DIVERSITY PRESERVATION MECHANISMS FOR POPULATION-BASED META-HEURISTICS

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During last years, a wide range of population-based meta-heuristics, such as evolutionary algorithms and swarm-based approaches, among others, have been proposed with the aim of dealing not only with benchmark optimisation problems, but also with real-world applications belonging to a significant number of fields.

Population-based approaches try to intrinsically keep the diversity in a set of solutions. As a result, by the recombination of those diverse solutions, the decision space may be explored in a much wider and efficient way. One common problem of population-based meta-heuristics however, is that for some test cases they might exhibit a tendency to converge towards local optima. One of the most frequent problems that these types of meta-heuristics have to deal with is, premature convergence , which arises when every member of the population is located at a sub-optimal area of the decision space from where they cannot escape. The main reason for the above phenomenon is called, genetic drift, which refers to the loss of diversity produced by the usage of finite population sizes.

A significant number of methods have been proposed in order to preserve the diversity in a set of solutions, e.g., mating-based approaches, disruptive operators, fitness sharing, crowding-based selection, and methods based on complex population structures, among others. Furthermore, some more recent proposals such as, diversity-based multi-objective approaches and multi-objectivisation , have taken protagonism during last years in the case of promoting diversity by means of the application of multi-objective algorithms to single-objective problems.

Topics

- Restarting mechanisms.
- Variable population size approaches.

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- Methods based on mating restrictions.
- Diversity-based operators.
- Niching and crowding mechanisms.
- Multi-objective methods for promoting diversity:
  - Mechanisms that transform a constrained single-objective problem into an unconstrained multi-objective problem.
  - Diversity-based multi-objective approaches: diversity considered as auxiliary objective functions: encoding-independent measures, genotypic and phenotypic measures, behavioural (diversity and novelty) measures, etc.
  - Multi-objectivisation by decomposition or aggregation.
- Methods based on complex population structures:
  - Island-based models and distributed algorithms.
  - Cellular approaches.
  - Segregation techniques.
- Clustering techniques.
- Management of diversity in memetic algorithms.
- Diversity metrics in combinatorial and continuous spaces.
- Premature convergence detection.
- Real-world applications requiring the application of diversity preservation mechanisms.