Collaborative Evolutionary Algorithms for Combinatorial Optimization

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ABSTRACT
A new evolutionary algorithm for problems having potential solutions encoded as permutations is proposed. The introduced algorithm is based on the collaboration between individuals that exchange information in order to accelerate the search process. Numerical experiments prove the efficiency of the proposed technique.

Categories and Subject Descriptors
I.2.8 [**Artificial Intelligence**]: Problem Solving, Control Methods, and Search – *heuristic methods.*

General Terms
Algorithms.

Keywords
Selection, Recombination, Generalized Travelling Salesman Problem, Combinatorial Optimization

1. INTRODUCTION
Evolutionary computation provides good approximate methods for solving problems whose solutions can be encoded by discrete variables. In the proposed evolutionary algorithm, the population imitates a social system where individuals communicate and share information. New selection and recombination operators are proposed in order to improve standard evolutionary algorithms, for problems involving solutions encoded as permutations.

2. COLLABORATIVE EVOLUTIONARY ALGORITHMS
In the proposed Collaborative Evolutionary Algorithm (CEA) each individual knows the value of the best individual obtained so far in the search process (*GlobalOpt*) and the value of its best related individual (*LineOpt*). Both *GlobalOpt* and *LineOpt* will guide the search process in the form of passing relevant genetic material to the offspring during recombination. This information sharing mechanism also affects the way selection is performed.

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2.1 COLLABORATIVE SELECTION
The goal of the proposed collaborative selection is to favor the fittest individuals within each group of individuals having the same *LineOpt*. The selection probability computed within a Monte Carlo scheme is therefore modified according to the rank of each individual in its group. This selection scheme promotes the exploitation of all promising regions discovered during the search process therefore preventing a group of high-fit individuals from dominating the next generation.

2.2 COLLABORATIVE RECOMBINATION
The proposed recombination operator transfers to the offspring not only genetic material from the parents, but from the parents' *LineOpt* and from the *GlobalOpt* as well, if they have common sequences of genes. The amount of genetic information transferred from the *GlobalOpt* and *LineOpt* to the offspring is controlled by taking into account the length of the common sequences and the number of the current generation relative to the total number of generations.

3. EXPERIMENTAL RESULTS
Results obtained by applying the proposed Collaborative Evolutionary Algorithm (CEA) for 18 instances of Generalized Travelling Salesman Problem are compared with the results obtained by applying discrete particle swarm optimization (DPSO) [1] and generalized – chromosome – based genetic algorithm (GCGA) [2]. The test results indicate that CEA finds the best known solution of the problem in 73.5% of the considered problems. The proposed CEA clearly outperforms the DPSO algorithm and obtains a better success rate than the GCGA technique.

4. REFERENCES
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