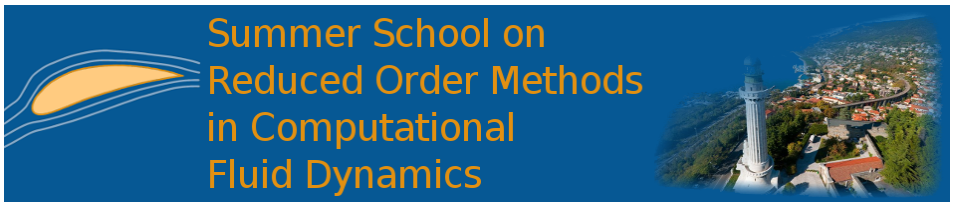

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Reduction of the Kolmogorov n-width for a transport dominated fluid-structure interaction problem

Wednesday, July 10, 2019 4:03 PM (3 minutes)

The aim of the work is to apply the reduced basis method to a two dimensional time dependent convection dominated fluid-structure interaction (FSI) problem.
One basic assumption of the reduced basis method is that the solution manifold $\mathcal{M}$ of the problem can be well approximated by a sequence of finite dimensional spaces: this mathematical assumption translates in the fact that the Kolmogorov n-width D_n of $\mathcal{M}$ decays fast.
For convection dominated problems this is not always the case, meaning that D_n can decay quite slowly, and this represents a great challenge for the reduced method.
We will show how we tried to overcome this situation, explaining the idea presented in [3]: the main feature of this new reduced method is the presence of a preprocessing phase, which is performed right after the offline step. Assume that Ω is the physical domain of the problem of interest: the preprocessing phase is based on the definition of a family $\mathcal{F}$ of smooth and invertible deformation maps of Ω, such that the "preprocessed" solution manifold $\mathcal{M}_{\mathcal{F}}$ has a smaller Kolmogorov n-width, where $\mathcal{M}_{\mathcal{F}}$ is the manifold of the solutions on the deformed domain. We will explain how to construct this family of mappings, once we have shown the behaviour of the solution of the specific problem.
After the POD on the preprocessed solution manifold we obtain a set of preprocessed reduced bases $\{\Phi_i\}_{i=1}^N$, with N small. With these preprocessed basis functions we then try to construct an approximation of the high order solution.
In our poster we will show the results we obtained so far, and we will also discuss some of the difficulties we encountered during this work: the attention that is required in handling the coupling conditions between the fluid equations and the structure equation, the search for a suitable family of deformation maps, and also the very important aspect of how to interpret the rate of decay of the Kolmogorov n-width of the original solution manifold for this particular problem.

[1] Ballarin F. and Rozza G., POD-Galerking monolithic reduced order models for parametrized fluid-structure interaction problems. *IJNMF*: **82**(12):1010–1034, 2016.
[2] Ballarin F., Rozza G. and Maday Y., Reduced-order semi-implicit schemes for fluid-structure interaction problems. *MSA* vol.17: 149-167, Springer International Publishing, 2017.
[3] Cagniart N., Maday Y. and Stamm B., Model order reduction for problems with large convection effects, 2016.

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