectral Theory of Cellular Sheaves and an Application to Flocking,* Colorado State University Topology Seminar	Feb 2024
9. *Topological Fractal Dimensions: Discreetness, Connectedness, and Beyond,* Colorado State University Topology Seminar	Oct 2023
10. *3D Sierpinski Relatives and their Persistent Homology*, Colorado State University Greenslopes Seminar	Sept 2023
11. *USGS Great Lakes Science Center Advanced Tech Work,* Michigan Technological University	Mar 2023
12. *Large-Scale Prediction of Nearshore Substrates in Lake Michigan from LiDAR Bathymetry using Machine Learning*, Joint Aquatic Sciences Meeting	May 2022

13. *High-Resolution Mapping of Spawning Reefs to Support Conservation in Northern Lake Michigan* (Co-Author), Joint Aquatic Sciences Meeting — May 2022

14. *Whole-lake indexing of round goby abundances and habitat in Lake Michigan with an imaging AUV* (Co-Author), Joint Aquatic Sciences Meeting — May 2022

15. *Persistent Homology and Extending the Sierpinski Relatives to 3D*, Front Range Applied Math Student Conference — Mar 2020

16. *Topological Data Analysis: Using Topology to Detect Bifurcations*, Front Range Applied Math Student Conference — Mar 2019

Posters

1. *A Model of Flocking Using Sheaves,* Topology Algebra and Geometry in Data Science Conference — Dec 2025

2. *Consensus on Higher Order Networks,* Dynamics Days 2025 and ICERM Patterns, Dynamics, and Data in Complex Systems — Jan 2025

3. *Artificial Intelligence Applied to Radar,* Sandia National Laboratories Summer Intern Symposium — Aug 2024

4. *Using Machine Learning to Differentiate Toxic Stamp Sands from Native Sands along the Keweenaw Peninsula*, Joint Aquatic Sciences Meeting — May 2022

5. *A Microcosm Experiment of Round Goby Catch Efficiency using Down Looking Still Imaging* (Co-Author), Joint Aquatic Sciences Meeting — May 2022

6. *Large-Scale Assessment of Benthic Algae Spatiotemporal Variation Enabled by Deep Learning on Autonomously Collected Imagery* (Co-Author), Joint Aquatic Sciences Meeting — May 2022

Computer Programs/Languages

- Languages: Python, C++, Mathematica, MATLAB, LaTeX
- Frameworks: Numpy, Pandas, OpenCV, Tensorflow, Scikit-Learn, OpenGL, ROS