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MOPSO algorithm and its application in multipurpose multireservoir operations

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ABSTRACT

The main reason for applying evolutionary algorithms in multi-objective optimization problems is to obtain near-optimal nondominated solutions/Pareto fronts, from which decision-makers can choose a suitable solution. The efficiency of multi-objective optimization algorithms depends on the quality and quantity of Pareto fronts produced by them. To compare different Pareto fronts resulting from different algorithms, criteria are considered and applied in multi-objective problems. Each criterion denotes a characteristic of the Pareto front. Thus, ranking approaches are commonly used to evaluate different algorithms based on different criteria. This paper presents three multi-objective optimization methods based on the multi-objective particle swarm optimization (MOPSO) algorithm. To evaluate these methods, bi-objective mathematical benchmark problems are considered. Results show that all proposed methods are successful in finding near-optimal Pareto fronts. A ranking method is used to compare the capability of the proposed methods and the best method for further study is suggested. Moreover, the nominated method is applied as an optimization tool in real multi-objective optimization problems in multireservoir system operations. A new technique in multi-objective optimization, called warm-up, based on the PSO algorithm is then applied to improve the quality of the Pareto front by single-objective search. Results show that the proposed technique is successful in finding an optimal Pareto front.

Key words | multi-objective particle swarm optimization (MOPSO), multipurpose, multireservoir systems, optimization problems

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INTRODUCTION

Application of a suitable multi-objective optimization technique is important in determining a compromise between different objectives. Traditional multi-objective methods attempt to find a set of nondominated solutions using mathematical programming (Balter & Fontane 2006). Both the weighting and ϵ-constraint methods are commonly used as traditional techniques that can produce nondominated solutions without any information from a decision-maker. In these methods, multi-objective problems are transformed to single-objective ones. Thus, solutions directly depend on weights in the weighting method and constraints in the ϵ-constraint method. In contrast, only one solution can be detected per optimization effort (Parsopoulos *et al.* 2004).

The increased complexity of engineering problems and especially in the field of water resources management has led to more applications of evolutionary algorithms. The latter are stochastic search methods that simulate natural biological evolution and/or the social behavior of species. Evolutionary algorithms present a set of nondominated solutions/Pareto fronts for multi-objective problems. Kennedy & Eberhart (1995)

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