Chris Zhuang

My research interest lies in neuroimaging with a focus in image processing and machine learning. This field is exciting because I understand how useful machine learning and image processing is as a tool for medical applications. While neuroscience applications are especially challenging, they are important to help us understand the brain better and develop technologies that can be used in a clinical setting, such as nerve detection during surgery.

My initial interest in machine learning developed when I took Data Science Principles and Data Science Lab at the University of Texas at Austin. My desire to work on machine learning research developed when I was accepted to a computational biology Research Experience for Undergraduates (REU) at the University of Tennessee at Chattanooga. I worked under Dr. Yu Liang and Dr. Dalei Wu on a project developing a graph neural network to better predict COVID-19 spread. In this experience, I learned the importance of going through literature and testing different neural networks to generate better results. I realized I enjoyed the multidisciplinary interface between machine learning and biology.

My fascination with the brain first developed when I took courses in neuroengineering and brain-computer interactions with Dr. Jose Millan. I enjoyed learning about different neurotechnologies that improve the lives of people with disabilities. I decided to continue exploring the field by conducting a research project with Dr. Millan on decoding and classifying neural signals from the hippocampus with the goal of restoring memory. I gained valuable experience using MATLAB to implement filters and machine learning algorithms on neural data. This along with my appreciation for multidisciplinary research led me to pursue opportunities combining machine learning and neuroscience research.

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A course in digital image processing established my specific interest in neuroimaging. I was especially interested in denoising and super resolution, and wanted to explore the applications towards medical images. The following semester, I worked with Dr. Bo Zhao on inverse imaging problems using magnetic resonance imaging (MRI) data collected from the brain. I learned to implement different machine learning models for image processing like the U-Net and the deep image prior. This experience taught me the importance of understanding the mathematical intuition behind specific image problems like MRI noise before approaching it with machine learning.

I further explored image processing this past summer in the Wellman-HST Summer Institute for Biomedical Optics REU at Massachusetts General Hospital (MGH). I interned under Dr. Benjamin Vakoc to implement a nerve detection algorithm using data collected from polarization sensitive optical coherence tomography, an exciting imaging technique that uses polarized light to detect intensity, phase retardation, and optic axis orientation. I was able to implement the Mask R-CNN, an instance segmentation model, and go through the entire process of creating a dataset. In this experience, I learned how to implement computer vision algorithms, utilize docker to set up a local host for annotations, and connect results to physiological properties along with properties of the imaging modality. Towards the end of the summer, I had the opportunity to prepare and present a research poster on my work which I shared with my peers and the research community at MGH. This experience confirmed my passion for research and my interest in neuroimaging with a focus on image processing and machine learning.

Columbia offers the opportunity to explore machine learning and image processing though the Vision and Robotics track. I plan to dive deep into machine learning and computer vision, and then branch out into the neuroimaging realm. I want to develop the intuition and

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understanding of the machine learning tools that I am using before applying them for neuroimaging clinical applications like MRI super resolution or nerve detection. I am excited to take courses in mathematics for machine learning and signal recognition, deep learning for computer vision, and applied machine learning. I am also excited by all the faculty in the Vision and Robotics track, and I would hope to be able to work with Dr. Shih-Fu Chang. Dr. Chang's work on few-shot object detection excites me as I believe there could be many applications for neuroimaging where complete images can be scarce.

After graduation, I plan to pursue a career in academia. My interest in teaching developed when I was a teaching assistant for Probability and Multivariable Calculus. My role for both involved holding office hours and grading homework. In order to help the students succeed, I made sure to review the material, fill in knowledge gaps, and regularly consult the professor. Collaborating with the graduate teaching assistants for these classes helped me see their passion for teaching and ability to easily disseminate engineering knowledge. I am looking forward to the opportunity of being a graduate teaching assistant at Columbia, as I believe it will boost my ability to thrive in academia.