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BEMA: Binary Exchange Market Algorithm

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Abstract

Exchange market algorithm (EMA) is one of the most recent population-based optimization algorithm. EMA inspired by the method of selling and purchasing of shares by elite stockbrokers, tries to solve the optimization problems. This algorithm has two searcher operators as well as two absorbent operators for individuals to be absorbed to the elite person, which leads to create and organize the random numbers in best way. The standard EMA algorithm is proposed only for continuous optimization problems. This paper proposes a binary version of EMA for discrete optimization problems. To investigate the performance of proposed binary exchange market algorithm on the discrete optimization, the algorithm has been successfully implemented on 7 Binary benchmark functions in large dimension variables. The obtained results indicate the high ability of the proposed algorithm in comparison with the other algorithms.

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Keywords: Exchange market; discrete optimization; benchmark function.

1. Introduction

Optimization is the process of figuring out the best answer or the global optimal point for an issue. In optimization, the global optimum point is the minimum or the maximum of a function value. The mathematical methods are able to optimize different problems with greater precision when compared to heuristic optimization methods (Ghorbani and Babaei, 2014). Meta-heuristic algorithms, unlike the mathematical methods, are able to obtain the output of the functions by using random numbers without considering the complexities and constraints of

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the function (Lera et al., 2010). These advantages have led to increase the application of heuristic algorithms in optimizing the complicated and practical functions in the real world, particularly the ones which mathematical methods cannot solve them (Ghorbani et al., 2014; Wang et al., 2013; Silva-Maximiano et al., 2013). So, vast research has been conducted in heuristic algorithms (Ding et al., 2016; Aminbakhsh and Sonmez, 2016). Inspired by nature or some systematic processes, these algorithms are composed of operators which try to optimize complicated and engineering issues. For example, the genetic algorithm (GA) uses operators inspired by natural genetic variation and natural selection (Long et al., 2015; Trivedia et al., 2015), particle swarm optimization (PSO) (Kennedy and Eberhart, 1995; Alam et al., 2015) is inspired by social behavior of bird flocking or fish schooling. Other examples are ant colony optimization (Mao et al., 2015), imperialist competitive algorithm (Atashpaz-Gargari and Lucas, 2007), biogeography-based optimization (Simon, 2008; Guo et al., 2016), harmony search (HS) algorithm (Saka et al., 2016), cuckoo optimization algorithm (Rajabioun, 2011) and gravitational search algorithm (GSA) (Rashedi et al., 2010; Das et al., 2016).

EMA inspired by the method of selling and purchasing of shares by elite stockbrokers, tries to solve the optimization problems (Ghorbani and Babaei, 2014). Investigating the performance of elite stockbrokers has led to the creation of EMA. The performance of elite stockbrokers varies in the market with oscillation and balanced markets (Tier, 2006). Successful stockbrokers have different performance when they have high or low success. The behavior and performance of elite stockbrokers have been assessed when their level of possessions is low, mean and high, and the results have been employed in the EMA. In EMA, the successful people are taking the necessary measures to introduce themselves as the most successful stockbrokers in the market; hence, they compete with each other. The EMA has been put forward for continuous issues whose results enjoy a great capability in finding the global optimum points in continuous issues (Ghorbani, 2016; Rajan and Malakar, 2016(1); Rajan and Malakar, 2016(2)). This paper proposes a binary version of EMA for discrete optimization problems. In EMA, the individual can own any type of share in any amount he wishes. In binary exchange market algorithm (BEMA), each person can own a specific type of share in the value of 1, or with the value of zero, not have any of those shares. In BEMA, the performance of shareholders will be similar to that of EMA. In a balanced market, the performance of BEMA is different from EMA. In order to assess the performance of BEMA in optimizing discrete functions, this algorithm has been implemented to solve 7 cases of benchmark Binary Functions with great dimension.

2. Exchange market algorithm

The detailed data about the EMA that is appropriate for continues problems, represented in Ghorbani and Babaei (2014) and for explanation the performance of BEMA, it mentioned briefly in this paper. In EMA, there are two market situations. After each market condition, the people with high, middle, and low ranks will be sorted as group 1, group 2, and group 3, respectively.

2.1. Exchange Market in balanced condition

In this section, each individual is ranked based on the fitness function and sorted as group 1, group 2, and group 3.

2.1.1. Frist Group: Shareholders with high ranks: The members of this group are the elite stockbrokers, or the best answers for the problems which are necessary to stay intact and unchangeable.

2.1.2. *Second Group: Shareholders with mean ranks:* The members of this group use the successful experiences of elite stockbrokers. The members of this group change the number of their shares based on the equation (1):

$$pop_j^{group(2)} = r \times pop_{1,i}^{group(1)} + (1-r) \times pop_{2,i}^{group(1)} \qquad i = 1,2,3,...,n_i \text{ and } j = 1,2,3,...,n_j \tag{1}$$

where, n_i and n_j are the n^{th} person of the first and second group respectively. r is a random number. $pop_{1,i}^{group(1)}$ and $pop_{2,i}^{group(1)}$ are the members of the first group and $pop_j^{group(2)}$ is the j^{th} person of the second group.

2.1.3. *Third Group: Shareholders with low ranks:* The members of this group to earn more profit would change the number of their shares based on the equation (3):

$$S_k = 2 \times r_1 \times \left(pop_{i,1}^{group(1)} - pop_k^{group(3)}\right) + 2 \times r_2 \times \left(pop_{i,2}^{group(1)} - pop_k^{group(3)}\right) \tag{2}$$

$$pop_k^{group(3),new} = pop_k^{group(3)} + 0.8 \times S_k \quad k = 1,2,3,...,n_k \tag{3}$$