A Computational Model of the Stimulus Response of Mimosa pudica

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Computational modeling offers a powerful method for studying cause-effect relationships in biology. This is immensely valuable for creating synthetic biomimicry structures. Mimosa pudica is of significant bioengineering interest for stimulus-response applications. I have built a novel computational model of the Mimosa pudica leaf that describes its response to touch stimuli of varying intensity. My model, built in Java programming language, consists of three Java classes: the lowest class describes a pinnule, the second constitutes a pinna and the third encompasses an entire leaf. Using pinna-level experimental data, I first built a pinnule class by abstracting the pulvinule as a McCulloch-Pitts neuron that outputs an exponential decay function when its input action potential exceeds a threshold. Then I progressively extended our model until I had comprehended an entire leaf consisting of multiple pinnae, a pulvinus and a petiole connecting the pinnae with the pulvinus. In my model, the mimosa leaf is a computational network of neurons, each of which outputs a response function upon receiving an input that exceeds a specified threshold. My model generated specific predictions of leaf-level behaviors that were successfully validated with subsequent stimulus experiments on the mimosa plant. Because my model abstracts out the physical and biological details of the plant, it can expand the bioengineering opportunities with mimosa beyond mere biomimicry to more effective design and process optimizations.