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Jump-preserving surface reconstruction from noisy data

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Abstract A new local smoothing procedure is suggested for jump-preserving surface reconstruction from noisy data. In a neighborhood of a given point in the design space, a plane is fitted by local linear kernel smoothing, giving the conventional local linear kernel estimator of the surface at the point. The neighborhood is then divided into two parts by a line passing through the given point and perpendicular to the gradient direction of the fitted plane. In the two parts, two half planes are fitted, respectively, by local linear kernel smoothing, providing two one-sided estimators of the surface at the given point. Our surface reconstruction procedure then proceeds in the following two steps. First, the fitted surface is defined by one of the three estimators, i.e., the conventional estimator and the two one-sided estimators, depending on the weighted residual means of squares of the fitted planes. The fitted surface of this step preserves the jumps well, but it is a bit noisy, compared to the conventional local linear kernel estimator. Second, the estimated surface values at the original design points obtained in the first step are used as new data, and the above procedure is applied to this data in the same way except that one of the three estimators is selected based on their estimated variances. Theoretical justification and numerical examples show that the fitted surface of the second step preserves jumps well and also removes noise efficiently. Besides two window widths, this procedure does not introduce other parameters. Its surface estimator has an explicit formula. All these features make it convenient to use and simple to compute.

Keywords Denoising · Edge detection · Image reconstruction · Gradient · Local linear kernel estimation · Local smoothing · Neighborhood · One-sided estimators · Surface estimation