Matt Piekenbrock

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— Education

Northeastern University — **Boston, MA**
PhD in Computer Science (advisor: Jose Perea) — 01/2025

Michigan State University (transferred) — **East Lansing, MI**
PhD in Computational Mathematics, Science, and Engineering — 09/2019 – 05/2021

Wright State University — **Dayton, OH**
M.S. in Computer Science (advisor: Derek Doran) — 05/2018
B.S. in Computer Science + Minor in Statistics — 12/2015

Awards & Fellowships

- Outstanding Graduate Student Award (Computer Science) — WSU, 2017/2018
- Ginther Fellow — 08/2019 – 05/2021
- ORISE Fellow — 07/2014 – 03/2017
- SOCHE Fellow — 12/2013 – 06/2014
- GRaM "Top. Lift" ML contest[1] - 2nd Place — ICML Top. Deep Learning Challenge 2024

— Skills

Languages: Python · R · C++ · CUDA · OpenCL · OpenMP · MPI · Cython · Rcpp
Tools / Libs: Meson · CMake · Git · Bash · Slurm · NumPy · SciPy · PyTorch
Specialities: Machine Learning · Optimization · Linear Algebra · Dim. Reduction · Topology · Comp. Geometry

— Experience

Tenet 3 — **Dayton, OH**
Senior Computer Scientist — 01/2025 – Present

- Engineered heuristics and exact algorithms for solving subgraph isomorphism and related NP-complete problems, enabling scalable pattern matching in large, sparse graphs relevant to defense and EDA applications.
- Contributed to high-assurance systems through performance-critical C++ and Python software, integrating algorithmic innovations into deployed tools used by defense and semi-conductor partners.
- Translated theoretical insights from graph theory into practical solutions that achieved measurable improvements in run-time, memory use, and accuracy across large real-world datasets.

Perea Lab — **Northeastern University**
Graduate Research Assistant — 09/2019 – 01/2025

- Developed algorithms[7,8] improving the efficiency of computing *Persistent Homology* in parameterized settings and demonstrated their utility in application domains, including manifold learning and time series analysis.
- Published open-source Python packages‡ documenting my doctoral research in topological dimensionality reduction [*tallem*], matrix function estimation [*primate*], and tangent space alignment [*geomcover*]
- Contributed talks to conferences, including the AMS23 and AMS24 Spring Eastern Sectional Meeting on Applied and Computational Topology, GTDAML23, ComPer23, ComPer24, JMM24, and UF-TDA24.

Air Force Research Laboratory — **KBR Wyle / ORAU**
Machine Learning Scientist — 06/2017 – 08/2019

- Developed geometric/topological loss functions for vision- or spatial- related tasks, such as object tracking from noisy video data and road detection from partially labeled LiDAR data.
- Published an open source R package extending the *Mapper* framework [*Mapper*] for topological data analysis. Parts of the software have since been incorporated into an AI startup[2] company. (R / C++)

Machine Learning & Complex Systems Lab — **Wright State University**
Graduate Research Assistant — 01/2015 – 05/2018

- Researched the use of *generative geometric graph models*[4] in predicting macroscopic patterns of real-world traffic networks inferred from time-varying trajectory data (e.g. GPS) and point-of-interest data (e.g. OSM)
- Developed trajectory mining and temporal network model validated on traffic simulation software [*sumor*]

[1] See https://pyt-team.github.io/packs/challenge.html for challenge details.
[2] See https://minedxai.com/ for more details

- Gave bi-annual research talks to industry partners, project sponsors, and fellow researchers on how to incorporate clustering into dynamic geospatial network models for aerial surveillance applications.

INTERNSHIPS

National Aeronautics and Space Administration — **Glenn Research Center**

SCaN / LERCIP Intern — 06/2018 – 09/2018, 06/2022 – 08/2022

- Established bound on shortest-path-affecting critical points encountered by a low-earth orbit satellite network over a single orbital period [NASA technical report pending; draft available to U.S. citizens].‡
- Validated the above bound empirically on an elliptical orbital simulation of STARLINK satellites (Python / C++)
- Presented research findings to program managers at the Space Communications and Navigation (SCaN) program on the benefits of geometrically-informed routing in delay- and disruption-tolerant networks.
- Worked on accelerating NASA's materials discovery and design process by researching the degree to which neural networks can infer multiscale structural properties from material stress-response data.
- Developed information-theoretic loss for process-structure-property inference which was successfully validated against a ground-truth micromechanics models (GMC); see subsequent publications[5,6] for details.

Google Summer of Code — **R Project for Statistical Computing**

Student Participant — 05/2017 – 08/2017

- Wrote successful Google Summer of Code grant[3] ($\leq$12% acceptance rate) to research the theory of density-based clustering and its connections to cluster trees (mentored by Dr. Mikhail Belkin and Dr. Michael Hahsler)
- Published R packages on CRAN [*dbscan*, *clustertree*] and a journal at the Journal of Statistical Software.[3]

TEACHING EXPERIENCE

- ⊛ Teaching assistant - Unsupervised Learning — Spring '24, Fall '23, Fall '22 (NEU)
- ⊛ Teaching assistant - Data Mining Techniques — Summer '23 (NEU)
- ⊛ Teaching assistant - Supervised Machine Learning — Spring '23 (NEU)
- ⊛ Teaching assistant - Computational Modeling & Data Analysis — Fall '20 (MSU)

– PUBLICATIONS & OPEN SOURCE CONTRIBUTIONS

The OS packages below have received over **3.2+ million** downloads / **120+** package dependents (as of 01/2024):

⊛ ***primate***	Python / C++	[gh]/peekxc/primate	*Author*
⊛ ***dbscan***	R / C++	[gh]/mhahsler/dbscan	*Coauthor*
⊛ ***Mapper***	R / C++	[gh]/peekxc/Mapper	*Author*
⊛ ***tallem***	Python / C++	[gh]/peekxc/tallem	*Coauthor*
⊛ ***clustertree***	R	[gh]/peekxc/clustertree	*Author*
⊛ ***sumor***	R / C++	[gh]/peekxc/sumor	*Author*

The research publications I (co-)authored below have collectively been cited over **800+ times** (as of 01/2024):

1. **M. Piekenbrock**, J. Robinson, L. Burchett, S. Nykl, B. Woolley, and A. Terzuoli, "Automated aerial refueling: Parallelized 3D iterative closest point: Subject area: Guidance and control," in 2016 IEEE National Aerospace and Electronics Conference (NAECON) and Ohio Innovation Summit (OIS), 2016, pp. 188–192. (DOI: 10.1109/NAECON.2016.7856797)
2. J. Robinson, **M. Piekenbrock**, L. Burchett, S. Nykl, B. Woolley, and A. Terzuoli, "Parallelized iterative closest point for autonomous aerial refueling," in Advances in Visual Computing: 12th International Symposium, ISVC 2016, Las Vegas, NV, USA, December 12-14, 2016, Proceedings, Part I 12, 2016, pp. 593–602. (DOI: 10.1007/978-3-319-50835-1_53)
3. M. Hahsler, **M. Piekenbrock**, and D. Doran. "dbscan: Fast density-based clustering with R." Journal of Statistical Software 91 (2019): p. 1-30. (DOI: 10.18637/jss.v091.i01)
4. **M. Piekenbrock** and D. Doran. "Intrinsic point of interest discovery from trajectory data." (DOI: 10.48550/arXiv.1712)
5. J.Stuckner, **M. Piekenbrock**, S.M. Arnold, and T.M. Ricks, "Optimal experimental design with fast neural network surrogate models," Computational Materials Science, vol. 200, p. 110747–110748, 2021.
6. S.M. Arnold, **M. Piekenbrock**, T.M. Ricks, and J. Stuckner, "Multiscale analysis of composites using surrogate modeling and information optimal designs," in AIAA Scitech 2020 Forum, 2020, p. 1863–1864. (DOI: 10.2514/6.2020-1863)
7. **M. Piekenbrock** and J. Perea, "Move schedules: fast persistence computations in coarse dynamic settings," Journal of Applied and Computational Topology, pp. 1–45, 2024. (DOI: 10.1007/s41468-023-00156-3)
8. **M. Piekenbrock** and J. Perea, "Spectral relaxations of the persistent rank invariant," in 2024 Joint Mathematics Meetings.
9. **M. Piekenbrock**, Matt. "Geometry helps in routing scalability." arXiv preprint arXiv:2412.07964 (2024). (DOI: 10.48550/arXiv.2412.07964)

[3] GSOC project ID: 5919718795902976-2017