Shape optimization and optimal control problems

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Shape optimization problems belong to a modern research area. They may be viewed as an extension of optimal control theory and of the classical calculus of variations. The minimization parameter is the domain itself, where the partial differential equation is defined. To the unknown domain and to the corresponding state, a cost functional to be minimized is associated, usually in integral form. Such problems have been studied sytematically starting with 1970, although Newton and Bernoulli have discussed famous examples in their works. It is to be noticed that there are many possible applications of this field of research and this justifies the remarkable interest from the mathematical community around this subject.

The complexity of such problems involving geometry, differential equations and optimization theory is obvious and there are many challenging questions. The questions start from the existence of the solution (which strongly depends on the regularity properties of the unknown domains and the aim is to relax such assumptions) up to numerical procedures for the computation of optimal shapes. The approximation approaches may be of a direct type or may use the optimality conditions.

In this project we shall analyze fixed domain approaches and optimal control methods that are both very efficient and advantageous in the implementation. The analysis will be theoretical and numerical. Convergence and stability properties will be discussed.