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A distribution input-output polynomial approach for estimating parameters in nonlinear models. Application to a chikungunya model.

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Abstract

This paper presents a numerical procedure based on a distribution approach for doing parameter estimation in nonlinear dynamical models. The originality of the paper is first, to present a complete study of the errors due to the method and due to the noise on the signal then, to apply it to a recent model describing the transmission of the chikungunya virus to the human population. The advantage of this numerical procedure is not to require any knowledge about the value of the parameters or about the statistics of measurement uncertainties. Furthermore, it attenuates a part of the noise improving consequently the results of the parameter estimation. The numerical results attest the relevance of this approach.

Key words: Parameter estimation, Distribution approach, Nonlinear models, Epidemiological model, Chikungunya virus

1. Introduction

Estimate unknown parameters from noisy observations can be a difficult and major task for validating a nonlinear model. Parameter estimation is usually carried out by optimizing some criterion function over the parameter space [10, 22]. However, these methods necessitate a first initial guess which can be obtained either by tests in the industrial domain or by a numerical procedure based on measurements [5, 9, 12, 16, 20]. The quality of this first initial guess ensures that the optimization process will take a reasonable amount of time, and may not converge to a local unrealistic solution.

[5, 9, 12, 16, 20] propose each of them a parameter estimation method based on the use of input-output polynomials, that is polynomials depending only on the inputs, the outputs and the parameters of the model. For example,

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