MARKOV CHAIN MONTE CARLO METHODS IN HYDROLOGY

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Bayesian methods for statistical modelling in hydrology provide a powerful framework for scientific reasoning in the context of uncertainty from many sources, such as measurement error and lack of knowledge of physical processes. Until relatively recently these methods have not been of practical use due to the formidable computational burden involved. Markov chain Monte Carlo (MCMC) methods have revolutionised the practice of Bayesian statistics, and have much to offer hydrological modellers (see, e.g., Campbell et al., 1998). We present the key concepts and potential benefits of MCMC, concluding with a summary of the emerging statistical methodology in this area of which the hydrology community should be aware.

Reference

Campbell, E.P., Fox, D.R. and Bates, B.C. (1998). A Bayesian approach to parameter estimation and pooling in nonlinear flood event models. *Water Resour. Res.* In Press.

ROBUST DISTANCES VERSUS THE WILKS DISCORDANCY MEASURE IN THE REGIONAL FREQUENCY ANALYSIS BASED ON L-MOMENTS OF FORMING HOMOGENEOUS REGIONS: A MONTE CARLO INVESTIGATION

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In order to investigate the performance of the standard discordance measure of Wilks and the robust distances, an extended Monte Carlo simulation is performed. This investigation includes several parameters that are simultaneously varied such as: (1) the number of sites in a region; (2) the record length of sites; (3) the intersite dependence of the data at-site and between sites; (4) the different levels of heterogeneity, (5) the misspecification of the regional frequency distributions; and (6) the regional versus the at-site estimation.

HSA9 Hydrology and applied mathematics *(co-sponsored by NP)*

01 Open session on statistical methods in hydrology - Poster Session

Convener: Franchini, M.
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A BAYESIAN NETWORK RAINFALL-RUNOFF MODEL FOR REAL-TIME DECISION MAKING DURING FLOODS

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Numerical rainfall-runoff simulation models are often inadequate to support complex decision making processes during floods. In the context of computerised decision support systems, the computational framework of numerical simulation is too rigid to enable the computer answer questions directly. Numerical models lack the ability to make inverse inference, since the flow of information is one-directional, from model input to model output. In practice, many questions relevant for decision making require knowledge of the range of inputs that may lead to a given output. In order to overcome these difficulties, the feasibility of an alternative computational structure, the bayesian network, is explored in this paper. An experimental rainfall-runoff model of basin response has been implemented under a bayesian network formulation. Hydrologic variables are described in a qualitative discrete space and represented as nodes in the network. Mutual influences between model variables are described as conditional probabilities and represented as links in the network. Network parameters are estimated through off-line Monte Carlo simulation. Model performance is evaluated, based on the goal of supporting conversation between a computer and a user about the physical system during a flood.

AN ADVANCED METHOD FOR PRESERVING SKEWNESS IN SINGLE-VARIATE, MULTIVARIATE, AND DISAGGREGATION MODELS IN STOCHASTIC HYDROLOGY

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Preservation of skewness in hydrological stochastic models is hard to accomplish, especially when the model structure involves a large number of noise (innovation) variables. This is the case in long memory single-variate ARMA models, in multivariate stochastic models, even with short-memory, and particularly in multivariate disaggregation models. The problem is in fact a consequence of the central limit theorem, because the linear combination of a large number of noise variables tends to have a symmetric distribution. However, it is well known that there exists an infinite number of coefficients of linear combinations of noise variables, all resulting in preservation of the first and second (marginal and joint) moments of the involved hydrological variables. Each of these infinite combinations results in different skewness coefficients of the noise variables. The smaller these skewness coefficients are, the more attainable their preservation is in a finite generated sample. Consequently, the problem may be formulated in an optimisation framework aiming at the minimisation of skewness coefficients of all noise variables. Analytical expressions of the derivatives of this objective function are derived, which allow the development of an effective nonlinear optimisation algorithm. The method is illustrated through real-world applications, which indicate a very satisfactory performance of the method.

ON THE INFLUENCE OF MEASURING ERRORS OVER RAINFALL STATISTICS AND EXTREMES

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A wide survey of operational rain gauges, presently in use by the Hydrographic Service of the Liguria region of Italy, has been performed using dynamic calibration in laboratory tests. More than 60 rain gauges with common characteristics have been tested and the survey is now being extended to cover the whole set of operational rain gauges in Liguria. The error curves obtained show - in average - larger underestimation of rainfall with increasing rainfall intensities, up to 15 – 20% at the highest. Underestimation affects historical datasets and has a clear influence on the derived rainfall statistics and extremes. In this paper the influence of the observed measuring errors over common probabilistic models of rainfall is quantified, with special emphasis on the evaluation of the return period of extreme rainfall. The use of data from new and/or revised instruments leads to a bias in the estimation of the return period for a given rainfall depth when this is evaluated from statistical curves. The correction of historical datasets is affected by the limitation that only accumulated data (hourly or daily) are recorded while the errors strongly depends on the variability of rainfall at higher temporal resolutions.