Optimization of multiple shapes for a fluid-mechanical problem

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Shape optimization has been an active field of research for the past decades and is used for example in engineering. Many relevant problems in the area of shape optimization involve a constraint in the form of a partial differential equation. In this talk, we concentrate on the Stokes equation and consider an objective function depending on multiple shapes. To handle problems where an objective function depends on multiple shapes, we need a theoretical framework, whereby the optimization variable can be represented as a vector of shapes belonging to a product shape space. Using an approach based on the Steklov-Poincaŕe metric and the so-called multi-shape derivative we present a gradient descent algorithm using Armijo backtracking stepsize control to solve multi-shape optimization problems. We apply our method to the minimization of viscous energy dissipation subject to the Stokes equations. Additional care is needed when the constraints contain inputs or material properties subject to uncertainty. Thus, we take a short glance at the minimization of viscous energy dissipation subject to the Stokes equations under uncertainty.

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