Some New Results on Lyapunov Diagonal Stability

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Abstract

In this talk, we present several recent developments regarding Lyapunov diagonal stability. This type of matrix stability plays an important role in various applied areas such as population dynamics, systems theory, complex networks, and mathematical economics. First, we examine a result of Redheffer that reduces Lyapunov diagonal stability of a matrix to common diagonal Lyapunov solutions on two matrices of order one less. An enhanced statement of this result based on the Schur complement formulation is presented here along with a shorter and purely matrix-theoretic proof. We develop a number of extensions to this result, and formulate the range of feasible common diagonal Lyapunov solutions. In particular, we derive explicit algebraic conditions for a set of 2×2 matrices to share a common diagonal Lyapunov solution. Second, we present a new characterization involving Hadamard multiplications for simultaneous Lyapunov diagonal stability on a set of matrices. This extends a useful characterization, due to Kraaijevanger, of Lyapunov diagonal stability in terms of the P-matrix property under similar Hadamard multiplications. Our development mainly relies on a new notion called $\mathcal{P}$-sets, which is a generalization of P-matrices, and a recent result of Berman, Goldberg, and Shorten.