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A BINARY SOCIAL SPIDER ALGORITHM FOR DISCOUNTED {0-1} KNAPSACK PROBLEM

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Abstract. *This paper proposed a new binary social spider algorithm with repair operator solving discounted {0-1} knapsack problem (DKP01). The solution of DKP01 is presented by a binary vector. Social spider algorithm is a simple and powerful optimization algorithm. A new function is used to convert real vector to binary vector to design binary social spider algorithm. We conducted extensive experiments on two types of 20 instances using our proposed approach. The experiments proved that the new method is efficient for solving DKP01.*
Keywords: Discounted {0-1} knapsack, SSA algorithm, Optimization algorithm, Artificial intelligence, Heuristic

1. **Introduction.** A new binary social spider algorithm is proposed to solve discounted {0-1} knapsack problem (DKP01). DKP01 formula is as the following:

$$\text{Maximize } f(X) = \sum_{i=0}^{n-1}(x_{3i}v_{3i} + x_{3i+1}v_{3i+1} + x_{3i+2}v_{3i+2}); \tag{1}$$

$$\text{Subject to } x_{3i} + x_{3i+1} + x_{3i+2} \le 1, \quad i \in \{0, \dots, n-1\}, \tag{2}$$

$$\text{Subject to } (x_{3i}w_{3i} + x_{3i+1}w_{3i+1} + x_{3i+2}w_{3i+2}) \le C, \tag{3}$$

$$x_{3i}, x_{3i+1}, x_{3i+2} \in \{0,1\}, \quad \forall i \in \{1, 2, \dots, n-1\}; \tag{4}$$

where, x_{3i}, x_{3i+1}, and x_{3i+2} represent whether the items $3i$, $3i+1$, and $3i+2$ are put into the knapsack: $x_j = 0$ indicates the item j ($j = 0, 1, \dots, 3m-1$) is not in knapsack, while $x_j = 1$ indicates the item j is in knapsack; w_{3i}, w_{3i+1}, and w_{3i+2} are the weight of items $3i$, $3i+1$, and $3i+2$ respectively. It is worth noting that a binary vector $X = (x_0, x_1, \dots, x_{3m-1}) \in \{0,1\}^{3m}$ is a potential solution of DKP01. Only if X meets both Equations (2) and (3), it is a feasible solution of DKP01.

The DKP01 is a new knapsack problem introduced by Guldan [1]. This problem has many applications in investment decision-making, mission selection, and budget control. Dynamic programming for solving DKP01 is first studied in [1]. [2] introduced the D-KP01 by using the core concept of the {0-1} knapsack problem, and combined dynamic programming with the core of the DKP01. Two algorithms of FirEGA and SecEGA are proposed by He et al. for DKP01 [3]. Recently, they [4] also had a detailed study of the algorithms of the DKP01 and proposed a brand new deterministic algorithm and approximation algorithms. They proposed PSO-GRDKP based on particle swarm optimization

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