Inverse Problems Using Polynomial Chaos

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Abstract

When modeling biological processes, there are always errors, uncertainties and variations present. It is important to quantify these uncertainties. In this paper, we consider that the coefficients in the mathematical model of are random variables, whose distribution and moments are unknown a-priori, and need be determined by comparison with experimental data. A stochastic spectral representation of the parameters and the unknown solution stochastic process is used, together with the polynomial chaos method. The polynomial chaos representation generates a system of equations of the same type as the original model. The inverse problem of finding the coefficients is reduced to establishing the coefficients of the chaos expansions and this is done using maximum likelihood estimation. In particular, in modeling biofilms, there are variations in the structure and in the bacterial behavior, measurement errors, and uncertainties in the processes.The biofilm growth model is given by a parabolic partial differential equation, so the polynomial chaos formulation generates a system of partial differential equations. Examples are presented.

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