The 18th International Conference on Finite Elements in Flow Problems (FEF2015)
16-18 March 2015, Taipei, Taiwan

REDUCED ORDER MODELS FOR REAL-TIME SIMULATION & CONTROL OF PHYSIOLOGICAL FLOWS

Alfio Quarteroni, Andrea Manzoni and Federico Negri

CMCS - Modelling and Scientific Computing,
MATHICSE - Mathematics Institute of Computational Science and Engineering,
EPFL - Ecole Polytechnique Fédérale de Lausanne,
Station 8, CH-1015 Lausanne, Switzerland.
E-mail: {alfio.quarteroni,andrea.manzoni,federico.negri}@epfl.ch

Key words: *reduced-order models, computational fluid dynamics, PDE-constrained optimization problems, optimal control, haemodynamics*

Parametrized optimization problems governed by PDEs occur in several applied contexts ranging from optimal control and/or design problems to inverse identification problems. Parameters may arise from physical coefficients, the geometrical configuration, or the control/design variables themselves. Solving these problems is rather challenging because of their large scale and iterative nature.
For instance, when using a descent method for the numerical optimization, the underlying state PDE has to be solved many times until the minimum of the cost functional is approached. Should we be interested to the solution of an optimal control problem for many input conditions, characterizing either the state problem or the cost functional, computational costs would be even higher [2, 3].

Projection-based reduced-order models (ROMs) provide efficient strategies to tackle parametrized optimization and control problems, thanks to Offline/Online computational stratagems, a posteriori error estimates, and the use of low-dimensional approximation spaces [1]. We propose suitable ROMs for the efficient simulation and optimization of flow problems arising in the haemodynamics context. Applications of interest range from the simulation of blood flow in cerebral aneurysms, to the optimization of arterial bypass grafts and the control of drug delivery systems.

REFERENCES

[1] T. Lassila, A. Manzoni, A. Quarteroni, G. Rozza. Model order reduction in fluid dynamics: challenges and perspectives. In Reduced Order Methods for Modeling and Computational Reduction, A. Quarteroni & G. Rozza (Eds.), Springer MS&A Series, Vol.9, pp. 235-274, 2014.

[2] A. Manzoni. *Reduced models for optimal control, shape optimization and inverse problems in haemodynamics*. PhD thesis, N. 5402, École Polytechnique Fédérale de Lausanne, 2012.

[3] F. Negri, G. Rozza, A. Manzoni, and A. Quarteroni. Reduced basis method for parametrized elliptic optimal control problems. SIAM J. Sci. Comput. 35 (5):A2316-A2340, 2013.