

# Garrett Bingham

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 Last Updated: March 6, 2023

## EDUCATION

### The University of Texas at Austin

Ph.D., Department of Computer Science  
Expected graduation: May 2023

Austin, TX · 2019 - 2023  
Advisor: Risto Miikkulainen

### Yale University

B.S., Computer Science & Mathematics, *cum laude*

New Haven, CT · 2015 - 2019

## RESEARCH AND WORK EXPERIENCE

### Cognizant AI Labs

Machine Learning Researcher

San Francisco, CA · May 2020 - Present

- Developed AQuaSurF, a technique for efficient activation function optimization through surrogate modeling.
- Fisher eigenvalues and function outputs are used to accurately predict performance, accelerating search for better activation functions.
- AQuaSurF is orders of magnitude more efficient than comparable methods and scales up to large datasets like ImageNet.
- Developed AutoInit, an approach for analytic signal-preserving weight initialization for neural networks.
- AutoInit improves performance of convolutional, residual, and transformer networks across a range of activation function, dropout, weight decay, learning rate, and normalizer settings.
- In neural architecture search and activation function discovery, AutoInit automatically calculates specialized weight initialization strategies for thousands of unique architectures and hundreds of unique activation functions.
- AutoInit improves performance in vision, language, tabular, multi-task, and transfer learning scenarios.
- Developed PANGAEA, a process combining evolutionary and gradient-based optimization to design deep network activation functions.
- Activation functions discovered by PANGAEA give statistically significant increases in performance over 31 baseline functions.

### Neural Networks Research Group

Graduate Research Assistant

Austin, TX · Aug 2019 - Present

- Demonstrated that evolutionary algorithms can design novel deep learning activation functions that outperform ReLU.
- Replacing ReLU with an evolved activation function in Wide ResNet gives a statistically significant increase in accuracy on CIFAR-100.
- Showed that an evolutionary algorithm discovers better activation functions more quickly than random search.

### Amazon Robotics AI

Software Development Engineer Intern

Seattle, WA · May - Aug 2019

- Migrated production large-scale video classification workflow to internal computation framework, optimizing for specific use cases.
- Parallelized 10TB dataset construction and preprocessing; used cached results from prior datasets to incrementally build new ones.
- Created model versioning scheme to allow framework to substitute precomputed per-epoch results instead of requiring two weeks of retraining for every experiment.
- Assisted visiting scientists with onboarding and added GPU support to the framework.

### Language, Information, and Learning at Yale (LILY) Lab

Undergraduate Researcher

New Haven, CT · Aug 2018 - May 2019

- Developed BiDARTS, a novel approach to automatically design bidirectional recurrent neural network architectures.
- BiDARTS approached state-of-the-art accuracy on word token part of speech tagging across 60 treebanks (91.32% vs. 91.83%).
- Empirically demonstrated that random search outperforms current gradient-based approaches to neural network architecture design.
- Improved English-Swahili and English-Tagalog cross-lingual document retrieval relevance scores by 5.2% by training support vector regressor to predict query-specific document cutoffs. Research done for IARPA MATERIAL Program.

**Reservoir Labs**  
Research Intern

New York, NY · Jun - Aug 2018

- Utilized polyhedral compiler to speed up neural network inference time by 12% without sacrificing accuracy.
- Implemented methods to translate TensorFlow operations to equivalent C code, increasing percentage of optimizable operations from 84% to 99% for Inception V3/V4 and from 58% to 95% for ResNet V2 50.
- Designed algorithm to optimize disjoint subgraphs of the neural network, decreasing optimization time to less than one minute.
- Improved robustness by developing algorithms that guarantee the optimized neural network remains acyclic.

**University of North Carolina Wilmington**  
NSF Research Experience for Undergraduates Intern

Wilmington, NC · May - Jul 2017

- Developed novel face recognition algorithm which classifies by weighting predictions made in multiple random feature subspaces.
- Improved accuracy from 60.9% to 78.8% on MORPH-II and from 90.3% to 94.8% on ORL datasets vs. related algorithms.
- Corrected 2,700 errors in the 55,000 entry MORPH-II face image dataset that previously published research missed.

## PUBLICATIONS

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### Journal Articles

1. G. Bingham and R. Miikkulainen. Discovering Parametric Activation Functions. *Neural Networks*, 2022

### Refereed Conference Papers

2. G. Bingham and R. Miikkulainen. AutoInit: Analytic Signal-Preserving Weight Initialization for Neural Networks. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 37, 2023
3. G. Bingham, W. Macke, and R. Miikkulainen. Evolutionary Optimization of Deep Learning Activation Functions. In *Genetic and Evolutionary Computation Conference (GECCO '20), July 8–12, 2020, Cancún, Mexico*, 2020
4. R. Zhang, C. Westerfield, S. Shim, G. Bingham, A. R. Fabbri, W. Hu, N. Verma, and D. Radev. Improving Low-Resource Cross-Lingual Document Retrieval by Reranking with Deep Bilingual Representations. In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 3173–3179, 2019
5. B. Yip, G. Bingham, K. Kempfert, J. Fabish, T. Kling, C. Chen, and Y. Wang. Preliminary Studies on a Large Face Database. In *2018 IEEE International Conference on Big Data (Big Data)*, pages 2572–2579. IEEE, 2018

### Technical Reports

6. G. Bingham. Optimizing Neural Networks through Activation Function Discovery and Automatic Weight Initialization. *Ph.D. Dissertation*, 2023
7. G. Bingham and R. Miikkulainen. Efficient Activation Function Optimization through Surrogate Modeling. *arXiv:2301.05785*, 2023
8. G. Bingham. Part of Speech Tagging with Neural Architecture Search. *Yale University Senior Project*, 2019
9. G. Bingham. Random Subspace Two-Dimensional LDA for Face Recognition. *arXiv:1711.00575*, 2017
10. G. Bingham, B. Yip, M. Ferguson, C. Nansalo, C. Chen, Y. Wang, and T. Kling. MORPH-II: Inconsistencies and Cleaning. *University of North Carolina Wilmington NSF REU*, 2017

## PRESENTATIONS

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### Oral Presentations

11. G. Bingham. Optimizing Neural Networks through Activation Function Discovery and Automatic Weight Initialization. Ph.D. Dissertation Defense. The University of Texas at Austin. Austin, TX. April 3, 2023
12. G. Bingham. AutoInit: Analytic Signal-Preserving Weight Initialization for Neural Networks. AAAI 2023. Washington, DC. February 7-14, 2023
13. G. Bingham. Automated Activation Function Design with Evolutionary Computation. Ph.D. Proposal. The University of Texas at Austin. Austin, TX. December 1, 2020
14. G. Bingham. Evolutionary Optimization of Deep Learning Activation Functions. BEACON Congress. August 12-14, 2020
15. G. Bingham. Evolutionary Optimization of Deep Learning Activation Functions. GECCO 2020. Cancún, Mexico. July 8-12, 2020
16. G. Bingham. Evolutionary Optimization of Deep Learning Activation Functions. Ph.D. Research Preparation Exam. The University of Texas at Austin. Austin, TX. April 21, 2020
17. G. Bingham. Random Subspace Two-Dimensional LDA for Face Recognition. NES Mathematical Association of America Meeting. Sacred Heart University. Fairfield, CT. November 17-18, 2017

### Poster Presentations

18. G. Bingham. AutoInit: Analytic Signal-Preserving Weight Initialization for Neural Networks. AAAI 2023. Washington, DC. February 7-14, 2023
19. G. Bingham. Random Subspace Two-Dimensional LDA for Face Recognition. Council on Undergraduate Research REU Symposium. The Westin Alexandria. Alexandria, VA. October 22-23, 2017
20. G. Bingham. Random Subspace Two-Dimensional LDA for Face Recognition. REU Research Showcase. The University of North Carolina Wilmington. Wilmington, NC. July 24, 2017

## PATENTS

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21. G. Bingham and R. Miikkulainen. System and method for evaluating weight initialization for neural network models, 2022. US Patent App. 63/245,281
22. G. Bingham and R. Miikkulainen. System and method for generating parametric activation functions, Feb. 17 2022. US Patent App. 17/399,470
23. One patent pending

## SOFTWARE

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24. G. Bingham. AQuaSurF. <https://github.com/cognizant-ai-labs/aquasurf>, 2023
25. G. Bingham. Act-Bench. <https://github.com/cognizant-ai-labs/act-bench>, 2023
26. G. Bingham et al. AutoInit. <https://github.com/cognizant-ai-labs/autoinit>, 2021

## REVIEWING

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### Journals

- ACM Journal on Emerging Technologies in Computing Systems
- IEEE Transactions on Evolutionary Computation
- Nature Machine Intelligence

### Conferences

- AAAI (Association for the Advancement of Artificial Intelligence) 2023
- GECCO (Genetic and Evolutionary Computation Conference) 2021, 2022
- ICML (International Conference on Machine Learning) 2022, 2023
- NeurIPS (Neural Information Processing Systems) 2022

## AWARDS

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University Graduate Continuing Fellowship, The University of Texas at Austin, 2021 - 2022, \$44,000. (declined)