스키마 추출 기법을 이용한 최적화 문제 해결

Solving Optimization Problems by Using the Schema Extraction Method

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Abstract : In this paper, we introduce a new genetic reordering operator based on the concept of schema to solve optimization problems such as the Traveling Salesman Problem(TSP) and maximizing or minimizing functions. In particular, because TSP is a well-known combinatorial optimization problem and belongs to a NP-complete problem, there is huge solution space to be searched. For robustness to local minima, the operator separates selected strings into two parts to reduce the destructive probability of good building blocks. And it applies inversion to the schema part to prevent the premature convergence. At the same time, it searches new spaces of solutions. Additionally, the non-schema part is applied to inversion for robustness to local minima. By doing so, we can preserve diversity of the distributions in population and make GA be adaptive to the dynamic environment.

Keywords : genetic algorithm, schema, schema extraction method, optimization

I. Introduction

In the optimization problems, we find out the best way that solves given problem under the restricting conditions. In many cases, the optimization problems are represented in the form of cost functions. Solving the optimization problem is finding out the minimum cost: solution minimizing the cost function at the same time satisfying all the conditions.

Given N cities and distances among them, the goal of the Traveling Salesman Problem (TSP) is to find an ordering of cities that makes the shortest tour for a virtual salesman to traverse each city only once and to return to the city from which he started. TSP is a representative combinatorial optimization problem and belongs to a class of problems known as NP-complete[1]. It minimizes the tour length a salesman travels but the number of possible tours existing in the search space of solutions increases exponentially as one city is added. In TSP case, the restrictions are i) traversing all the cities, ii) visiting each city only once, and iii) returning to the starting city. And the cost function is total distance among the cities which the virtual salesman traversed.

The various researches have been carried out to find near optimal solution. Simulated annealing[5] executes iterative global search to solve TSP according to the schedule of the temperature transition and cooling rates. The Hopfield network[4] defines neurons as cities and minimizes the energy function inducted from the constraints of TSP by recall process. Genetic Algorithms (GAs) search the space of solutions by producing more offsprings whose parents have higher fitness values, based on the mechanics of natural selection and natural genetics[2, 3].

GAs, first invented by John Holland, mimic the mechanism of biological evolution. They select good strings of chromosomes, i.e. ones with higher fitness to the environment or given problem, then produce better offsprings by genetic operators: reproduction, crossover, and mutation. Reproduction has good parent strings bear more children than others, crossover mixtures the good parts of parents to reproduce fitter offsprings than those of former generations. Mutation protects from losing some potentially useful genetic material, so that it provides possibility to find the optimal solution and the variety of population preserved and improved. Each strings in population is regarded as one search point in the search space. As generation goes, the initial population evolve in the way to contain solutions close to optimum. Although GAs have simple structures, they show the powerful performance over the other algorithms. Holland explained this through schema theorem: short, low-order, above-average schemata receive exponentially increasing trials in subsequent generations. Until recently this theoretical foundation was the basis of almost all subsequent theoretical work on genetic algorithms.

In general TSP with GAs, the order of visiting cities is represented as chromosome and an allele's meaning is position-independent. Therefore, crossover and mutation, the basic operators of the simple GA, cannot be used because they will destroy the important orderings with high probability. For this reason, a lot of new GA operators were introduced: inversion, partially matched crossover(PMX), order crossover(OX), cycle crossover(CX), etc. We call them reordering operators in general. Their performances vary along

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