Abstract

This thesis aims to develop a hybrid genetic algorithm, obtained by integrating the classical approach of genetic algorithms with machine learning techniques such as *clustering* and reinforcement learning. The main goal is to improve performance in searching for optimal solutions in complex optimization problems, overcoming some of the limitations of traditional genetic algorithms.

Initially, a review of evolutionary algorithms, particularly genetic algorithms, and their possible criticalities is proposed, along with an explanation of clustering techniques and reinforcement learning algorithms.

Subsequently, the structure and implementation of the hybrid algorithm are illustrated, where *clustering* is used to group solutions into homogeneous subdomains, while reinforcement learning is employed to adaptively guide the selection and evolution process based on feedback (rewards/penalties) derived from reinforcement learning.

The conducted experimentation compared the performance of the hybrid algorithm with that of a MOEA/D genetic algorithm through a series of *benchmark* optimization problems: DTLZ2 and ZDT3 for real-valued solutions, ZDT5 and MONRP for binary solutions, and MOTSP and mQAP for permutative solutions.

The results indicate that, in general, the developed algorithm performs better in terms of execution time and *hypervolume*. Specifically, it is generally faster for problems with binary and real-valued solutions, while slightly worse or similar for problems with permutative solutions. In terms of *hypervolume*, which represents the quality of the solutions, it is either better or similar compared to MOEA/D.

The main criticalities encountered concern the survival phase of the solutions, where the adopted strategy might limit population diversity. Refining this aspect could lead to a significant performance improvement, making the hybrid algorithm distinctly superior to a traditional approach.

This study represents a first step toward the development of more efficient hybrid genetic algorithms, paving the way for future optimizations.