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Multi-scale simulation of structures within the Arlequin framework

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Summary

The Arlequin method was first proposed by Ben Dhia aiming to provide an efficient analysis of engineering structures with some local-global property. Using reliable energy partition function and coupling operators, the Arlequin method can be used to couple two different mechanical states to conduct multi-scale or multi-model simulations.

This study explores the various applications of the Arlequin method to multi-scale or multi-model simulation of structures. The Arlequin method has been implemented into the large commercial finite element software ABAQUS by using the user defined elements (UELs). The 1D, 2D and 3D UELs have been systematically developed within the Lagrange-multipler based Arlequin framework, which enables the realization of linear static and dynamic multi-scale simulations of structures. The penalty-based Arlequin framework is also employed to conduct the geometric nonlinear analysis of structures in the ABAQUS platform. To verify the correctness of the programming, some simple but reasonable numerical examples are presented and the local stress analysis at arch foot of a deck arch bridge is also presented. The Arlequin method has also been used for the first time to couple the finite element method and the element free Galerkin method. Two numerical examples based on Matlab software are presented to verify the efficiency of the proposed method.