Title: Modeling Postsynaptic Current at the Glutamatergic Synapse of a CA1 Pyramidal Neuron: Development and Adaptation for Multi-Scale Simulations.

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Synapses are small, subcellular structures on neurons responsible for communication between other cells. Despite their miniscule size, they contain intricate molecular signaling pathways that are critical for the regulation of network activity in neuron networks. Despite their importance, many large scale simulations of neuron networks utilize simplistic, linear synapses that do not consider the many molecular mechanisms which can influence and change the strength of the connections. This is, in part, due to the computational cost required for a detailed synapse model to be implemented into a large scale network. Here we propose a means to adapt a previously developed complex parametric synapse model to enable multi-scale modeling. The parametric model calculates the postsynaptic current, as well as many other conditions, based on the presynaptic input and the kinetic properties of receptor channel models. In order to better accompany a multi-scale format, we use an Input-Output (IO) representation to accurately replicate the nonlinear response of the postsynaptic current, with a lower computational cost compared to the original parametric model. We show that we are able to successfully adapt the electrical response of the synapse and are currently extending the procedure to more complex molecular processes - namely, postsynaptic calcium dynamics. In conclusion, we show that the Input-Output Synapse model reliably and efficiently replicates the dynamics of the original mechanistic synapse model, providing a valid alternative for incorporation into large scale models.

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