Geophysical Research Abstracts, Vol. 7, 04593, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04593

The multiobjective evolutionary annealing-simplex method and its application in calibrating hydrological models

A. Efstratiadis (1) and D. Koutsoyiannis (1)

(1) Department of Water Resources, School of Civil Engineering, National Technical University of Athens, Greece. [Contact Email: andreas@itia.ntua.gr /Fax: +30 210 7722832]

Optimisation problems related to water resources are, by nature, multiobjective, even if traditionally handled as single-objective. Current advances in hydrological modelling employ multiobjective approaches to treat the well-known problem of "equifinality", thus assessing the uncertainties related to the parameter estimation procedure. However, computer tools generating Pareto-optimal solutions are still particularly time-consuming, especially in real-world applications, with many parameters and many fitting criteria. Moreover, the mathematical concept of Pareto optimality often leads to solutions that are far away from an acceptable compromise between the conflicting objectives. Most multiobjective optimisation tools are adaptations of evolutionary algorithms. In multiobjective evolutionary optimisation two are the major goals: (a) guiding the search towards the Pareto-optimal front, and (b) generating a well-distributed set of nondominated solutions. Both are achieved through the fitness evaluation and selection procedures; using the fundamental principle of dominance, scalar fitness values are assigned to individuals, then evolved by employing the typical genetic operators (crossover, mutation). The multiobjective evolutionary annealing-simplex (MEAS) method is an innovative scheme, also comprising an evaluation phase and an evolution phase. The evaluation aims to assign a performance measure to each member of the population, which requires the comparison of all individuals against each other and against all criteria. A fitness strategy inspired from the strength-Pareto approach of Zitlzer and Thiele (IEEE Trans. Evol. Comp., 3(4), 1999), in addition to an extension of the definition of dominance, provides a large variety of discrete performance values. The population is guided towards a promising sub-region of the Pareto front (not the entire front), that contains representative

trade-offs, among which the best-compromise may easily detected. The generation of solutions with extreme performance, i.e. too good against some criteria, too bad for the rest ones, is prohibited, by means of penalty functions. In this manner, the discrete fitness space is transformed to a continuous space, which may be explored through global search techniques. The latter (i.e., the evolution phase) is implemented through a set of combined deterministic and stochastic transition rules, most of them based on a simplex-evolving pattern. During evolution, the degree of randomness is controlled through an adaptive annealing cooling schedule, which automatically regulates the "temperature" of the system. The MEAS method was tested on a variety of benchmark functions taken from the literature, as well as on some challenging hydrological applications, formerly handled through weighted objective functions. The analysis indicate that the proposed algorithm locates good trade-offs among the conflicting objectives simultaneously being much more efficient if compared to other, well-established multiobjective evolutionary schemes.