Neural field equations with neuron-dependent Heaviside-type activation function and spatial-dependent delay

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Abstract

We introduce a neural field equation with a neuron-dependent Heaviside-type activation function and spatial-dependent delay. The basic object of the study is represented by a Volterra Hammerstein integral equation involving a discontinuous nonlinearity with respect to the state variable that is both time- and space-dependent. We replace the discontinuous nonlinearity by its multi-valued convexification and obtain the corresponding Volterra Hammerstein integral inclusion. We investigate the solvability of this inclusion using the properties of upper semi-continuous multi-valued mappings with convex closed values. Based on these results, we study the solvability of an initial-prehistory problem for the former neural field equation with the Heaviside-type activation function. The application of multi-valued analysis techniques allowed us to avoid some restrictive assumptions standardly used in the investigations of the solutions to neural field equations involving Heaviside-type activation functions.

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