

Title: NEventSpaces and NeuronX: A Framework for Modeling Neural Events and Structures

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Abstract:

NEventSpaces and NeuronX are two frameworks that provide a powerful tool for modeling neural events and structures. In this paper, we present an overview of these frameworks, their formal specifications, and their applications in two examples: a Mimosa Pudica hair and peduncle model and a neural filter for detecting dendritic branch point failure. We discuss the potential of these frameworks for investigating the mechanisms of neural development, plasticity, and function, and for developing innovative applications in neuroscience and beyond.

Introduction:

Event calculus is a logical formalism for representing events and their effects over time. In neuroscience, NEventSpaces can be used to model neural events triggered by spikes in a soliton alphabet, and to define neurons with spatiotemporal models. NeuronX provides a framework for defining neural structures using L System, IFS, or reactive diffusion models. In this paper, we explore the potential of NEventSpaces and NeuronX for modeling neural events and structures.

Main Thesis:

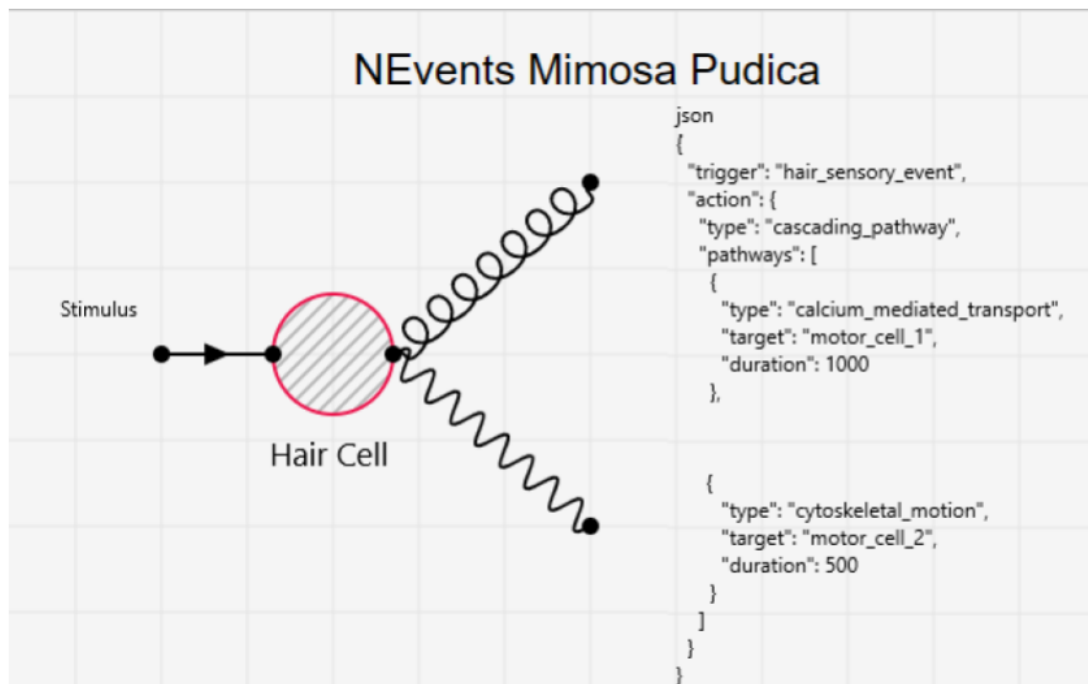
NEventSpaces and NeuronX provide a flexible and powerful framework for modeling neural events and structures. The event calculus formalism allows for the representation of complex events over time, enabling researchers to explore the temporal dynamics of neural systems. NEventSpaces is a space of NEvents, which are events triggered by action potentials or spikes

described in an alphabet of solitons. NeuronX provides a framework for defining neural structures using L System, IFS, or reactive diffusion models.

Formal Specifications of NEventSpaces and NeuronX:

NEventSpaces can be defined as a space of NEvents, where each NEvent is described by a JSON data structure that encapsulates several pathways to actions. NeuronX provides a framework for defining neural structures using L System, IFS, or reactive diffusion models. L System rules can be used to model dendrite growth and branching, and to define failure conditions at specific branch points.

Examples:



The Mimosa Pudica hair and peduncle model can be represented using NEventSpaces and NeuronX. The model can be used to represent the events triggered by the movement of the Mimosa Pudica plant in response to touch.

Feynman diagrams are adopted from representing a path integral formulation to particle interactions, to an event calculus framework for neuromodulation events. In the above diagram two pathways, a cytoskeletal mechanism and a turgor pressure mechanism, represented as cloud functions are encapsulated as NEvents in JSON, triggered by a single or train of spikes from a mimosa pudica hair cell model of ion channels.

- The Mimosa Pudica plant is well-known for its ability to move its leaves and stems in response to touch.
- This movement is controlled by specialized structures called pulvini, which are located at

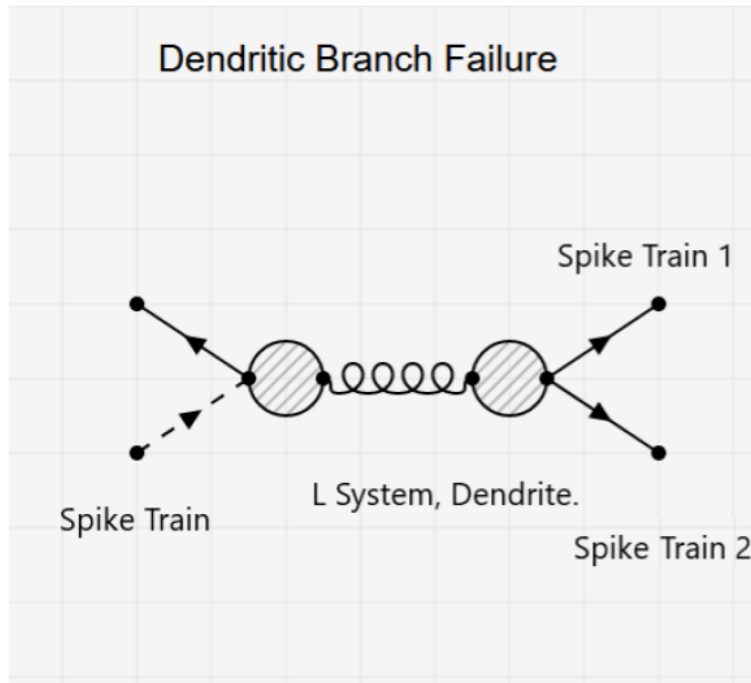
- the base of each leaf and stem.
- The movement of the pulvini is triggered by the movement of tiny hairs called mechanoreceptors, which are located on the surface of the plant.
- A model of the Mimosa Pudica hair and peduncle system can be represented using NEventSpaces and NeuronX.

Main Points:

- NEventSpaces and NeuronX can be used to model the events triggered by the movement of the Mimosa Pudica plant in response to touch.
- The model would represent the mechanoreceptor events triggered by touch and their effects on the pulvini, which ultimately result in the movement of the plant.
- The model would be represented using NEvents, which are events triggered by action potentials or spikes or spike trains described in an alphabet of solitons.
- The JSON data structure of an NEvent would encapsulate several pathways to actions, representing the potential effects of the event on the pulvini.
- NeuronX could be used to define the neural structures involved in the Mimosa Pudica hair and peduncle model, such as the mechanoreceptor cells, pulvinar cells, and interneurons.

Conclusion:

- NEventSpaces and NeuronX provide a powerful tool for modeling complex biological systems, such as the Mimosa Pudica hair and peduncle model.
- By representing events and their effects using NEvents, we can gain insights into the underlying neural mechanisms that drive the movement of the plant.
- In this presentation, we will explore how NEventSpaces and NeuronX can be used to model the Mimosa Pudica hair and peduncle system and other complex biological systems.



The dendritic branch point failure filter demonstrates how NEventSpaces and NeuronX can be used to model the dendritic network and classify spike trains based on their trajectory through the network.

In this slide a feynman diagram represents a L System model of a dendrite in NeuronX, with a bifurcating spike train, into two spike train for information processing.

- Dendritic branching is a critical process in neural development and plasticity, but it can also lead to failures and malfunctions in the neural network.
- A neural filter can be created using NEventSpaces and NeuronX to detect dendritic branch point failure and classify spike trains based on their trajectory through the network.

Main Points:

- L System rules can be used to model dendrite growth and branching in a neuron.
- Using NeuronX, we can define the neural structures involved in the dendritic network, such as the dendritic arbors, branching points, and synaptic connections.
- Failure conditions can be defined at specific branch points using L System rules, such as the loss of synaptic connections or the formation of inhibitory connections.
- NEventSpaces can be used to represent the events triggered by spikes in the dendritic network, such as the activation of downstream neurons or the inhibition of other neurons.
- The resulting model can be used to classify spike trains based on their trajectory through the network, either passing through the failed branch or being diverted into a new spike

train.

Conclusion:

- NEventSpaces and NeuronX provide a powerful tool for creating neural filters that can detect dendritic branch point failure and classify spike trains based on their trajectory through the network.
- By modeling dendritic branching using L System rules and defining failure conditions at specific branch points, we can gain insights into the mechanisms that underlie neural development and plasticity.
- In this presentation, we will explore how NEventSpaces and NeuronX can be used to create neural filters for a variety of applications in neuroscience and beyond.

Discussion:

NEventSpaces and NeuronX provide a flexible and powerful framework for modeling neural events and structures. These frameworks enable researchers to explore the temporal dynamics of neural systems, gain insights into the mechanisms of neural development and plasticity, and apply these insights to a range of applications in neuroscience and beyond. The Mimosa Pudica model and the dendritic branch point failure filter demonstrate the flexibility and usefulness of this approach in neuroscience research.

Citations:

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