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A Review on Genetic Algorithm Operations and Application in Telecommunication Routing

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***Abstract*:** Genetic algorithm is a powerful tool and wide class of global optimization methods. It belongs to the large class of evolutionary algorithm and an efficient way to get optimal solutions. There is a large class of optimization problems that are quite hard to solve by conventional optimization technique but genetic algorithm (GA) is very efficient in that case too. Genetic Algorithm is used to solve many real world problems, some applications are as automotive design, Robotics, Optimized Telecommunications Routing, Biometric invention, Trip-traffic and Shipment routing, Computer gaming, Gene expression profiting, Marketing and Merchandising, etc. The main goal of this work is to solve the telecommunication routing problem by using Genetic Algorithm.

***Keywords*:** Genetic Algorithm, Telecommunication Routing, Optimization Technique, Evolutionary Algorithm.

I. INTRODUCTION

There are many optimization problems in telecommunication world, in particular LAN performance, internet access, which are complex to solve by conventional optimization technique [1]. There are many search techniques available for optimizing the solution. But Genetic algorithm is one of the most widely known types of evolutionary algorithm. It differs from a conventional optimization technique in two main ways (a) Genetic Algorithm (GA) generates a population of points at each iteration. The best point in the population approaches on optimal solution whereas in conventional algorithm generates a single point at each iteration. The sequence of points approaches an optimal solution [3]. (b) GA selects the next population by computation which uses random number generators whereas conventional algorithm selects the next point in the sequence by a deterministic computation [4].

John Holland introduced GA in 1960. In 1975 the book is published by John Holland & his colleagues, named as - Adaption in Natural & Artificial system. In 1980, Genetic algorithm was being applied to a broad range of objects. In 1992 John Koza has used GA to evolve program to perform certain tasks [2]. He called his methods genetic programming (GP). The basic idea of Genetic algorithm is borrowed from the biological process of survival & adaption. But the terminology is different in Genetics algorithm as compared to natural genetics system as shown in the table 1 below:

Table 1: Genetic Algorithm Terminology

BIOLOGICAL SYSTEM	GENETIC SYSTEM
Chromosome	String
Gene	Bit, Feature Or Detector
Allele	Feature Value
Locus	Position
Genotype	Structure, Coded Solution
Phenotype	Behaviour , Parameter Set

Genetic algorithm is an optimization algorithm that maximizes or minimizes the given function. The aim of optimization is to find that point or set of points in the search space [5].In genetic algorithm, a chromosome is a set of parameters that defines the solution of problem. These chromosomes are represented in the form of string.

A. METHOD OF REPRESENTATION

First, encode as binary strings: sequence of 1's & 0's where the digit at each position represents the value of some aspect of the solutions as shown in Fig.1. Second, approach is encoding solution as arrays of integers or decimal numbers. Third, approach is to represent individuals in a Genetic algorithm as strings of letters, where each letter again stands for a specific aspect of the solution [9].

0	1	1	0	0	0	0	1	1

Figure 1: Representation in Genetic Algorithm

B. METHODS OF SELECTION

Selection is the stage of a genetic algorithm in which individual genomes are chosen from a population for next generations (using cross over operator). A generic selection procedure may be implemented as follows:

1. The fitness function is evaluated for each individual, providing fitness values, which are then normalized. Normalization means dividing the fitness values of each individual by the arm of all fitness values, so that the sum of all resulting fitness values equal 1.
2. Population is sorted by descending fitness values.
3. Accumulated normalized fitness values are computed. Accumulated fitness values of an individual is the sum of its own fitness value plus the fitness values of all the last individuals should be 1, otherwise something went wrong in the normalization step
4. A random number R between 0 & 1 is chosen.
5. The selected individuals are the last one whose accumulated normalized value is greater than or equal to R [10].

C. METHOD OF REPRODUCTION:

Once selection has chosen fit individuals, they must be randomly altered in hopes of improving their fitness for the next generation. There are two basic strategies to accomplish this:

1. Crossover 2. Mutation

Genetic Algorithm Operators

Genetic operators is an operator used in genetic algorithms to guide the algorithm towards solution to given problem. There are mainly three operators (selection, crossover, mutation) which must be appropriately used for optimal solutions.

SELECTION

Selection is the operator mainly works at the level of chromosomes. Selection is one of the important operation in Genetic algorithm process. Different selection techniques works differently according to the situations. Correct technique has to be chosen for the specific problem to increase the optimality of the solution. There are many techniques under selection operator: -

A. Roulette Wheel Selection:

Roulette wheel selection is also called fitness proportionate selection. Conceptually, this can be represented as a game of roulette. Each individual gets a slice of the wheel, but more fit once get larger slice than less fit ones [11]. If it is the fitness of individual in the population, its probability of being selected is:

$$P_i = \frac{fi}{\sum_{j=1}^{N} fj}$$ Where, N = number of individuals in the populations.

B. Elitist Selection:

Elitist is the preservation of few best solutions of the population pool. Elitism is defined in percentage or in numbers. The core principle is to select all possible pairs among the best candidates.

C. Scaling Selection:

Fitness scaling converts the raw fitness scores that are returned by the fitness function to values in a range that is suitable for the selection function. The selection function uses the scaled fitness values to select the parents of the next generation. The selection function assigns a higher probability of selection to individuals with higher scaled values.

D. Hierarchical Selection:

In Hierarchical genetic algorithm, the chromosomes represents in a given tree. The coding scheme includes a node element and an object element as shown in Fig 2. Each chromosome represents:

1) An array of nodes, each node containing the index of the first child node and the number of its child node [6].
2) Array holds the assignation of each object [16].

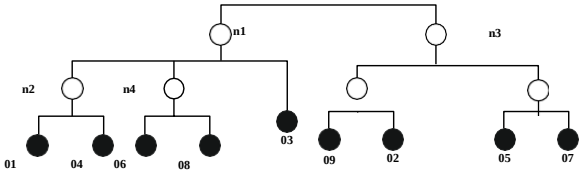


Figure 2: Hierarchical Representation in Selection Methods

E. Rank Selection:

Each individual in the population is assigned a numerical rank based on fitness and selection is based on this ranking.

CROSSOVER

Crossover operator combines 2 or more chromosomes to produce a new chromosome. So that, it may be possible the new chromosome is better than both of the parents.

Crossover Methods:

[1] **1 - Point Crossover:** 1- point crossover first selects two parents used for crossover and then randomly selects any crossover point [7].

Parent 1:	1 0 1 0 | 1 0 0 1 0	Parents 2:	1 0 1 1 | 1 0 1 1 0
Offspring 1:	1 0 1 0 | 1 0 1 1 0	Offspring 2:	1 0 1 1 | 1 0 0 1 0

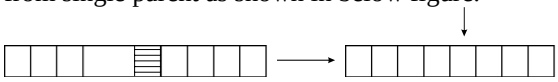
[2] **K - Point Crossover:** K - point crossover first selects the two parents used for crossover and then randomly selects the crossover point [8].

Parent 1:	1 0 | 1 0 | 1 0 0 | 1 0	Parent 2:	1 1 | 0 0 | 1 0 1 | 1 0
Offspring 1:	1 0 | 0 0 | 1 0 0 | 1 0	Offspring 2:	1 1 | 1 0 | 1 0 1 | 1 0

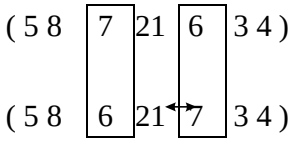
[3] **Uniform Crossover:** Uniform Crossover provides uniformity in combining the bits of both parents [14]. It performs these operations of swapping bits in the parents to be included in the offspring by choosing a uniform random real number [15]. Uniform crossover selects two parents for crossover :

Parent 1:	1 1 1 0 1 0 0 1 0	Parent 2:	1 0 0 0 1 0 1 1 0
Offspring 1:	1 1 0 0 1 0 1 1 0	Offspring 2:	1 0 1 0 1 0 0 1 0

MUTATION: Mutation is one of the powerful operator to generate next generation. It is like generating new offspring from single parent as shown in below figure.



In mutation, the solution may change entirely from the previous solution. Hence GA can come to a better solution by using mutation. Mutation involves re-ordering of the list as shown in figure.



II. GENETIC ALGORITHM FOR OPTIMIZATION OF NETWORK ROUTING

Routing is defined as a finding route between two entities with minimum disturbance. There are mainly two types of available routing, active routing and passive routing. In the first type of routing the paths are pre-computed based on predetermined factors and saved. In second type of routing, the paths are rearranged based on the factors like congestion and optimization. In the last decade there is unprecedented growth of network. The tremendous size and complexity that is associated with large scale and distributed system set limits of our ability to manage the network. The main problem with network is congestion. It refers to a network state where a node or link carries so much data that it may deteriorate network service.

There are generally two reasons for congestion in telecommunications. The first reason is that packet arrival rate is much more of packet service rate. The second reason is due to aspect of performance in level link such as competition, interference and bit error rate. Congestion in telecommunication networks has a direct impact on efficiency and quality of service. For example congestion can lead to a buffer over flow, large queue delay and losing more packets. Packet loss reduces the reliability and quality of service. Thus, congestion in telecommunication networks should be controlled. There are several congestion control techniques. But for finding the optimum values, genetic algorithm is preferred. Genetic algorithms are used for optimization of both distance and congestion factor. This approach is different from other approaches in the fact that congestion in the network for optimization [16].

There are number of paths between starting terminals and ending terminals. But some paths are large and take much time and create disturbance in completing their respective journey. Genetic algorithm helps to find the minimum distance covered with least congestion values by taking the maximum value of objective function. Objective function is opposite of total distance covered. For any telecommunication network it is important to take optimum time between starting and ending terminal. Thus the network called as "smart network".
TDF = Total Distance + Congestion

$$\text{Objective Function} = \frac{1}{\text{TDF}}$$

III. CONCLUSION

Genetic algorithm is an adaptive strategy and a global optimization technique. The case of algorithm is very simple. It will be the same for all the problems. Only implementation of genetic operators is varied according to the problem and according to the optimal solutions. The applications of genetic algorithm reduce the time to find fit solutions. It is an evolutionary algorithm and belongs to broader study of evolutionary computation. Genetic algorithm is a search technique that is inspired by Charles Darwin theory of natural evolution. This paper reviews some work related to genetic algorithm operations and focusing on the application of genetic algorithm in telecommunication. With the help of genetic algorithm minimum distance can be covered with least congestion with maximum function. It is very helpful to finding the best result in minimum time. Various techniques are available of genetic algorithm which are incorporated by the various researcher in telecommunication are discussed in next research paper.

REFERENCES

[1] J. Holland, "Adaptation in Natural and Artificial Systems", University of Michigan Press, Ann Arbor. (Technical Report ORA Projects 01252 and 08226).Ann Arbor: University of Michigan, Department of Computer and Communication Sciences, (1975).
[2] D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison- Wesley Publishing Co., Inc., Reading, Mass, (1989).
[3] R. Sivaraj and T. Ravichandran, "Review of selection methods in genetic algorithm", International Journal of Engineering Science and Technology (IJEST), 2011, Vol. 3, Issue 5, pp. 3792-3797.
[4] T. Weise, Global Optimization Algorithms – Theory and Application Second Ed., Self-Published. (2009).
[5] J. Kennedy, and R. Eberhart, "Particle Swarm Optimization."IEEE, 7. (1995).
[6] Y. Kaya, M. Uyar, and R. Tekdn, "A Novel Crossover Operator for Genetic Algorithms: Ring Crossover." (2011).
[7] A. Otman and A. Jaafar, "A Comparative Study of Adaptive Crossover Operators for Genetic Algorithms to Resolve the Traveling Salesman Problem."International Journal of Computer Applications, 9.(2011), 31(11).
[8] M. J. Varnamkhasti, L. S. Lee, M. R. A. Bakar and W. J. Leong, "A Genetic Algorithm with Fuzzy Crossover Operator and Probability." Hindawi Publishing Corporation, Advances in Operations Research, 2012, 16. (2011).
[9] D. Vrajitoru, "Crossover improvement for the genetic algorithm in information retrieval." (1998).
[10] M. Srinivas and L. M. Patnaik, "Adaptive Probabilities of Crossover and Mutation in Genetic Algorithms." IEEE Transactions on systems, man and cybernetic, (1994), 24(4), 656-667.
[11] Tomasz Dominik Gwiazda, "Genetic Algorithms Reference", Volume –I, Poland: Tomasz Gwiazda, 2006.
[12] David E. Goldberg and Robert Lingle Jr., "Alleles, loci and the traveling salesman problem", Proceedings of the 1st International Conference on Genetic Algorithms, 1985,pp. 154- 159.
[13] I. M. Oliver, D. J. Smith, and J. R. C. Holland, "A study of permutation crossover operators on the TSP", Proceedings of the 2nd International Conference on Genetic Algorithms on Genetic Algorithms and their Application, 1987, pp. 224-230.
[14] Lawrence Davis, "Applying adaptive algorithms to epistatic domains", Proceedings of the 9th international joint conference on Artificial

Intelligence, 1985, Vol. 1, pp. 162- 164.
[15] Gilbert Syswerda, "Schedule optimization using genetic algorithms", Handbook of Genetic Algorithms, 1991, pp. 332- 349, New York: Van Nostrand Reinhold.
[16] H. Muhlenbein, "Parallel genetic algorithms, population genetics and combinatorial optimization", Proceedings of Workshop on Parallel Processing: Logic, Organization and Technology, 1991, pp. 398-406.
[17] Michael Meise, Vasileios Pappas, Lixia Zhang, "A taxonomy of biologically inspired research in computer network", Computer Network, 54(2010), pp. 901-916, ELSEVIER.
[18] International Journal of Scientific Research in Computer Sciences and Engineering (ISSN: 2320-7639)
[19] International Journal of Scientific Research in Network Security and Communication (ISSN: 2321-3256)

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