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RELIABLE PREDICTIONS IN BIOMEDICAL APPLICATIONS: UNCERTAINTY QUANTIFICATION, BAYESIAN INFERENCE AND MODEL SELECTION.

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MINI-SYMPOSIUM PROPOSAL

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Patient-specific numerical simulations of healthy and diseased physiologies are of great interest to biomedical applications, such as assessing each patient health conditions, analysing what-if scenarios, helping clinical decision-making through virtual surgeries or virtual implantation of medical devices. Reliable numerical predictions require access to high-fidelity patient-specific data in order to build accurate and robust numerical models. In practice, available data are often indirect observations of the quantity of interest, they are scarce and inevitably corrupted by measurement uncertainty (noise). In order to estimate model parameters by exploiting the data, inverse and identification problems must be solved. To this end, several methods were proposed in the literature. Important insight, especially regarding the model adequacy, may be gained by casting the inverse problem in a statistical inference framework. In particular, in the last years, methods under the realm of Bayesian Inference have gained in popularity, due to their ability to naturally incorporate and account for the inherent uncertainty of the systems under investigation. Furthermore, in the case in which the parameter variability (probability distributions) are known a priori, or have been estimated, the effect of parameter uncertainty needs to be assessed in relation to the numerical predictions of the clinical quantity of interest, in order to provide reliable predictions. This can be performed through an Uncertainty Quantification analysis. All these methods, when applied by using full-scale direct numerical simulations are often, nowadays, out of reach and generate an overwhelming amount of data that is of little practical and effective use to the clinicians in support of their medical diagnostics and interventions. It is then common usage to rely, at least partly, to more efficient but less accurate reduced-order models. This interdisciplinary mini symposium, with a particular emphasis on biomedical applications, for example, cardiovascular, fluid-flow, implantable devices, structural, and electrophysiological aspects, will consider a wide range of problems to assess and quantify uncertainty, infer model parameters, and perform model selection and fusion. Topics include, but are not limited to, methods and advances for:

- Bayesian inference to estimate probability distributions of model parameters through uncertain clinical data
- Forward propagation of uncertainty.
- Uncertainty quantification in reduced order models of physiology.
- Bayesian model selection.
- Multi-fidelity information fusion.