Optimization of Route in a Network using Genetic Algorithm

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ABSTRACT

The problem of finding the optimal path in MANET is a well known problem due to the mobility of its nodes. Optimal routing is associated with the total cost reduction of a path. The main goal of this paper is to consider the problem of path optimization between the sender and receiver in a dynamic network. A new adaptive algorithm based on genetic techniques is proposed to find out the Optimal Path in dynamic nature problem. Genetic algorithm provides the solution of optimal path using the technique which is inspired by the natural process that is initial population, selection, crossover and mutation. The proposed algorithm used a repair function to cure all the infeasible chromosomes. The quality of solutions and rate of convergence is enhanced by performing the crossover and mutation function on the initial population. Even though path optimization algorithms are already well established, but the researchers are still trying to find the alternative methods to optimize the paths in a dynamic network. One such alternative is to use genetic algorithm. The first section of this paper explain the introduction, second explains the genetic operator used in algorithm, third is about the proposed algorithm, fourth about the proposed work and last fifth section have the conclusion of this paper.

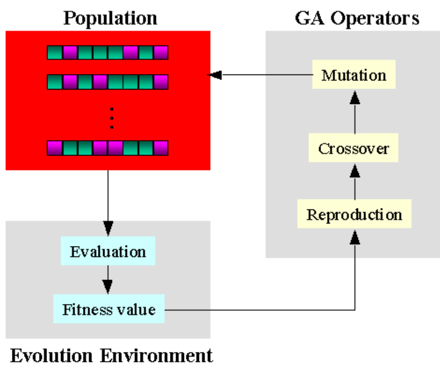
Keyword: Crossover, Mutation, MANET, Selection

1. INTRODUCTION

A Mobile Ad-Hoc Network is the collection of wireless nodes that does not depends on any infrastructure. Therefore MANET is a "spontaneous network "that automatically "emerges" when nodes gather together. Each node in a MANET can perform as a router. Nodes in the MANET can communicate with other all nodes within their radio range or can use intermediates nodes to communicate with the nodes that are not present in their radio range. MANET is characterized by dynamic topology, use unidirectional links, constrained resources and network partitions. The main two attributes are mobility and multihop communication between the nodes. One tries to find the route which has lower cost in comparison to other routes in the network. [1][2]

There are several search algorithms for the shortest path (SP) problem: the breadth-first search algorithm, the Dijkstra algorithm and the Bellman-Ford algorithm, to name a few [3]. Since these algorithms are effective in fixed infrastructure wireless or wired networks. But, they exhibit high computational complexity for real-time communications involving rapidly changing network topologies [3][4].In MANET nodes are free to move randomly, thus the network topology which is typically multihop may change randomly in unpredictable time. Since the network topologies are changing, it is necessary to change the routes randomly and find out the optimum path in real time.

Genetic algorithms are an optimization technique that deals with the uncertainties related with dynamic environment. As in the MANET nodes are mobile, We use GA for dynamic problems as it is robust and good for noisy environments, it easily makes most of previous and alternate solutions, modular, supports multi-objective optimization, evolutionary technique, adaptive to changes. Genetic algorithms are based on the natural evolution process. Genetic algorithm uses the idea of "survival of the fittest" to search the optimum path solutions. The idea applied to a problem by first guessing the possible solutions and then uses the fittest solution to create a new generation which should be better than previous generation by applying GA operators like crossover and mutations on previous generation.[5][6][7][8].Fig 2



Genetic Algorithm Evolution Flow

Fig:1

Genetic algorithm: Genetic algorithm is a technique that follows the principal of natural evolution. The idea of natural evolution is used in proposed algorithm. Firstly guessing the all possible solutions and then combine the fittest solutions to create a new generation of solution which will be better than the previous generation and will give the better fitness value.

2. GENETIC ALGORITHM OPERATOR

Initial population: Initial population is all the existing paths (known as chromosomes) from sender to receiver that can be generated randomly or on the basis of heuristic technique foe better result.

Fitness Function: The weight of all existing path from sender to receiver is helpful to compute the fitness value of chromosomes. The chromosomes which have the low weight have the high fitness value.

$$F = \begin{cases} \dfrac{1}{\sum_{i=1}^{N-1} C_i(n_i, n_{i+1})} & ; \quad \text{Feasible path} \\ 0 & ; \quad \text{Infeasible path} \end{cases}$$

C_i (n_i, n_{i+1}) is the cost or weight between nodes n_i and adjacent node n_{i+1} in the network.

Encoding: A binary encoding is used for all the chromosomes weight.

Selections: Selection is the process of choosing the chromosomes from all initial population which has the better capability to generate the new generation and to perform the mating operation.

Crossover: Crossover is the process of generating the new population by recombination process. A crossover point is selected along the string length of selected chromosomes. Part of the string is swapped after and before the crossover point to generate the offspring by using parent chromosomes.

Mutation: Mutation avoids the problem of local minimum in an algorithm. This operator flips the some of the bits in a chromosome.

3. PROPOSED ALGORITHM

Adaptive algorithm for Network

Construct a graph with V nodes and E edges and weight on the edges are W.

Input: G = (V, E), P [ ], W [ ])

1. Initialization of population:

(i)Generate randomly all the existing path from sender to destination known as initial population.

(ii)Binary encodes the weight of all existing path.

(iii)Compute the fitness value of all existing initial population.

2. Selection:

(i)Select the population those have high fitness value and assign as a parent node.

(ii)Sort the all selected population according to their fitness in decreasing order.

3. Crossover:

(i)Perform the two point crossover on pair of parent chromosomes.

(ii)Generate the offspring by swapping the binary weights of parent pair.

4. Mutation:

(i) Randomly interchange (flips) the bit of offspring if they improve the solution (decreasing total cost or increasing fitness value).

(ii) New population:

Assign the offspring as a new generation.

1. Repeat the step 3 to 8.

2. Stop the algorithm when the number of iteration has been completed or best fitness value is computed.

3. Show the best fitness value and its chromosomes value as an output.

4. Chromosome value is the optimum path between senders to destination.

4. PROPOSED WORK

A graph G= ([V, E], [w]) with 6 nodes and 10 edges is shown in fig .We have to find the optimum path between node 1 to 6.

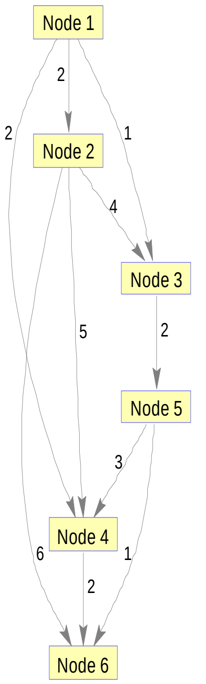


Fig:2

Initial population: All possible solutions are initial population.

Table No. 1

Path	Chromosomes	weight	Total cost
P1	1 4 6	2 2	4
P2	1 2 4 6	2 5 2	9
P3	1 2 6	2 6	8
P4	1 3 5 6	1 2 1	4
P5	1 2 3 5 6	2 4 2 1	9
P6	1 2 3 5 4 6	2 4 2 3 2	13

Selection and sorting: By implementing the process of selection and sorting parent chromosomes are find out. Select the chromosomes which have low cost.

Table No. 2

Path	chromosomes	weight	Total cost
P1	1 4 6	2 2	4
P4	1 3 5 6	1 2 1	4
P3	1 2 6	2 6	8
P2	1 2 4 6	2 5 2	9
P5	1 2 3 5 6	2 4 2 1	9

Encoding and Crossover: After binary encode the weights, crossover function is performed on the parent node.0 represents no link and use for the comparison purpose.

Table No. 3

Path	weight	Encoding	Crossover function
P1 P4	2 2 0 1 2 1	0010 0010 0000 0010 0010 0001	0010 0010 0000
P3 P2	2 6 0 2 5 2	0010 0110 0000 0010 0101 0010	0001 0101 0000
P5	2 4 2 1	0010 0100 0010 0001	0010 0100 0010 0001

Red bits are used to show the point of crossover.

New Generation: After the crossover function new generation is generated known as a offspring that gives better fitness value.

Again repeat the same step for the optimum solution.

5. Conclusion

MANET is an autonomous system that generate for short time and due to mobility of node the corresponding weight can be change randomly. In proposed algorithm all the path are generated randomly and genetic operator is applied on weight function to optimize the result or maximize the fitness value.

A new population gives the reduced size of routing table for a pair of source and destination therefore the less memory requirement. The paper concludes the path which is obtained as a offspring give the near optimum value of best solution and low delay.

6. References

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