Lipschitz-based Optimization of Singular Values with Applications to Dynamical Systems

Results in Brief

Algorithms for optimising non-convex eigenvalue functions of matrices dependent on a few parameters

Optimisation problems arise in many different mathematical disciplines. EU-funded scientists addressed the optimisation problems involving non-convex eigen value functions that arise in theory as well as in practice, particularly in engineering.

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For most real-world mathematical applications, it is typical for a matrix to depend on many parameters and its eigenvalues are needed for parameter selection. In many cases, the choice of parameters is dictated by some optimisation objective.

In their work for the project OPT OF SINGULAR VALS (Lipschitz-based optimization of singular values with applications to dynamical systems), scientists concentrated on particular model problems. Among many others, they looked into matrix-nearness problems. These problems involve identifying analytic matrix-valued functions with a set of predefined eigenvalues.

In control applications, where the size of the largest eigenvalue represents system stability, it may be desirable to minimise the largest eigenvalue. On the other hand, for structure analysis where the smallest eigenvalue corresponds to buckling load, it is necessary to maximise the smallest eigenvalue.

If one matrix is very close to another matrix with multiple eigenvalues, one of the eigenvalues of the matrix is very sensitive to perturbations of the entries of the first matrix. Such problems arise in control applications.

OPT OF SINGULAR VALS scientists developed algorithms for solving such optimisation problems depending on a few parameters. A robust implementation of the algorithms, named EIGOPT, has been made publicly available here together with a guide.

During the course of the project, the scientists gained extensive numerical experience with the new algorithms, solving problems that arise in linear, polynomial and nonlinear settings. This is utilised in a new joint project with the Technische Universität Berlin in Germany, École polytechnique fédérale de Lausanne in Switzerland and Koç Üniversitesi in Turkey.

Keywords

Algorithm | eigenvalues | optimisation problems | matrix | control applications | structure analysis

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