PAUL SOULOS

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I am a computational cognitive scientist, AI researcher, and software engineer with industry and academic experience:

- Led neural network research, resulting in publications and awards at premier conferences including NeurIPS, ICML, EMNLP, and NAACL.
- Demonstrated track record of successful research collaborations with major tech companies including Microsoft and IBM.
- Shipped software helping people connect and live healthier lives to over half a billion users while at Google and Fitbit.

EDUCATION

Johns Hopkins University

Ph.D. in Computational Cognitive Science, GPA: 4.0/4.0
Advisors: Paul Smolensky, Leyla Isik
Expected 07/2025

Johns Hopkins University

B.S. in Computer Science, GPA: 3.85/4.0
B.S. in Applied Mathematics, GPA: 3.74/4.0
Graduated 12/2012

RESEARCH EXPERIENCE

Johns Hopkins University

2019-PRESENT

Graduate Researcher, Neurosymbolic Computation Lab

- Invented neural network architectures to enhance generalization in neural networks, resulting in first-author publications at NeurIPS, ICML, and various workshops.
- Developed a framework for interpreting neural network representations by uncovering latent compositional structure, resulting in a first-author publication at BlackboxNLP.
- Led collaborations with Microsoft Research to integrate neurosymbolic methods into Transformers.

IBM Research

2024

Research Scientist Intern, In-memory Computing Group

- Investigated methods to improve Transformer generalization on formal languages, resulting in a first-author publication at the System-2 Reasoning at Scale workshop.
- Developed a novel method to finetune the Llama 3 Large Language Model into a Recurrent Neural Network to improve entity tracking performance in natural language.

Microsoft Research

2020-2024

Research Scientist Intern and Collaborating Researcher, Deep Learning Group

- Improved Transformers for abstractive summarization and machine translation, resulting in publications at NAACL and LoResMT2021.
- Surveyed experts in Compositionality to understand the current state of the field, resulting in a publication at EMNLP.
- Led cross-institutional collaborations between academia and industry to improve systematic generalization in neural networks, resulting in first-author publications at NeurIPS and ICML.

Johns Hopkins University 2020-2022

Graduate Researcher, Computational Cognitive Neuroscience Lab

- Led research integrating disentangled deep generative models with fMRI analysis to reveal coding principles in the human face processing network, resulting in a first-author publication in PLOS Computational Biology and multiple workshop/conference presentations

UC Berkeley 2017-2018

Research Assistant, Computational Cognitive Science Lab

- Assisted on novel training paradigms for convolutional neural networks using hierarchical linguistic labels to better capture human psychological taxonomies and generalization patterns, resulting in a journal publication in the Journal of Vision.

SOFTWARE ENGINEERING EXPERIENCE

Fitbit 2017-2019

Senior Software Engineer

- Led development of female health tracking and sleep monitoring features for 20+ million Android users.
- Collaborated cross-functionally with product, design, and data science teams to deliver key Health & Wellness initiatives.

Google 2013-2016

Software Engineer

- Created and designed Google apps for Android Wear, defined APIs and libraries for third party developers, and helped with core operating system functionality, leading to a presentation at Google I/O.
- Collaborated with the Google Fit team to build Google's fitness experience for wearables.
- Worked with the industrial design and marketing teams to promote accessories and personalization.
- Launched the Contacts experience on Android Lollipop, which was used by over half a billion users, resulting in a performance spot bonus.
- Worked on cloud infrastructure to support Google's mobile application offerings and built tools for third party mobile developers to utilize Google App Engine.
- Assisted on improvements for Gmail search functionality and autocomplete.

Persistent Systems 2011-2012

Software Engineer

- Built the Android application to interface with Persistent Systems' wireless radio systems used in a diverse set of markets including military, agriculture, government, mining, and first responders.

SELECTED PUBLICATIONS

1. **Paul Soulos**, Henry Conklin, Mattia Opper, Paul Smolensky, Jianfeng Gao, and Roland Fernandez. Compositional Generalization Across Distributional Shifts with Sparse Tree Operations. In *Thirty-seventh Conference on Neural Information Processing Systems (NeurIPS)*, 2024.

2. Kate McCurdy, **Paul Soulos**, and Paul Smolensky. Toward Compositional Behavior in Neural Models: A Survey of Current Views. In *Proceedings of the 2024 Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2024.
3. **Paul Soulos** and Leyla Isik. Disentangled Face Representations in Humans and Machines. In *PLOS Computational Biology*, 2024.
4. **Paul Soulos**, Edward Hu, Kate McCurdy, Yunmo Chen, Roland Fernandez, Paul Smolensky, and Jianfeng Gao. Differentiable Tree Operations Promote Compositional Generalization. In *Proceedings of the 40th International Conference on Machine Learning (ICML)*, 2023.
5. Yichen Jiang, Asli Celikyilmaz, Paul Smolensky, **Paul Soulos**, Sudha Rao, Hamid Palangi, Roland Fernandez, Caitlin Smith, Mohit Bansal, and Jianfeng Gao. Enriching Transformers with Structured Tensor-Product Representations for Abstractive Summarization. In *Proceedings of the 2021 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies (NAACL)*, 2021.
6. Joshua C Peterson, **Paul Soulos**, Aida Nematzadeh, and Thomas L Griffiths. Learning to generalize like humans using basic-level object labels. In *Journal of Vision*, 2019.
7. **Paul Soulos** and Allyson Gale. Context-aware system for providing fitness information. US Patent App. 14/812, 379.

SELECTED WORKSHOP PAPERS

1. **Paul Soulos**, Aleksandar Terzić, Michael Hersche, and Abbas Rahimi. Recurrent Transformers Trade-off Parallelism for Length Generalization on Regular Languages. In *The First Workshop on System-2 Reasoning at Scale, NeurIPS'24*.
2. **Paul Soulos**, Sudha Rao, Caitlin Smith, Eric Rosen, Asli Celikyilmaz, R. Thomas McCoy, Yichen Jiang, Coleman Haley, Roland Fernandez, Hamid Palangi, Jianfeng Gao, and Paul Smolensky. Structural Biases for Improving Transformers on Translation into Morphologically Rich Languages. In *Proceedings of the 4th Workshop on Technologies for MT of Low Resource Languages (LoResMT2021)*, 2021.
3. **Paul Soulos**, R. Thomas McCoy, Tal Linzen, and Paul Smolensky. Discovering the Compositional Structure of Vector Representations with Role Learning Networks. In *Proceedings of the Third BlackboxNLP Workshop on Analyzing and Interpreting Neural Networks for NLP*, 2020.

AWARDS AND HONORS

1. Spotlight Award at NeurIPS 2024 for Compositional Generalization Across Distributional Shifts with Sparse Tree Operations. 2024.
2. Spotlight oral presentation at NeurIPS 2024 System 2 Reasoning at Scale Workshop for Compositional Generalization Across Distributional Shifts with Sparse Tree Operations. 2024.
3. Scholar Award for NeurIPS 2024. 2024.
4. Selected lightning talk at Johns Hopkins AI-X Foundry Fall 2023 Symposium for Differentiable Tree Operations Promote Compositional Generalization. 2023.
5. Spotlight oral presentation at NeurIPS 2019 Workshop on Context and Compositionality in Biological and Artificial Neural Systems for Discovering the Compositional Structure of Vector Representations with Role Learning Networks. 2019.

6. Living Tapestry artwork selected for the NIPS 2017 Workshop on Machine Learning for Creativity and Design. 2017.
7. Participated in a trial period at the Interaction Design department of Fabrica. 2017.
8. Presented at Google I/O on building apps for Android Wear 2.0. 2016.
9. Graduated with honors from Johns Hopkins University. 2012.
10. Graduated with departmental honors from Johns Hopkins University's Department of Computer Science. 2012.

SKILLS

Neural Networks, Generalization, Algorithmic Reasoning, Computational Linguistics, Cognitive Science, Large Language Models (LLMs), Formal Languages, Python, PyTorch