ELI LAIRD
CURRICULUM VITAE

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RESEARCH INTERESTS

My research centers on developing graph-based world models that empower autonomous agents to reason and interact effectively within their environments. Graphs serve as a universal language that can distill complex interactions and models of the world in a digestible and explainable manner. I specialize in graph representation learning and self-supervised learning, which are essential tools for constructing interpretable and concept-driven world models. I am particularly interested in the intersection of graph-based world models and neural algorithmic reasoning, as graphs provide a clean interface for reasoning about the world. Beyond my theoretical pursuits, I am deeply committed to applying these methods to real-world challenges like drug discovery and model-based reinforcement learning for robotics. My career aspirations are driven by an overarching vision: leveraging AI's world modeling and reasoning capabilities to advance medical and scientific discoveries.

EDUCATION

- ***Southern Methodist University* (2023-2026)**
  - *2nd Year Doctor of Philosophy in Computer Science Student*
    - O'Donnell Data Science and Research Computing Institute Research Fellow
    - Dissertation Topic: "Building Graph-based World Models for Understanding Complex Environments"
    - Advisor: Dr. Corey Clark

- ***St. John's College, University of Cambridge* (Jan-Mar 2025)**
  - *Visiting Researcher*
    - Graph-based World Models
    - Alongside Dr. Matthias Dörrzapf

- ***Southern Methodist University* (2021-2023)**
  - *Master's of Science in Computer Science*
    - Track: Biometrics & Data Science

- ***Southern Methodist University* (2017-2021)**
  - *Bachelor of Science in Computer Science*
    - Track: Machine Learning & Artificial Intelligence
    - Honored with Departmental Distinction Award in Computer Science

- ***Stanford University (Summer 2019)***
  - *Summer Sessions Program*
    - Courses: Intro to Artificial Intelligence; Data Mining

RESEARCH & PROFESSIONAL EXPERIENCE

- ***O'Donnell Data Science and Research Computing Institute & Human and Machine Intelligence Lab (*2023-Present)**
  - *PhD. Student & Graduate Research Fellow*
    - Awarded research fellowship to develop graph-based world models for reasoning and planning
    - Develop novel graph-based self-supervised learning methodologies using Pytorch Geometric
    - Research graph-based world models for object-centric reinforcement learning
    - Design and maintain the SmartCADD open-source virtual drug screening platform that combines AI-based filtering with GNNs with quantum mechanical methods like XTB into a user-friendly framework
    - Train equivariant graph neural networks to filter chemical compounds by quantum properties for virtual screening in JAX

- Published Explainable AI method XInsight at XAI-23, for understanding and discovering knowledge learned in graph neural networks trained on chemical compounds

- ***Intelligent Systems and Bias Examination Lab (ISaBEL) @ SMU (*2023-Present)**
  - *Design and Scientific Lead*
    - Lead the design of the Synthetic Identity Generation (SIG) pipeline for generating face recognition evaluation datasets, including the ControlFace10k and ControlFace3M (*Published in ICPR 2024*)
    - Lead a research team in measuring and removing bias from face recognition systems like the ArcFace and GhostFaceNet models
    - Train ResNet-based face recognition models in a data and model-distributed manner using PyTorch over a Slurm cluster of GPU nodes
    - Design and develop a Docker-based algorithm evaluation services used to evaluate commercial and open-source biometrics algorithms deployed on a Kubernetes cluster
    - Train ControlNet models to enhance the abilities of Stable Diffusion models to control for pose, lighting, and other features used for testing face recognition algorithms
    - Design contrastive loss functions that evenly distribute demographic categories across an embedding space with the goal of reducing bias in face recognition algorithms

- ***Science Applications International Corporation | Maryland Test Facility (MdTF) (2020-2023)***
  - *Data Scientist – Full-Time*
    - First-author to two publications proposing the Gini Aggregation Rate for Biometric Equitability (GARBE) for measuring demographic bias and novel bias removal methods based on linear methods like Singular Value Decomposition
    - Designed bias metric (GARBE) included in the Internation Standard on Biometric Performance Testing and Reporting (*ISO/IEC 19795-10:2024*)
    - Presented published papers at ICPR Biometrics Workshop
    - Designed GoLang and Python data processing pipelines used to process live data collected during the MdTF's Biometric Rally all deployed on Kubernetes with RancherOS
    - Operated the MdTF's Biometric Rally designed to study the existence of bias in commercial biometrics systems with 500-600 human volunteer subjects
    - Built custom face detection systems using OpenCV and PyTorch to perform in the Maryland Test Facility's Biometric Rally
    - Built data collection systems run on edge devices connected through RabbitMQ and Docker
    - Designed analytics workflows using Python and R

- ***SMU Human & Machine Intelligence Lab (2019-2021)***
  - *Undergraduate Researcher*
    - Research methods of distributing machine learning models securely across a volunteer computing grid such as the BOINC and the Golem networks
    - Assess the computational and time constraints of parallelizing end-to-end encrypted machine learning models and data using IBM's Homomorphic Encryption Library in C++
    - Assist research developing human-in-the-loop machine learning models to diagnose age-related macular degeneration; Integrated and trained U-Net, ResNet, and FCNN models on SMU's super-computing cluster

PUBLICATIONS

- Madushanka, A., Laird, E., Clark, C., Kraka, E. (2024). SmartCADD: AI-QM Empowered Drug Discovery Platform with Explainability. *Journal of Chemical Information Modeling (JCIM)*.
- Nzalasse, K., Rishav, R, Laird, E., Clark, C. (2024). SIG: A Synthetic Identity Generation Pipeline for Generating Evaluation Datasets for Face Recognition. *International Conference on Pattern Recognition FAIRBio Workshop*. arXiv preprint arXiv:2409.08345.
- Laird, E., Lee, H., Harper, C., Larson, E., & Clark, C. (2024). Message-Passing Joint Embedding Predictive Architectures (*Under Review*).

- Laird, E., Madushanka, A., Kraka, E., Clark, C. (2023). XInsight: Revealing Model Insights for GNNs with Flow-Based Explanations. In: Longo, L. (eds) Explainable Artificial Intelligence. xAI 2023. Communications in Computer and Information Science, vol 1902. Springer, Cham. https://doi.org/10.1007/978-3-031-44067-0_16
- Howard, J.J., Laird, E.J., Rubin, R.E., Sirotin, Y.B., Tipton, J.L., Vemury, A.R. (2023). Evaluating Proposed Fairness Models for Face Recognition Algorithms. In: Rousseau, JJ., Kapralos, B. (eds) Pattern Recognition, Computer Vision, and Image Processing. ICPR 2022 International Workshops and Challenges. ICPR 2022. Lecture Notes in Computer Science, vol 13643. Springer, Cham. https://doi.org/10.1007/978-3-031-37660-3_31
- Howard, J.J., Laird, E.J., Sirotin, Y.B. (2023). Disparate Impact in Facial Recognition Stems from the Broad Homogeneity Effect: A Case Study and Method to Resolve. In: Rousseau, JJ., Kapralos, B. (eds) Pattern Recognition, Computer Vision, and Image Processing. ICPR 2022 International Workshops and Challenges. ICPR 2022. Lecture Notes in Computer Science, vol 13643. Springer, Cham. https://doi.org/10.1007/978-3-031-37660-3_32

VOLUNTEER AND COMMUNITY WORK

- **Dallas AI (2022-Present)**
  - *Volunteer & Student Program Lead*
    - Lead the design and execution of the *Dallas AI Summer Program* that provides college students with an opportunity to build, learn, and showcase AI-based projects
    - Plan and coordinate Dallas AI meetups and speaker events
    - Host hands-on workshops covering machine learning model development and agent-based AI development in Langchain and Huggingface
    - Work with industry leading companies, including Microsoft and Amazon, to provide cloud compute credits for students

OPEN-SOURCE CONTRIBUTIONS & PROJECTS

- *SmartCADD*: an open-source virtual screening platform that combines deep learning, computer-aided drug design (CADD), and quantum mechanics methodologies within a user-friendly Python framework. GitHub: https://github.com/SMU-CATCO/SmartCADD
- *XInsight-graph-explanations*: Implementation of the XInsight Model-Level Explanation Algorithm. GitHub: https://github.com/elilaird/xinsight-graph-explanations
- *Quantum-GFlowNets*: implementation of Quantum Generative Flow Networks. GitHub: https://github.com/elilaird/quantum-gflownets
- *Torch*-geometric contributions:
  - log-softmax implementation for batched graphs. PR: https://github.com/pyg-team/pytorch_geometric/pull/8909

AWARDS

- O'Donnell Data Science and Research Computing Institute Research Fellow (2024)
- Research & Innovation Week 2024 Dean's Award (2024)
- SMU Departmental Award in Computer Science (2021)
- National Academy of Sciences Idea Competition Winner (2020)
- SMU Second Century Scholarship (2017-2021)
- SMU Opportunity Scholarship (2017-2021)
- SMU Discovery Scholarship (2017-2021)

TEACHING

- ***Southern Methodist University (2018-2024)***
  - *Private Python & C++ Tutor*
    - Tutor students in Algorithms, Data Structures, Machine Learning, Python, and C++

- *Head Teaching Assistant (2018-2020)*
  - Facilitate Data Structures weekly lab sessions, graded programming projects and written tests, and tutored students in C++ programming practices

REFERENCES

Dr. Corey Clark
Deputy Director of Research at SMU Guildhall
Assistant Professor of Computer Science at SMU Lyle School of Engineering
Chief Technology Officer at Balanced Media | Technology
coreyc@smu.edu

Dr. John J. Howard
Principal Scientist at SAIC Identity and Data Science Laboratory & Maryland Test Facility
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