Part 1: Research Interests

My fascination with the inner workings of deep neural networks and my commitment to improving their interpretability drive me to pursue a PhD at UBC. Deep models are often considered 'black boxes' due to their complexity, and understanding their decision-making is a significant challenge. Additionally, they often fail in real-world scenarios where inputs can be unpredictable, adversarial, or noisy. As society increasingly relies on deep learning in high-stakes fields such as healthcare and medicine, it is critical to improve our understanding of how deep learning works so that we can address its limitations. In my PhD, I aim to deepen my technical expertise in deep learning and its mathematical foundations to design *effective*, *robust*, and *interpretable* models. UBC is an ideal environment for my pursuit of advancing our understanding of the scientific principles underlying deep learning.

Prior work and publications: I studied the effects of weight structure with Dr. Kameron Decker Harris in structured random feature (SRF) networks, which are grounded in kernel theory and use biologically-inspired frozen weights in the hidden layers [Pandey et al., 2022]. While traditional deep networks learn complex input-output mappings, fixed SRF weights have more interpretable covariance inspired by the structure of mouse V1 neurons. After showing that V1-like structured weights in convolutional networks can improve performance against unstructured weights and wavelet scattering networks, I won a grant from the International Network for Bio-Inspired Computing to bring my project to Mila - Quebec AI Institute for an internship. I learned how to develop research ideas and clearly articulate my objectives, methodology, and findings for grant proposals.

At Mila, I collaborated with Dr. Guillaume Lajoie and Dr. Guy Wolf to develop a novel learnable SRF architecture. Alongside improving our understanding of trainable weight structures, we wanted to investigate rainbow networks [Guth et al., 2024], which model the probability distribution of pre-trained network weights using learned weight covariances and rotations of layer activations. I developed SRF convolutions that learn the separable product of the channel and spatial weight covariances, finding that learning covariances recovers most of the performance of fully-trained deep networks while massively reducing the learnable parameter count. We then investigated rainbow networks using SRF convolutions and found that sampling pre-trained weights failed in deeper networks. I wrote and published my debut first-author paper to an ICLR workshop **[White et al., 2024a]**, gaining valuable skills in fundamental deep learning and research collaboration.

Motivated to improve parameter compression and validate observations of low-rank covariances in Guth et al. [2024], I built low-rank SRF convolutions and found that low-rank models can preserve performance. My involvement in discussions of reformulating the SRF layers and modifying the training procedure helped implement the first deep rainbow network. I refactored our rainbow implementation with low-rank covariances and ran over 700 experiments to validate that our method scales to deep networks in a variety of architectures and that its covariances are effectively low-rank. My work resulted in my second first-author workshop paper to NeurIPS **[White et al., 2024b]**. I improved my understanding of the mathematical foundations of deep networks and learned how to design impactful scientific experiments and critically evaluate my findings.

Additionally, I published a first-author paper with Dr. Fuqun Huang to the ISSRE Workshop on Human Factors for Software Dependability **[White et al., 2024c]**. We developed Human Error Scenario Analysis, a novel methodology for elucidating cognitive errors behind software defects based on psychological principles. While different from the machine learning research I aim to pursue, this interdisciplinary work enhanced my leadership skills in research: I guided two other undergraduates throughout the project. This experience imbues me with confidence in my ability to lead research collaborations at UBC

Presentations and awards: I presented posters at seven national and international workshops and conferences during my undergraduate studies, notably winning **first place** at the 2024 NSF AAAS Emerging Researchers National conference in the Computer Science and Information Systems division. I have also delivered spotlight talks on my computational neuroscience research to academic experts (most recently at NeuroAI Eugene) and the general public, honing my ability to communicate research to diverse audiences. The CS department at Western Washington University honored me with an **Outstanding Graduate Award** for my hard work in research. I am also among two CS Master's students awarded graduate tuition waivers for top academic performance.

Diversity and service: I am committed to advancing diversity in computer science. At WWU, I mentored two undergraduate women in the CS/Math Distinguished Scholars program, funded by an NSF S-STEM grant to support academically talented students with financial need. Given the bonds I formed with my mentees, I would embrace to the opportunity to mentor undergraduate and master's students at UBC, especially in research. My diverse mentors instilled in me the importance of representation, and I am eager to engage in outreach to empower underrepresented students interested in CS throughout my PhD.

Research interests: UBC's globally renowned leadership in machine learning research will provide the training I need to become an innovator in the field. I am interested in working with Dr. Danica Sutherland, whose research on kernels (for instance, [Mohamadi et al., 2022]) is closely aligned with my goal of developing theoretically tractable networks. I am excited about leveraging kernels to improve the mathematical foundations of wide networks. I am also eager to work with Dr. Geoff Pleiss. His focus on theoretical machine learning and robustness complements my goal of building theoretically sound and reliable deep models. I am interested in working with him on Bayesian optimization or neural network uncertainty quantification. Vancouver's thriving tech ecosystem, with its numerous AI startups and research labs, makes it an exceptional location for me to pursue innovative deep learning research.

Future career plans: After completing my PhD, I plan to advance our scientific understanding of deep networks by pursuing a career as a machine learning research scientist. My experience researching rainbow networks inspires me to shed light on neural network black boxes. UBC's expert mentorship and resources will enable me to lead significant advancements in deep learning during my PhD and beyond.

References

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Mohamad Amin Mohamadi, Wonho Bae, and Danica J. Sutherland. A fast, well-founded approximation to the empirical neural tangent kernel. 2022. doi: 10.48550/ARXIV.2206.12543. URL https://arxiv.org/abs/2206.12543.

Part 2: Publications

Refereed Workshop Papers

3. V White, MS Chaudhary, G Wolf, G Lajoie, KD Harris, 2024, Learning Stochastic Rainbow Networks, NeurIPS Workshop on Scientific Methods for Understanding Deep Learning, 5 pages.

2. V White, A White, J Wild, T Nguyen, F Huang, 2024, Human Error Scenario Analysis of Software Defects, ISSRE Workshop on Human Factors for Software Dependability, 8 pages.

1. V White, MS Chaudhary, G Wolf, G Lajoie, KD Harris, 2024, Learning and Aligning Structured Random Feature Networks, ICLR 2024 Workshop on Representational Alignment, 9 pages.

Refereed Talks

1. V White, 2024, Learning and Aligning Structured Random Feature Networks, NeuroAI Eugene Workshop.

Refereed Posters

7. V White and KD Harris, 2024, Learning Stochastic Rainbow Networks, NeurIPS Workshop on Scientific Methods for Understanding Deep Learning.

6. V White and MS Chaudhary, 2024, Learning and Aligning Structured Random Feature Networks, ICLR Workshop on Representational Alignment.

5. V White, 2024, Learning and Aligning Structured Random Feature Networks, NSF/AAAS Emerging Researchers National Conference.

4. V White, 2023, Randomized Scattering Convolutional Networks, NeuroAI Montréal Workshop.

3. V White, 2023, Randomized Scattering Convolutional Networks, DeepMath Conference.

2. V White, 2024, Randomized Scattering Convolutional Networks, NSF S-STEM Scholars Meeting.

1. V White, 2022, Randomized Scattering Convolutional Networks, NeuroAI Seattle Workshop.

Part 3: Summary of Awards

14. Dean J. Alan Ross Travel Fund Award, $100 USD. Institutional award. 2024. Travel funding to present my poster accepted to NeurIPS workshop from the WWU Graduate School.
13. CS Graduate Fellowship, $1500 USD. Institutional award. 2024-2025. Competitive graduate scholarship from the WWU CS Department.
12. Graduate Recruitment Tuition Waiver, $4000 USD. Institutional award. 2024-2025. One of two CS recipients awarded a tuition waiver on the basis of academic achievements from the WWU Graduate School.
11. Outstanding Undergraduate in Computer Science. Institutional award. 2024. Recognized by the CS department as one of three top graduating students in the 2023-2024 academic year.
10. 1st-place award for CS poster presentation at the Emerging Researchers National Conference, $300 USD. National award. 2024. Received first-place in the Computer Science and Information Systems division for undergraduate poster presentations.
9. Barbara Ellen Maguire-Veith Family Scholarship, $4400 USD. Institutional award. 2023-2024. Competitive research-based scholarship from the WWU College of Science and Engineering.
8. International Network for Bio-Inspired Computing Fellow, $10000 USD. International award. 2023. The first undergraduate recipient of a grant from the IN-BIC to fund a summer research internship.
7. Lars and Elaine Giusti Scholarship for Computer Science, $2000 USD. Institutional award. 2022-2023. Competitive undergraduate scholarship from the WW CS department.
6. Computer Science/Math Distinguished Scholar Award, $13694 USD. Institutional award. 2020-2023. Tuition scholarship from NSF-funded S-STEM Scholars program on the basis of academic merit, financial need, and STEM career interest.
5. Western Foundation Distinguished Scholar Award, $1000 USD. Institutional award. 2020-2024. Award for my National Merit Finalist scholarship package.
4. Merit Scholarship, $1000 USD. Institutional award. 2020-2024. Award for my National Merit Finalist scholarship package.
3. Admissions Achievement Award, $12000. Institutional award. 2020-2022. Award for my National Merit Finalist scholarship package.
2. Admissions Annual Scholarship, $2000 USD, 2020-2021. Awarded to an incoming freshman who has demonstrated academic achievement.
1. Scholarship Award, WSECU, $3000 USD, 2020-2021. Scholarship for WSECU bank members pursuing higher education.

Total scholarships and awards: **$54994 USD.**