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GENETIC ALGORITHM BASED ROUTE OPTIMIZATION TECHNIQUES IN DIFFERENT NETWORKS: A SURVEY

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ABSTRACT

One of the common problems encountered in computer networks, is finding the shortest path (SP) between source and destination. There are different types of networks those networks use multiple Quality of Services (QoS) constraints to find the feasible solution. Genetic Algorithm is one of the soft computing techniques which give desired results for finding the optimal path from source to destination.

Key Words: Routing, Genetic algorithm, QoS

I. INTRODUCTION

In any kind of networking most important factor affecting network performance is routing. How routing is carried out between source to destination is explained in 1.1. And genetic algorithm is applied to improve the routing and it helps to find the highly optimal (shortest) path from the entire feasible path which is explained in 1.2.

1.1 Routing

Routing is the procedure of transmitting data packets from source to target node with the least rate [1]. There are two types of routing one is static routing and another one is dynamic routing. Static routing is the one that is created manually by a network administrator it means routing table has to be maintained, updated manually. But in dynamic routing, routing table is automatically updated and maintained through an ongoing communication between routers. A routing strategy contains many issues, Routing issues includes loss of connectivity, failure of the nodes and loss of data services etc. Those issues are solved by using many of the soft computing techniques those are Genetic algorithm, Ant colony optimization, Evolution Strategies (ES) etc. These methodologies give the best optimization and they also solve the routing problems in variety of the networks.

1.2 Overview of Genetic Algorithm

Genetic algorithm (GA) were originally developed by Bremermann in 1958 and popularized in early 1970s by John Holland. Genetic algorithm is potentially huge global search algorithm which is used to solve

complex issues by natural selection and natural reproduction of biology. Genetic algorithm is an optimization process that represents the process of natural selection. This process is mainly used to develop efficient solutions [1].

Genetic algorithm is a search technique used in computing to find true and approximate solutions to optimization and search problems. A genetic algorithm maintains a population of candidate solutions. Each candidate solution is called a chromosome. Each individual section of the chromosome is called as gene (or) each character in the string, is called a gene. Genetic algorithms are example of evolutionary computing methods and optimization type algorithms. Genetic algorithm is one of the evolutionary techniques done in biology; this evolution produces the best fittest individuals. A set of chromosomes form a population which is evaluated by a fitness function. A genetic algorithm (GA) is a computational representation it first creates the initial population. Candidates of initial population are subjected to calculate the fittest values. After finding the fittest values, which chromosomes have the highest fittest values those chromosomes have to be put into the reproduction operations. Reproduction operations include crossover and mutation operations. The problem occur in the network is solved by the genetic algorithm based on the fitness value of the chromosome (Routing path) [2].

II. ROUTING IN DIFFERENT KINDS OF NETWORKS

2.1 Adhoc network

An ad hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration or standard support services. The topology of the adhoc network may change rapidly and unexpectedly. One of the most problems encountered in these networks, is finding the shortest path (SP) between source and destination nodes within a specified time so as to satisfy the Quality of Service (QoS) [3].

2.2 VANET

Vehicular Ad-hoc Network (VANET) is a most important class of mobile ad-hoc network (MANET) that enables roadside vehicles to intelligently interact with one another and with outside infrastructure anytime anywhere in the global network. VANETs consist of On Board Units (OBUs) and Roadside Units (RSUs). OBUs are installed on the vehicle to provide the facility of wireless communication with other vehicles or RSUs and RSUs are communication units located aside the road. RSUs are connected with application server and truth authority (TA). VANETs challenges are optimize traffic management, road safety, information inaccessibility and authentication [1].

2.3 Sensor network

A DSN is a high level dispersed set of sensors that are interconnected by a communication network in the environment. The sensors are deeply embedded devices that are integrated with a physical environment and capable of acquiring signals, processing the signals, communicating, context aware computing and performing simple computation tasks. While this new class of networks has the potential to enable wide range of applications, it also pose serious challenges like routing, data gathering and dissemination, frequent network topology change, and fault tolerance [4].

2.4 Mobile adhoc network

Mobile Ad Hoc Network is a type of wireless ad hoc networks. It is a collection of mobile nodes which can dynamically exchange information between nodes without any centralized infrastructure. Due to node mobility the topology of the network can change frequently, nodes can move away from the transmission range. So, there may be a chance of node failure or link failure and node have to consume more energy to transfer the packets from source to destination [5]. The performance of the routing will be decreased because of the failures. Node failure occurs when lack of power it causes route failure in the network.

2.5 MPLS Networks

Fault tolerance in Multi-protocol label switching (MPLS) networks has been actively researched for several years with the outcome of several algorithms. MPLS does fault tolerance by computing the alternate route either prior to the fault or upon occurrence of the fault. Multi-protocol label switching has been proved to be a promising

approach for traffic engineering in the Internet especially for the backbone network. This is because it provides the use of labels which ease the procedure of packet look up and routing. With the use of this label, the network Administrator can easily impose explicit routing as per the policy of the network. The path between the ingress node and egress node in the MPLS networks is called a Label Switched Path (LSP) [6].

2.6 Wireless Mesh Network

In a Wireless Mesh Network (WMN), high speed routers equipped with advanced antennas, communicate with each other in a multi-hop fashion over wireless channels and form a broadband backhaul. WMNs provide fault-tolerance and reliable connectivity, as each node is connected to several other nodes. However, the throughput of a WMN may be severely degraded due to presence of some selfish routers that avoid forwarding packets for other nodes even as they send their own traffic through the network and this introduces unnecessary delay in delivery of valid packets[7].

2.7 Convergent network

Convergent network refers to the coexistence of three networks within a single network. It means user interface has to be created between video transmission, a telephone network and data communication etc. which shares the bandwidth. In response to rapidly growing customer demands, convergent network has become the backbone of any digital internet activity. Web surfing, quality analysis, testing, VoIP, video and audio conferencing and e-commerce all use convergent network to engage with the public and business groups. This convergent networks has the potential to enable wide range of applications, it also pose serious challenges like routing, data gathering and dissemination, frequent network topology change, and fault tolerance. With all these constraints an efficient and effective method to extract faults from the network is challenging task. A converged network incorporates Ethernet and Fiber Channel traffic over a common infrastructure. Ethernet is the foundation for converged networks due to the ubiquity of its presence for connecting data traffic between computers.

III. GENETIC ALGORITHM APPLIED IN ROUTING

Genetic algorithms (GAs) are global search and optimization techniques modeled from natural selection, genetic and evolution. The GA simulates this process through coding and special operators. A genetic algorithm maintains a population of candidate solutions, where each candidate solution is usually coded as binary string called a chromosome. The best choice of coding has been shown to be a binary coding. A set of chromosomes forms a population, which is evaluated and ranked by fitness evaluation function. The fitness evaluation function play a critical role in GAs because it provides information how good each candidate. The initial population is usually generated at random. The evolution from one generation to the next one involves mainly three steps: fitness evaluation, selection and reproduction.

3.1 Representation of chromosomes

Any network topology can be represented in graph structure that is G (v, e) where **v** is the set of vertices that represents nodes present in the network topology. And **e** is the link exists between the nodes. In genetic algorithm chromosome is the routing path exist between source node to destination. Chromosome can be represented either in edge based or node based format.

In edge based format uses fixed length chromosome structure here length of chromosome is depends upon the how many number of edges the topology contains.

e1	e2	e3	-------	---------	En

Fig 1: Edge based chromosome structure

Where **e** is the edge number and **n** is the total number of edges.

In node based chromosome structure chromosome consists of sequences of positive integers.

i1	i2	i3	--------	---------	In

Fig 2: Node based chromosome structure

Where **i** represent the IDs of nodes through which a routing path passes with the source node followed by intermediate nodes (via nodes) and **n** represents total number of nodes.

In binary encoding the chromosomes are represented by the binary string as {0, 1}.

1	0	1	1	0	0	0	1

Fig 3: Binary encoding

Tree-based GAs represents the set of paths from source to destination as a tree and encodes them through the crossed junction's single paths in the chromosome. In this algorithm GA is designed with binary encoding that use junction based encoding model and represent classes of paths in each chromosome [11]. Example for tree based encoding scheme is as shown in the fig 4.

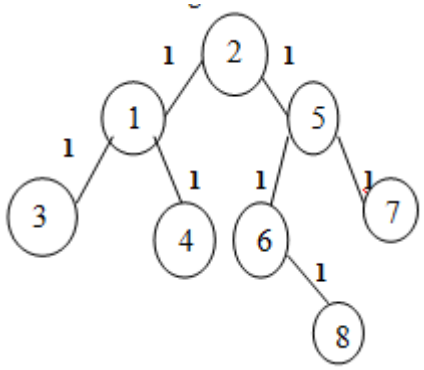

Fig 4: Tree based encoding

In above example if path exist between the nodes it can be represented with '1' otherwise it can be represented as '0'.

3.2 Initial population

A genetic algorithm maintains a set of chromosomes called population, which is evaluated by fitness evaluation function and then ranked based on their fitness. The initial population is usually generated at random. A new generation is created with the goal of improving the fitness.

3.3 Fitness evaluation

A fitness function is a particular type of objective function that prescribes the optimality of a solution (that is, a chromosome) in a genetic algorithm. For evaluation of fitness function in routing it mainly depends upon the various types of QoS parameters like delay, jitter, loss, throughput, bit rate etc. Each network uses their corresponding type of QoS parameters to calculate the fitness value.

3.4 Selection

GA select "parents" from the current population with a bias that better chromosome are likely to be selected. This is accomplished by the fitness value or ranking of a chromosome. Selection process is carried out by different types of methods those are as follows.

3.4.1 Tournament Selection

In tournament selection, n individuals are selected randomly from the larger population, and the selected individuals compete against each other. The individual with the highest fitness wins and will be included as one of the next generation population. The number of individuals competing in each tournament is referred to as tournament size, commonly set to 2 (also called binary tournament) [8].

3.4.2 Roulette Wheel Selection

The simplest selection scheme is roulette-wheel selection, also called stochastic sampling with replacement. Here selection process is based on spinning the wheel the number of times equal to population size, each selecting a single chromosome for the new procedure. There two types of Roulette wheel selection one is rank based and another one is proportionate based.

3.5 Crossover

GA reproduces "children" (new strings) from selected parents using crossover and/or mutation operators. Crossover is basically consists in a random exchange of bits between two strings of the intermediate population [9]. There are different types of crossovers those are single point, multipoint and uniform crossover. The examples of single point, multipoint, uniform crossovers are shown in the figures 5, 6 and 7 respectively.

Parent 1	001010 | 0101001010
Parent 2	010101 | 1010101101
Child	001010 1010101101

Fig. 5 Single point crossover

Parent 1	001010 | 01010 | 10101
Parent 2	010101 | 10101 | 01110
Child	001010 10101 10101

Fig. 6 Multi point crossover

Parent 1	0000000000000000
Parent 2	1111111111111111
Child	1001001101110100

Fig. 7 Uniform Crossover

3.6 MUTATION

Finally, the mutation operator alters randomly some bits of the new strings. There are different types of mutation In general mutation process is shown in the figure 8.

Original Chromosome	1010100001011111100
Mutated chromosome	1010000001111110100

Fig 8: Mutation

This algorithm terminates when an acceptable solution is found, when convergence criteria are met or when a predetermined limit number of iteration is reached. The main features of GAs are that they can explore the search space in parallel and don't need the optimized function to be differentiable or have any smooth properties. The precision of the solution obtained depends on the number of bits used to code a particular variable (length of chromosome) and a sufficient number of iterations [10].

IV. CONCLUSIONS

A Survey on different types of network gives information about the genetic algorithm that can be applied to optimize the routing criteria. Genetic algorithm is efficient soft computing technique for finding the optimal path from source to destination in network. By using Genetic algorithm it helps to find the feasible paths in different networks with different types of quality of services based on the requirements which gives satisfactory results.

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