Simplex stochastic collocation for piecewise smooth functions with kinks

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Abstract

We consider the treatment of higher dimensional non-smooth functions with kinks. For example, such kinks can arise in the uncertainty quantification of quantities of interest for gas networks. This is due to the regulation of the gas flow, pressure, or temperature. But, one can exploit that for each sample in the parameter space it is known if a regulator was active or not, which can be obtained from the result of the corresponding numerical solution. This information can be exploited in a stochastic collocation method based on simplices.

We approximate the function separately on each smooth region by polynomial interpolation and obtain an approximation to the kink. Note that one does not need information about the exact location of kinks, but only an indicator assigning each sample point to its smooth region. We obtain a global order of convergence of $(p+1)/d$, where p is the degree of the employed polynomials and d the dimension of the parameter space. We show the empirical performance of the approach in up to four dimensions on synthetic test functions and for the uncertainty quantification of the expected pressure of a node in a gas network caused by uncertain input data.

References

[1] B. Fuchs and J. Garcke: *Simplex stochastic collocation for piecewise smooth functions with kinks*, International Journal for Uncertainty Quantification, 2019, accepted.