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Universal realizability in low dimension

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Abstract

We say that a list $\Lambda = \{\lambda_1, \dots, \lambda_n\}$ of complex numbers is realizable, if it is the spectrum of a nonnegative matrix A (a realizing matrix). We say that Λ is universally realizable if it is realizable for each possible Jordan canonical form allowed by Λ . This work studies the universal realizability of spectra in low dimension, that is, realizable spectra of size $n \leq 5$. It is clear that for $n \leq 3$ the concepts of universally realizable and realizable are equivalent. We characterize the universal realizability of real spectra of size 4 and of size 5 with trace zero, and we describe a region for the universal realizability of nonreal 5-spectra with trace zero. As an important by-product of our study, we also show that realizable lists on the left half-plane, that is, lists $\Lambda = \{\lambda_1, \dots, \lambda_n\}$, where λ_1 is the Perron eigenvalue and $\operatorname{Re} \lambda_i \leq 0$, for $i = 2, \dots, n$, are not necessarily universally realizable.

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