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# Reduced basis methods for parametrized fluid dynamics equations: application to inverse problems in haemodynamics


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**Abstract:** Despite the computer resources nowadays available, it is still difficult -- and often impossible -- to deal with applications and scenarios involving the repeated solution of PDEs on different data settings (many-query context) or requiring a numerical solution within a real time context -- or at least very rapidly. For instance, the most common numerical strategies used to tackle optimal control, shape optimization and more general inverse problems under PDE constraints are based on iterative optimization procedures, involving several input/output evaluations as well as many repeated PDE solutions. With this respect, reduced order modelling can represent a suitable strategy to allow for the solution of these problems, entailing an acceptable amount of CPU time and limited storage capacity. The developed framework deals with inverse problems in fluid dynamics -- such as flow control, shape optimization, inverse identification problems -- and it is based on the coupling between suitable (control, shape, etc.) parametrization strategies and the reduced basis method for the rapid and reliable solutions of parametrized PDEs. We review the current state of the art of the reduced basis method for fluid dynamics equations, with a special emphasis on a posteriori error estimation and Offline/Online decomposition in the Stokes and Navier-Stokes equations in affinely and nonaffinely parametrized geometries, obtained e.g. by means of volume-based shape parametrizations such as free-form deformation or radial basis function techniques. Numerical examples dealing with inverse problems arising in haemodynamics are presented in order to show the capabilities of our reduced framework.