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Young Plenary Lecture

Uncertainty quantification methods for PDEs with applications to biomathematics

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Abstract

Various deterministic numerical techniques have been and are currently being developed to solve, as efficiently and accurately as possible, problems related to physical, biological, social and economic systems. The use of such numerical schemes, though, requires that initial conditions, boundary conditions and all the parameters involved in the mathematical model describing the phenomenon of interest are known. However, in practical applications this assumption is rarely true. Indeed, our knowledge is limited by the ability to measure, bias in observations and, in general, an incomplete understanding of processes, especially when dealing with biological and social sciences. In this context, our numerical simulations present uncertain inputs that give rise to uncertainty in the outputs of interest, which must be clearly identified and quantified in order to correctly interpret numerical results and draw meaningful conclusions.

In this talk, different Uncertainty Quantification (UQ) techniques, widely used in response to these issues, will be presented, highlighting the advantages and drawbacks of each. Examples of applications of these methods in the biomathematical field will also be discussed. In particular, problems such as the quantification of uncertainties related to geometric and mechanical parameters involved in the study of human cardiovascular fluid dynamics and uncertainties in initial conditions in the analysis of the spatial spread of infectious diseases will be addressed.