Discontinuity indicators based on null rules for non-regular surface reconstruction

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The detection of discontinuity curves of bivariate functions (and of their gradients) is an important problem that arises in many contexts, ranging from surface and scattered data reconstruction to edge detection in image and geometric processing, see for example [1, 3] and references therein. We present a fault detection method based on the so-called null rules, computed as a vector in the null space of certain collocation matrices [4]. These rules are used as weights in a linear combination of function evaluations to indicate the local behavior of the function itself. By analyzing the asymptotic properties of the rules, we introduce two indicators (one for faults and one for gradient faults) by locally computing just one rule with degree of precision 2. This leads to a cheap and reliable scheme, which allows us to effectively detect and classify points close to discontinuities. We then show how this information can be suitably combined with adaptive approximation methods based on hierarchical spline spaces [5, 2] in the reconstruction process of surfaces with discontinuities. The considered adaptive methods exploit the ability of the hierarchical spaces to be locally refined, and the fault detection is a natural way to guide the refinement with low computational cost. Several numerical tests will be presented in order to show the behavior of the proposed methods.

Joint work with: Francesco Calabrò, Carlotta Giannelli.

References

[1] M. Bozzini, L. Lenarduzzi, M. Rossini. Non-regular Surface Approximation. in M. Floater et al., *Mathematical Methods for Curves and Surfaces: 8th International Conference, MMCS 2012, Oslo, Norway*, pages 68-87, 2014.

[2] C. Bracco, C. Giannelli, D. Großmann A. Sestini. Adaptive fitting with THB-splines: Error analysis and industrial applications. *Computer Aided Geom. D.*, 62:239-252, 2018.

[3] C. Bracco, O. Davydov, C. Giannelli, A. Sestini. Fault and gradient fault detection and reconstruction form scattered data. *Computer Aided Geom. D.*, 75, 2019.

[4] F. Calabrò, D. Bravo, C. Carissimo, E. Di Fazio, A. Di Pasquale, A. Eldray, C. Fabrizi, J. Gerges, S. Palazzo, J. Wassef. Null rules for the detection of lower regularity of functions. *J. Comp. Appl. Math.*, 361: 547-553, 2019.

[5] G. Kiss, C. Giannelli, U. Zore, B. Jüttler, D. Großmann, J. Barner. Adaptive CAD model (re-)construction with THB-splines. *Graph. Models*, 76: 273-288, 2014.