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FAST DIVERGENCE-CONFORMING REDUCED ORDER MODELS FOR FLOW PROBLEMS

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Numerical methods and tools for simulating flow around complex geometries have evolved rapidly in recent years. However, their usage usually requires access to high-performance computating facilities, which is not always feasible. New methods are required for an ever-increasing demand for computationally efficient desktop tools usable in real-time control, optimization and management. One such solution is dimensionality reduction through Reduced Order Modelling (ROM) based on Proper Orthogonal Decomposition (POD).[1]

We detail in this work an experiment involving two-dimensional stationary flow around a NACA0015 airfoil at various velocities and angles of attack. Two different methods are proposed: one run-of-the-mill reduced basis method based on a conventional Taylor-Hood high-fidelity solver, and one based on a divergence-conforming isogeometric flow solver. The reduced bases were constructed with Proper Orthogonal Decomposition (POD) and enhanced with supremizers[2] to stabilize the pressure field. We show how the latter method produces a fully divergence-free reduced basis, and how this property influences the linear systems by creating three-by-three block triangular matrices, a structure that can be exploited for significant speedups over the traditional matrix structure arising from the regular method.

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