

# Path Selection Optimization using Genetic Algorithm in IP Network

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**Abstract**— A novel approach of optimized routing which is based on Genetic Algorithm has been introduced. It finds out the optimum and the most suitable path which qualifies Objective Function criteria. Optimization Approaches have been applied to various real life issues in communication and networking. The path which is best fitted in the population is considered as the optimal path. It is obtained after qualifying the fitness function measuring criteria. The fitness function measures the best fitted path based on constraints; bandwidth, delay, link utilization and hop count. Population is composition of valid and invalid paths. In this research work we proposed a new genetic algorithm for network path optimization. Network path selection is based upon the fitness function measuring average packet delay for a network path. The population comprises of all chromosomes of variable length, so that the algorithm can perform efficiently in all scenarios. Rank-based selection is used for cross-over operation. Mutation operation is used for maintaining the population diversity. The results prove our assertion that our proposed algorithm finds the optimized shortest path between source nodes to destination node more efficiently than existing algorithms.

**Key words:** GA, Optimization, IP network, path selection, protocol

## I. INTRODUCTION

Genetic Algorithms are search algorithms that are based on concepts of natural selection and natural genetics. Genetic algorithm was developed to simulate some of the processes observed in natural evolution, a process that operates on chromosomes (organic devices for encoding the structure of living being). The genetic algorithm differs from other search methods in that it searches among a population of points, and works with a coding of parameter set, rather than the parameter values themselves. It also uses objective function information without any gradient information. The transition scheme of the genetic algorithm is probabilistic, whereas traditional methods use gradient information. Because of these features of genetic algorithm; they are used as general purpose optimization algorithm. They also provide means to search irregular space and hence are applied to a variety of function optimization, parameter estimation and machine learning applications.

The Genetic Algorithm search approach emerged to meet the global optimization needs in a complex search space. The GA search approach is now the underlying solution methodology of many optimization systems and has fundamentally changed the way many organizations operate. Genetic algorithms employ the concepts of natural selection and genetics. Using path information, the GA directs the search with expected improved performance. The concept of genetic algorithm is based on the theory of adaptive natural and artificial systems. In adaptive artificial systems, adaptation starts with an initial set of structures or possible candidate solutions, typically referred to as chromosomes.

The initial structures are modified according to using an adaptive plan to improve the performance of these structures. The modification procedure involves crossover and mutation operations. It has been shown that repeated applications of this adaptive plan to input structures result in optimal or near optimal solutions. Many traditional and optimal search techniques are not guaranteed to yield the overall optimal solution, since they are not complete and are only searching a subset of the search space. Other algorithms that focus on enumerative methods are not efficient when the search space is too large[2,8].

An implementation of a genetic algorithm begins with a population of typically random Chromosomes. One then evaluates these structures and allocates reproductive opportunities in such a way that those chromosomes which represent a better solution to the target problem are given more chances to reproduce than those chromosomes which are poorer solutions[16]. The goodness of a solution is typically defined with respect to the current population[27]. As the natural evaluation has the following feature:

- The individual characteristics are encoded on a chromosome.
- Each chromosome has a certain fitness function value according to the environment in which it exists.
- Individual chromosomes judged stronger are able to survive and produce next generations of strong individual chromosomes.

## II. PROBLEM FORMULATION

Communication networks contain nodes sourcing demands destined for other nodes, where each demand requires QoS constraints (delay, bandwidth constraints and related objective functions). Every demand is routed via zero or more nodes subject to the demands delay and bandwidth constraints. Each routed demand consumes the network resources and conforms to the current network resource availability.

There is always a chance that the demands may not be covered totally because of the current network resources and routing tables. This is called service degradation. But a network that is appropriately planned for possible traffic demands still has the chance to recover from service degradation. This is accomplished by managing the routing tables or route reservations while adapting to the dynamic traffic demands. At each time instance of the communication throughout the network, total cost of the network is evaluated and an optimization process is run to minimize this cost. In the general routing problem, there are no limitations on how flows can be distributed along the paths from source to destination, and the problem can be formulated and solved in polynomial time as a multi commodity flow problem.

Routing optimization plays a crucial role for network planning (initial design and extension planning) as

well as for network operation (traffic engineering). Given a certain traffic demand matrix with QoS constraints (i.e. delay constraint and bandwidth requirements), it is the objective to minimize network cost (i.e. packet loss rate, max link utilization) only by modifying the routes of traffic flows through the network and not by changing or extending the network infrastructure. This optimization problem is called the network routing problem.

### III. METHODOLOGY

#### A. Step 1 (Initialization Of Population):

Population is comprised of chromosome which contains the network nodes between source and destination nodes. Source node and destination node are fixed and population is generated randomly.

#### B. Step 2 (Parents Selection):

Rank based selection is. In this the parents are ranked on the basis of their proposed fitness function value which is average mean packet delay. Based upon fitness function best chromosome are selected which forms the mating pool.

#### C. Step 3 (Crossing Over):

One site crossover technique is used. Two chromosomes are selected from the mating pool and one site crossover technique is applied over them. Mutual exchange of information takes place which results in better chromosomes.

#### D. Step 4 (Mutation):

Mutation adds new information in a random way to the genetic search process and ultimately helps to avoid getting trapped at local optima. It is an operator that introduces diversity in the population. Mutation has been done as per the scenarios which are:

- 1) *Scenario 1 (Repeating Node):*
  - The location of repeating node is traced out.
  - Any of the missing nodes is find out.
  - Place the missing node at traced location.
- 2) *Scenario 2 (No Missing Or Repeating Node):*
  - Randomly pick two nodes from chromosome
  - Swap those nodes
- 3) *Scenario 3 (Minimum Chromosome Length):*
  - Minimum length of chromosome is 2
  - It has only source and destination nodes
  - There will be no mutation
- 4) *Scenario 4 (Length Of Chromosome Is One More Than The Minimum):*
  - Length of chromosome one more than minimum constitutes of 3 nodes
  - Only middle node is flipped with missing node

#### E. Step 5: (Termination Condition):

- Run the loop for 100 iteration and check for the minimum average packet delay

#### F. Step 6:

Go to step 2 until termination condition is satisfied.

### IV. RESULTS & ANALYSIS

Existing Fitness function is applied over the whole population. The population is generated 100 times. The minimum average Delay is taken till 100 iterations. So, there will be a delay in getting the optimum result. The horizontal axis is showing the generation and the vertical axis is showing the delay average (fitness function value) against every generation with random selection of population. The green line showing the average delay whole population and blue line showing the average delay random population. As per the results obtained the number of hops is also reducing. The hops are more at the start of the generation, but as the generations are increasing their number of hops is also reducing. Therefore, it is involving traffic engineering of the network as well. So in this case it is sharing the load of network through delay and bandwidth constraints. In this utilization factor is not involved in fitness function criteria. At start the hops count of the paths are more as per the network scenario, but in final result the number of hops is lesser. Thus, it is also handling the traffic engineering problem of the network. This is thus sharing and balancing the network load as per bandwidth and delay criteria.

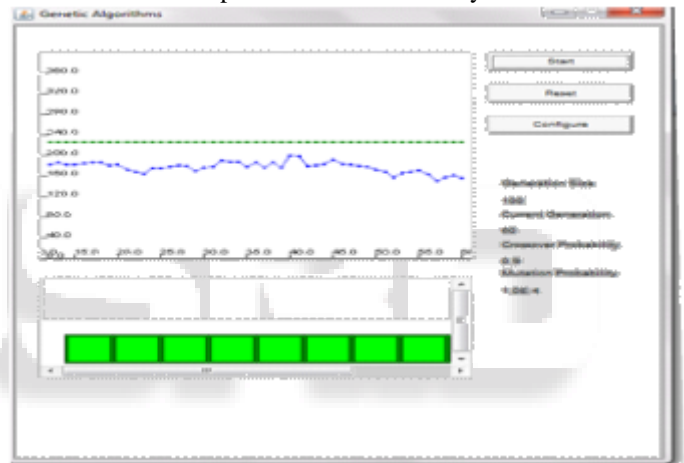


Fig. 1: Average packet delay based upon proposed fitness function

Now the proposed strategy fitness function is applied over the network. Population selection is random. It involves the delay, bandwidth and utilization constraints. It also involves hop count. In the fig 1 there is variation in fitness value involving delay and utilization factors of the network. Thus it is reaching the minimum value earlier than the previous algorithm discussed. It is reaching minimum value at earlier stage which fitness function graph is showing after mid generation.

The fitness function which is involving more constraints are showing better results. So for calculating the optimum path of the network the Fitness Function should be applied over the network for congestion control and traffic engineering problems.

### V. CONCLUSION

In this paper, routing optimization methods for communication networks have been discussed. Thus, different optimization methods for preventing data loss on overloaded communication links and methods for utilizing the network resources efficiently have been introduced and routing optimization problem has been defined. Genetic

algorithms technique has been used to solve the optimization problem. The “trial & error” process is also used considerably in deciding various GA parameters, including population size, crossover probability, and mutation probability constraints. Bandwidth utilization and traffic engineering problem is catered in this research work. A new genetic algorithm based upon a new fitness function has been proposed which measures the average mean delay. Our proposed algorithm finds the average mean delay in lesser population generations and new approach is compared with the existing work. The average packet delay for a network can be reduced in lesser number of generations.

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