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Multi-objective parameter optimization of the HYPE model using shuffled frog-leaping algorithm

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The calibration of hydrological models using bio-inspired meta-heuristic optimization techniques has been extensively tested to find the optimal parameters for hydrological models. Shuffled frog-leaping algorithm (SFLA) is a population-based cooperative search technique containing virtual interactive frogs distributed into multiple memeplexes. The frogs search locally in each memeplex and are periodically shuffled into new memeplexes to ensure global exploration. Though it is developed for discrete optimization, it can be used to solve multi-objective combinatorial optimization problems as well.

In this study, a hydrological catchment model, Hydrological Predictions for the Environment (HYPE) is calibrated for streamflow and nitrate concentration in the catchment using SFLA. HYPE is a semi-distributed watershed model that simulates runoff and other hydrological processes based on physical as well as conceptual laws. SFLA with 200 runtimes and 5 memeplexes containing 10 frogs each is used to calibrate 22 model parameters. It is compared with manual calibration and Differential Evolution Markov Chain (DEMC) method from the HYPE-tool. The preliminary results of the statistical performance measures for streamflow calibration show that SFLA has the fastest convergence speed and higher stability when compared with the DEMC method. NSE of 0.68 and PBIAS of 7.72 are recorded for the best run of SFLA during the calibration of streamflow. In comparison, the HYPE-tool DEMC produced the best NSE of 0.45 and a PBIAS of -3.37 while the manual calibration resulted in NSE of 0.64 and PBIAS of 2.01.