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Positive constrained approximation via RBF-based partition of unity method

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Abstract

In this paper, we discuss the problem of constructing Radial Basis Function (RBF)-based Partition of Unity (PU) interpolants that are positive if data values are positive. More specifically, we compute positive local approximants by adding up several constraints to the interpolation conditions. This approach, considering a global approximation problem and Compactly Supported RBFs (CSRBFs), has been previously proposed in [39]. Here, the use of the PU technique enables us to intervene only locally and as a consequence to reach a better accuracy. This is also due to the fact that we select the *optimal* number of positive constraints by means of an *a priori* error estimate and we do not restrict to the use of CSRBFs. Numerical experiments and applications to population dynamics are provided to illustrate the effectiveness of the method in applied sciences.

Keywords: meshfree approximation, partition of unity method, constrained approximation, positivity-preserving property, radial basis functions, applications to population dynamics.
2010 MSC: 65D05, 65D15, 65D17.

1. Introduction

Given a set of samples, the scattered data interpolation problem consists in finding an approximating function that matches the given measurements at their corresponding locations. Furthermore, dealing with applications, we often have additional properties, such as the non-negativity of the measurements, which we wish to be preserved during the interpolation process. Note that, since such property is known as *positivity-preserving property*, to keep a common notation with existing literature, we use the term positive (instead of non-negative) function values or interpolants.

To preserve such property, mostly considering rational spline functions with C^1 or C^2 continuity, the recent research studies techniques which force the approximants to be positive. As example, the conditions under which the positivity of a cubic piece may be lost are investigated in [30]. Moreover, in order to preserve the positivity, the use of bicubic splines, coupled with a

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