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**Statement of purpose**

I’ve always been passionate about understanding how the mind works. This passion led me to complete a bachelor degree in psychology and a Master’s in neuroscience. While I’ve learned a lot during these degrees, I’ve also been disappointed by how little we understand the computations the brain does. I wish to pursue a PhD in neuroscience to fulfill my curiosity and work towards better neuroscience theories. I am especially interested in neuroplasticity, as I believe we would understand the brain much better if we had a better understanding of the learning rules behind neuronal connections. These learning rules must have some properties to solve complex problems at the system level, which is why I am impatient to discover more about it.

We are rich in knowledge about how neuroplasticity works at the cellular level, but how these rules allow neural circuitry to solve complex problems is still poorly understood. Spike Timing Dependent Plasticity (STDP) is a temporally asymmetric form of Hebbian learning where long-term potentiation (LTP) occurs in excitatory neurons when a presynaptic spike precedes a postsynaptic spike, with the opposite leading to long-term depression (LTD). This important role of time-dynamics in neuroplasticity is often overlooked, with most researchers modeling neural networks with plasticity rules based on correlation (e.g. Olshausen & Field, 1996). An example project I am interested in would be to use the NMDA-dependent bidirectional plasticity model from Shouval, Bear & Cooper (2002) to study the computational properties of STDP at the network level. We could model the early visual system by using natural movies as inputs, as to mimic the temporal correlations of the real-world. Such a model could help test some theories about receptive fields of LGN and V1 neurons. For example, we could test whether inhibitory interneurons in primary visual cortex are more likely to have complex-like receptive-fields (Lauritzen & Miller, 2003) because of their opposite STDP learning rules compared to excitatory neurons (Caporale & Dan, 2008).

I have a lot of experience in applying computational approaches to solve neuroscience problems, which makes me a great candidate to carry out a computational neuroscience project at the University of Texas at Houston. This expertise can be seen in two of my recent projects, my Master’s thesis and my recent publication in the journal of computational biology. My master’s thesis, “Transient inhibition to light explains stronger V1 responses to dark stimuli”, aimed to study the mechanisms behind stronger responses to dark than light stimuli in primary visual cortex. We used machine learning to do system identification of recorded V1 neurons. We discover the stronger dark responses found by previous research (Jin et al., 2008; Shapley et al., 2009) to only occur at early latencies, and to be due to slower intracortical inhibition to dark than light stimuli. During this research project, I’ve greatly improved my machine learning skills and learned how to use Tensorflow to build my own custom, biologically-inspired convolutional neural network. I’ve also developed a solid expertise in both visual neuroscience and electrophysiology, on top of learning how to review and understand the literature to relate my results to it.

My recent publication “Visual perception of texture regularity: conjoint measurements and a wavelet response-distribution model” is a good demonstration of how I can apply my statistical expertise to experimental problems. This project uses Maximum-Likelihood Conjoint Measurement (MLCM), a statistical method for analyzing psychophysical data with a specific type of experimental design. While MLCM was originally designed to study one-way and two-way interactions, our study was the first to simultaneously estimate the effect of three different variables. As the group’s statistical expert, I designed a new statistical framework to extend MLCM to test for three-way interactions. This work was published in the Journal of Cognitive Neuroscience, and received compliments from Kennett Knoblauch, who invented MLCM. As my record shows, I have a solid background in computational neuroscience which is going to be a strong foundation for pursuing a PhD.

The University of Texas at Houston neuroscience would be the perfect place for me to pursue my PhD in neuroscience, as it has some of the best neuroplasticity researchers in the world. I could learn a lot from professors such as Dr. Harel Shouval, who does amazing work at modeling STDP from calcium-dependent mechanisms. Doing a PhD under his supervision would be a golden opportunity for me to become an expert in neuroplasticity and to improve my computational modeling skills. I am certain doing so would be both fascinating and propel my research career to the next level.