Implementation and Analysis for Efficient Selection of Fitness in Genetic Algorithm for Mobile Ad-hoc Networks

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ABSTRACT:
The objective of this paper is to provide an introduction to genetic algorithm and its basic functionality. The basic operations involved in genetic algorithm are selection, crossover and mutation. It evolves around Darwin's theory which states that "survival of the fittest". Fitness refers not only to an organism's strength or athletic ability, but rather the ability to survive and reproduce. Efficient methods for fitness selections while route selection process is reviewed based on the strategies for shortest path methods. Comparative analysis and the best fit implementations are suggested for Adhoc Networks which do not have any fixed architecture

KEYWORDS: Genetic algorithm, RIGA, MEGA, MRIGA, selection, crossover, mutation

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I INTRODUCTION:

Genetic algorithm came into existence when John Holland introduced it for the first time in 1970. It is also used to implement optimization strategies by simulation of evolution of species using natural selection. The algorithm mainly focuses on selecting the best with the given population and then producing the offspring's through crossover and mutation.It is an adaptive, meta-heuristic, probabilistic search algorithm which adapts with real world problems that provide accurate solutions. The paper gives an idea on how it can be applied to MANET system. It also gives a brief idea on how routes are selected using genetic algorithm.

Genetic algorithm is one of the techniques which involves programming and its main base is dependent on biological evolution. As we see in this world, there exists different kinds of creatures which are adaptable to the environment which undergo evolution that is a process which involves natural selection, crossover and mutation [1].Genetic algorithms are nothing but adaptive, meta-heuristic, probabilistic optimization methods which depend on the stages of evolution to obtain an accurate solution. This algorithm has been successfully adapted in various fields such as aircraft design, computer animation, telecommunications, etc [2].

The genetic algorithm is basically based on Darwin's theory of evolution which states that "survival of the fittest". Fitness refers not to an organism's strength or athletic ability, but rather the ability to survive and reproduce.

This algorithm first came into existence when it was first introduced by John Holland in 1970. John Holland was responsible in carrying out complex adaptive systems (CAS) that consists of interrelating genes in the year1960. J. Holland made the use of biological analogy of chromosomes to convert them into a thread of binary symbols which encode a solution to areal-world problem. He introduced the operations such as selection, crossover and mutation where in a given population of chromosomes gets a better solution at every increasing step [2]. In the set of population provided, first the fitness value of each individual is calculated. Then among the population, an individual with best fitness value is selected through the operation of selection. In the second step, the operation crossover is applied between the pair of individuals selected in order to generate offspring. As we reach the third step, the operation mutation comes into picture. In this the genes of the obtained offspring are exchanged in order to obtain the most efficient solution [2].

Apart from these operations, it also undergoes encoding, initialization of population and calculation of

fitness function. Genetic algorithm involves following terminologies.

1) Individual: A single component/ chromosome/ node having any possible solution.
2) Population: Consists of group of individuals.
3) Search space: Includes every possible solution to the problem provided.
4) Chromosome: Represents blueprint for an individual.
5) Trait: Represents character of an individual.
6) Allele: Consists of possible settings for a trait.
7) Locus: Position of gene on the chromosome.
8) Genome: Collection of all chromosomes for an individual [4].

II SELECTION IMPLEMENTATIONS IN GA

1) SELECTION:

Selection is a process where in individuals with the best fitness value are selected from the population provided. It is a process where in selective individuals are selected as parents from current population that are capable of generating offspring. The criteria used for such selection is the fitness value of the individual [3]. There are various methods for selection operation.

a) Roulette wheel selection:

This method involves a wheel kind of structure. It is known to be a roulette wheel as shown in the fig 1.1. All the available chromosomes in the provided population are placed onto the roulette wheel. The amount of space each chromosome has to contain on the roulette wheel depends on their fitness function. The better the fitness function of a chromosome, there are better chances of its selection [3].In this method the chromosome with highest fitness value is given more space on the wheel. Therefore, it has the highest probability of getting selected when the roulette wheel is spun.

The output in terms of generation of a random 0 and 1. Another method named as subtractive method is applied to pick up the obtained random number. In this way, two individuals are selected randomly for further operations in genetic algorithm to take place [6].

Algorithm implementation:

For (all individuals in population)
Sum = sum +fitness value of individual
End
For (all individuals in population)
Probability of selection=sum of probabilities+(fitness/sum)
End
(till new population is full continue the process)
Generate random number 0 and 1
For (all individuals in population)
Number > probability then selected
End
Generate offspring
End

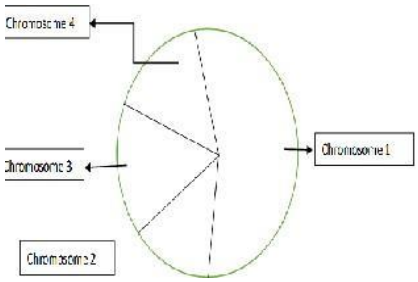

Fig 1.1 Roulette wheel selection

b) Rank selection:

In the roulette wheel selection process, there are chances that all chromosomes are not given a chance of selection. For example, if a chromosome has 90% fitness in the given population and other chromosomes are having a fitness value below 90%, there are chances that the chromosomes with fitness below are selected is very low. In order to avoid this problem, rank selection is used. In this method, first the population is sorted based on fitness and then each chromosome is provided with a rank for its fitness value. Then all chromosomes get equal chances of getting selected. The probability that a particular chromosome is selected is proportional to its rank rather than the fitness value [3].

This algorithm will concentrate on efficient selection of pathand these procedures are based on the left over energy of the node. Here node in the connected network will measure the left out residual energy. Once the energy i=used during the consumption is set by the network for every simple message that has been transfered on the network, This residual energy is evaluated in the form based on the RANK for each route where each nodenare connected and the nodes with the highestr no of rank are selected for message transmission in the network

This method can avoid premature convergence. It is found to be quite expensive than other methods as it manages the population based on fitness value.

c) Elitism selection:

During the operation of crossover and mutation which leads to generation of a new population, there is high possibility that the best chromosome from current population is removed. So, in elitism selection, the best chromosome is transferred to new population and rest of the selection follows the traditional method [3].

This increases the performance of genetic algorithm as it does not allow the best individuals to be destroyed when a new population is created.

d) Tournament selection:

In this method, some individuals are randomly selected and then from these are selected the best individuals for other processes. This process is repeated until the best ones are obtained.

The population is divided into sub groups. The members of each sub group are compared between themselves for best fitness value. One individual from each sub group is then selected for generation of offspring [4].

Considering elitist model then probability of selecting a parent Ti denoted as p(Ti) is,

$$p(Ti) = f(Ti)/\sum f(Tj)$$

the summation limits from j=1 to Np, where f(Ti) is the fitness function and Np is the population size.

Algorithm:

Select k random individuals from population
Loop
Select best individual (fitness value) of probability p
Select next best individuals of probability p*(1-p)
Select next best individuals of probability p*(p*(1-p))
Continue
End loop
Generate offspring
End

COMPARITIVE STUDY ON TYPES OF SELECTION METHODS:

TYPE OF METHOD	MECHANISM	CALCULATION OF FITNESS VAUE	ADVANTAGES	DISADVANTAGES
Roulette wheel	Chromosomes are placed on a wheel.	More fitness value gets more space.	Chromosomes with more fitness has more chance to be parent as it occupies more space on the wheel.	It is not that good mechanism as the worst individuals will never get a chance to be selected.
Rank	Population is sorted and then ranks are provided to individuals.	Chromosome with best fitness value gets best rank.	Preserves diversity.	Slower convergence and computationally expensive.
Tournament	Sub-groups division for selection	Each individual in sub-group compared for best fitness.	No sorting of population required.	Weak individuals have less chance if tournament size is large.
Elitism	Best ones from old population transferred to new.	Follows any of the above three mechanisms.	Gives chance for best individuals in old environment.	No disadvantage as known to be most efficient.

Table 1.1 comparitive analysis based selections

III CROSSOVER IMPLEMENTATIONS IN GA

The next step towards generation of a new population is to proceed with the operation called crossover [4]. As in the real world the genes of the pair of parents selected are mixed for reproduction. The chromosomes of the parents are randomly splitted and merged to generate the offspring. By performing this operation, it is found that the offspring gets some of the genes from one parent and rest from the other parent. So, parents with good fitness value produce efficient offspring's [1].

a) Single point crossover:

In this kind of crossover, crossover mask is selected in such a way that it begins with a string containing 'n' 1's then followed by required number of 0's. when such a mask is constructed then it results in offspring in which first n-bits are contributed by parent-1 as shown in the figure 2.1 and rest by parent-2. The crossover point-n is chosen at random and then the mask is applied [3].

Algorithm:

Select a crossover point p in the chromosome
I=0
For i=0 to p

Child 1[i]=parent 1[i]

Child 2[i]=parent 2[i]
End
For p to chromosome length
Child 1[i]=parent 2[i]
Child 2[i]=parent 1[i]
End

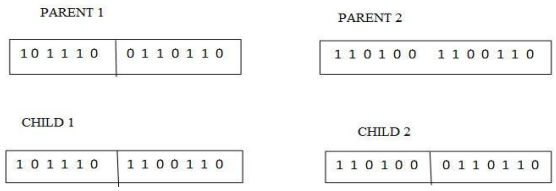

Fig 2.1 point cross over selection

b) **Two – point crossover:**

The two-point crossover follows the reverse order of a single point crossover. In this the mask is a string starting with 'n' 0's and then followed by 'n' 1's and rest of the string contains required number of 0's. mask is generated by randomly choosing 1's and 0's [3].

c) Uniform crossover:

This mask is generated by selecting a random bit string where each bit is chosen randomly and independent of others [3].

For example,

1 1 0 0 1 0 0 1 1 1 1 1 0 0 1 1 0 1 0 1 1 1

IV MUTATIONS FOR ROUTING IN GENETIC ALGORITHM:

This is an operation in which takes place deformation of genetic information of the obtained offspring through crossover with the help of radioactive and environmental influences. This technique is mainly applied to avoid the chances that the individuals turn out to be same after crossover. This involves a selection of random bit of the offspring which seems to be changed and then it is replaced [4].

Genetic algorithm has been known to be the best suited for developing routing mechanisms. For each source and destination pair, a routing table is constructed. The number of paths between the nodes purely depends on the topology of the network. If the network is very large (i.e.), it contains large number of nodes then the number of possible routes between source and destination nodes are many. Listing all the paths is not possible when this algorithm is applied to a real-world problem as real-world problem contains large networks. So, a pre-defined route is already selected and then chromosomes are optimized. Crossover and mutation operations are run on only variable length of chromosome [2].When route selection for a fixed infrastructure network comes into picture then Bellman-Ford and Dijkstra algorithms are well used. But MANETS have no fixed infrastructure. In order to define the shortest path in MANETS, genetic algorithm has been of great use [2].

i) BELLMAN-FORD ALGORITHM:

This computes the shortest path in the network considering a single source node to all other nodes in the network (or) graph. It is more versatile. It is capable of handling even negative numbers in the graph.

ii)DILKSTRA'S ALGORITHM:

It evaluates the shortest path from a source node to every other node in the network. It is possible to stop the evaluation of checking for each and every node by stopping the algorithm once the shortest path between source and destination node is evaluated.

In order to establish shortest path in MANETS, genetic algorithm-based protocol named "Cluster gateway switch routing protocol (CGSRP)" has been introduced. This protocol helps in selecting the head node of the network. This protocol encodes the unique ID in the chromosomes. The chromosomes that are encoded are then evaluated against parameters like fitness function and are then selected in the route decision.

DIFFERENCES BETWEEN BELLAMAN-FORD AND DIJKSTRA'S ALGORITHM:

BELLAMAN-FORD	DIJKSTRA'S

1) Works when there is negative amount of weight edge. 2) Result will contain vertices in which contains the indicating the information about the other vertices that are interconnected 3) Easily implemented in distributed network. 4) Less time consuming.	1) Won't work when there is higher negative amount weight edge. 2) Result will contains vertices containing whole amount of information about network not only includes vertices they are connected to. 3) Not easily implementable in distributed area network. 4) More time consuming.

V ROUTE OPTIMIZATIONS USING GA

a)Genetic Algorithm With Immigrant's Scheme (Riga):

In dynamic optimization problems, the major problem faced by genetic algorithm is the convergence. So, random immigrant's based genetic algorithm (RIGA) approach is applied. In this approach, the immigrants move in and out of the population between two generations. So, diversity is maintained by replacing certain individuals with some random individuals.

In slowly changing environments, random individuals may divert the search approach. Where as if environment changes only slightly then random individuals may not have any effect. For this reason, elitism-based individuals was introduced [5].

b)Genetic Algorithm With Memory Schemes (Mega):

The basic idea of memory schemes is to enhance the genetic algorithm performance towards dynamic optimization problems. This scheme stores the important information in a separate memory explicitly which can be widely used for new population. It can also be stored implicitly. If the useful information from current generation is stored in separate memory then old solutions that fit into new environment are reactivated and then genetic algorithm is applied. Memory storage works well as in the cyclic process there is always a chance of occurrence of old environment that has been optimized beforehand [5].

c)Genetic Algorithm With Memory And Immigrant's Schemes (Mriga):

In the random immigrant's approach, population diversity level is maintained and memory scheme aims to move on the genetic algorithm directly to an old environment which is similar to new one with already consisting of optimized solution.

The only difference between MRIGA[7] and MEGA is that in MRIGA, the random immigrants are swapped with the current population to remove the worst individuals before entering into a new environment [5].

COMPARITIVE ANALYSIS ON ABOVE THREE APPROACHES:

TYPE OF APPROACH	MECHANISM	ADVANTAGES	DISADVANTAGES
RIGA	Replaces current population with random immigrants.	Maintains diversity level in the population.	In slowly changing environment, random immigrants may divert the searching force of genetic algorithm.
MEGA	Stores information of good solutions from current population implicitly or explicitly in extra memory.	Enhances performance of genetic algorithm. Old solutions in memory that fir in new environment are reactivated.	Memory is chosen randomly.

MRIGA	Follows the mechanism of both RIGA and MEGA.	Involves both random selection and storing in extra memory bringing out diversity and enhancing performance.	Difference between MEGA and MRIGA is in MRIGA before entering new population, random immigrants are swapped to replace the worst individuals.

VI CONCLUSION:

The proposed GA algorithm is embedded in the basic routing protocol with the above selection fuctions and the simulation is achieved in radio environment with the network

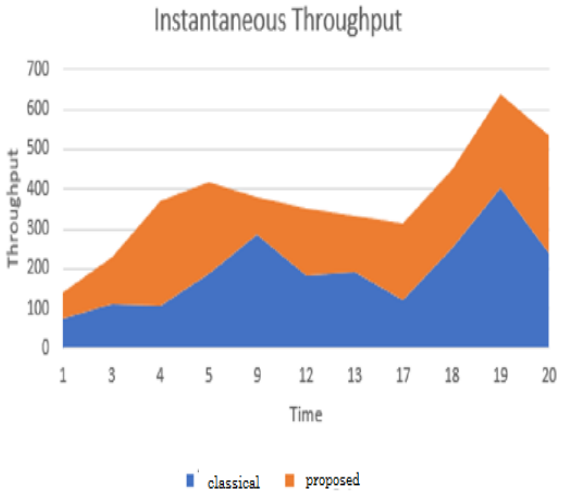

Figure.5.1: Throughput of node network

For these networks the instantaneous way throughput of analysis is used here to identify which one node of the network is participating lesser in process of packet forwarding schemes and mechanism and also the status one of individual nodes involved in routing mechanism and which makes sure that the maximum no of packets are transmitted to the network.The selections proposed have improved the rate of throughput usng the selections which will improve the performance oof the network for ad-hoc characterization which changes on the requirement and the situation demanded[9]

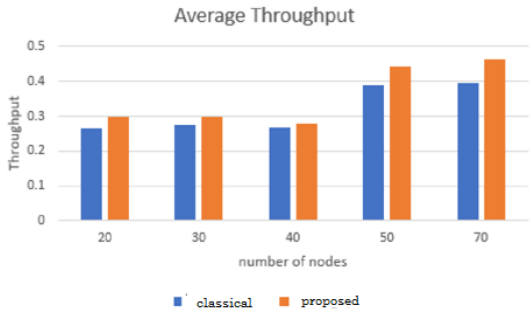

Figure.5.2: Throughput Improvement comparison

The above analysis in figure 5.2 shows the significant improvement in throughput using the GA methods when compared to traditional implementations[8] using the best fit solutions and selections using the simulation senerious ,Throughput in the network is valued as thelnumber of packets total delivered in a given slot of time. This illistrates how accurate the network is routed by using data handing terms and it inturn is used to calculate the packets dropped in the network due to heavy congestion along with another causes. the figure below gives the net amount of throughput of different node collections in networks In concluding this paper on genetic algorithm, we bring out the most important points of genetic algorithm,

1) Search parallel from population of points.
2) It is probabilistic selection and not deterministic.
3) It is adaptive (i.e.), adapts to any kind of environment and is meta-heuristic.
4) Works on chromosomes which are encoded version of potential solution parameters.
5) Uses fitness score for selection.
6) Supports multi-objective optimization.

We can conclude by saying that these selection methods in genetic algorithm are few of the best enhancing and optimization techniques that can be applied to any wireless ad-hoc network.

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