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Sequential derivative-based screening of large nonlinear models

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Large computer models used in environmental science require the specification of an increasing number of model parameters. Since these parameters may not be precisely known, model calibration can be used to tune the model parameters to fit observed values, and uncertainty and sensitivity analysis can be used to quantify and analyse the resulting uncertainty. In both cases however, the run-time of the model, coupled with the sheer number of model parameters, can be an obstacle to an effective model calibration and to an accurate sensitivity analysis. One way to alleviate this problem is to perform a preliminary "screening" step (i.e. a low-resolution sensitivity analysis), in which uninfluential model parameters are identified, in order to be kept fixed in the subsequent calibration or full-resolution sensitivity/uncertainty analysis. It is of great interest then to be able to identify uninfluential parameters as efficiently as possible in order to save computational time.

This work investigates approaches for screening in high-dimensions with as few model runs as possible. In particular, a sequential approach is proposed which builds on previous work by Cuntz et al (2015), but makes use of derivative-based sensitivity measures as well as elementary effects, which should perform better in the case on non-monotonic responses. The new approach is compared with the standard elementary effects method, as well as with moment-independent sensitivity measures, on a number of test functions to investigate its efficiency. The objective is to guide environmental modellers on how to maximise the impact of their model runs.

CUNTZ, Matthias, et al. Computationally inexpensive identification of noninformative model parameters by sequential screening. Water Resources Research, 2015, 51.8: 6417-6441.