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Improving Random Balance Designs For The Estimation Of First Order Sensitivity Indices

Stefano Tarantola* Masato Koda+

*Joint Research Centre of the European Commission, Ispra (VA) - ITALY
+University of Tsukuba, Tsukuba - JAPAN

Abstract

The original Random Balance Design (RBD) approach is here further analysed and improved in terms of accuracy of the estimates. The dependency of the algorithm on the tricky parameter M, i.e. the maximum number of frequency harmonics, is eliminated, rendering the procedure fully non parametric.

Keywords: Type your keywords here, separated by semicolons ;

1. Main text

Given a computational model in the form of a function y=f(X), where X is a k-dimensional vector of model inputs, and y is a scalar model output, the method of random balance designs (RBD) -- introduced by Tarantola et al in 2007, is a quite efficient procedure to estimating first order sensitivity measures through a single sample of size N (usually a few hundred points). This means that, with the same set of N points, and the corresponding model evaluations, RBD yields all k first order sensitivity measures. Mara (2009) extended this approach to the estimation of total sensitivity indices, using a procedure that requires higher computational cost, dependent on k.

In this paper we focus on the original RBD with the objective of improving the accuracy of the first order sensitivity estimates. We apply the procedure of Donoho et al (1995) -- used in signal processing to enhance the signal to noise ratio, to the Fourier coefficients of the RBD before summing them up to obtain the sensitivity estimates.

The inclusion of this de-noising step has two advantages: i) it eliminates the tricky parameter M, i.e. the maximum number of harmonics, which, in the original RBD (as well as in FAST), has to be set by the analyst, rendering the algorithm completely non parametric; ii) it generally improves the accuracy of the estimates.

The new implementation is validated and compared to the original on a number of test cases, both analytical and numerical.

* Stefano Tarantola. Tel.: +39-0332-789928; fax: +39-0332-785639.
E-mail address: stefano.tarantola@jrc.ec.europa.eu.

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