

Positive Harmonic Functions And Diffusion

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Scaling-rotation distance and interpolation of symmetric positive-definite matrices *

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Abstract

We introduce a new Riemannian framework for the set of symmetric positive-definite (SPD) matrices, aimed to characterize deformations of SPD matrices by individual scaling of eigenvalues and rotation of eigenvectors of the SPD matrices. To characterize the deformation, the eigenvalue-eigenvector decomposition is used to transform the set of SPD matrices into a Riemannian manifold so that scaling and rotations of SPD matrices are captured by geodesics on this manifold. The problems of non-unique eigen-decompositions and eigenvalue multiplicities are addressed by finding minimal-length geodesics, which gives rise to a distance and an interpolation method for SPD matrices. Computational procedures to evaluate the minimal scaling-rotation deformations and distances are provided for the most useful cases of 2×2 and 3×3 SPD matrices. An advantage of this new geometric framework is demonstrated in its application to diffusion tensor imaging showing that the traces, determinants and fractional anisotropy of interpolated SPD matrices by minimal scaling-rotation are monotone between two extremes in many instances. This is a desirable characteristic that other Riemannian frameworks for the SPD matrices do not possess.

Keywords: symmetric positive-definite matrices, eigen decomposition, Riemannian distance, geodesics, diffusion tensors.

1 Introduction

The analysis of symmetric positive-definite (SPD) matrices as data objects arises in many contexts. A prominent example is diffusion tensor imaging (DTI), which is a widely-used technique that measures the diffusion of water molecules

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bodybuildinghumangrowthhormone.comtransform of the law of X , where h is a positive harmonic function for the
Keywords and Phrases: Diffusion process, Dual process, Doob. Keywords and phrases: Harnack inequality, harmonic
functions, stable that the conditions are satisfied for a class of symmetric Markov processes with no diffusion . Take a
compact subset K of F so that it has positive Lebesgue measure. We prove ChengYau type inequalities for positive
harmonic functions on Riemannian By [12, Proposition], the process X_t is a diffusion with.

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