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Nonnegative Data Interpolation by Spherical Splines

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Abstract

We present a spherical spline method for scattered data interpolation over the unit sphere which preserves nonnegativity of the data values. The method is based on a classic constrained minimization approach. The usual side conditions of smoothness and data interpolation are supplemented by non-negativity constraints. We establish existence and uniqueness of non-negative minimizers in three cases: C^1 spline spaces of odd degree greater than or equal to five over generic triangulations; C^1 cubic spline spaces over Clough-Tocher triangulations; C^1 cubic spline spaces over triangulations of convex quadrangulations. We present the results on approximation order of nonnegative minimizers as well. The method extends to range restricted interpolation. We establish sufficient conditions on the spline coefficients that guarantee range restrictions on the spherical splines. Numerical solutions are computed by means of a projected gradient method. Numerical examples illustrate performance of non-negative and range-restricted data fitting.

Keywords: non-negative data interpolation, spherical splines, shape preservation

Declarations of interest: none.

1. Introduction

Spherical splines are piecewise smooth homogeneous polynomials with respect to rectangular coordinates. Given a triangulation $\triangle$ of the unit sphere $\mathbb{S}^2$, a tri-variate homogeneous polynomial can be defined on every triangle in

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