A DOMAIN DECOMPOSITION FRAMEWORK FOR MODELING DIMENSIONALLY HETEROGENEOUS PROBLEMS

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ABSTRACT

In the last decade, there has been an increasing interest in the use of dimensionally heterogeneous representations of different physical systems. This so-called geometrical multiscale modeling has been applied successfully to represent physical phenomena arising in different fields such as, e.g., fluid-dynamics and structural modeling.

The appealing aspect of such an approach is that it is possible to account for the interactions between different geometrical scales in a given system. For instance, in the context of the cardiovascular system, this allows for the integrated modeling of the blood flow, taking into account the interplay between the global systemic dynamics and the complex local blood flow behavior.

In this talk we present a general theoretical framework for coupling dimensionally heterogeneous partial differential equations and we provide some guidelines for the abstract well-posedness analysis of such problems both in the continuous and in the discrete cases. Moreover, we show how to construct suitable partitioning methodologies in the context of domain decomposition methods. In particular, we discuss some alternative possibilities to those encountered in the classical domain decomposition literature, specifically devised for the dimensionally-heterogeneous case.

Finally, we present some numerical results to illustrate the effectiveness of our approach.