**Statement of purpose**

Neuroplasticity is the key to understand how neurons synapse with each other to solve complex tasks. 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. Even though many researchers have modeled neural networks with learning rules inspired from Hebbian learning (), these learning rules are usually based on correlation and overlook the important role of time-dynamics in neuroplasticity. 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). Although it is challenging to model STDP because it involves having inputs that are temporally correlated, it would greatly benefit our understanding of how shapes the receptive fields of neurons. For example, inhibitory interneurons in primary visual cortex have complex-like receptive-fields (), which could be due to having opposite STDP learning rules compared to excitatory neurons (). It would be possible to test this by using natural movies as inputs, as they are temporally correlated. We could then filter these natural movies through temporal Gabor and spatial Difference-of-Gaussians filters, to simulate receptive fields of the lateral-geniculate-nucleus (LGN) which synapse excitatory inputs into the primary visual cortex.

The Gatsby computational neuroscience unit would be the perfect place for me to pursue my PhD, as it is a world-renowned institute for theoretical neuroscience and machine learning. I would be a great candidate to absorb this expertise, as I already have strong backgrounds in both neuroscience and machine learning. I’ve learned about a variety of cognitive and behavioral neuroscience fields during my undergraduate degree, which is also when I’ve started to develop an expertise in both machine learning and statistics. I then went to complete my Master’s degree in neuroscience, where I’ve applied my machine learning knowledge to build a biologically-inspired convolutional neural network for system identification of recorded V1 neurons. This project taught me how to

These plasticity learning rules as well studied, with multiple mathematical models being proposed for how different synaptic levels of calcicul leads to either LTP or LTD. However,

My point is, I’m sure we’ll manage to wrap these phenomenon together someday and I’m curious to see what such theories will look like.

From the primary visual cortex to the frontal lobes, we have conducted countless experiments to discover what neurons do, only to discover the brain is much more complex than what we could have imagined. By creating and testing new theories, theoretical research plays a crucial role in pushing our understanding of neuroscience to the next level. We can gain great insight into how the brain works by solving problems such as how neuroplasticity helps shape computations in different brain regions. In the following section I will explain why this problem is of particular interest to me, and why I think it could greatly improve our understanding of neural circuitry. I will then show you why I would be a great PhD candidate for the Gatsby computational neuroscience unit.

Litterature so far – attempts at relating receptive fields with STDP

Limitations of these models – not as biologically realistic as one would like, calcium dependent theories, etc

What I would like to do for my PhD

Why I am a strong candidate – background in electrophysiology, cognitive neuroscience, psychology, stats, machine learning, etc.

Neuroplasticity tells us that If know the rules of how neurons like to synapse with each other, and how such a system behaves under different inputs , we can understand how the brain was built.

One of the biggest mysteries of neuroscience is how complex behavior arises from a large number of individual neurons.

The Gatsby computational neuroscience unit is I strive to contribute to the future theories that will explain the mysteries of the brain, which is why I wish to pursue a PhD at the Gatsby computational neuroscience unit, a renowned world class institute for theoretical neuroscience.

More specifically, I believe studying biologically-realistic models of neuroplasticity holds great promise to

there is so much we know about what neurons do. However, we because the brain is so complex, experiments alone are not sufficient to fully understand how it works.

The vast amount neuroscientific knowledge we have accumulated is nothing short of miraculous. From the primary visual cortex to the frontal lobes, there is so much we know about what neurons do. However, we because the brain is so complex, experiments alone are not sufficient to fully understand how it works. We need to invent and test novel theories if we want to better understand the brain, which is why theoretical research plays such a crucial role in pushing neuroscience to the next level.

By doing so, I believe we can eventually achieve a general set of theories that can explain exactly how neurons work together to perform such a multitude of tasks. I wish to pursue a PhD at the Gatsby computational neuroscience unit, a renowned world class institute for theoretical neuroscience, because I strive to become a successful researcher who can contribute his work and thoughts to the field of theoretical neuroscience.