Title: Mapping of coherent structures in parameterized flows by learning optimal transportation with Gaussian models

Speakers: Angelo Iollo (Inria)

Abstract : Classical model reduction techniques approximate the solution of a physical model by affine combinations of empirical modes. However, the nature of the parametric dependence of the PDE can be such that the main solution features are displaced (or advected) in space and eventually time. For example, coherent structures like advected vortices in a wake or displacing shock structures in supersonic flows are not accurately retrieved by linear compression methods. In order to identify and model the displacement of coherent structures with respect to parameter variation, we employ optimal transportation theory and the notion of displacement interpolant. Although for several notable cases the exact displacement interpolant coincides with the exact solution of the physical model, in general it is not possible to readily identify an extensive scalar physical quantity (a density distribution) that is representative of the whole solution field displacement. Moreover, the optimal transport map is not usually available in closed form and its computational approximation can be challenging. In the last few decades, there has been a growing interest in determining effective algorithms to approximate the solution to optimal transportation problems for arbitrary choices of the solution densities.

In this work, we pursue a different approach: first, we identify a Gaussian model of the solution of the PDE; then, we exploit the knowledge in closed-form of the optimal mapping to define the interpolation operator and the displacement interpolant. Preliminary results of this approach will be discussed.

This work is in collaboration with Dr. Tommaso Taddei.