Multi-Parent Extension of Edge Recombination

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ABSTRACT

This paper proposes a multi-parent crossover based on edge recombination. The original edge table is modified to record the adjacency information for more than two parents. Experimental results on the traveling salesman problem show the proposed multi-parent edge recombination is capable of enhancing edge recombination in solution quality.

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

General Terms: Algorithms

Keywords: Genetic algorithms, multi-parent crossover, edge recombination, the traveling salesman problem

1. INTRODUCTION

Multi-parent crossover breaks through the convention of using two parents in crossover and has received considerable success in improving the performance of genetic algorithms (GAs) [1]. However, it still lacks effective multi-parent crossover for order-based GAs. In this paper we extend edge recombination [3] into multi-parent crossover as *multi-parent edge recombination* (MPEX) to enhance order-based GAs using edge recombination.

2. MPEX

The proposed MPEX allows more than two parents participating in edge recombination. To this end, the original edge table is extended by replacing the negative sign with a number indicating the occurrence times of a particular common edge. The table can then support the operation of edge recombination with more than two parents.

In this paper we present two variants of MPEX: MPEX-1 and MPEX-3. The former adopts the heuristic of edge recombination EX-1 [3] to select edges with priority for the isolating cities. Consequently, MPEX-1 always picks the cities holding fewest links in the process of building offspring tours. Another proposed crossover, MPEX-3, uses the heuristic of EX-3 [2]: giving a higher priority to frequent links than the isolating cities. The heuristic is implemented in MPEX-3 through the extended edge table to identify the frequent links. Note that 2-parent MPEX-1 and 2-parent MPEX-3 correspond to EX-1 and Ex-3, respectively.

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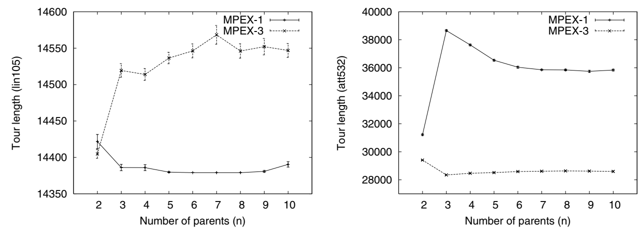

Figure 1: Mean best tour length for MPEX-1 and MPEX-3 using different numbers of parents

3. RESULTS AND CONCLUSIONS

The performance of MPEX is evaluated by experiments on two TSP instances: lin105 and att532. The setting of GAs is steady-state GA, order-based representation, 2-tournament selection, crossover rate 1.0, no mutation, 2-opt local search, worst-deletion survivor, and 50000 generations. Population size is empirically set to be the number of cities in the TSP. Each experiment includes 30 independent runs.

Figure 1 shows the superiority of MPEX over edge recombination in solution quality: The multi-parent crossover MPEX-1 outperforms EX-1 and MPEX-3 on the lin105; moreover, the solution quality improves with the number of parents in MPEX-1 using 2–9 parents. On the other hand, MPEX-3 using more than two parents outperforms EX-3 and MPEX-1 on the att532. The significance of the above-stated performance enhancement of MPEX on edge recombination is further validated by statistical t-test.

For future work, more experiments on different test problems are required to verify the versatility of MPEX. In addition, the computation cost of using more than two parents in MPEX and the effects of local search need to be considered.

4. ACKNOWLEDGMENTS

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5. REFERENCES

[1] A. Eiben. Multiparent recombination in evolutionary computing. In *Advances in Evolutionary Computing*, pages 175–192, 2002.

[2] K. Mathias and D. Whitley. Genetic operators, the fitness landscape, and the traveling salesman problem. In *Parallel Problem Solving from Nature II*, 1992.

[3] D. Whitley, T. Starkweather, and D. Fuquay. Scheduling problems and traveling salesman: The genetic edge recombination operator. In *Proceedings of the Third International Conference on Genetic Algorithms*, pages 133–140, 1989.