Research of using Genetic Algorithm of Improvement to Compute the Most Short Path

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Abstract—**The genetic algorithm is a computation model that simulats Darwin's genetic selection and the natural selection organic evolution process. Its thought stems from the biological genetics and the survival of the fittest natural law, and has "the survival + examination" iterative process searching algorithm. As one kind of new global optimization searching algorithm, the genetic algorithm by its simple general, robustness strong, is suitable for the parallel processing as well as highly effective, practical and so on outstanding feature, it obtained the widespread application in each domain, has obtained the good results, and becomes one of gradually important intelligent algorithms. This article makes the improvement to the original genetic algorithm, and uses the C++ language to realize, through to the TSP question's test experiment, after obtaining the improvement the result, the effect is very good.**

Keywords-Genetic Algorithm ; selection ; crossover ; mutation ; Genetic Algorithm of Improvement

I.   INTRODUCTION

The genetic algorithm (Genetic Algorithm) is one kind of random reconnaissance methods which comes from biosphere's evolution rule (survival of the fittest, superior win and the inferior wash out heredity mechanism) . In 1975, it was proposed firstly by US's Professor J.Holland . Its main feature is as follows, operating directly to the structure object, having no derivation and function continuous definition; Having the intrinsic hidden parallelism and better optimization ability of overall situation; Using the optimization method of randomization, It can gain and instruct the optimized search space automatically . Furthermore,it can adjust the search direction auto-adapted that does not need to determine rule. The genetic algorithm takes all individuals of one population as an object, and uses the randomisation technology to carry on highly effective searching the parameter space which is coded . The genetic algorithm common operations are constituted of the selection, crossover and the mutation ; The code of parameter, the initial community's hypothesis, the fitness function's design, the heredity operation design, the controlled variable are five essential factors about the genetic algorithm central content . These characters of Genetic algorithm have been widely applied by the people in the domains of the combination optimization, machine learning, signal processing, adaptive control and artificial life and so on

.It is one of the most key technologies of the modern intelligence computation .

II.   THE ELEMENTARY OPERATION OF GENETIC ALGORITHM

The genetic algorithm is simulates Darwin's genetic selection and the natural selection organic evolution process computation model. Its thought stems from the biological genetics and the survival of the fittest natural law, has "the survival + examination" iterative process searching algorithm. The main feature of the genetic algorithm are as follows, operating directly to the structure object, did not have the derivation and the function continuous definition; Has the intrinsic hidden parallelism and better optimization ability of overall situation; Uses the optimization method of randomization, It can gain and instruct the optimized search space automatically , furthermore,it can adjust the search direction auto-adapted that does not need to determine rule. The genetic algorithm take all individuals of one population as an object, and using the random technology to carry on highly effective searching the parameter space which is coded . The genetic algorithm common operations are constituted of the selection, crossover and the mutation ; The code of parameter, the initial community's hypothesis, the fitness function's design, the heredity operation design, the controlled variable are five essential factors about the genetic algorithm central content .

A.   Selection

The operation that selects the superior individual from the community and the eliminate inferior individual is called the selection. Sometimes, it is called reproduction operator. The goal of selectionis producing the optimized individual the immediate heredity to the next generation or producing the new individual to inherit again alternately to the next generation through crossover of the pair. The choose operation is based of fitness appraisal of the individual in the community , at present ,the commonly uses of choose operator are as follows: fitness proportion method, stochastic traversal sampling method, partial trial-and-error method, partial trial-and-error method.

And roulette wheel selection is the simple and the most commonly used selection method. In this method, it becomes the proportion between each individual's selection probability

and its fitness value . Supposes the population size is n, the individual i fitness is f i , then the probability of the chosen is $p_i = f_i / \sum_{j-1}^{n} f_j$. Obviously, the probability had reflected the the proportion whose individual i fitness occupies in the entire community's individual fitness sum total.The individual fitness is bigger, the probability of selectionis higher. After calculating selection probability of each individual of the community , in order to choose the copulation individual, sometimes, it needs to carry on the multi-wheel selection. Each round will produce a even random number in [0,1] , according to the indicator this random number ,it will achieve to determine to selection which individual. After the individual chooses, random composes the copulation , supplies to the following interlace operation.

B. Crossover

The biology molecular genetic reorganization is playing an important role in nature organic evolution process . Similarly, The crossover operator which is key section of the operation of inherits in genetic algorithm. Crossover is an operation that produces new individual through reorganizing partial structures of two father generation of individual . Through crossover, the search ability of genetic algorithm will be risen in a large scale.

One-point crossover is a crossover operator which is always used in the genetic algorithm. The concrete operations are as follows: Establishes an intersection stochastically in the individual string, when implements crossover, carring on the exchange the two individual's partial structures after or before this spot , finally ,producing two new individuals.

C. Mutation

At first ,it will select an individual from the community randomly, and change the data of some string value in the selected individual randomly by certain probability. Looking like the nature , the probability of the mutation happened in the genetic algorithm is very low, the value is usually set between 0.1%~0.8%. The mutation provides some opportunities to the production of new individual .

D. Code

According to the concrete question, the code is ready for the solution through describing the question by one kind of expression .The code is the premise of the genetic algorithm that is carried on the operation . The way of code has many kinds as follows: the binary system, the decimal system, the floating number code and so on. Before carrying on the solution , it will express the solution data of solution space to genotype's syntagma data of the heredity space with the predetermined code , these different combination of syntagma data are constituted the different spot.
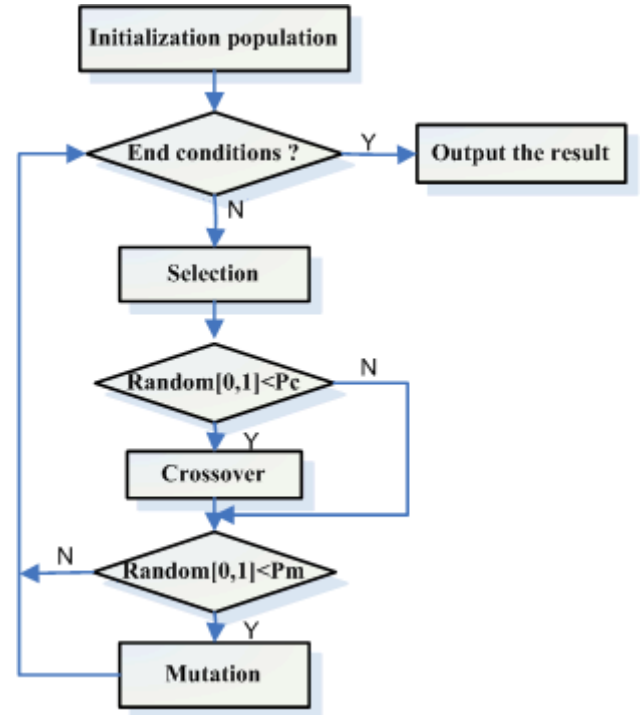
E. Fitness

The fitness is individual or the solution fit and unfit quality . The different questions, the fitness function's definition mode is also different. The fitness function has the following two kinds:

(1)When the objective function is the question which is asked for the maximum value, transforming the objective function of waiting for the solution to the fitness function directly;

(2)When the objective function is the question which is asked for the minimal value , adopting to "boundary structure law", but this method will possibly cause some questions of estimating difficultly of the threshold quantity and impossible precise in advance.

### III. THE COMPUTATIONAL PROCESS OF GENETIC ALGORITHM

First, according to special details of the question, choosing the appropriate encoding method, producing the initial group, computing the compatible value of initial community; if does not satisfy the condition to carry on the selection, crossover,mutation, and calculate the compatible value of the new generation community again , until satisfies the condition. The close condition might act to choose according to the concrete term, for example ,it can take certain the number of generation as the termination condition, and it also can take difference of the two generation of between fitness be smaller than some fixed value as the termination condition.

IV. THE GENETIC ALGORITHM OF IMPROVEMENT

At first, sorting the fitness from high to low to the old individual , and choosing half of the individual to enter the copulation pond, to participate crossover and carry on mutation operation. After computing the fitness of the new community , it carries on sorting the fitness from high to low again to the current new and old individual according to the fitness value,and retaining the high fitness popsize individual to the next generation.

Before each generation carries on the pair , it will sort at one times. According to the gene block supposition, the individuals of two high fitness have the possibility to produce the fitness night-watch high individual alternately. After the sorting, it may enhance the crossover operation alternately the efficiency. Thus it raises the restraining speed . The figure of evolution flow is as follows:
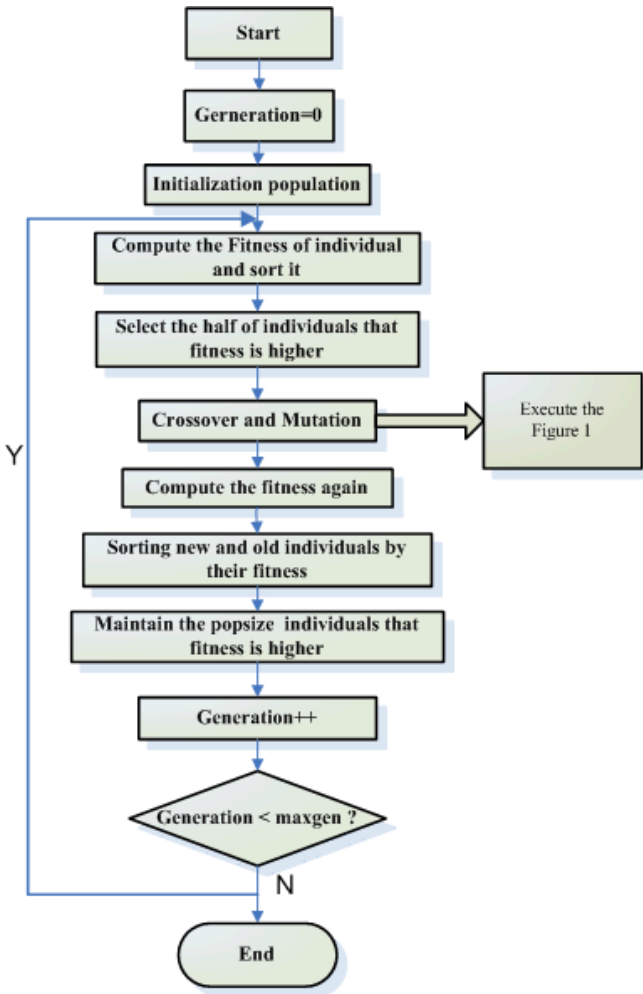
V.   A TEST OF EXAMPLE

A. The selection of experiment

Travelling Salesman Problem is one of the famous questions in mathematics domain. The supposition that a commerical traveller needs to visit n city, he must choose the way which he wants, the limit of pass is that each city can only visit one time, furthermore,he must return to the city which is the first. The goal of selection is the way that is minimum value in all ways.

The author achieved the genetic algorithm of improvement with the C++ language to solve the question of TSP . The object of test is the question of TSP of 31 cities . Through setting the parameters as follows: the length of chromosome, the scale of population, the probability of crossover and the probability of mutation and so on, has achieved this genetic algorithm of improvement successfully and obtained the very good result.

1)   The hard and software environment of this test :

CPU	Memory	Operation System
Pentium4 3.06GHz	512M	Windows XP Professional sp3

2)   The selected parameter of this test :

Probability of crossover	Probability of mutation	generation	population
0.8	0.01	10	300

B. The result of this Test

Inputing the coordinates of 31 cities to the procedure, and giving each urban a number separately, the serial numbers are as follows: ABCDEFGHIJKLMNOPQRSTUVWXYZabcde. After running ten times , evolving 100 generations , we have obtained a shortest path, the sequence of this path are VUTXYZbadecAONLMGJIHBDPEFKWSQCR . The length of the shortest path is 15382.5km, the run time is 37.82s. Comparing with other literature, we have achieved a very well result. The result figure of this program which has run is as follows:

VI.   CONCLUSION

Through improving the genetic algorithm, and setting the reasonable parameter of experiment, finally, we have obtained a very good traversal city sequence , a relatively ideal path which is the shortest . Comparing with the former literature, the genetic algorithm of improvement has the quite tangible effect, but it also has some fitness ,for instance,in the aspect of run time . Meanwhile, the Paralle Genetic Algorithms is just enough to solve the speed question of the genetic algorithm . The Paralle Genetic Algorithms combines the high speed

Parallelism of parallel machine and the natural parallel of the genetic algorithm to union, and enhances the solution speed of the population . Because of expanding the population scale and isolating each sub-population, The Paralle Genetic Algorithms is able to maintain the abundant and various population , reduce the possibility of immature restraining , and improve the solution quality largely . Therefore , we will continue to make effort to improve and achieve the Paralle Genetic Algorithms.

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