The role of Evolve-Filter-Relax Regularization in Feedback Control for convection-dominated Navier-Stokes Equations: full and reduced order model.

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Abstract:

This talk focuses on feedback control for Navier-Stokes equations featuring large Reynolds. The controllability of flows is a predominant need in many industrial and scientific applications. In these contexts, steering the flow regime towards a beneficial state is crucial. Therefore, we propose linear feedback control as a suboptimal (yet accurate) strategy to tackle this task.

First, we define a novel linear feedback control law to deal with the Navier-Stokes equations with large Reynolds and prove its exponential convergence in time to the desired state. Numerically, a natural question arises: is there a need for other stabilization strategies when the Reynolds number increases?

We theoretically study the impact of the Evolve-Filter-Relax (EFR) algorithm on the feedback control convergence in time to the desired state. Guided by the theoretical results, we propose an adaptive EFR (aEFR) approach to alleviate the numerical oscillations of the controlled setting, recovering the exponential convergence of the original problem.

The theoretical results are tested numerically. Indeed, we show the advantages of exploiting the aEFR algorithm on a 2D flow past cylinder with Reynolds 1000 at the full and reduced order model level.