Reservoir Model Calibration and Uncertainty Quantification Using a Self-adapted Evolutionary Strategy

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ABSTRACT:

Reservoir model calibration and uncertainty quantification are two important research topics in oil & gas industry. Within the Bayesian inference framework, reservoir model calibration is applied to update our reservoir models when well testing, production and/or time-lapse seismic data are available. Due to the inverse problem nature of this process and very limited and sparse reservoir knowledge, multiple solutions may be existed. Uncertainty quantification is thus necessary in predicting the future performance of a reservoir. Gradient-based methods have been successfully implemented in the automatic reservoir model calibration workflow. However, their deterministic nature very likely traps themselves in local minima and cannot provide a rigorous quantification of uncertainties. Recently, global stochastic optimization algorithms, such as evolutionary strategy and particle swarm optimization (PSO), have gained popularity in the petroleum society. In this study, we evaluate the performance of a self-adapted evolutionary strategy called covariance matrix adaptation evolutionary strategy (CMA-ES) in reservoir model calibration. NA-Bayes resampler is employed for the posterior uncertainty quantification of the ensemble of models obtained after calibration. The self-adapted nature of CMA-ES greatly reduces human influences in choosing control parameters by try-and-error, which is a problem suffered in PSO. Punq-S3 model is used as case study and performances are compared with PSO.