Adamson, M. W.; **Morozov, A. Yu.**

When can we trust our model predictions? Unearthing structural sensitivity in biological systems. (English) Zbl 1371.92057

Proc. R. Soc. Lond., Ser. A, Math. Phys. Eng. Sci. 469, No. 2149, Article ID 20120500, 19 p. (2013).

Summary: It is well recognized that models in the life sciences can be sensitive to small variations in their model functions, a phenomenon known as 'structural sensitivity'. Conventionally, modellers test for sensitivity by varying parameters for a specific formulation of the model functions, but models can show structural sensitivity to the choice of functional representations used: a particularly concerning problem when system processes are too complex, or insufficiently understood, to theoretically justify specific parameterizations. Here we propose a rigorous test for the detection of structural sensitivity in a system with respect to the local stability of equilibria, the main idea being to project infinite dimensional function space onto a finite dimensional space by considering the local properties of the model functions. As an illustrative example, we use our test to demonstrate structural sensitivity in the seminal Rosenzweig-MacArthur predator-prey model, and show that the conventional parameter-based approach can fail to do so. We also consider some implications that structural sensitivity has for ecological modelling: we argue that when the model exhibits structural sensitivity but experimental results remain consistent it may indicate that there is a problem with the model construction, and that in some cases trying to find an 'optimal' parameterization of a model function may simply be impossible when the model exhibits structural sensitivity. Finally, we suggest that the phenomenon of structural sensitivity in biological models may help explain the irregular oscillations often observed in real ecosystems.

MSC:

92C42	Systems biology, networks
34A12	Initial value problems, existence, uniqueness, continuous dependence and continuation of solutions to ordinary differential equations
34C23	Bifurcation theory for ordinary differential equations

Keywords:

structural sensitivity

Full Text: DOI