Artificial bee colony algorithm for constrained possibilistic portfolio optimization problem

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Abstract
In this paper, we discuss the portfolio optimization problem with real-world constraints under the assumption that the returns of risky assets are fuzzy numbers. A new possibilistic mean-semiabsolute deviation model is proposed, in which transaction costs, cardinality and quantity constraints are considered. Due to such constraints the proposed model becomes a mixed integer nonlinear programming problem and traditional optimization methods fail to find the optimal solution efficiently. Thus, a modified artificial bee colony (MABC) algorithm is developed to solve the corresponding optimization problem. Finally, a numerical example is given to illustrate the effectiveness of the proposed model and the corresponding algorithm.

1. Introduction
Portfolio selection discusses the problem of how to allocate a certain amount of investors' wealth among different assets and form a satisfying portfolio. The mean–variance (M–V) model proposed by Markowitz [1] has become the foundation of the modern finance theory since 1950s. It combines probability with optimization techniques to model the behavior investment under uncertainty. The key principle of the M–V model is to use the expected return of a portfolio as the investment return and to use the variance of a portfolio as the risk measure. After Markowitz's work, a lot of work has been done to improve and extend the standard M–V model in three directions: (i) the simplification of the type and amount of the input data; (ii) the introduction of alternative measures of risk; and (iii) the inclusion of the real-world constraints. In this study we concentrate on the second and third directions.

In the original Markowitz model [1], the risk is measured by the standard deviation or variance. However, as pointed out by Grootveld and Hallerbach in Ref. [2], the distinguished drawback is that variance treats high returns as equally unde-
The purpose of this paper is to construct a mean-semiabsolute deviation portfolio model based on the possibility theory and to develop an efficient heuristic approach based on ABC algorithm for solving proposed model. The main contributions of our paper can be summarized as follows. We propose a possibilistic mean-semiabsolute deviation portfolio model including transaction costs, cardinality and quantity constraints, in which for a given return level, the investor penalizes the negative semiabsolute deviation that is defined as a risk. Meanwhile, we present a MABC algorithm for the solution, in which chaotic initialization based on logistic map is used to produce initial population, and a hybridization method of ABC and PSO is presented to further improve the performance of ABC. Finally, we give a numerical example to illustrate the idea of our model and demonstrate the effectiveness of the designed algorithm.
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