Improved Genetic Algorithm for Optimizing TSP Problem

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Abstract. Based on the analysis of the existing characteristics of genetic algorithm and traditional genetic algorithm in the problem, proposed to solve the traveling salesman problem by genetic algorithm framework, constructing appropriate to establish effective genetic operations (Traveling Sales man Problem) method for the TSP problem, through to the population size, the number of iterations, the crossover probability and mutation the probability of selection, the final verification of the superiority of the improved genetic algorithm in the optimization problem in TSP.

Introduction to Genetic Algorithms

Genetic Algorithms (GA) was born in the late 1960s to the early 70s, Mainly by Professor Holland and colleagues and students at Michigan University in the United States, in the design of artificial adaptive systems, the groundbreaking use of natural evolution principles, search mechanism generated ideas, The research work in the future, the formation of the theory of algorithm \cite{1} is a complete, he published his famous book” Adaption in Natural and Artificial Systems” in 1975, the foundation for the development of genetic algorithm and establishes the perfect. It attempts to explain the complex nature system, from the biological adaptive process, to simulate the biological evolution mechanism, and to construct the artificial system model. At the same time, Professor Holland student De Jong for the first time the application of genetic algorithm in function optimization, genetic algorithm is designed to implement strategy and performance evaluation index, he selected 5 special function for genetic algorithm numerical experiment is still in frequent use, he on-line and off-line index are still the main means to optimize the performance of genetic algorithm.

The genetic algorithm using relatively simple encoding technique, simulation of biological reproduction mechanism, the complex phenomenon of problems by encoding the formal description of our group search strategy was used to exchange information, it does not require the continuity, the existence of derivative and unimodal hypothesis and so on, are not subject to restriction of the search space. With the development of artificial life science, genetic algorithm has been paid more attention.

At present, genetic algorithm has been widely used in machine language learning, optimization, parallel processing and other fields.

Characteristics of Genetic Algorithms

Genetic algorithm (GA) is a general algorithm \cite{2} for solving search problems. It is applicable to a variety of general problems. In addition to the characteristics of search algorithms, genetic algorithms also have the following characteristics:

(1) The genetic algorithm starts with the string of the solution of the problem instead of starting with a single solution. That is, the parallel nature of the genetic algorithm itself. This is the biggest difference between the genetic algorithm and the traditional optimization algorithm. The traditional
optimization algorithm solves the optimal solution iteratively from a single initial value, and easily goes into the local optimum. The genetic algorithm starts from the set of sets and covers a large coverage, which is advantageous to the global selection.

(2) The genetic algorithm uses encoding mechanism as the computing object. It is convenient to use genetic operators to solve the problem.

(3) The genetic algorithm does not use the knowledge of searching space or other auxiliary information, and only uses the fitness function value to evaluate the individual. It only needs the object function and the corresponding fitness function that influence the search direction. The fitness function is not subject to continuous differentiable constraints, and the domain of its definition can be arbitrarily set. This feature extends the range of applications of genetic algorithms.

(4) It has the characteristics of self-organization, self-adaptation and self-study. The genetic algorithm based on evolutionary process to obtain information (e.g., encoding scheme, fitness function and genetic operators) organized search, individual survival probability has high hardness, and can adjust the rules and characteristics of the problem itself according to the changes of external factors.

(5) The genetic algorithm deals with multiple individuals in the swarm, that is, evaluating multiple solutions in the search space, reducing the risk of getting into the local optimal solution, and at the same time, the algorithm itself is easy to implement parallelization.

(6) The genetic algorithm does not use deterministic rules, but uses probabilistic transition rules to guide his search.

Defects of the Traditional Genetic Algorithm

Although the genetic algorithm has many advantages, but from the computer simulation analysis results, there are still some problems [3]. Such as:

(1) The scaling method of fitness value can be diversified, and there is no concise and general method to the application of genetic algorithm.

(2) Premature phenomenon of genetic algorithm.

(3) When it approaches the optimal solution, it swings around the optimal solution and converges slowly.

Genetic algorithms usually need to solve the following problems, such as determining the coding scheme, the fitness function scaling, the selection of genetic operations, and the related control parameters. Aiming at some problems have appeared in the traditional genetic algorithm and the insufficiency, usually on genetic algorithm, the basic way summed up as: the composition change of genetic algorithm or the use of technology, such as the selection of the optimal control parameters, suitable for the problem of encoding technology; using nonstandard genetic operators.

Improvement of Genetic Algorithm

Aiming at some problems of traditional [4] genetic algorithm shown in solving the TSP problem, such as the best individual in the genetic operation and the generation of easy to be replaced or eliminated by the loss that cannot be reserved the best individual, leading to unnecessary repetition of the iterative process. In addition, there are some defects in the selection of each operator in genetic operation, which may destroy the superior individual model. When the population showed better individual mode, is toward the optimal solution of evolution, and genetic operator improper selection may cause damage to the entire population evolves toward the non-ideal direction, there may be into the local optimal solution[5]. In view of the shortcomings of the genetic algorithm in solving the TSP problem, this paper attempts to solve the TSP problem with the idea of improved genetic algorithm from the retention of the optimal solution and the transformation of the relevant genetic operators.

The improvement process can be described as chart 1:
Through the improvement of genetic algorithm, namely in the selection or before after the current state of preserving the best solution, one can converge to the optimal solution, many algorithms theory can prove that the improved genetic algorithm can converge to the optimal solution, but the convergence to the optimal solution the time required may be quite long. In addition, the premature convergence problem in the algorithm cannot be ignored, showing [6]. The improved genetic algorithm adopts the following methods to solve it:

(1) In the process of mutation, we cannot simply change a certain gene; otherwise it will make the change have no actual meaning. The solution is to generate two random numbers in an individual according to the probability of variation, to determine the switching positions, to exchange the genes of the two positions, and to achieve the effect of mutation operation suitable for the problem environment. Gene reversal operations that alter the operation of the mutation can prevent the fine genes from being destroyed by mutations, and introduce new genes into the population when they are trapped in local optima.

(2) Improvement of selection methods. On the choice of Roulette is improved to avoid genetic manipulations in the early high fitness individuals quickly occupy the whole population, and progress in the late in the population because of the individual fitness between the difference and cause the entire population to stop the evolution; selection in roulette in the traditional way, every individual will get the chance to replicate itself, so the competitive advantage is not reflected, will not be achieved in genetic algorithm the principle of survival of the fittest. To solve this problem, a selection algorithm based on the individual fitness of population is used to keep the best individuals of each generation and can be directly entered into the next generation.

Based on the above analysis, the main body of the improved algorithm is described as:
In the initial population, all individuals are sorted according to their fitness, and then individual support and confidence [7] are calculated;

Retain the best individual (or optimal proportion) directly to the next generation;

Mutation according to gene reversion. The advantage of this algorithm is in every evolution process of the generation of offspring, always retain the best individual parent, as in the "high fitness model ancestry direction search better so as to ensure the final sample, you can search the global optimal solution.

Conclusion
By changing the selection mechanism and the mutation method, the optimal individual progressive process is maintained, and the iterative evolution is carried out without destroying the optimal model. When solving the problem, the convergence of the optimal solution is affected by the size of the group, the number of iterations, the cross probability and the selection of the mutation probability. Through the improvement of the genetic algorithm, we can see that the operation of the improved genetic algorithm is optimized in the target solution, and the search efficiency is improved.

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Reference