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INTERATIVE STRONG COUPLING OF DIMENSIONALLY-HETEROGENEOUS MODELS

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Abstract. In this presentation we propose a decomposition strategy especially tailored to perform strong coupling of dimensionally-heterogeneous models, under the hypothesis that one wants to solve each submodel separately and implement the interaction between subdomains by boundary conditions alone. The novel methodology takes full advantage of the small number of interface unknowns in this kind of problems. Previous algorithms can be viewed as variants of the "natural" staggered algorithm in which each domain transfers function values to the other, and receives fluxes (or forces), and viceversa. This "natural" algorithm is known as Dirichlet-to-Neumann in the Domain Decomposition literature, and all Richardson-like relaxation algorithms are variants of it. In our framework, this algorithm is viewed as a nothing but a Gauss–Seidel iterative procedure on a suitably defined (linear or nonlinear) system of equations and set of unknowns. From the viewpoint proposed by our framework, it becomes intuitive to switch to other iterative solvers such as GMRES or other Krylov-based method, which we assess through numerical experiments showing the significant gain that can be achieved. Indeed, the benefit is that an extremely flexible, automatic coupling strategy can be developed, which in addition leads to iterative procedures that are parameter-free and rapidly converging. Further, in linear problems they have the finite termination property. In the presentation we show applications of this methodology in both heat transfer devices and hydraulic networks.