Experimental Design Method for Multi-Parent Crossover

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EXTENDED ABSTRACT

In genetic algorithm, the most commonly used recombination operator involves two parents to produce offspring. A few attempts to study the effect of using multi-parent recombination in genetic algorithm have been reported in the literatures [1][3]. The rationale is to bias the recombination with more parents to improve the performance. In evolution strategies, a recombination operation was first proposed to produce new offspring that may inherit genes from more than two parents. In that approach, the number of parents is not fixed.

Eiben has proposed diagonal crossover for producing new offspring with allele inherited from multiple parents [1]. Experimental result shows that it can improve the performance of genetic algorithm on some numerical optimization problems. Similar to multi-point crossover, it generalizes crossover point in N parents and composing N children by taking the resulting in N chromosome segments from the parent "along the diagonals". Such scheme has the potential problem that the n favorable gene will be inherited to the next generation since no information associated the quality of the inherited genes.

In traditional quality engineering, experimental design techniques are extremely effective for robust product and process design to improve product quality while keeping the cost of product or manufacturing processes low [2]. In particular, sample points are under a systematical control mechanism to explore the search space. Experimental design techniques are used to identify the improved factor levels of controllable design or process parameters. It is extremely effective for improving quality in problems that involve a large number of factors. It is far more economical than the popular factorial design and fractional design in terms of number of experiments required identifying the significant factors and the corresponding values.

Our main idea is based on the observation that the multi-parent recombination operation can be considered as an experiment. If the sophisticated experimental design technique is applied to strengthen this operation, the resulting operation can be statistically sound and have a better performance. By compensating the random searching as in traditional genetic algorithm, it has the characteristic of experimental design method in exploring the solution space effectively.

We tested the proposed algorithm on a set of benchmark problems, and compared with the performance of Pure Genetic Algorithm (PGA) [4] and Eiben's Multi-Parent Genetic Algorithm (MPGA) [1]. It showed that the proposed method has a better performance in terms of qualify of solution and computational efficiency comparing with the other two approaches.

References

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