Some advances in isogeometric analysis of coupled and complex problems

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ABSTRACT

Isogeometric Analysis (IGA) is a successful simulation framework originally proposed by T.J.R. Hughes et al., in 2005, with the aim of bridging Computational Mechanics and Computer Aided Design. In addition to this, thanks to the high-regularity properties of its basis functions, IGA has shown a better accuracy per degree-of-freedom and an enhanced robustness with respect to standard finite elements in many applications - ranging from solids and structures to fluids, as well as to different kinds of coupled problems - opening also the door for the approximation in primal form of higher-order partial differential equations.

After a concise introduction of the basic isogeometric concepts, this lecture aims at presenting an overview of some recent advances in IGA with a special focus on coupled problems where the characteristics of IGA seem to be of great advantage. In particular, applications that will be discussed include the simulation of fluid-structure interaction in different contexts like, e.g., biomechanical problems, studies on the effect of mechanically-induced stresses on prostate cancer growth, thermo-mechanical simulations of additive manufacturing processes, electro-mechanical simulations for biological tissues, and the use of phase-field modeling for fracture and topology optimization problems or for predicting the polarization evolution in elastic ferroelectric materials. The last part of the presentation will be finally devoted to the description of a simple, accurate, and inexpensive simulation technique for laminated structures, allowed by the peculiar IGA features.