GAGE DEZOORT

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SUMMARY

Machine learning researcher and physicist specializing in graph neural networks (GNNs), graph transformers, and scalable deep learning for scientific data. Develops principled ML architectures with an emphasis on optimization stability, hyperparameter transfer, and robust inference. Published in machine learning, physics, and scientific computing venues; experienced mentoring researchers and translating advanced ML methods into practical tools and curricula.

TECHNICAL SPECIALTIES

- **Machine Learning**: GNNs, graph transformers, hyperparameter transfer, optimization stability
- **Programming**: Python, PyTorch, PyG, PyTorch Lightning, NumPy, scikit-learn, pandas, Git, C/C++
- **Computing**: Linux/Unix, HPC job scheduling

EDUCATION

Ph.D. in Experimental Particle Physics | Princeton University | 2023

Thesis: *Search for a Pseudoscalar Higgs Boson*, advised by Professor Daniel Marlow. Completed the Princeton University Center for Statistics and Machine Learning Certificate.

B.S. in Physics and Engineering Science | University of Virginia | 2018

Highest Distinction. Jefferson Scholar and Rodman Scholar.

WORK EXPERIENCE

Postdoctoral Research Associate | Princeton University, ORFE | Princeton, NJ | 2023—Present

- Developed theoretical scaling rules and PyTorch/PyG experiments for forward/backward pass stability and hyperparameter transfer in GNNs and graph transformers.
- Created and taught Jupyter notebook-based ML workshops; mentored student researchers.

Graduate Researcher | Princeton University, Physics | Princeton, NJ | 2018—2023

- Applied edge-classifying GNNs to charged particle tracking in large-scale particle physics datasets.
- Built columnar analysis workflows using Awkward Array and Coffea to search for a pseudoscalar Higgs boson in Run 2 Large Hadron Collider (LHC) collision data.

SELECTED RESEARCH PROJECTS

Hyperparameter Transfer for Coupled Node-Edge Attention Networks

- Developing hyperparameter transfer principles for attention-based GNNs with edge features.
- Extending graph attention to higher-order interactions including hyper-edges and node-edge interactions.
- Applying these models to scientific ML problems including jet classification in particle physics and stellar stream identification in astronomical datasets.

Hyperparameter Transfer for Graph Neural Networks

- Developed and validated hyperparameter transfer parameterizations for GNNs trained with gradient descent, Adam, and AdamW.

- Designed controlled PyTorch Lightning/PyG experiments across graph benchmarks to test stability and transfer behavior across width, depth, optimizer choice, and message-passing normalization.
- Identified graph-specific scaling effects in first-layer learning rates and message-passing normalization.

Principles for Initialization and Architecture Selection in Graph Neural Networks

- Derived a graph-specific generalization of He initialization for ReLU GNNs with generalized message-passing operators, preserving stable feature and gradient scales at initialization.
- Proved that fixed message-passing operators lead to oversmoothing at large depth and introduced residual aggregation operators that slow the rate of smoothing.
- Analyzed correlation collapse in deep GNNs and showed that residual connections improve trainability.
- Validated architecture choices through controlled PyG ablation studies.

SELECTED PUBLICATIONS AND PREPRINTS

Hyperparameter Transfer in Graph Neural Networks | Gage DeZoort and Boris Hanin (2026)
arXiv preprint: arXiv:2607.05017

Principles for Initialization and Architecture Selection in Graph Neural Networks with ReLU Activations | Gage DeZoort and Boris Hanin (2024)
SIAM Journal on Mathematics of Data Science: doi:10.1137/23M1600621

Graph Neural Networks at the Large Hadron Collider | Gage DeZoort et al. (2023)
Nature Reviews Physics 5, 281-303: doi:10.1038/s42254-023-00569-0

Charged Particle Tracking via Edge-Classifying Interaction Networks | Gage DeZoort et al. (2021)
Computing and Software for Big Science 5(26): doi:10.1007/s41781-021-00073-z

An Object Condensation Pipeline for Charged Particle Tracking at the High Luminosity LHC | Kilian Lieret and Gage DeZoort (2023)
26th International Conference on Computing in High Energy and Nuclear Physics (CHEP 2023): doi.org/10.1051/epjconf/202429509004

SELECTED TECHNICAL INSTRUCTION

Crash Course in Practical ML | Instructor | UC Irvine (2025)

- 3-day course with over 100 attendees taught as a UCI School of Physical Sciences Visiting Fellow.
- Course Repo: github.com/GageDeZoort/intro_ml_uci

Graph Neural Networks for Your Research | Instructor | Princeton (2022, 2023, 2025)

- Technical deep-dive into GNNs and PyTorch Geometric, taught as a standalone workshop and as part of Princeton Research Computing's Introduction to Machine Learning mini-course.
- Course Repo: https://github.com/GageDeZoort/prc_gnn_tutorial

SELECTED HONORS

School of Physical Sciences Visiting Fellowship | UC Irvine | 2025—2026
Kusaka Memorial Prize in Physics | Princeton University | 2022
Departmental Equity, Diversity, and Inclusion Award | Princeton University | 2021, 2022
Departmental Teaching Award | Princeton University | 2020