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Reduced Order Modelling in Computational Fluid Dynamics: state of the art, challenges and perspectives:
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ABSTRACT

We provide the state of the art of Reduced Order Methods (ROM) for parametric Partial Differential Equations (PDEs), and we focus on some perspectives in their current trends and developments, with a special interest in parametric problems arising in offline-online Computational Fluid Dynamics (CFD) [1]. Recent developments involve a better integration of emerging topics with model reduction, such as high performance computing (HPC), uncertainty quantification (UQ), data science (DS), machine learning (ML) in a data driven perspective, in order to allow a better exploitation of digital twins. All the previous aspects are quite relevant -- and often challenging — when well integrated also in CFD problems, including turbulence, to focus on real time simulations for complex parametric industrial, environmental and biomedical flows, or even in a flow control/inverse problems setting with data assimilation. Crucial aspects to be addressed are related with uniqueness, stability, accuracy, as well as reliability of solutions. Some model problems will be illustrated by focusing on few benchmark study cases, for example on fluid-structure interaction problems and/or on shape optimisation, applied to some industrial and applied science problems of interest.

REFERENCES

[1] Rozza, Gianluigi, Giovanni Stabile, and Francesco Ballarin, eds. *Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics*. Society for Industrial and Applied Mathematics, Philadelphia, US, 2022, Vol. 26 CSE series.