





# Garrett Bingham

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## EDUCATION

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**The University of Texas at Austin**  
Ph.D., Department of Computer Science  
Advanced to candidacy, Fall 2020

Austin, TX · 2019 - Present  
Advisor: Risto Miikkulainen

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

New Haven, CT · 2015 - 2019

## RESEARCH AND WORK EXPERIENCE

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**Cognizant Technology Solutions**  
Evolutionary AI Researcher

San Francisco, CA · May 2019 - Present

- 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 28 baseline functions.
- Submission under review; patent pending.

**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 evolutionary algorithm discovers better activation functions more quickly than random search.
- *Evolutionary Optimization of Deep Learning Activation Functions* published at GECCO 2020.

**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; publication at ACL 2019.

**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.

- 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.
- Second-author publication at the 2018 IEEE International Conference on Big Data, first-author oral presentation at the NES Mathematical Association of America Meeting, and first-author poster presentation at the Council on Undergraduate Research REU Symposium.

## PUBLICATIONS

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### Refereed Conference Papers

1. 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*
2. 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
3. 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

4. G. Bingham and R. Miikkulainen. Discovering parametric activation functions. *arXiv:2006.03179*, 2020
5. G. Bingham. Part of speech tagging with neural architecture search. *Yale University Senior Project*, 2019
6. G. Bingham. Random subspace two-dimensional lda for face recognition. *arXiv:1711.00575*, 2017
7. 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

8. G. Bingham. Automated activation function design with evolutionary computation. Ph.D. Proposal. The University of Texas at Austin. Austin, TX. December 1, 2020
9. G. Bingham. Evolutionary optimization of deep learning activation functions. BEACON Congress. August 12-14, 2020
10. 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
11. 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

12. 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
13. G. Bingham. Random subspace two-dimensional lda for face recognition. REU Research Showcase. The University of North Carolina Wilmington. Wilmington, NC. July 24, 2017

**REVIEWING**

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**Journals**

IEEE Transactions on Evolutionary Computation