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# Extended quantification of the generalized recurrence plot

Maik Riedl, Norbert Marwan, and Jürgen Kurths
Potsdam Institute for Climate Impact Research,Potsdam,Germany

The generalized recurrence plot is a modern tool for quantification of complex spatial patterns. Its application spans the analysis of trabecular bone structures, Turing structures, turbulent spatial plankton patterns, and fractals. But, it is also successfully applied to the description of spatio-temporal dynamics and the detection of regime shifts, such as in the complex Ginzburg-Landau- equation. The recurrence plot based determinism is a central measure in this framework quantifying the level of regularities in temporal and spatial structures. We extend this measure for the generalized recurrence plot considering additional operations of symmetry than the simple translation. It is tested not only on two-dimensional regular patterns and noise but also on complex spatial patterns reconstructing the parameter space of the complex Ginzburg-Landau-equation. The extended version of the determinism resulted in values which are consistent to the original recurrence plot approach. Furthermore, the proposed method allows a split of the determinism into parts which based on laminar and non-laminar regions of the two-dimensional pattern of the complex Ginzburg-Landau-equation. A comparison of these parts with a standard method of image classification, the co-occurrence matrix approach, shows differences especially in the description of patterns associated with turbulence. In that case, it seems that the extended version of the determinism allows a distinction of phase turbulence and defect turbulence by means of their spatial patterns. This ability of the proposed method promise new insights in other systems with turbulent dynamics coming from climatology, biology, ecology, and social sciences, for example.