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A STATISTICAL APPROACH FOR BUILDING SPARSE POLYNOMIAL CHAOS EXPANSIONS

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Abstract. *Over the last years, a lot of effort has been made to make existing uncertainty quantification techniques more efficient in high dimensions. An important class of methods relies on the assumption that the polynomial chaos representation of the model response is sparse. This paper contributes to the validation and assessment of an innovative basis selection technique for building sparse polynomial chaos expansions. A regression approach is used for computing the polynomial chaos coefficients. The technique is based on statistical inference theory which provides information about the true regression model from an estimated regression model based on samples. The latter information is used to build iteratively the sparse polynomial chaos expansion. Using the developed methodology, a more robust and efficient basis selection technique is obtained. For validation purpose, the methodology is applied to high dimensional analytical test cases, including the Oakley & O'Hagan function (d=15) and the Morris function (d=20). The results are compared with those obtained from two state-of-the-art techniques, namely the LARS-based algorithm and compressive sampling. As compared to previous work, more comparisons with the LARS-based method are provided, through the use of UQLab, a MATLAB-based uncertainty quantification framework developed by Sudret and Marelli [1]. It is shown that, with equal settings, the developed methodology results in a more accurate polynomial chaos expansion compared to the aforementioned technique. In addition, a new criterion for building an optimal polynomial chaos expansion is further investigated. The conclusions are in-line with previous findings, i.e. the present criterion always builds a sparser polynomial chaos expansion which is, in addition, at least as accurate as compared to the optimal polynomial chaos expansion obtained from the classical cross validation technique.*