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A solution to bi/tri-level programming problems using particle swarm optimization

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Abstract: Multilevel (including bi-level and tri-level) programming aims to solve decentralized decision-making problems that feature interactive decision entities distributed throughout a hierarchical organization. Since the multilevel programming problem is strongly NP-hard and traditional exact algorithmic approaches lack efficiency, heuristics-based particle swarm optimization (PSO) algorithms have been used to generate an alternative for solving such problems. However, the existing PSO algorithms are limited to solving linear or small-scale bi-level programming problems. This paper first develops a novel bi-level PSO algorithm to solve general bi-level programs involving nonlinear and large-scale problems. It then proposes a tri-level PSO algorithm for handling tri-level programming problems that are more challenging than bi-level programs and have not been well solved by existing algorithms. For the sake of exploring the algorithms' performance, the proposed bi/tri-level PSO algorithms are applied to solve 62 benchmark problems and 810 large-scale problems which are randomly constructed. The computational results and comparison with other algorithms clearly illustrate the effectiveness of the proposed PSO algorithms in solving bi-level and tri-level programming problems.

Keywords: Bi-level programming, tri-level programming, multilevel decision-making, particle swarm optimization, computational intelligence.

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