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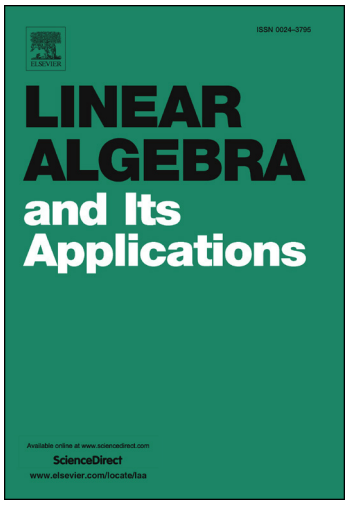

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Isospectral matrix flow maintaining staircase structure and total positivity of an initial matrix

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Abstract

In this paper we introduce an isospectral matrix flow (Lax flow) that preserves some structures of an initial matrix. This flow is given by

$$\frac{dA}{dt} = [A_u - A_l, A], \quad A(0) = A_0,$$

where A is a real $n \times n$ matrix (not necessarily symmetric), $[A, B] = AB - BA$ is the matrix commutator (also known as the Lie bracket), A_u is the strictly upper triangular part of A and A_l is the strictly lower triangular part of A. We prove that if the initial matrix A_0 is staircase, so is $A(t)$. Moreover, we prove that this flow preserves the certain positivity properties of A_0. Also we prove that if the initial matrix A_0 is totally positive or totally nonnegative with non-zero codiagonal elements and distinct eigenvalues, then the solution $A(t)$ converges to a diagonal matrix while preserving the spectrum of A_0. Some simulations are provided to confirm the convergence properties.

Keywords: Isospectral flow, Staircase matrix, Totally positive matrix, Oscillatory matrix

2010 MSC: 58J53; 15A18; 15B35; 15A24

1. Introduction

Isospectral matrix flows on the space of real $n \times n$ matrices $\mathcal{M}_n$ are characterized by the matrix differential equation

$$\frac{dA}{dt} = [U(A), A], \quad A(0) = A_0, \tag{1}$$

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