6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

MULTIFIDELITY APPROACHES FOR CARDIOVASCULAR HEMODYNAMICS

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Keywords: *Stochastic Computational Modeling, Cardiovascular Simulation, Uncertainty Quantification, Stochastic Submodels.*

Predictions from numerical hemodynamics are increasingly adopted and trusted in the diagnosis and treatment of cardiovascular disease. However, the predictive abilities of deterministic numerical models are limited due to the large number of possible sources of uncertainty including boundary conditions, vessel wall material properties, and patient-specific model anatomy. Stochastic approaches have been proposed as a possible improvement, but are penalized by the large computational cost associated with repeated solutions of the underlying deterministic model [2]. We propose a stochastic framework [1] which leverages three cardiovascular model fidelities, i.e., three-, one- and zero-dimensional representations of cardiovascular blood flow. Specifically, we employ multi-level and multi-fidelity estimators from Sandia's open-source DAKOTA toolkit to reduce the variance in our estimated quantities of interest, while maintaining the computational cost reasonable. The performance of these estimators in terms of computational cost reductions is investigated for global and local hemodynamic indicators.

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