Parameter Identification Method based on the Localization of Information (PIMLI)

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a) Introduction:

Classical automated parameter estimation strategies typically use one or more aggregate statistics of model performance over a large range of hydrologic behaviors (batch processing of information). This results in considerable loss of important information that can be used to distinguish between competing parameter sets. On the contrary, recursive parameter estimation strategies sequentially move through a time series, thereby increasing information retrieval from the experimental data. The Parameter Identification Method based on the Localization of Information (PIMLI) is a hybrid approach that merges the strengths of the Generalized Sensitivity Analysis (GSA), Bayesian recursive estimation, and the sampling efficiency of the Metropolis-Hastings algorithm, to recursively estimate model parameters in hydrologic models.

b) Advantages

- Provides a recursive estimation of the model parameters, which facilitates the identification of:
- (a) model structural deficiencies;
- (b) the most informative measurements for parameter estimation;
- (c) time varying parameters (related to varying characteristics of the underlying system);
- Generates classical Bayesian uncertainty bounds on the model predictions

c) Disadvantages

- The method assumes that all the uncertainty in the input-output representation of the model is attributed to parameter uncertainty. No explicit treatment of input, ouput, and model structural error;
- Estimation of model parameter relies on classical Bayesian estimation;
- The method is computationally demanding, especially for high-dimensional parameter estimation problems;
- The method focuses on parameter estimation alone, without recourse to state estimation. Corrupted parameter estimates compensate for wrong state estimate.

d) Assumptions

Uses classical Bayesian density functions to estimate model parameters (derived under the assumption of no input/model structural error).

Fully based on Bayesian model identification

Model is available (based on a-prior information)

e) Most appropriate application areas

Watershed model calibration/evaluation

Subsurface hydrologic modeling/contaminant transport

Any field where modeling/measuring interface

f) Reading list

Vrugt, J.A., W. Bouten, H.V. Gupta, and S. Sorooshian, Toward improved identifiability of hydrologic model parameters: The information content of experimental data, Water Resour. Res., 38 (12), art. No. 1312, DOI: 10.1029/2001WR001118, 2002.

Vrugt, J.A., S.C. Dekker, and W. Bouten, Identification of rainfall interception model parameters from measurements of throughfall and forest canopy storage, Water Resour. Res., 39 (9), art. No. 1251, DOI:10.1029/2003WR002013, 2003c.

g) Software availability

Available in MATLAB and OCTAVE. Currently busy with implementation of SCEMUA, MOSCEM-UA, PIMLI and SODA on parallel grid computers.

h) Web links or other information

http://staff.science.uva.nl/~jvrugt/ and http://www.science.uva.nl/ibed/research/Research_Fields/cbpg/products/

i) Figures

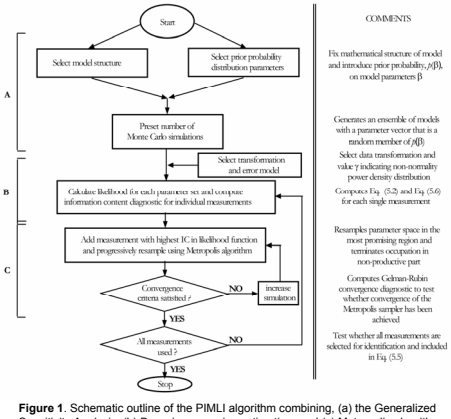

Figure 1. Schematic outline of the PIMLI algorithm combining, (a) the Generalized Sensitivity Analysis, (b) Bayesian recursive estimation, and (c) Metropolis algorithm.

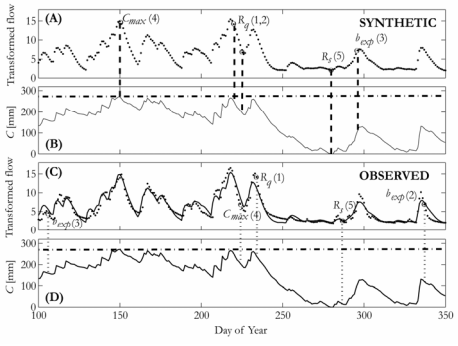

Figure 2. Location of the 5 most informative streamflow measurements along the hydrograph using synthetic (a) and observed (c) streamflow data (dots). The solid line in (c) denotes synthetic data. The selection order of the most informative measurements is indicated betweeen parantheses, (b,d) Soil moisture storage dynamics derived using the "true"parameter set.

j) Delegates Comments (please add !!)