Stabilization of a matrix via a low-rank-adaptive ODE

Stefano Sicilia (Gran Sasso Science Institute), Nicola Guglielmi

Let A be a square matrix with a given structure (e.g. real matrix, sparsity pattern, Toeplitz structure, etc.) and assume that it is unstable, i.e. at least one of its eigenvalues lies in the complex right half-plane. The problem of stabilizing A consists in the computation of a matrix B, whose eigenvalues have all negative real part and such that the perturbation $\Delta = B - A$ has minimal norm. The structured stabilization further requires that the perturbation preserves the structural pattern of A. This non-convex problem is solved by a two-level procedure which involves the computation of the stationary points of a matrix ODE. It is possible to exploit the underlying low-rank features of the problem by using an adaptive-rank integrator that follows rigidly the rank of the solution. Some benefits derived from the low-rank setting are shown in several numerical examples. These computational advantages also allow to deal with high dimensional problems.

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