

SHIRUI (CARL) CHEN

Research Scientist

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I am an applied mathematics Ph.D. candidate specializing in generative AI, computational neuroscience, and deep learning theory. Part of my research aims to understand how neural circuits can implement various generative AI models such as diffusion models and LLMs. My academic rigor and hands-on research experience equip me to address cutting-edge challenges in AI research and development.

RESEARCH INTERESTS

Generative Models, Neural Network Generalization, Machine Learning, Computational Neuroscience.

TECHNICAL STRENGTHS

PyTorch, Python, MATLAB, C++, Java, R, Linux, LaTeX, and SQL

EDUCATION

University of Washington, Seattle	2021 - Present
Ph.D. Candidate	Advisor: Prof. Lillian Ratliff (ECE), Prof. Eric Shea-Brown (AMATH)
M.S., Applied Mathematics	<u>GPA: 3.98</u>

University of Wisconsin, Madison	2017 - 2021
B.Sc. in Mathematics and Computer Science	<u>Major GPA: 4.00</u>
Nominated for 2021 Dean's Prize (top 51 students in the class of 2021)	<u>Cumulative GPA: 3.98</u>

SELECTED RESEARCH PROJECTS

Generative Biological RNN	2022- 2023
<ul style="list-style-type: none">Investigated how the human brain models uncertainty using generative models, specifically diffusion models.Developed a novel computational model, the Reservoir-Sampler Network (RSN), mimicking brain-like processes for decision-making. This model was shared with the wider scientific community through the release of the PyTorch code.Utilized mathematical techniques (stochastic differential equations) to understand how neural circuits can implement human-like decision-making processes, offering insights into both neuroscience and artificial intelligence.	

Generalization of Neural Networks	2023 - Present
<ul style="list-style-type: none">Explored how neural networks, which are the backbone of modern AI, process and interpret information, with a focus on their reliability and accuracy.Investigated specific mathematical properties (sharpness, volume compression, maximum local sensitivity) that influence how well these networks can generalize from training data to test data.Conducted practical experiments with widely-used deep learning architectures, showing how these mathematical properties affect the network's generalization performance, crucial for improving AI reliability in applications like autonomous vehicles and medical diagnostics.	

Bayesian Inference of Synaptic Plasticity	2020 - 2022
<ul style="list-style-type: none">Tackled the challenge of understanding how brain cells adapt and learn, using Bayesian statistics, a method of statistical inference.Developed a novel approach for analyzing sparse and complex brain data, making significant strides in understanding the rules governing brain plasticity.This research is particularly relevant for the development of efficient data analysis methods in neuroscience, with potential applications in designing better AI algorithms that mimic human learning processes.	

PUBLICATION

Peer-reviewed journal and conference

- [1] **Shirui Chen**, Linxing Jiang, P.N. Rajesh Rao, and Eric Shea-Brown. “Expressive probabilistic sampling in recurrent neural networks”. In: *Advances in Neural Information Processing Systems (NeurIPS)*. 2023. URL: <https://arxiv.org/abs/2308.11809>.
- [2] **Shirui Chen**, Qixin Yang, and Sukbin Lim. “Efficient inference of synaptic plasticity rule with Gaussian process regression”. In: *iScience* 26.3 (2023), p. 106182. ISSN: 2589-0042. DOI: [10.1016/j.isci.2023.106182](https://doi.org/10.1016/j.isci.2023.106182).
- [3] **Shirui Chen**, Kai Zhou, Liguang Yang, Guohui Ding, and Hong Li. “Racial Differences in Esophageal Squamous Cell Carcinoma: Incidence and Molecular Features”. In: *BioMed Research International* 2017 (Mar. 14, 2017). Publisher: Hindawi, p. 1204082. ISSN: 2314-6133. DOI: [10.1155/2017/1204082](https://doi.org/10.1155/2017/1204082).

Preprint

- [4] **Shirui Chen**, Stefano Recanatesi, and Eric Shea-Brown. “A simple connection from loss flatness to compressed representations in neural networks”. In: *arXiv preprint arXiv:2310.01770* (2023). URL: <https://arxiv.org/abs/2310.01770>.

AWARDS

The Violet Higgitt Frank Scholarship	2020
International Collegiate Programming Contest (ICPC), World Finalist	2019
Mathematical Contest in Modeling (MCM) Meritorious Winner (Top 10% out of 10670 teams)	2018

INDUSTRY EXPERIENCE

Enterprise Software Engineer <i>Facebook Inc.</i>	2019 Summer <i>Menlo Park, CA</i>
<ul style="list-style-type: none"> · Developed an intuitive web interface enabling users to seamlessly create and modify purchase orders. Ensured real-time synchronization of changes with the backend database, leading to the project’s widespread use within the organization. The implemented interface greatly simplified the enterprise ordering pipeline. · Full-stack role involves React, JavaScript, Relay, and Hack (PHP). · Contributed over 3000 lines of code and received a return offer for superior performance. 	