Controlled Content Crossover: A New Crossover Scheme and Its Application to Optical Network Component Allocation Problem

Mohammad Amin Dallaali and Malin Premaratne

Advanced Computing and Simulation Laboratory (AXL)
Department of Electrical and Computer System Engineering
P.O. Box: 35 Monash University, Clayton Victoria 3800 Australia
Amin.Dallaali@eng.monash.edu.au

Abstract. In this paper, a new genetic mating scheme called Controlled Content Crossover (CCC) is proposed and applied to solve the optical network component allocation problem. In order to solve the constrained optimization problem, CCC finds the selected set of the components with the minimum cost while it keeps the total dispersion value of the answer within a double-sided limit. The simulation results show that CCC finds the optimum answer matching closely with CPLEX solution.

1 Introduction

Increasing the number of search branches in the search and optimization problems, conventional methods fail to find the answer in finite time. On the other hand, evolutionary computation schemes such as Genetic Algorithms (GAs) show promising performances. Genetic algorithm which was initially introduces by J. H. Holland in 1975 is adopted from the natural evolution of the best-fitted offspring when it is selected over the consequent generations [1]. Real world projects are mostly limited to the boundaries and therefore, constraints optimization problems are one of the major challenges that genetic algorithms are dealing with. There are several constraints handling methods discussed in the literature. For example a group of methods tries to code the search points so that they reserve the feasibility of the strings during the iterations [2]. In this paper the genetic algorithm is applied to solve the commercially important problem on optical network component allocation. The aim is to find the optimum selection of optical components with the minimum cost subject to the constraint that the total dispersion values of the selected components do not violate a double-sided limit. [3]

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2 The Algorithm

The main body of the algorithm consists of iterative genetic processors. The randomly generated initial population is sent into the iteration part. The final stable result is obtained after the sufficient turns of iterations. Mating, mutation and selection are the three main genetic operators. Mating or crossover is totally redesigned. The new proposed method is a bit-wise exchange phase that distributes the bits of the parents' string over the offspring. In the simulation, two parents are mated with each other and two offspring are obtained. The logic behind the distribution is that it tries to allocate the bits of parents to the offspring so that the total dispersion values of the obtained offspring maintain to be as equal as possible. In order to perform the process, there is an ordering phase before the crossover. The bits of strings are ordered based on the dispersion value that each of them contributes to the total dispersion value of the string. Therefore, a bit that represents a larger dispersion value is ordered with a higher rank. Afterward, the exchange phase starts and the first bit of the parents are randomly allocated to the offspring. For the next exchange turn, the total accumulated dispersion value of the offspring is calculated and the bit of the parents with the less dispersion value is allocated to the offspring that has more total dispersion value up to the previous exchange turn. This is of course intended in order to fairly distribute the dispersion values of the parents over the offspring.

3 Simulation and Results

A sample test data set consisting of 80 component types was used for the simulation. Figure 1 shows the convergence of the cost value over 200 iterations. It also compares the final stable value with the answer obtained from CPLEX software. The total dispersion values of the strings are shown in figure 2. For the last turns of iterations where the algorithm is in the steady state phase, the total dispersion values of the offspring are between the dispersion boundaries set up in the simulation.

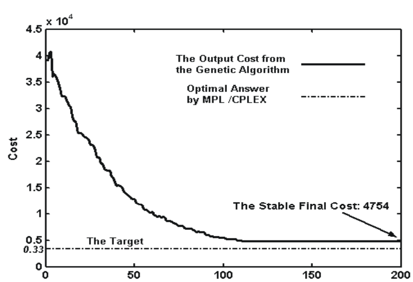

Fig. 1. The cost

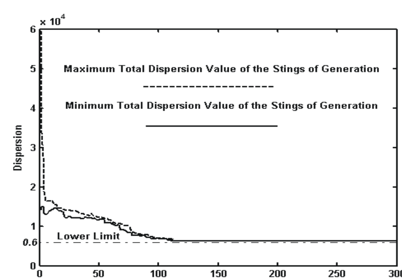

Fig. 2. The dispersion value

4 Conclusions

A new crossover scheme called Control Content Crossover (CCC) is proposed to solve the optical network component allocation problem. CCC is designed to perform the genetic crossover so that the total dispersion values of the obtained offspring fall into the constraint band. At the same time the algorithm finds the optimal solution that is the set of components with the minimal cost. The results showed that the performance of CCC is comparable with the result obtained by CPLEX and it fully satisfies the constraints.

References

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