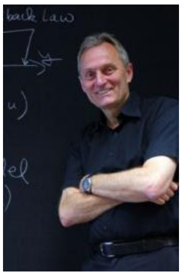

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Removing Critical Eigenvalues of Structured Matrix Pencils and Hamiltonian Matrices with Optimal Perturbations

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It is well known that eigenvalues of a Hermitian matrix pencil $L(\lambda) = \lambda A - B$, occur in pairs $(\lambda, \bar{\lambda})$ with eigenvalues, if any, on the extended real line being the ones where the symmetry breaks down. We refer to such eigenvalues as critical eigenvalues and study the problem of finding optimal Hermitian perturbations of $L(\lambda)$ when it is of even size such that the perturbed Hermitian matrix pencil is regular and if it has any critical eigenvalues, then those can be removed by a further arbitrarily small Hermitian perturbation. Additionally, the optimal perturbations are required to be real if $L(\lambda)$ is real. This leads to upper and lower bounds on the distance to a nearest regular Hermitian matrix pencil without critical eigenvalues. It is observed that when $L(\lambda)$ is randomly generated, the upper bound is sometimes equal to the lower bound and is often within a factor of $\sqrt{2}$ of the lower bound.

The work is also extended to the case of $*$-alternating and $*$-palindromic matrix pencils of even size with respect to their corresponding critical eigenvalues.

Under additional assumptions on the coefficient A of $L(\lambda)$, we also study the same problem while perturbing only B. In such cases, the distance is attained by the lower bound if $L(\lambda)$ is a definite pencil. However, in practice we find many examples where this happens even when $L(\lambda)$ is not a definite pencil. The techniques may also be applied to the Hamiltonian matrices to find upper and lower bounds on the distance to \emph{bounded realness}. In such cases it is proved that if the Hamiltonian matrix has only purely imaginary eigenvalues with the ones of positive type being separated from those of negative type, then the distance is attained by the lower bound. However, as experiments demonstrate, this can also happen when the Hamiltonian matrix does not satisfy this condition.

Author: BORA, Shreemayee (Indian Institute of Technology Guwahati)

Co-author: Mr R, Kannan (Indian Institute of Technology Guwahati)

Presenter: BORA, Shreemayee (Indian Institute of Technology Guwahati)

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