Matthew Piekenbrock

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Education

Northeastern University (NEU) **2021-Present**
(Pursuing) PhD of Computer Science *GPA: 3.83*

Michigan State University (MSU) **2019-2021**
(Transferred) PhD of Comp. Mathematics, Science, and Engineering *GPA: 3.50*

Wright State University (WSU) **2015-2018**
Masters of Science in Computer Science *GPA: 3.83*
Bachelor of Science in Computer Science + Minor in Statistics *GPA: 3.42 (In-Major)*

Teaching Experience

- Teaching assistant - Unsupervised Learning — CS 6220 / DS 5230, Spring 2024 (NEU)
- Teaching assistant - Unsupervised Learning — CS 6220 / DS 5230, Fall 2023 (NEU)
- Teaching assistant - Data Mining Techniques — CS 6220 / DS 5230, Summer 2023 (NEU)
- Teaching assistant - Supervised Machine Learning — CS 6140/4420, Spring 2023 (NEU)
- Teaching assistant - Unsupervised Learning — DS 5230, Fall 2022 (NEU)
- Teaching assistant - Comp. Modeling & Data Analysis — CMSE 201, Fall 2020 (MSU)

Experience

Graduate Research Assistant **Perea Lab**
Northeastern University / Michigan State University *Fall 2019-Present (Graduating Summer 24)*

My PhD research focused on developing computationally tractable extensions of *Persistent Homology* in dynamic and multi-parameter settings, and in showing viable applications to problems such as periodic time series analysis, characterizing graph similarity, and n-D shape matching. Subsequent work focused on topological dimensionality reduction using fiber bundle theory (see **tallem** in the **Open Source** section) and on spectral-relaxations of the persistent rank invariant, with applications to exploratory data analysis.

LERCIP Intern **National Aeronautics and Space Administration**
John H. Glenn Research Center at Lewis Field *Summer 2022*

I was re-hired back at NASA as part of the Space Communications and Navigation (SCaN) program to expand the algorithmic theory necessary to have effective satellite communications in space environments. My research focused on incorporating additional geometric assumptions into routing models built for of delay- and disruption-tolerant networks, particularly in the low Earth orbit regime. Publications summarizing the works can be found in my CV. Project materials are available upon request for U.S. citizens only.

Machine Learning Scientist **Air Force Research Laboratory**
Oak Ridge Institute for Science and Education *Fall 2018-Fall 2019, Fall 2017*

In an effort to promote research into the frontiers of Topology Data Analysis (TDA), I joined a research group at the Air Force Research Labs (AFRL) to study how to combine techniques from the field of topology with machine learning in both supervised and unsupervised settings. I primarily researched multi-scale extensions to the *Mapper* framework, an often used modality for performing TDA. The group has since founded an AI startup[1] company.

LERCIP Intern **National Aeronautics and Space Administration**
John H. Glenn Research Center at Lewis Field *Summer 2018*

Towards accelerating materials discovery and design, I was hired by Dr. Steven Arnold (Multiscale Modeling Materials and Structures Division) to spend an extended internship at NASA using ML to infer multiscale structural properties from material stress-response data. The project involved using *experimental design theory* to deduce process-structure-property relationships from a surrogate regression model trained on laminate stress-strain curve data. My time was primarily spent learning basic micromechanics and lamination theory, architecting a neural network to model material stress-response data, and implementing a custom information-theoretic estimator (the loss function). Publications summarizing the works can be found in my CV. Other technical material including reports, presentations, and code are available upon request for U.S. citizens only.

Graduate Research Assistant **Machine Learning & Complex Systems Lab**
Wright State University *Fall 2015 - Spring 2018*

[1] See `https://minedxai.com/` for more details

I joined the Machine Learning and Complex Systems lab under a graduate research assistantship to research the possibility of using *generative graph models* to understand macroscopic patterns of real-world traffic networks inferred from trajectory (e.g. GPS) data. Topic areas spanned by the research include *density based clustering*, *geospatial analysis*, *stochastic block models*. My masters thesis focused using the *cluster tree*—a level-set shape characteristic of an estimated density function—to infer significant clusters of movement. This research was supported by the Center for Surveillance Research, a National Science Foundation I/UCRC.

Student Participant **Google Summer of Code**
R Project for Statistical Computing *Summer 2017*

I received funding for a proposal accepted by the Google Summer of Code (GSOC) Initiative to the R Project for Statistical Computing to explore, develop, and unify developments related the theory of density-based clustering, namely theory related to the *cluster tree*. This involved a variety of code development which culminated in the form of an R package; for more details, see the project page.[2]

Research Associate **Oak Ridge Institute for Science and Education**
Air Force Institute of Technology *2014 - 2016*

As part of an ORISE fellowship, I primarily worked on developing a novel Iterative Closest Point algorithm amenable to massive parallelization for real-time tracking of aircraft in turbulent conditions. Our proposed solution involved combining k-NN data structures with the geometric structure of Delaunay meshes, which lead to significant speedup compared to state of the art methods and several subsequent publications (see CV**??**. During my tenure at AFIT, I also worked on parallelizing various atmospheric absorption routines (C++/OpenCL) and coding a nonlinear optimization algorithm (C/MATLAB).

Undergraduate Research Assistant **Southwestern Ohio Council for Higher Education**
Air Force Institute of Technology *2013 - 2014*

I was hired at the Air Force Institute of Technology (AFIT) as an undergraduate student to do research in a multi-disciplinary team called the Low Orbitals Radar and Electromagnetism group, where I worked on a diverse set of projects involving computational, statistical, or physics-based requirements. As my first experience doing research, I assisted graduate students with primarily programmatic or educational tasks. Exemplary research projects include the implementation of an *unsplittable flow* approximation algorithm in (C++ / Python) and developing a graphical UI to enhance searching and viewing of 3D models (C++ / JavaScript).

Open Source Contributions

primate (python package)	[gh]/peekxc/primate	(Author)
dbscan (R package)	[gh]/mhahsler/dbscan	(Coauthor)
clustertree (R package)	[gh]/peekxc/clustertree	(Author)
Mapper (R package)	[gh]/peekxc/Mapper	(Author)
simplextree (python/R package)	[gh]/peekxc/simplextree	(Author)
tallem (python package)	[gh]/peekxc/tallem	(Author)

Awards, Extra Curricular, Misc.

Ginther Fellow:	MSU 2019-2020
Outstanding Masters Student Award (Computer Science):	WSU 2017-2018
ORISE Fellow:	AFIT 2016-2016
SOCHE Fellow:	AFIT 2013-2014
Outstanding Position Paper Award:	National Model United Nations Annual Conference (2014)
Outstanding Delegation Award:	National Model United Nations Annual Conference (2013)

[2] https://summerofcode.withgoogle.com/archive/2017/projects/5919718795902976/