Block Low-Rank (BLR) approximations to improve multifrontal sparse solvers.

Clément Weisbecker

Université de Toulouse, INPT(ENSEEIHT)-IRIT, France

In collaboration with O. Boiteau (EDF R& D, France) and C. Ashcraft(LSTC,USA).
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Abstract

Matrices coming from elliptic Partial Differential Equations (PDEs) have been shown to have a low-rank property: well defined off-diagonal blocks of their Schur complements can be approximated by low-rank products. In the multifrontal context, this can be exploited within the fronts in order to obtain a substantial reduction of the memory requirement and an efficient way to perform many of the basic dense algebra operations. Many hierarchical representations have been proposed in the literature to benefit from these low-rank compressions, mainly the H and HSS matrices. We propose a flexible, flat format, called Block Low-Rank, designed to be easily adapted to any robust algebraic multifrontal solver without conceding the versatility of such a solver. The memory requirement and the operation count of the multifrontal process could be divided by a factor of at least 2 and 5, respectively, on various applicative problems such as structural mechanics (EDF) and time-harmonic wave equations for full waveform inversion (Seiscope project).