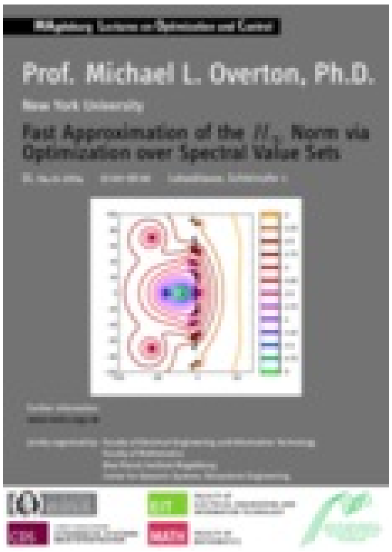
MAGDEBURG LECTURES ON OPTIMIZATION AND CONTROL

Michael Overton



Fast Approximation of the H∞ Norm via Optimization over Spectral Value Sets

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Time & Place

The presentation on November 4, 2014 will be given in the Lukas Klause ›(Schleinufer 1, 39104 Magdeburg) (http://ifatwww.et.uni-magdeburg.de/syst/maloc/seminars/Standort%20Lukas%20Klause.pdf) and starts at 5.00 p.m.

Abstract

The H∞ norm of a transfer matrix function for a continuous-time control system is the maximum of the norm of the transfer matrix on the imaginary axis, or equivalently, the reciprocal of the largest value of ε such that the associated ε-spectral value set is contained in the left half-plane. We start by defining spectral value sets and discussing some of their fundamental properties, including the intricate relationship between the singular vectors of the transfer matrix and the eigenvectors of the corresponding perturbed system matrix. We then introduce an iterative method for approximating the ε-spectral value set abscissa (the maximum of the real part of the points in the set), characterizing the fixed points of the iteration, and explain how the procedure can be combined with a Newton-bisection outer iteration to approximate the H∞ norm. We then explain why this idealized algorithm sometimes breaks down and introduce a method called hybrid expansion-contraction to address this deficiency. Under reasonable assumptions, the new algorithm finds locally maximal values of the norm of the transfer matrix on the imaginary axis and although these are only lower bounds on the H∞ norm, it typically finds good approximations in cases where we can test this. It is much faster than the standard Boyd-Balakrishnan-Bruinsma-Steinbuch algorithm to compute the H∞ norm when the system matrices are large and sparse. The main work required by the algorithm is the computation of the rightmost eigenvalues of a sequence of matrices that are rank-one perturbations of a sparse matrix.

Short CV

Michael L. Overton is Professor of Computer Science and Mathematics at the Courant Institute of Mathematical Sciences, New York University. He received his Ph.D. in Computer Science from Stanford University in 1979. He is a fellow of SIAM (Society for Industrial and Applied Mathematics) and of the IMA (Institute of Mathematics and its Applications, UK). He served on the Council and Board of Trustees of SIAM from 1991 to 2005, including a term as Chair of the Board from 2004 to 2005. He served as Editor-in-Chief of SIAM Journal on Optimization from 1995 to 1999 and of the IMA Journal of Numerical Analysis from 2007 to 2008, and was the Editor-in-Chief of the MPS(Mathematical Programming Society)-SIAM joint book series from 2003 to 2007. His research interests are at the interface of optimization and linear algebra, especially nonsmooth optimization problems involving eigenvalues, pseudospectra, stability and robust control. He is the author of "Numerical Computing with IEEE Floating Point Arithmetic" (SIAM, 2001).