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Monotone cubic spline interpolation for functions with a strong gradient. (English)

Summary: Spline interpolation has been used in several applications due to its favorable properties regarding smoothness and accuracy of the interpolant. However, when there exists a discontinuity or a steep gradient in the data, some artifacts can appear due to the Gibbs phenomenon. Also, preservation of data monotonicity is a requirement in some applications, and that property is not automatically verified by the interpolator. Hence, some additional techniques have to be incorporated so as to ensure monotonicity. The final interpolator is not actually a spline as $C^2$ regularity and monotonicity are not ensured at the same time. In this paper, we study sufficient conditions to obtain monotone cubic splines based on Hermite cubic interpolators and propose two different ways to construct them using non-linear formulas. The methods are tailored so as to minimize either the regions where the order of accuracy is not maximal, or the points where the interpolator does not achieve $C^2$ regularity. The order of accuracy and regularity of the interpolant are studied in both cases and several numerical experiments are performed to contrast the theoretical results.

MSC:
65Dxx Numerical approximation and computational geometry (primarily algorithms)
41Axx Approximations and expansions
65Nxx Numerical methods for partial differential equations, boundary value problems

Keywords:
monotonicity; cubic Hermite interpolants; cubic spline interpolants; non-linear computation of derivatives

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References:


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