Maggie Beheler-Amass

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Research Focus: Developing interpretable deep learning frameworks for biological systems, specializing in Neural ODEs for simultaneous gene regulatory network inference and biophysical parameter estimation **for perturbation response predictions.**

EDUCATION AND HONORS

New York University, Graduate Schools of Arts and Sciences — New York, New York
PhD in Computational Biology — 2020-July 15 2025

- GPA: 3.98/4.0
- **Research:** Interpretable Neural ODEs for Dynamic Gene Regulatory Network Inference
- ISMB Merit-Based Travel Grant Recipient (2024)
- Quantitative Biological Systems Training Fellow 2021-22
- Qualifying Exam Passed with Honors
- **Relevant Coursework:** Statistics, Machine Learning, Bioinformatics, Inference

Thesis Overview: My research focuses on developing interpretable deep learning frameworks for gene regulatory network inference (GRNi) and transcription factor activity estimation from biological data. Using **physics-informed deep learning** and **Neural ODEs**, I model the complex dynamics of gene regulation to predict cellular responses to **perturbations** from single-cell RNA-seq and estimate biophysical parameters. This work enables ***in silic*o prediction** of gene expression at unseen time points and **inferring responses to experimental perturbations** through interpretable biological mechanisms.

University of Wisconsin-Madison, College of Letters and Sciences — Madison, Wisconsin
B.S. in Physics, Astronomy-Physics, French — 2014-2018

- Bernice Durand Undergraduate Research Scholarship — 2015-2016
- David H. Durra Scholarship — 2016-2017
- NSF Graduate Research Fellowship Program Honorable Mention — 2017-2018
- **Relevant Coursework:** Ordinary and Partial Differential Equations, Linear Algebra

SKILLS

Programming: Python (scikit-learn, PyTorch, TensorFlow, OpenCL), JAX, C++, R
Specializations: Neural ODEs, Graph Neural Networks, Interpretable Deep Learning, Geometric Deep Learning, Algorithm Development, Agent Based Modeling
Methods: Network Inference, Causal Representation Learning, Physics-Informed ML
Data Analysis: scRNA-seq, Transcriptomics, Perturbation Analysis, Temporal Dynamics, Multimodal Integration, Signal Processing
Network Biology: Gene Regulatory Networks, TF-target relationships

PROFESSIONAL EXPERIENCE

New York University — 2020-Present
Gene Regulatory Network Inference (GRNi), PhD Student with Professor Richard Bonneau

- Created in-CAHOOTTs: an interpretable **Neural Ordinary Differential Equation** model for biophysical, dynamic GRNi to estimate biophysical parameters and predict gene expression for **drug-perturbations** in *S. cerevisiae*
- Developed an **interpretable deep learning** framework (SupirFactor) for GRNi and transcription factor activity estimation
- Implemented **multitask-learning** into a PyTorch deep autoencoder framework for GRNi
- Analyzed human immune cells in healthy and diseased populations for GRNi

Genentech Research and Development (gRED) 2022
Oncology Department, Bioinformatics Research Intern South San Francisco, CA
- Developed a **Deep Neural Network Graph-Learning**-based model for GRNi
- Designed data pipeline and code repository to automatically graph structure data for training
- Performed a preliminary performance study of the GRNi model on human immune cells

Wisconsin Center for Sleep and Consciousness 2019-2020
Computational Neuroscience, Associate Researcher Madison, WI
- Designed and evolved Markovian neural networks through agent based modeling in C++
- Developed an **information theoretic framework for causal inference** in complex networks
- Created software to analyze causal inference for nonbinary networks in Python

University of Wisconsin-Madison 2014-2018
Askaryan Radio Array for Neutrino Particle Physics, Undergraduate Researcher Madison, WI
- Developed cross correlation algorithms in C++ and Python for neutrino signal processing
- Accelerated computing on GPUs via parallel programming in OpenCL for particle Big Data
- Applied basis spline interpolation to create path raytracing software in C++ and Python

Nevis Laboratories, Columbia University 2017
Deep Underground Neutrino Experiment, NSF REU Student New York, New York
- Developed and optimized zero suppression algorithms to wrangle 40 TB/s while remaining sensitive to neutrino signals, successfully retaining ~MB/s
- Simulated particle interactions to analyze efficiency and estimate data rates from algorithms

Wisconsin IceCube Particle Astrophysics Center, Madison, WI November 2015-2016
IceCube, Undergraduate Research Assistant with WIPAC Director Professor Kael Hanson
- Created circuit boards and sensors to study mechanisms of scintillation in glass
- Designed pilot python analysis searching for dark-matter-like interactions within IceCube

Johannes Gutenberg University of Mainz, 2015
Precision IceCube Next Generation Upgrade (PINGU) Mainz, Germany
NSF International Research Experience for Students with Professor Sebastian Böser
- Concentrated on understanding mechanisms of cold temperature glass scintillation for developing detector aspects
- Created Arduino-based temperature sensors and analyzed data from sensors
- Quantified study through analysis of scintillation intensity spectrums

PUBLICATIONS

Beheler-Amass M, Jackson CA, et al. *Biophysically-Motivated Neural ODEs for Dynamic Gene Regulatory Network Inference and Perturbation Response Prediction*, (manuscript in progress).

Tjärnberg A , Beheler-Amass M, Jackson CA et al. *Structure-primed embedding on the transcription factor manifold enables transparent model architectures for gene regulatory network and latent activity inference.* Genome Biol **25**, 24 (2024).

Jackson CA, Beheler-Amass M, Tjärnberg A et al. *Simultaneous estimation of gene regulatory network structure and RNA kinetics from single cell gene expression.* bioRxiv 2023.09.21.558277 (2023).

Gomeze J.D., Mayner W, Beheler-Amass M et al. *Computing Integrated Information (Φ) in Discrete Dynamical Systems with Multi-Valued Elements.* Entropy **2021**, *23*, 6 (2021).

Albantakis L, Massari F, Beheler-Amass M et al. *A macro agent and its actions,* Top-Down Causation and Emergence, 135-155 (2021).

P. Allison, et al. *Constraints on the Diffuse Flux of Ultra-High Energy Neutrinos from Four Years of Askaryan Radio Array Data in Two Stations*, *Phys.Rev.D* 102 4, 043021 (2020).

M. Beheler-Amass et al. (ARA Collaboration), *Neutrino Vertex Reconstruction in South Pole Ice* EPJ Web Conf. **216**, 02011 (2019).

M. Beheler-Amass, et al. (ARA Collaboration), *Interferometric Neutrino Event Reconstruction in Inhomogeneous Media with the Askaryan Radio Array,* PoS (ICRC 2017) **1054** (2017).

P. Allison, et al. *Design and Performance of an Interferometric Trigger Array for Radio Detection of High-Energy Neutrinos*, arXiv:1809.04573 [astro-ph.IM] (2018).

P. Allison, et al. *Observation of Reconstructable Radio Emission Coincident with an X-Class Solar Flare in the Askaryan Radio Array Prototype Station,* arXiv:1807.03335 [astro-ph.HE] (2018).

U. Abdul, et al*., Measurement of the real dielectric permittivity εr of glacial ice,* arXiv: 1712.03301 [astro-ph.IM] (2017).

SELECTED TALKS

Dynamic Gene Regulatory Network Inference with Interpretable, Biophysically-Motivated Neural ODEs, ISMB, Montreal 2024, (talk, merit-based fellowship awardee).

Interpretable, Biophysically-Motivated Neural ODEs for Dynamic Gene Regulatory Inference, RECOMB/ISCB Regulatory & Systems Genomics, Los Angeles, November 2023, (poster).

Interpretable Deep Learning for Gene Regulatory Network Inference, Network Biology Meeting, Cold Spring Harbor Laboratory, March 2023, (poster).

Interpretable Deep Learning for Multimodal Gene Regulatory Network Inference Uncovers Novel Transcriptional Interactions in PBMC, Winter Quantitative-Biology Conference, Puerto Rico, February 2023, (contributed talk and poster).

Developing Data Reduction Schemes by Zero-Suppression, DUNE Collaboration Meeting, Fermilab, August 2017, (invited).

Developing Zero-Suppression Schemes for the Deep Underground Neutrino Experiment, Final REU Talk, Nevis Labs, August 2017, (invited).

Radiospline, ARA Collaboration Meeting, University of Chicago, August 2016, (invited).

Dark Matter Analysis, IceCube Collaboration Meeting, Johannes Gutenberg University in Mainz, October 2016, (invited).

Spline Raytracing Techniques for Radio Neutrino Event Reconstruction, Conference for Undergraduate Women in Physics, Black Hills State University, January 2016, (poster).

Exploring Temperature Dependent Scintillation in Glass, Johannes Gutenberg University in Mainz, Physics Department Colloquium, August 2015, (invited).

EXTERNAL COMMUNICATIONS AND OUTREACH

TA for the NYU Center for Data Science Summer AI School for Undergraduates	2023
Organizer and TA for DeepMay Data Science Intensive Bootcamp	2019