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Poster presentation

A dynamic neural field mechanism for self-organization

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As introduced by Amari [1], dynamic neural fields (DNF) are a mathematical formalism aiming to describe the spatio-temporal evolution of the electrical potential of a population of cortical neurons. Various cognitive tasks have been successfully solved using this paradigm, but nevertheless, tasks requiring learning and self-organizing abilities have rarely been addressed. Aiming to extend the applicative area of DNF, we are hereby interested in using this computational model to implement such self-organizing mechanisms. Adapting the Kohonen's classical algorithm [2] for developing self-organizing maps (SOM), we propose a DNF-driven architecture that may deploy also a self-organizing mechanism. Benefiting from the biologically inspired features of the DNF, the advantage of such structure is that the computation is fully-distributed among its entities. Unlike the classical SOM algorithm, which requires a centralized computation of the global maximum, our proposed architecture implements a distributed decision computation, based on the local competition mechanism deployed by neural fields. Once the architecture implemented, we investigate the capacity of different neural field equations to solve simple self-organization tasks. Our analysis concludes that the considered equations (those of Amari [1] and Folias [3]) do not perform satisfactory, as seen in Figure 1, panels b and c. Highlighting the deficiencies of these equations that impeded them to behave as expected, we propose a new system of equations, enhancing that proposed by Folias [3] in order to handle the observed undesired effects. In summary, the novelty of these equations consist in introducing an adaptive term that triggers the re-inhibition of a so-called "unsustainable" bump of the field's activity (one that no longer is stimulated by strong input, but only but strong lateral excitation). As a conclusion, a field driven by the new equations achieves good results in solving the considered self-organizing task (as seen in Figure 1d). Our research thus opens the way to new approaches that aim using dynamic neural field to solve more complex cognitive tasks.

References

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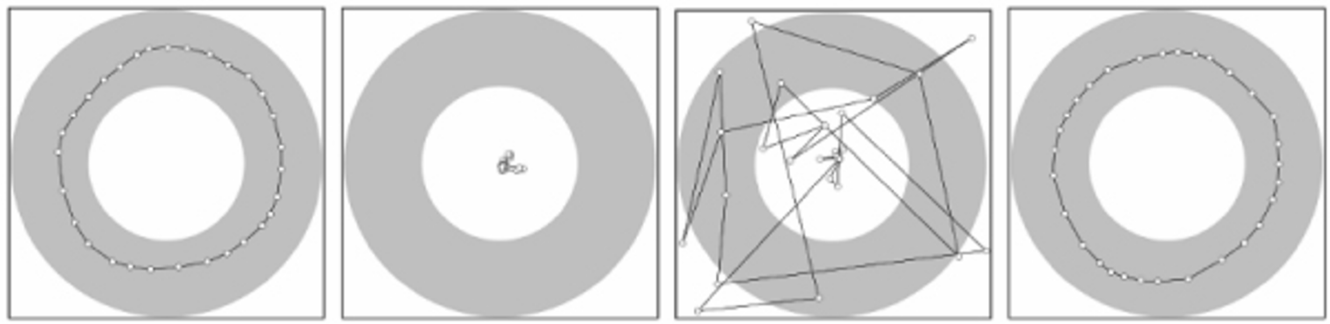

Figure 1
Solving a one-dimensional self-organizing task, aiming to learn the herein shown coronal shape (inner radius 0.5, outer radius 1.0), with the support provided by the 3-layer architecture described in the document. From left to right: a. Kohonen classical SOM; b. Amari DNF; c. Folias DNF; d. the new DNF system of equations.