Genetic Algorithm for Shortest Path Optimization In Network

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DOI: 10.29322/IJSRP.9.07.2019.p9188
http://dx.doi.org/10.29322/IJSRP.9.07.2019.p9188

Abstract : An Internet Service Provider (ISP) is an organization that provides services for accessing, using or participating in the internet. Internet service providers may be organized in various forms, such as commercial, community-owned, non-profit, or otherwise privately owned. Routing of data packets can affect network Resources utilization. I have implemented a genetic algorithm to finds the set of optimal routes to send the traffic from source to destination.

Keywords – Genetic Algorithm, Chromosomes, Cross over, Mutation.

I. INTRODUCTION

Data Network routing is a process of transferring packets from source node to destination node with minimum cost (delay-transmission, processing and queuing delay, bandwidth, load, jitter, reliability etc.) Routing is complex in large networks because of the many potential intermediate destinations a packet might traverse before reaching its destination. Hence routing algorithm has to acquire, organize and distribute information about network states. It should generate feasible routes between nodes and send traffic along the selected path and also achieve high performing.

The weights of links in network are assigned by the network operator. The lower the weight, the greater the chance that traffic will get routed on the like [BLU00]. When on sends or receives data over the Internet. the information id divided into small chunks called packets or datagram's. A header, containing the necessary transmission information, such as the destination Internet Protocol (IP) address, is attached to each packet. The data packets are sent reaches a router, the incoming datagram's are stored in a queue to await processing. The router reads the datagram header, takes the IP destination address and determines the best way to forward this packet for it to reach its final destination.

Genetic algorithm is one in which the population associated with each node co-evolve to solve the problem.

II. NETWORK ROUTING

A router is a process of selecting path along which the data can be transferred from source to be destination. A router works at the network layer in the OSI and internet layer in TCP/IP model. A router is a networking device that forwards the packet based on the information available in the packet header and forwarding table. The new router are generated based on the factors like traffic, link utilization. bandwidth, jitter, delay etc which is aimed at having maximum performance. Other classification of routing policy is optimal routing (global routing) and shortest path routing (local routing). Some of the shortest path algorithms are distance vector algorithm and link state algorithm. Each node in the network is of the type store and forward. The like performance may be measured in terms of bandwidth or link delay. The topology of the network may change due to growth in number of nodes, or failure of node. This change in topology should be reflected in the routing table, which in turn helps the routing protocol to generate optimal route for the current state of network. Some of the protocols are Routing Information Protocol (RIP). Interior gateway routing protocol (IGRP), Open source shortest path first (OSPF) and Border gateway protocol (BGP). OSPF is a link state routing protocol used in IP networks which uses shortest path first algorithm to compute low cost route to destination.

III. GENETIC ALGORITHM

Concerning its internal Functioning, a genetic algorithms is an iterative procedure which usually operates on a population of constants size and is basically executed in the following way :

An initial population of individuals (also called "Solution candidates" or "chromosomes") is generated randomly or heuristically. During each iteration step, also called a "generation," the individuals of the current population are evaluated and assigned a certain fitness value. In order to form a new population, individuals are first selected (usually with a probability proportional to their relative fitness values), and then produce offspring candidates which in turn form the next generation of parents. This ensures that the expected number of times an individual is chosen is approximately proportional to its relative performance in the population. For producing new solution candidates genetic algorithms use two operation, namely crossover and mutation:

- Crossover is the primary genetic operator : It takes two individuals called parents, and produces one or two new individuals, called offspring, by combining parts of the parents. In its simplest form, the operator works by swapping (exchanging) substrings before and after a randomly selected crossover point.
- The second genetic operator, mutation, is essentially an arbitrary modification which helps to prevent premature convergence by randomly sampling new points in the search space. In the case of bit strings, mutation is applied by simply flipping bits randomly in a string with a certain probability called mutation rate.

Genetic algorithms are stochastic iterative algorithms, which cannot guarantee convergence; termination is hereby commonly triggered by reaching a maximum number of generations or by finding an acceptable solution or more sophisticated termination criteria indicating premature convergence.

IV. Problem Definition

The network under consideration is represented as G=(V,E), a connected graph with N nodes. The metric of optimization is cost of path between the nodes. The total cost is the sum of cost of individual hops. The goal is to find the path with minimum total cost between source node V_{src} and destination V_{dest}, where V_{src} and V_{dest} belong V. This paper presents the efficient on-demand. source initiated rouging algorithm using genetic algorithm. Finally data is sent along the generation path.

1.1 Initialization of routing table

A module is used to generate all possible paths from a given node to all other nodes in the network. Initially, n' random paths are considered (chromosome). This 'n' defines the population size. These chromosomes act as population of first generation.

1.2 Optimal paths generation

This module deals with finding the optimal path using genetic algorithm. The input to this module is the set of paths generated. Each path is called as chromosome. As the source node receives m' (say 10-population size) chromosomes –

(a) Calculate the fitness of each of the chromosome.

The fitness of the chromosome is evaluated as : Fitness = no of hops in path * 10 – total cost of path Number of hops defines the number of intermediate nodes visited along the path from source to destination and total cost is the sum of cost of individual links in the path.

(b) Select best two chromosome as parents (using some selection method-Roulette Wheel)
(c) Perform crossover with probability 0.7.
(d) Perform mutation with probability 0.01.
(e) Place children in the population and eliminates the worst chromosome having very poor fitness values.
(f) If termination condition is not attained then repeat the steps.
(g) Refresh the path after duration of t seconds to know the current status of dynamic networks.

1.3 Selection

It is a feature of GA for selecting parents for next generation. Current work is based on roulette wheel selection. Fittest chromosomes get larger slice. Some of the other selection methods are rank selection, elitist selection, scaling selecting, tournament selection, etc.

1.4 Crossover

Crossover operator combines sub parts of two parent chromosomes and produces offspring that contains some part of both the parent genetic material. This paper deals with PMX crossover. In Partially Matched Crossover [SIV08], two string are aligned, and two crossover point are selected uniformly at random along the length of the strings.

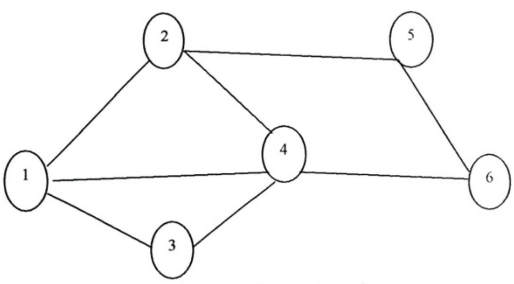
Each offspring contains ordering information partially determined by each of its parents. PMX can be applied to problems with permutation representation. Generated offspring should be validated. Validation is done by checking the offspring with all possible routes. If offspring belongs to all possible routes then its fitness is computed and sent to next operation. If the offspring does not belong to all possible route set, then it is dropped as route does not involve valid connection of nodes in network.

1.5 Mutation

Crossover operation may produce degenerate population. In order to undo this, mutation operation is performed. The paper uses insertion method. In case of insertion a node is inserted at random position in the string. This is because a node along the optimal path may be eliminated through crossover. Using insertion, it can be brought back. Once mutation is completed, the offspring generated by mutation have to be validated with the same process used in crossover.

1.6 Termination Criteria

It allows the convergence of algorithm Maximum generation, No change in population fitness and stall generation are considered as algorithm stopping condition. We have taken the maximum number (say 1000) of generation as it will allow algorithm to check, upto what number of generations there is improvement in chromosome fitness. A second stopping criterion is until some chromosome reaches a specified fitness level. As the optimal solution is generated using GA. data is transmitted along that path. There may be change in topology of network as some nodes may join the network or some nodes may leave the network or some nodes may fail. Under these circumstances the optimal path may no m ore be the shortest. Hence the network has to be refreshed at every t seconds and new routes may be generated.



Sample Network Topology

V. RESULT

Current work is based on network consisting 6 nodes. Initially 15 random chromosomes are generated, out of which best ten are considered for 1st generation. At each generation the chromosomes are validated and best fit chromosomes are sent to next generation. It is found that fitness vale improves at each generation fro chromosomes Generates 15 random chromosomes.

We have taken population size of 10 in fist generation. By selecting the chromosome based on roulette selection and application of GA operators generations are performed. After the path to all nodes from source node 1 is computed, the set of paths to a specific node will be displayed. Let the destination node is node 6. Following is the set of paths from node 1 to node 6. The optimal path returned is 1,3, 4 and 6 with delay factor of 8.

VI. CONCLUSION

GA is well suited for solving problems where the solution space is huge and time taken to research exhaustively is very high. As the size of network increase, the possible solution for transferring date between two nodes increase. Adding of few new nodes in the network increases the size of search space exponentially. So, GA is well suited for routing problem as it explores chance to attain local optimum. GA has ability to solve problems with no previous knowledge.

Current work can be improved by using some intelligent approach for populating routing table and using better crossover, mutation probabilities and enhancing it to support for load balancing.

VII. REFERENCE

1) (ALU06) Aluizio F. R. Araujo et. al. (2006). Multicast Routing Using Genetic Algorithm Seen as a Permutation Problem proceeding of the 20th International Conference on Advanced Information Networking and Application (AINA' 06)
2) [BIL 08] Bilai Gonen (2008) : Genetic Algorithm Finding the Shortest Path in Network, 2008.
3) [BLU00] Black U. (2000) : IP Routing Protocols RIP, OSPF, BGP, PNNI & Cisco Routing protocols, Prentice Hall.
4) (CAU 00) Cauvery , N. K. & Viswanatha, K. V. (2000) : Routing in Dynamic Network using Ants and Genetic Algorithm International Journal of Computer Science and Network Security, VOL. 9 No. 3, March 2000.
5) (GOL89) Goldberg E. David (1989) : Genetic Algorithms in search, optimization and machine learning, Person Education.
6) (LAU91) Laurence Davis (1991) : Hands book of Genetic Algorithms, 1991.
7) [SIV08] Sivanandam S. N. & Deepa S. N. (2008): Introduction to Genetic Algorithms, 2008.
8) (VIJ08) Vijayalakshmi K & Radhakrishanan S (2008) : Dynamic Routing to Multiple Destinations in IP Networking using hybrid Genetic Algorithms (DRHGA). International Journal of Information Technology, Vol 4, No 1, PP 45-52, 2008.
9) (YIN06) Yinzhen Li, Ruichun He, & Yaohuang Guo. (2006) : Faster Genetic Algorithm for Network Paths, The Sixth International Symposiumon Operations Research and Its Application (ISORA'06), pp380-389.