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A-posteriori error-estimation and optimal-adaptive refinement for fluid-solid-interaction problems

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ABSTRACT

A-posteriori error estimation and corresponding optimal adaptive-refinement strategies form an interesting paradigm for multiphysics problems such as fluid-solid interaction, as typically engineering interest is restricted to only one of the subsystems, and the complexity of the subsystems can be distinctly different. For instance, in the interaction of a turbulent flow with a structure, how accurately should the flow be resolved to obtain an accurate approximation of the structural displacement? In principle, multiphysics problems can be treated in accordance with the general framework for a-posteriori error estimation and adaptive refinement as developed by, notably, Becker and Rannacher [1] and Oden and Prudhomme [2,3]. Free-boundary problems such as fluid-structure interaction, do however not admit a straightforward condensation into canonical variation form, on account of the inherent interconnection between the initial-boundary-value problems and their domains of definition. Hence, in the linearization that is necessary to derive the linearized dual problem, one has to account for *domain derivatives* [4,5].

In this presentation, we consider two approaches to derive the domain derivatives for free-boundary problems, analogous to the *material derivative* and the *shape derivative* in shape optimization. Both derivatives can serve to construct suitable dual problems, which can in turn be used for goal-oriented error estimates for discretizations of fluid-structure-interaction problems.

To illustrate the error-estimation and refinement procedures, we present examples such as incompressible flow past a backward-facing step with a flexible bottom [6].

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