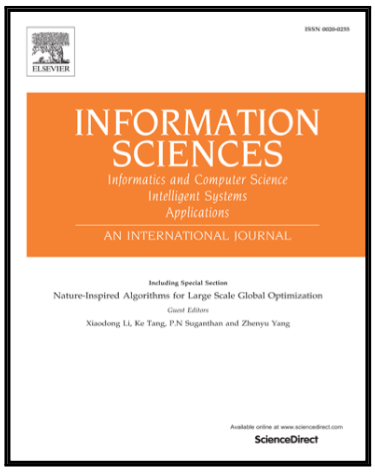

CADE: A Hybridization of Cultural Algorithm and Differential Evolution for Numerical Optimization

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CADE: A Hybridization of Cultural Algorithm and Differential Evolution for Numerical Optimization

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Abstract

Many real-world problems can be formulated as optimization problems. Such problems pose a challenge for researchers in the design of efficient algorithms capable of finding the best solution with the least computational cost. In this paper, a new evolutionary algorithm is proposed that combines the explorative and exploitative capabilities of two evolutionary algorithms, Cultural Algorithms (CA) and Differential Evolution (DE) algorithm. This hybridization follows the HTH (High-level Teamwork Hybrid) nomenclature in which two meta-heuristics are executed in parallel. The new algorithm named as CADE, manages an overall population which is shared between CA and DE simultaneously. Four modified knowledge sources have been used in proposed CA which are: topographical, situational, normative and domain. The role of the used acceptance function in belief space is to select the knowledge of the best individuals to update the current knowledge. A novel quality function is used to determine the participation ratio for both CA and DE, and then a competitive selection takes place in order to select the proportion of function evaluations allocated for each technique. This collaborative synergy emerges between the DE and CA techniques and is shown to improve the quality of solutions, beyond what each of these two algorithms alone. The performance of the algorithm is evaluated on a set of 50 scalable optimization problems taken from two sources. The first set of 35 came from existing benchmark sets available in the literature. The second set came from the 2014 IEEE Single Function optimization competition. The overall results show that CADE has a favorable performance and scalability behaviors when compared to other recent state-of-the-art algorithms. CADE's overall performance ranked at number 1 for each of the two sets of problems. It is suggested that CADE's success across such a broad spectrum of problem types and complexities bodes well for its application to new and novel applications.

Keywords

Evolutionary Algorithm, Cultural Algorithm, Differential Evolution, Numerical Optimization.

1. Introduction

Many real life problems can be formulated as optimization problems. Hence, a considerable amount of research has been devoted to the location of a global optimal solution. Generally, any optimization problem can be expressed as follows:

Minimize: $f(\vec{X}), \vec{X} = \{x_1, x_2, ..., x_D\}, x_i \in [x_l, x_u]$, (1)

where $f(x)$ is the objective function being optimized over $\vec{X}$, D is the dimensionality of the problem, and x_l, x_u are the lower and upper bounds of parameter x_i respectively.