Stanford

Kyrus Mama

Ph.D. Student in Neurosciences, admitted Autumn 2022

Bio

BIO

I am a Neurosciences Ph.D. candidate at Stanford with a background in theoretical and experimental neuroscience. I study how ion channels shape the way neurons process synaptic inputs.

EDUCATION AND CERTIFICATIONS

- M. Eng, Cornell University , Computer Science (2021)
- BA, Cornell University , Majors: Psychology, Computer Science, Mathematics Minor: Cognitive Science (2021)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

I study how individual neurons distinguish sequences of synaptic inputs and how their dendrites contribute to this computation. In Kwabena Boahen's Brains in Silicon laboratory at Stanford, I combine mathematical analysis, biophysical modeling, and, more recently, optical experiments to connect the properties of ion channels and synapses to the computations a neuron can perform.

My doctoral work examines how excitation and inhibition allow a dendrite to respond differently to the same inputs delivered in different orders. I developed analytical cable models and biophysical simulations showing that NMDA receptors and G protein-coupled inward-rectifying potassium (GIRK) channels can sustain a boundary between a depolarized plateau and a resting stretch of dendrite. An excitatory input near this boundary can advance the plateau, whereas the same input farther away evokes a response that decays without advancing it. Successive inputs can therefore move the boundary along a dendrite in one order but fail to do so in another. The models identify how conductance strength, synaptic spacing, and input timing constrain this mechanism and predict that a dendrite can distinguish inputs separated by only a few micrometers.

I am now developing experiments to test these predictions in hippocampal CA1 neurons, in collaboration with Michael Lin's laboratory. I have achieved sparse expression of genetically encoded voltage indicators and recorded preliminary fluorescence responses in vivo and in acute slices. I am developing targeted glutamate uncaging alongside ASAP7 voltage imaging to control where and when excitatory inputs arrive while measuring voltage changes along dendrites. I plan to compare plateau duration and spread before and during GABA-B receptor activation and test whether reversing the order of inputs prevents a plateau from advancing. Experiments in slices and in vivo will test whether the spatial and temporal rules predicted by the models hold in neurons.

My broader interests include how dendritic mechanisms support sequence learning and how these mechanisms can inform artificial intelligence and neuromorphic computing. I have contributed to work on dendrocentric neural networks for energy-efficient classification of event-based data. Earlier, at Cornell, I studied how neuromodulation of the olfactory bulb changes cortical odor responses. I also helped develop an analytical account of how

heterogeneous representations of sensory inputs regularize activity in spiking neural networks, published in Scientific Reports. These projects drew on my training in mathematics, computer science, and psychology.

LAB AFFILIATIONS

- Kwabena Boahen, Brains in Silicon (6/5/2023)

Publications

PUBLICATIONS

- **Heterogeneous quantization regularizes spiking neural network activity.** *Scientific reports*
  Moyal, R., Mama, K. R., Einhorn, M., Borthakur, A., Cleland, T. A.
  2025; 15 (1): 14045