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Comparison of Various Optimization Methods for Calibration of Conceptual Rainfall-Runoff Models

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Abstract:

Runoff forecasts are needed in many water resources activities such as flood and drought management, irrigation practices, and water distribution systems, etc. Runoff is generally forecasted using rainfall-runoff models by using hydrologic data in the catchment. Computer based hydrologic models have become popular with practicing hydrologists and water resources engineers for performing hydrologic forecasts and for managing water systems. Rainfall-runoff library (RRL) is computer software developed by Cooperative Research Centre for Catchment Hydrology (CRCCH), Australia. The RRL consists of five different conceptual rainfall-runoff models and has been in operation in many water resources applications in Australia. RRL is designed to simulate catchment runoff by using daily rainfall and evapotranspiration data.

In this paper, the results from an investigation on the use of different optimization methods for the calibration of various conceptual rainfall-runoff models available in RRL toolkit are presented. Out of the five conceptual models in the RRL toolkit, AWBM (The Australian Water Balance Model) has been employed. Seven different optimization methods are investigated for the calibration of the AWBM model. The optimization methods investigated include uniform random sampling, pattern search, multi start pattern search, Rosenbrock search, Rosenbrock multi-start search, Shuffled Complex Evolution (SCE-UA) and Genetic Algorithm (GA). Trial and error procedures were employed to arrive at the best values of various parameters involved in the optimizers for all to develop the AWBM. The results obtained from the best configuration of the AWBM are presented here for all optimization methods. The daily rainfall and runoff data derived from Bird Creek Basin, Oklahoma, USA have been employed to develop all the models included here. A wide range of error statistics have been used to evaluate the performance of all the models developed in this study. It has been found that the AWBM model calibrated using GA optimizer performs better than the other optimization methods. The AWBM model calibrated using uniform random sampling optimizer performed comparable to the one calibrated using GA but it is more computationally expensive. The results obtained in this study indicate that the evolutionary approaches based on the laws of probability and competitive evolution may be useful in modeling the conceptual rainfall-runoff process in real catchments. More research is needed in using efficient optimization methods based on evolutionary approaches in conceptual rainfall-runoff modeling. It is hoped that the future research efforts will focus in such directions.