A Simplification of Differential Evolution with Enhanced Diversity Maintenance

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Evolutionary Algorithms (EAS) are a population-based meta-heuristics widely used in complex optimization problems. In spite of their remarkable performance, its behaviour can be seriously deteriorated by several reasons. Premature convergence is one of the most important drawbacks that EAS faces. A way to alliviate this drawback dwells in the incorporation of managment techniques in which is aimed a balance between exploration and exploitation among the evolutionary search[1]. Therefore, the theme of interest is driven to attain such balance. In 2013, Črepinšek et al.[2] proposed a quite popular classification of these methods which depends on the sort of components modified in the EA. A popular taxonomy identifies the following groups: *selection-based*, *population-based*, *crossover/mutation-based*, *fitness-based*, and *replacement-based*. Some of the most successful methods designed to attain this balance yields in the *replacement-based* operator. The basic principle that governs this replacement operator is the modification of the level of exploration in successive generations by controlling the diversity of the survivors. In this way, an adequate selection of diverse survivors might slow down the inconvenient of an accelerated convergence. Recent reseach has shown that important advances are attained when the balance between exploration and intensification is managed by relating the amount of maintained population's diversity to the stopping criterion and elapsed period of execution. Particularly, these methods reduce the importance given to the preservation of diversity as the end of the optimization is approached. This principle has been used to find a new best-known solutions for the Frequency Assignment Problem, and to the design of the winning strategy of the extended round of Google Hash Code 2020.

In the last year was proposed "Differential Evolution with Enhanced Diversity Maintenance" (DE-EDM), which incorporates a replacement phase to DE. In particular this algorithm explicitly preserves diversity in several stages among the execution. Hence, a dynamic balance between exploration and exploitation is carried out with the aim of adapting the optimizer to the requirements of the different optimization stages. DE-EDM was validated with several test problems proposed in competitions of the well-known IEEE Congress on Evolutionary Computation (CEC). In such comparison, the top-rank algorithms of each competition (CEC 2016 and CEC 2017), as well other diversity-based schemes were taken into account. The results showed that DE-EDM avoided premature convergence which improved remarkably to state-of-the-art algorithms.

Although the benefits of explicitly promoting the diversity in DE are quite evident, those kind of strategies require the setting of two extra user-parameters. Those parameters are the initial distance factor (D_I) and final moment of diversity (D_F). While the former indicates the initial level of diversity required by the replacement operator. The later is the final moment among the execution in which the diversity is explicitly promoted. Originally, the initial distance factor of the DE-EDM has been empirically tested with the promotion of diversity only until the 90% of the total execution ($D_F = 90\%$). Those results showed

[1]Auto-tuning strategy for evolutionary algorithms: balancing between exploration and exploitation
[2]Exploration and exploitation in evolutionary algorithms: A survey

that the performance of D_I is quite robust in the sense that a large range of values provided good enough results. In this work is presented DE-EDM-II, which is a simplification of the DE-EDM. In particular, the elite vectors are removed, leaving only the multi-set of target and trial vectors. Finally, under the same experimental validation, a more complete analyzes of the diversity parameters (D_I and D_F) is carried out. This last analyzes explains the effect of promoting diversity to diferent levels in long-term executions.