

Riley C. W. O'Neill

2120 Long Lake Rd
New Brighton, MN, 55112
(651) 955-7399
oneil571@umn.edu

Github: <https://github.com/oneil571>

WORK AND RESEARCH EXPERIENCE:

National Science Foundation Graduate Research Fellow – University of Minnesota, Minneapolis, MN *Sept. 2022 – Present*

- Active researcher in machine learning, computer vision, and differential geometry; large language models and generative modeling
- Work with [AMAAZE Consortium](#) in developing new forms of convolutional neural networks for surfaces (PWN & triangulations) for classification of CT scans of ancient bone fragments. Developing metrics to analyze wear-patterns in teeth.
- Developed processing workflow for Micro-CT scanning of 100+ bone fragments at once: automatic segmentation and surfacing without bringing entire scan (240GB+) into memory; cleaning of produced meshes.
- Collaboration with UCLA in developing graph-based contrastive/active learning frameworks for learned embeddings in low-label-rate and unsupervised environments. Coauthored publication in SPIE for state-of-the-art classification of Synthetic Aperture Radar Images [4]. Current work aimed toward ImageNet and NLP applications.
- Extensive use of Python (Joblib, PyTorch Distributed for training models on multiple GPU's), SSH, VPN, Slurm, Linux. Ran and managed parameter searches at Minnesota Supercomputing Institute, often running 20-40 trials at once on A100 GPU's.

Instructor, MCFAM Machine Learning Summer Camp – University of Minnesota, Minneapolis, MN *June 2024 – July. 2024*

- Taught high school students introductory and advanced machine learning.
- Created new course materials, mentored group projects, and hosted guest speakers.

Summer Researcher, Mitsubishi Electric - UCLA G-RIPS Program – Sendai, Japan *June 2023 – Aug. 2023*

- Collaborated with a team of 7 to create new and improved algorithms for GPS trajectory registration.
- Designed and implemented an end-to-end machine learning framework for learnable edge adjacency weights in Dijkstra's algorithm for road trajectory extraction. Prepared technical papers and powerpoints to disseminate results.

Graduate REU – University of California, Los Angeles (remote) *May 2022 – Aug. 2022*

- Developed active-graph learning framework using contrastive embeddings in low-label-rate environments for SAR images.

Instructor, MCFAM Machine Learning Summer Camp – University of Minnesota, Minneapolis, MN *June 2022 – July 2022*

- Taught high school students introductory and advanced machine learning.
- Created new course materials, mentored group projects, and hosted guest speakers.

Instructor, College Algebra and Probability – University of Minnesota, Minneapolis, MN *Jan. 2022 – May 2022*

- Lectured 34 students. Developed lectures and new course material, graded projects and exams, worked with students to overcome obstacles in learning. Supervised and delegated work to my TA.

Research Assistant, Plant Genetics Department – University of Minnesota, St. Paul, MN *May 2021 – Jan 2022*

- Work in obtaining digital 3D reconstructions of soybeans from turntable imaging via machine learning and other approaches for architectural phenotyping. Extensive use of Python (PyTorch, OpenCV) for model deployment and camera calibration.
- Conducted field sampling and data collection. Established imaging protocols and best practices.
- Implemented algorithms in Matlab for measuring seed shape, area, curvature, and coloration at mass scale.

TA, MCFAM Machine Learning Summer Camp – University of Minnesota, Minneapolis, MN *June 2021 – July 2021*

- Helped educate high school students in advanced machine learning methods.

Teacher's Assistant, Calculus I & IV – University of Minnesota, Minneapolis, MN *Sept. 2020 – May 2021*

- Taught Calculus I and CSE Multivariable Calculus virtually. Hosted classes and review sessions over Zoom, made lesson plans and worksheets, graded assignments and exams.

Undergrad Research Assistant, Plant Genetics Department – University of Minnesota, St. Paul, MN *May 2019 – May 2020*

- Founded an interdisciplinary research project in mass scale, automated plant phenotyping from images in Matlab.
- Developed robust pipelines for image segmentation, branch angle measurements via clustering, leaf segmentation, leaflet area, signature curves for leaf shape classification, & stem length measurements.
- Conducted lab work in Stupar and Muehlbauer laboratories (BSL-1 and BSL-2): Tissue cultures, gel electrophoresis, growth media preparation, field phenotyping, and Gator driving.

Undergrad Researcher, Center for Applied Math – University of St. Thomas, St. Paul, MN

May 2018 – May 2020

- Worked with UMN AMAAZE Consortium toward automatic reassembly of ancient bone fragments.
- Developed and deployed algorithms in Matlab, C/C++, and Python working with high-resolution surface meshes.
- Implemented new methods for local surface metrics on triangulations (SVI / Principal Curvatures [5], among others).
- Achieved bone surface refitting via gradient descent on L1/L2 loss in SO(3) with local feature matching terms.
- Created methods for break-edge and break-face detection from surface metrics via thresholding, non-max suppression / hysteresis, extracting connected subgraphs, Dijkstra's algorithm, graph-based clustering, & filtering by comparing metrics.
- Extensive figure and GIF generation. Made research presentations, posters, and Meshlab plugin for surface metrics in C++.
- Lead author on paper published in SIAM [5]. Work conducted under NSF REU grants.

Sales Personnel - J. Donald Donahue & Associates Estate Sales, 2017 to 2019 (as needed)

- Assisted in appraising, setting up, and running estate and moving sales. Preparing tickets of sale, tending to customers, moving large items.

Apprentice - Gardens of Rice Creek, Summers 2012 - 2016

- Worked for horticulturist Betty Ann Addison, renowned for her Rhododendron hybrids and rock garden designs. Propagating, pruning, potting plants for sale, hybridizing cultivars, fertilizing, subdividing, weeding.

EDUCATION:

University of Minnesota, Minneapolis, MN — *Applied Math PhD Student, September 2020 - May 2026 (anticipated)*. Working with co-advisors Jeff Calder and Peter Olver.

University of St. Thomas, St. Paul, MN — *Graduate, September 2017 - August 2020*. Double majored in pure mathematics (BA) and physics (BA). Graduated with Magna Cum Laude honors, Aquinas Scholar and Catholic honors society member.

Irondale High School, New Brighton, MN — *Graduate, September 2013 - May 2017* Graduated with highest honors; took all AP and college level courses possible.

PUBLICATIONS:

- [1] Wonjun Lee, **Riley C. W. O'Neill**, Dongmian Zou, Jeff Calder, & Gilad Lerman. "Geometry-Preserving Encoder/Decoder in Latent Generative Models." *Submitted manuscript*, 2025.
- [2] **Riley C. W. O'Neill**, Katrina Yezzi-Woodley, Jeff Calder, & Peter J. Olver. "En masse scanning and automated surfacing of small objects using Micro-CT." arXiv preprint arXiv:2410.07385. <https://arxiv.org/abs/2410.07385>
- [3] Frank Cole, Yulong Lu, **Riley O'Neill**, Tianhao Zhang. "Provable In-Context Learning of Linear Systems and Linear Elliptic PDEs with Transformers." NeurIPS 2024. <https://arxiv.org/abs/2409.12293>
- [4] Jeremy J. Lin, Tomoro Mochida, Riley C. W. O'Neill, Atsuro Yoshida, Masashi Yamazaki, and Akinobu Sasada. "Two Online Map Matching Algorithms Based on Analytic Hierarchy Process and Fuzzy Logic." arXiv preprint arXiv:2402.11866 (2024). <https://arxiv.org/abs/2402.11866>
- [5] Suma Sreekanta, Allison Haaning, Austin Dobbels, **Riley O'Neill**, Anna Hofstad, Kamaldeep Viridi, Fumiaki Katagiri, Robert M. Stupar, Gary J. Muehlbauer, and Aaron J. Lorenz. "Variation in shoot architecture traits and their relationship to canopy coverage and light interception in soybean (Glycine max)." BMC plant biology 24, no. 1 (2024): 194. <https://link.springer.com/article/10.1186/s12870-024-04859-2>
- [6] Jason Brown, **Riley C. W. O'Neill**, Jeff Calder, & Andrea Bertozzi. "Utilizing contrastive learning for graph-based active learning of SAR data." Algorithms for Synthetic Aperture Radar Imagery, Vol. 12520, SPIE, 2023. <https://doi.org/10.1117/12.2663099>
- [7] **Riley C. W. O'Neill**, Pedro Angulo-Umaña, Jeff Calder, Bo Hessburg, Peter J. Olver, Chehrzad Shakiban, & Katrina Yezzi-Woodley. "Computation of Circular Area and Spherical Volume Invariants via Boundary Integrals." SIAM Journal on Imaging Sciences, Vol. 13, No. 1, 2 020, pp. 53-77. <https://doi.org/10.1137/19M1260803>

SKILLS:

Coding - adept in Matlab, Python (Tensorflow, Pytorch, Pytorch distributed for several GPUs, Huggingface, SciKitLearn), Labview, Mathematica, and LaTeX; familiarity with C/C++, SQL, Spark, and Pyspark. Extensive use of VPN, SSH, Terminal, Slurm (UMN MSI), QGIS, and screen environments on Linux for long-term processes.

Machine Learning - worked extensively with Pytorch, Tensorflow, and Huggingface. Actively working in developing end-to-end graph-based neural networks for representation learning, contrastive learning, active learning, and new 3D convolutional neural networks for surface meshes. Taken numerous graduate courses in machine learning (Introductory, NLP, Computer Vision, Spatial AI), data science, and optimization (IE 8564). Also took a workshop in ML for financial applications in summer 2021.

Natural Language Processing - Fall 2022 course in state-of-the-art machine learning methods for NLP. Huggingface library, text classification and generation, prompt learning with GPT-3. Extensive use of transformers and RNN's. Completed final project in author imitation learning.

Spatial AI - Spring 2022 course. Thorough study of state of the art convolutional and recurrent neural networks for spatial-temporal applications. Implemented methods for overhead object recognition, cloud front forecasting using Conv-LSTM, and identification of Scottish ruins from aerial LiDAR images using UNets and a focal loss. Utilized Spark, PySpark, SQL, Python (PyTorch, SciKitLearn), and Google Cloud environments.

Computer Vision - Spring 2022 course. Increased familiarity with fundamentals of computer vision. Implemented model for pose recognition of monkeys.

Chemical & Biological Techniques - took quantitative analysis, experience with NMR, sample extraction & isolation, spectroscopy, chromatography (GC, HPLC, CE, TLC), detectors, gel electrophoresis, and more. Capable of conducting nearly all procedures shown on *Forensic Files*. Also experience with plant tissue and bacteria cultures (sterile technique, subculturing and incubation).

Physical / Electrical Instrumentation - Lock-in amplifiers, cloud chambers, class III lasers, built optical tweezers from scratch, oscilloscopes, function generators, signal filters, DAQ, and more.

AWARDS AND ACHIEVEMENTS:

2022-Present - National Science Foundation (NSF) Research Fellow. One of 2,193 graduate students across the sciences awarded 3 years of funding to conduct research (from over 12,000 applicants). Selection based on intellectual merit and broader impacts of the proposed research and myself.

2021 Spring - Award for dedication to student learning from UMN Center for Educational Innovation

2020 Fall - 2 awards for dedication to student learning from UMN Center for Educational Innovation

2017-2020 - UST Dean's list, all but one semester.

2017-2020 - member of Aquinas Scholar honors program.

2017-2020 - Recipient of University of St. Thomas Presidential Scholarship.

2018-2020 - DES Catholic honors program at the University of St Thomas.

2019 - Not a finalist for St. Thomas Center for Applied Math Outstanding Summer Achievement award on basis of research being "too advanced."

2018 - One of three finalists for St. Thomas Center for Applied Math outstanding summer achievement award.

2016 - First Place bonsai at Minnesota State Fair exhibition (first & only time entering).

2016 - Selected Page for Minnesota State Capitol via High School Page Program

2015 - Youngest member ever on the board of directors for DFL Senate district 41.

RESEARCH PRESENTATIONS I'VE GIVEN:

Regional, National, and International Conferences:

R. C. W. O'Neill, K. Yezzi-Woodley, J. Calder, P.J. Olver. "Enmasse scanning and curation of small objects using microCT." **CAA International**, Presentation, Auckland, NZ April 2024.

R. Luther, **R. C. W. O'Neill**. "The virtual goniometer: A novel tool for 3D molar segmentation and occlusal wear surface angle measurements." **CAA International**, Presentation, Auckland, NZ April 2024.

MAA Mathfest, Presentation, Cincinnati, OH July 2019

MAA Sectional, Presentation, Minneapolis MN, April 2019

At the University of Minnesota:

AMAAZE Seminar, Presentation, Minneapolis, MN, November 2019.

Muehlbauer Lab Meeting, St. Paul, MN, October 2019.

Stupar Lab Meeting, St. Paul, MN, September 2019.

At the University of St. Thomas:

UST Inquiry, 2 Posters, St. Paul, MN, Fall 2019

UST Engineering Reverse Job Fair, 2 Posters, St. Paul, MN, Fall 2019

UST CAM Symposium, Presentation, St. Paul, MN, Summer 2019

UST Inquiry Poster, St. Paul, MN, Spring 2019

Selected presenter at UST Investiture Ceremony for Dean Yohuru Williams. St. Paul, MN, April, 2019

UST Inquiry, Poster, St. Paul, MN, Fall 2018

UST CAM Symposium, Presentation, St. Paul, MN, Summer 2018

OTHER CONFERENCES I'VE ATTENDED:

Joint Mathematics Meeting, January 2025

Symmetry, Invariants, & Their Applications: A Celebration of Peter Olver's 70th Birthday. Aug 2022, Halifax, Nova Scotia.

OTHER APPEARANCES AND TALKS:

Outreach: UST First Year Experience course, invited speaker, October 2021. Talked on research, wellness, relationships, and offered advice on other aspects of the college experience.

LANGUAGES:

~ Five years of Chinese

~ Enough Japanese to navigate basic life in Japan

~ Enough Italian to negotiate at flea markets.

~ Enough Spanish to order at English speaking Mexican restaurants.

EXTRACURRICULAR AFFILIATIONS:

Minnesota Bonsai Society - Member, 2016 - Present.

University of St. Thomas Physics Club - Executive board member, 2019 - 2020.

UST Rowing Club - Member, 2018-2019.

DFL Senate District 41 - Former director on the executive committee.

EXTRACURRICULAR PURSUITS:

Pruning - I prune and maintain over 145 bonsai and 25 large scale topiaries.

Gardening - I have curated my own rock and Japanese gardens since 2010 with particular interest in hardy cacti, succulents and conifers, as well as rare and unusual plants. I have over 80 different varieties of cactus that winter outside in Minnesota.

Antiques - I have collected antiques since I was a child. Particularly interested in 17th-19th century Chinese and Japanese antiques.

Disco dancing

Book writing - work in progress