Justin Carpenter, Ph.D.

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Summary

Ph.D. Machine Learning Researcher & Systems Engineer with 5+ years building production-grade GNNs, LLMs, and scalable ML infrastructure. Expertise in zero-shot graph learning (LLM-GMP, IEEE '25), temporal GNNs (VLDB '23), and optimized deployments of Higher-Order graph representation learning (2FWL-SIRGN, IEEE '24). The techniques have been proven by combining novel algorithms with real-world systems for research and engineering roles.

Technical Skills

Machine Learning: PyTorch, TensorFlow, DGL (Deep Graph Library), NetworkX, Scikit-learn, BERT

AI & LLM Ops: Ollama, HuggingFace, OpenAI, RAG, Quantization, Local Inference Optimization

Programming: Python, Java, C, C++, Rust, SQL, Jupyter, LaTeX

Infrastructure: Linux (Bash), Windows, MacOS, Docker, Kubernetes (K3s), AWS

Data & Graphs: Pandas, SciPy, Matplotlib, Structural Node Representation, Temporal Graph Analysis

Education

Boise State University — Boise, ID
Ph.D. in Computing (Machine Learning & Graph Representation Learning) — *Aug 2020 – Dec 2025*
- Dissertation: Scalable and Expressive Graph Representation Learning with Temporal, Structural, and Zero-Shot Capabilities.

Boise State University — Boise, ID
B.S. in Computer Science — *Aug 2016 – May 2020*

Experience

Graduate Research Assistant — Dec 2020 – Dec 2025
AI-based Security (AIbS) Lab, Boise State University — *Boise, ID*
- Research and development for 4 IEEE/VLDB publications, including addressing current limitations, algorithm design, competitive analysis, and testing experiments.
- Developed structural graph partitioning algorithms that improved processing time by up to 83%.
- Developed two efficient temporal and higher-order graph representation learning approaches for graph nodes that rivaled state-of-the-art methods.
- Developed a zero-shot learning method for graph nodes using LLMs.

Graduate Teaching Assistant — Dec 2020 – Dec 2025
Boise State University — *Boise, ID*
- **CS 535: Large Scale Data Analysis** – Instructed on algorithms and infrastructure for managing large-scale data (MapReduce, Hadoop, Spark); graded assignments and hosted tutoring sessions.
- **CS 534: Machine Learning** – Mentored on ML algorithms (GNNs, SVMs, Logistic Regression, Decision Trees); graded and tutored on debugging and concepts.
- **CS 321: Data Structures** – Taught design of data structures (hash tables, queues); graded and collaborated on tutoring.

Computer Science Lab Assistant — Jan 2020 – May 2020
Boise State University — *Boise, ID*
- Assisted students in CS 121 with debugging, development strategies, and project comprehension.
- Collaborated with professors and tutors to enhance learning during the transition to online classes.

Projects

LLM-GMP: Large Language Model-Based Message Passing Published 2025

Zero-Shot Learning on Graphs | *Python, LLMs, Graph Representation*

- Developed a novel zero-shot learning framework leveraging semantic reasoning of LLMs to perform message passing on graph structures without labeled training data.
- Deployed a wide range of quantized LLM models, prompt creations and optimizations, and rigorous testing and evaluation.

2FWL-SIRGN: Higher-Order Weisfeiler-Lehman Graph Representation Learning Published 2024

Higher-Order Graph Representation Learning | *Python, Spark, Multi-Threading*

- Implemented 2FWL-SIRGN, an extension of SIR-GN that applies higher-order (2-dimensional) Folklore Weisfeiler-Lehman for richer structural node representations.
- Engineered a structural graph partitioning algorithm to distribute subgraph computations across machines, overcoming the quadratic computational bottleneck for massive datasets.

Temporal SIR-GN: Dynamic Network Analysis Published 2023

Temporal Graph Learning | *Python, SIR-GN*

- Extended Structural Iterative Representation learning on graph nodes (SIR-GN) into the temporal dimension to detect evolving structural patterns in dynamic networks.
- Achieved state-of-the-art accuracy in node and link prediction tasks while requiring significantly lower computational resources than comparable deep GNN architectures.

Botnet Node Detection via Structural Learning Published 2021

Cybersecurity Application | *Python, Inferential Structural Node Representation*

- Applied inferential structural node representation learning to cybersecurity, identifying malicious botnet nodes within high-volume internet traffic.
- Created a model that prevents overfitting—a common failure in traffic analysis—while operating at less than 50% of the computational cost of existing intrusion detection systems.

Manta Ray Identification System Dec 2019 – Jun 2020

Computer Vision Project | *Python, TensorFlow, PyTorch*

- Developed a lightweight system to process aerial footage from drones or low aircraft to identify manta rays in water.
- Utilized transfer learning on a TensorFlow object detection model within a Python API for open-source researcher assistance.

Publications

Carpenter, J., Islam, M., Serra, E. (2025). "LLM-GMP: Large Language Model-Based Message Passing for Zero-Shot Learning on Graphs." *Proceedings of the IEEE International Conference on Big Data*.

Carpenter, J., Serra, E. (2024). "2FWL-SIRGN: A Scalable Structural 2-dimensional Folklore Weisfeiler-Lehman Graph Representation Learning Approach." *Proceedings of the IEEE International Conference on Big Data*.

Layne, J., Carpenter, J., Serra, E., Gullo, F. (2023). "Temporal SIR-GN: Efficient and Effective Structural Representation Learning for Temporal Graphs." *Proceedings of the VLDB Endowment*.

Carpenter, J., Layne, J., Serra, E., Cuzzocrea, A. (2021). "Detecting Botnet Nodes via Structural Node Representation Learning." *Proceedings of the IEEE International Conference on Big Data*.