ISSN : 0974 - 7435 Volume 10 Issue 9

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(9), 2014 [3670-3678]

The genetic algorithm optimize computing applications in computer network reliability analysis

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ABSTRACT

With the continuous development of the times and network technology continues to improve. Among the current areas of all walks of life computer networks has become a major tool of work, how to be able to once again raise the existing foundation on the face of the reliability of the computer network, which is a lot of people are concerned about the problem. With respect to the conventional algorithm, the genetic algorithm itself has Solving convenient, fast search also the algorithm itself is relatively simple structure, etc., and even when the global calculated to obtain optimal approximation. The main task is to maximize the improvement of the reliability of the network. In the course of the study of this problem, how to be able to reduce the total cost of the network link conditions so that the reliability of the network becomes higher, this issue has no doubt become a network designers as well as users are most concerned about the focus, if the breakthrough must be able to bring great benefits. Therefore, under these two premises in the computer network link media costs as well as network reliability teaching model factors in order to practice the way of computer network reliability optimization calculation reform, genetic algorithm is applied to which achieved good results in this paper.

KEYWORDS

Genetic algorithm; Computer network; Reliability optimization computing; Applications.

INTRODUCTION

Computer network technology in today's technological development as well as the perfect society, which is becoming increasingly popular, it is beyond the people can be expected to speed development Various fields which have not be able to lack of computer the auxiliary network technology support, also led to the nodes of the network users is constantly increasing trend in network size increases constantly inevitably lead to the network itself to become more complex and difficult to defense. At the same time this gate technology for computer network also increasingly dependent, if the computer network system is faulty, then it will definitely lead to a huge loss, such loss is sometimes not able to measure. Under such an environment, the reliability of the network itself is the comprehensive performance of the entire computer network system itself, one of the most major evaluation criteria. The reliability of computer networks are also known as is the availability of a computer network, and English as the Availability, the present meaning of the computer network which have a spanning tree it itself has much possibility of its own for the computer network between different users can ensure connectivity plays an important role in the parameters These parameters are a measure of mainly includes the following aspects: the network connectivity, survival, anti-destructive, as well as under a variety of modes, the network element itself effectiveness problems. To solve the reliability of computer networks to optimize the calculation of this problem and then solved using traditional methods already outdated, because this technology is difficult to cope with such a complex problem of the optimization of NP. In order to be able to be a better solution to this phenomenon, some scholars proposed genetic algorithm, computer network reliability optimization design, and the plan has been achieved, and achieved good results in the practical application of them[1].

A BRIEF ANALYSIS OF THE RELIABILITY OF THE CONCEPT OF A COMPUTER NETWORK

Under a certain operation, the load as well as temperature and humidity, and maintenance mode environment, the computer within a certain time can Unicom network, and also to ensure the ability of the communication of the network itself, which is called the reliability of computer networks. The development of its own system to the now considerable scientific and complete and constantly replenished than half a century of time as well as the development of, and even now has been regarded as a system engineering sciences[2].

Computer network reliability, in general, are divided into three different types: (1) α-terminal reliability: There is at least one be able to run normally link between developing Meeting Point and the development of a source point, so the probability is also called α terminal reliability; (2) γ terminal reliability: for the specified γ-by point, the collection of which they are constituted has the presence of the normal link, so that the probability of known as γ terminal reliability; (3) terminal reliability: two arbitrary points, which all have the presence of a normal link, this probability is called full terminal reliability. In addition, the parameters for the normal operation of computer network support to include computer network structure, the structure in which the running of the computer network, is an extremely important one of the parameters[3].

PROBLEM DESCRIPTION

First, the mathematical diagrams are available in the computer network FIG G = (N, L). As portrayed basis to this, and which in the diagram, between two random nodes, are not able to exist more than one direct link; Second is we want to be clear: the reliability of the network link media, this with the media itself and the length does not matter; network node in the network, which itself does not have any problems, that is the source of the fault lies not in the network node; final network as well as its link

itself only the existence of two states, that is the normal state and fault state, and their failure occur, there would be no impact.

$$C_0 = \begin{bmatrix} c_{11}\, c_{12} \ldots c_{1n} \\ c_{21}\, c_{22} \ldots c_{2n} \\ \ldots \ \ldots \ \ldots \ \ldots \\ c_{m1}\, c_{m2} \ldots c_{mn} \end{bmatrix} \quad \textbf{(1)}$$

On the left which indicates the network link is the hypothetical medium cost matrix, where C_0 is the cost matrix C_{ij} is one of the junction points, where in either i or J, their own values are not greater than or equal to 1, $i \le m, j \le n$, this is the cost of the medium of the link between them[4].

$$\begin{aligned} &Min\, c = \sum_{i=1}^{N} \sum_{j=1}^{i} c_{ij} g_{ij} \\ &s.t.\ D_i \alpha_{ij} \le \alpha \,(i, j = 1, \cdots, N) \\ &\sum_{j=1, j \ne i} g_{ij} \ge \beta \left(i = 1, \cdots, N\right) \end{aligned} \quad \textbf{(2)}$$

The first formula in the picture on the left is the network link which in this paper the mathematical model of the media costs. Article II above, there is a third of the formula which $g_{ij} = 1$, when, to prove that there is a direct link between the settled point i and node j if $g_{ij} = 0$ when said node and no direct link between i and node j. Among the above formula, C represents the total cost of the entire network and N said the network summarizes points, D_{iaij} this represented each node i to another node j, logical shortest chain road number of media, represented by α and β is the constraint length of the reliability of network nodes. Which itself has its own meaning, and the role played by them in this model is very important[5].

$$R_0 = \begin{bmatrix} r_{11}\, r_{12} \ldots\ r_{1n} \\ r_{21}\, r_{22} \ldots\ r_{2n} \\ \ldots \ \ldots \ \ldots \ \ldots \\ r_{m1}\, r_{m2} \ldots r_{mn} \end{bmatrix} \quad \textbf{(3)}$$

The left of the formula which represented the reliability of the network link medium matrix. Is indicated in the beginning of R_0 Reliability matrix, and r_{ij} is between the node i node j they link medium itself exists reliability. Wherein either i or j, their own values are not greater than or is equal to 1, and $i \le m, j \le n$.

In this model, G = (N, L), it may be a subset of L which can be in the normal state, the subset is within the L range, all of the nodes to be in the normal the reliability of the state, we can build a mathematical model shown in this model as shown below[6].

$$R=\left|\sum_{\Omega}\left|\prod_{i\in L'}P(l_i)\right|\bullet\left|\prod_{i\in(L/L')'}(1-P(l_i))\right|\bullet\prod_{i=1}^{n}P(n_i) \quad (4)$$

GENETIC ALGORITHM

The concept of genetic algorithms

The so-called genetic algorithm is a relatively new algorithm, genetic algorithm has become better and better through continuous expansion and development. It is built on the basis of the biological mechanism of natural selection and genetic. In nature, genetic and evolutionary process of biological, which was simulated by genetic algorithms, population search also the exchange of information between different individuals, on the mouth in such a manner to a bit to search, and so create a globally applicable optimization search. The genetic algorithm itself has a very prominent globally its own operation is not complicated, and it is still quite significant advantage is that the search will not only be able to parallel performance among groups search, this advantage is determined by its complex problems above has a lot of potential[7].

To apply the genetic algorithm, the first thing to do is to establish a scientific coding scheme, which is encoded sequence as a chromosome. Coding elements of these components is what we call genes. Followed by random manner, creating an initial set of chromosomes, the chromosome is the initial population[8].

Then do fitness operator, selection operator, crossover operator and mutation operator respectively according to their coded information and their own circumstances. Them to be constantly in the computation process is repeated in accordance with this operation mode the iterative calculation, in order to allow generating the result of the stopping criterion is met, to obtain the optimized individual. Note that in the process of the application of genetic algorithms often set the fitness value so that it can become a function of overall satisfaction, which is to meet the requirements of customers, the highest overall satisfaction backbone design, so that we can get the result is the most optimized[9].

Application of genetic algorithms advantage

Between each node, the routing is how to select the best, and assigned each a link between the capacity problems, this has always been a computer network optimization process which must be noted that two key points. Note in the design process is how to be able to meet the performance indicators have been identified at the same time, and also allows the maximum degree of reduction of the cost of the network consumption has been obtained under conditions of the network topology as well as the exchange of energy, link capacity also between the node routing design, this has become a computer network that we acknowledge the core focus of the optimal solution. Use genetic algorithm to automatically search time, based on the objective function as a starting point, in terms of global adaptation based on the probability standards as the basis. By optimize the parameters of the project itself as well as the nature of the impact of the low probability of the guidelines form structural model of the constraints of the genetic algorithm is infinitely close to zero, so the genetic algorithm can well solve some NP-hard above the problem and in this aspect that controls the reliability can be very wide range of applications[10].

Genetic algorithm has five major components of gene expression, to determine the initial population, accounting genes suitable numerical, crossover and mutation genetic operator selection operator, also called evolutionary computing, these fivea part of the concept of genetic algorithms, in binary units encoded as a means to determine the entire network of genes, to design individual costs for which the entire population in descending order, to make it into an effective function, so the role of timely and effective prevention of fraud occurs. Choose when to make the choice probabilities of each gene and its appropriate value to become directly proportional to this wheel choice thinking is correct, by the cross operation, so that the entire network communication can be maintained in good standards.

All in all is the most important role of genetic computing in computer network optimization process which is capable of virtue precision of the computation itself convenient, to become its most obvious advantage. To sum up, the advantages of the genetic algorithm is as follows:

Very fast and convenient NP-hard problem to solve, this feature makes it in terms of the reliability of the computer network of a wide range of applications and gradual promotion; flexibility and reasonable use of the multi-operator, then as a means of computer binary units encoded network gene production in order to achieve the prevention of computer fraud incidents; choose the way of thinking is to let the probability of selection and the appropriate value for each gene can be proportional to the wheel, so to be able to guarantee the network under the crossover operation run communication status[11].

Arbitrary individual L + N number of the gene; the N genes after which the switching equipment is mainly corresponding to each other and the presence of N nodes in the computer network; thus connecting medium and exchanging the type of equipment will be generated between the corresponding effect, front L gene area of {1,2,..., k} and then the N gene values is {1,2,..., m}.

The genetic algorithm Fitness

Because the computer network topology is one of the conditions we already know, the more common approach to the network topology preprocessing our current is backtracking algorithm, the benefits of doing so is that we can use to the state collection solving, which the process of evolution in the computer networks, this collection can enhance any program calculated reliability. At the same time, it allows groups which exist in feasible solutions, and it is quite necessary things:

Because in normal circumstances a viable solution as well as a non-feasible solution will be able to constitute the optimal solution in which the boundary of the feasible region; But the current situation is not completely effective means to ensure that the offspring of two feasible solutions is also feasible[12].

The determination of the initial population as well as the appropriate value calculation

Among the respective nodes to the concurrent execution of the way, and thus be able to interfere with each other produce their own initial population. With respect to a large populations are generated by the same processor and then be assigned in a random manner, this junction point allocation even more time-saving, it is possible to effectively improve the efficiency.

The groups which the individual cost is only carried out arrangement, in descending order, we were able to obtain the appropriate value of the function is as follows: f (x) = (X-1) / (PoP-size-1); Among this function, X represents each position of the individual cost sort which smallest here, the individual cost of the sort code is a 1; PoP-size indicates the maximum costs of the individual sort Code[13].

The genetic operator as well as the evolution of computing

The most major computing in genetic operators is the crossover and mutation algorithms. Operation mode is in the so-called crossover within the scope of the nodes in the network, that is {I, N]} between generates a corresponding random number to implement the operation of the gene cross position of each node, and each time only for one position to be carried out, such an approach can let the original network connectivity save the maximum extent, the disadvantage is that there may appear wrong structure of network connectivity, so you want to continue to be adjusted according to the actual situation[14].

The first thing to do is to confirm the mutant genes and their number, then, within the selected range, a new gene fragment to be selected. The gene fragments elected to replace the old gene fragments, then the offspring generation. Probability of gene mutation offspring generated in this way is

usually in between 0.001-0.01, but there are special circumstances occur, because the mutation the wrong network connectivity structural gene, you need to be adjusted according to the actual situation.

$$P_k = f_k / \sum_{j=1}^{P_o P} f_i \quad \textbf{(5)}$$

The left of the figure is the evolutionary computing formula, in this formula, which must ensure that the selection probability of each gene, and it corresponds to the appropriate value is proportional relationship. In this formula, pk expressed by a gene selected probability fk is represented by the appropriate value of the gene.

The final step is to adjust the algorithm in the process of adjustment, the first thing to do is to judge each of the expression of the gene itself. The judgment object is the structure of the network connectivity. g_{ij} visit, if it is equal to 1 then the original cross there mutation operation, if it is equal to 0 then it is equal to 1. Still does not operate after making such a change can be performed, it is necessary to jump to the above judgment step in front of each gene expression is the structure of the network connectivity, the continuous loop until able to achieve so far[15].

The genetic algorithm solving process

Begin
T ← 0
Initialization p (t)
Rate p (t)
While termination condition is not met do
Begin
The recombinant p (t) to obtain c (t)
Assessment of c (t)
Is selected from p (t) and c (t) p (t +1)
t ← t +1
End
End

This solution process is the more common method, but it is also too slow convergence and convergence is not enough maturity shortcomings. To make the use of genetic operators becomes more convenient and effective, and the greatest degree of improve the reliability of the network optimization. Quantum computing integration into the genetic algorithm, genetic coding that there will be a quantum state vector can better exploit the advantages between calculating population diversity and global optimization capability further improved.

SPECIFIC GENETIC ALGORITHM DESIGN

Gene expression

In this document, it is mainly used is a binary one-dimensional coding method to determine which network gene N junction point. The traditional abdominal hysterectomy for N computer network design of node structure gene is shown as TABLE 1.

TABLE 1: The traditional abdominal hysterectomy for n computer network design of node structure gene

N_1	N_2	…
g_{11}	g_{21}	…

…	…	…
g_{1n}	g_{2n}	…

TABLE 2 : Schematic 4 computer network design of node structure gene

N1	N2	N3	N4
0101	1010	0101	1010

Now give a corresponding example, in the following TABLE 2 which are displayed is the four junction point between the gene expression of the network node. Schematic 4 computer network design of node structure gene is shown as TABLE 2. Schematic diagram of network structure of four gene nodes is shown as Figure 1.

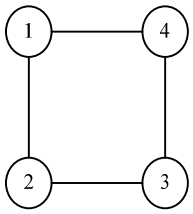

Figure 1 : Schematic diagram of network structure of four gene nodes

Evolutionary computing

Choose a runner, and the way the basic principle is to make each gene can choose to become proportional to the road with its own fitness value.

Genetic computing

Crossover operator, that is, each with a different network node between random node crossing method for computing, that is, [1, N] within this interval arbitrarily generated random number in order to be able to position each one gene cross has been recognized. Only for one position of the junctions can be crossed every time. In normal circumstances, the crossover rate Pc ε (0.01, 0.1). This article cites an example to help readers more in-depth understanding, shown as TABLE 3. First to cross node 3 position and it will have a new offspring generated, shown as TABLE 4.

TABLE 3 : The parent of genetic computing example

Parent 1	N1	N2	N3	N4	N5	N6
	010110	101100	010101	101011	100101	001110
Parent 2	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**
	010010	101100	011101	100111	100101	101110

TABLE 4 : The progeny of genetic computing example

Parent 1	N1	N2	N3	N4	N5	N6
	010110	101100	011101	101011	100101	001110
Parent 2	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**
	010010	101100	010101	100111	100101	101110

The crossover operation above has retained the original connectivity of the network itself at the maximum, but the probability of the wrong network connectivity structure is relatively large, so during the operation must seriously check found wrong time to timely correct.

Mutation operation, the first thing to determine is the mutated gene, and has produced a number of variants, as follows:

First, we first mutated gene Let x = [x1 x2... xk];

Followed randomly selected integer k specified ranges, and then be able to obtain the following results, and k ∈ [1, n], u ∈ [1, N], they generate offspring x '= [x1 x2...x'k... xk], in this which x'k is to have a certain range. In the above third step, if not able to realize the operation, and then go to the second step which.

Adjust the concrete steps of the algorithm

In the above, we have a rough adjustment algorithm is detailed examples are introduced.

Step one: The first thing to do is for all gene expression to judge these expressions all network connectivity structure we must be careful, otherwise an error occurs;

Step two: if gij is equal to 1, then we will be able to proceed with the original cross, then the mutation operation.

Step Three: If we find that the g_{ij} values at this time is equal to 1, then, then we need to do is to gij life to 0.

Step Four: If the above steps can not be smooth, and then go directly to step one and continue the cycle until the problem.

Simulation examples

Here we first simulate a computer network reliability optimization to calculate the actual case, is this above described mathematical model.

$$C_0 = \begin{vmatrix} 0 & 5 & 8 & 12 & 14 & 7 \\ 5 & 0 & 9 & 4 & 8 & 11 \\ 8 & 9 & 0 & 5 & 10 & 9 \\ 12 & 4 & 5 & 0 & 3 & 7 \\ 14 & 8 & 10 & 3 & 0 & 6 \\ 7 & 11 & 9 & 7 & 6 & 0 \end{vmatrix} \quad \textbf{(6)}$$

On the left is the model among network link medium cost matrix. This figure is the reliability matrix of the model.

$$C_0 = \begin{vmatrix} 0 & 0.98 & 0.95 & 0.99 & 0.999 & 0.96 \\ 0.98 & 0 & 0.97 & 0.988 & 0.996 & 0.99 \\ 0.95 & 0.97 & 0 & 0.96 & 0.95 & 0.998 \\ 0.99 & 0.988 & 0.96 & 0 & 0.93 & 0.92 \\ 0.999 & 0.996 & 0.95 & 0.93 & 0 & 0.97 \\ 0.96 & 0.99 & 0.998 & 0.92 & 0.97 & 0 \end{vmatrix} \quad \textbf{(7)}$$

Among the above model, the nodes of the network, N = 6 and the network node itself, the reliability constraint constant alpha compared 2 and β is also a 2 will be a total of 100 times of the genetic manipulation of the number of iterations. Then out of the results obtained through simulation

solving the medium total cost of the network link is 45 in this process, we are always able to ensure maximum network reliability in 0.885.

CONCLUSION

In this paper, the genetic algorithm is applied to a computer network reliability optimization calculation. The cost of the medium of the network link in a maximum degree of reduction, and the network reliability is increased at the same time. The algorithm itself has a simple operation and programming difficulty is not high, and has a good readability. This paper conducted simulation instance proved genetic algorithm to solve the computer network reliability optimization problems which exist in the calculations, you can know that it has great practical value in itself.

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