Optimization of non-convex water resource problems by honey-bee mating optimization (HBMO) algorithm

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Abstract

Purpose – The purpose of this paper is to present the honey-bee mating optimization (HBMO) algorithm tested with, first, a well-known, non-linear, non-separable, irregular, multi-modal "Fletcher-Powell" function; and second, with a single hydropower reservoir operation optimization problem, to demonstrate the efficiency of the algorithm in handling complex mathematical problems as well as non-convex water resource management problems. HBMO and genetic algorithm (GA) are applied to the second problem and the results are compared with those of a gradient-based method non-linear programming (NLP).

Design/methodology/approach – The HBMO algorithm is a hybrid optimization algorithm comprised of three features: simulated annealing, GA, and local search. This algorithm uses the individual features of these approaches and combines them together, resulting in an enhanced performance of HBMO in finding near optimal solutions.

Findings – Results of the "Fletcher-Powell" function show more accuracy and higher convergence speed when applying HBMO algorithm rather than GA. When solving the single hydropower reservoir operation optimization problem, by disregarding evaporation from the model structure, both NLP solver and HBMO resulted in approximately the same near-optimal solutions. However, when evaporation was added to the model, the NLP solver failed to find a feasible solution, whereas the proposed HBMO algorithm resulted in a feasible, near-optimal solution.

Originality/value – This paper shows that the HBMO algorithm is not complicated to use and does not require much mathematical sophistication to understand its mechanisms. A tool such as the HBMO algorithm can be considered as an optimization tool able to provide alternative solutions from which designers/decision makers may choose.

Keywords Programming and algorithm theory, Water retention and flow works, Reservoirs

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Introduction

Non-linear programming (NLP) offers a general mathematical formulation, handling a non-separable objective function and non-linear constraints in many water resources management models. Although, in many cases, the NLP problems are non-convex, local solvers are applied. Methods of obtaining global solutions for non-convex