Topological-numerical analysis of recurrence in applied dynamical systems

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A topological method based on rigorous numerics and a set-oriented approach for the analysis of applied dynamical systems will be introduced. Using a finite representation of a dynamical system with respect to a cubical grid in the euclidean space, the purpose of the method is to split the dynamics into recurrent and gradient-like components, and to use the Conley index as well as direct recurrence analysis in order to provide insight into the structure of isolated invariant sets found in the system. The method also allows one to determine changes in the dynamics that occur when parameters of the system are varied. The method originates from [1] and has been considerably improved since then. An application of this method to the analysis of a two-dimensional discrete-time model of a neuron [2] will be discussed.

References

[1] Z. Arai, W. Kalies, H. Kokubu, K. Mischaikow, H. Oka, P. Pilarczyk. A database schema for the analysis of global dynamics of multiparameter systems. *SIAM J. Appl. Dyn. Syst.* **8** (2009), 757–789. DOI: 10.1137/080734935.

[2] P. Pilarczyk, J. Signerska-Rynkowska, G. Graff. Topological-numerical analysis of a two-dimensional discrete neuron model. *Chaos* **33** (2023), 043110. DOI: 10.1063/5.0129859.