SELECTION SCHEMES USED IN GENETIC ALGORITHM FOR ATM NETWORKS

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ABSTRACT *One of the most important objective of Asynchronous Transfer Mode (ATM) based network is to support multimedia traffic services. Efficient bandwidth allocation and bandwidth optimization algorithms are required to ensure QOS requirements for each type of traffic. Genetic algorithm (GA), is an effective optimization method is applied to the bandwidth allocation in ATM. The GA operator includes crossover, selection, and mutation. Selection is one of the important operation in the GA process. This paper reviews the various selection methods and the comparison of GA performance in bandwidth allocation problem using different selection strategy.*

Keywords: *Genetic algorithm (GA), Asynchronous Transfer Mode (ATM).*

1. Introduction

Asynchronous Transfer Mode (ATM) is a high speed networking standard designed to support voice, video and data communications and to improve utilization and quality of service (QOS) on high traffic networks. ATM transfers information in fixed size units called cells. Each cell consists of 53 bytes, the first 5 bytes contains cell header information and the remaining 48 contain the payload. Small fixed length cells are well suited to transfer voice and video traffic because such traffic is intolerance to delays that results from having to wait for a large data packet to download, among other things. Using ATM it can be flexibly reconfigure the network and re-assign the bandwidth to meet the requirements of all types of services. Hence bandwidth optimization is a critical task for ATM. towards the bandwidth optimization in ATM networks, genetic algorithm is used.

2. Genetic Algorithm Approach

Genetic algorithms are the heuristic search and optimization techniques that mimic the process of natural selection.GA is a non traditional based optimization technique which can be used to optimize the ATM network.GA represents an intelligent exploitation of a random search used to solve optimization problems.GA are particular class of evolutionary algorithms. The main operations of GA are selection, crossover and mutation.

The evolution of GA starts from a population of randomly generated individuals. In each iteration, the fitness of every individual in a population calculated multiple individuals are selected from current population and modified to form a new population. The new population is used in the next iteration of the algorithm. The algorithm terminates when either a maximum no of generations has been produced or a satisfactory fitness level has been reached for the population.

The working principle of Genetic algorithm is described as

1. Choose initial population
2. Assign a fitness function
3. Perform selection
4. Perform crossover
5. Perform mutation

Repeat step 2 through step5 until stopping criteria.

Working procedure of GA

Step-1: **Initialization**

The function of Initialization in GA: Create initial population, Population size is chosen, Parameters to be optimized are encoded. This Initialization step uses the encoding method to create a random initial population by randomly generating a suitable number of chromosomes. Each chromosome represents in binary string.

Encoding

The process of representing the solution in the form of a string that conveys the necessary information. Various kinds of encoding methods are Binary encoding, Octal encoding, Hexadecimal encoding, Permutation encoding, Value encoding.

In this paper considers binary encoding to represents the chromosomes in the form of 1s and 0s.

Ex: Chromosome A-1011100010101010 Chromosome B-1111110011101010

Step-2: **Fitness Function**: Fitness function is objective function should be either minimized or maximized depending on problem specification.

Step-3 **Selection**

The main objective of selection operator is to emphasize the good solutions and eliminates the bad solutions in a population while keeping the population size constant. [3]

Some of the more popular methods are Roulette Wheel Selection, Rank Selection, Tournament Selection, Proportional Selection, and Steady State Selection.

(i) **Roulette Wheel Selection**

Selection in this method is proportionate to the fitness of individual. Higher the fitness of individual, higher the chance of getting selected. The probabilities of selecting a parent can be seen as spinning a roulette wheel with the size of the segment for each parent being proportional to its fitness. Probability of parenthood is proportional to fitness. The wheel is spun until two parents are selected. The two parents create one offspring. The process is repeated to create a new population for the next generation.

Let f1, f2,f3…fn be fitness value of individual 1,2,3…..n. Then the selection probability, Pi for individual i is defined as $Pi=\frac{fi}{\sum_{j=1}^{n} fi}$[1]

The Roulette wheel selection will have problems when the fitness values differ very much in this case the chromosomes with low fitness values will have very a few chances to select. This problem can be avoided using ranking selection.

(ii)**Rank Selection**

In rank selection, after sorting the individuals on the basis of their fitness, rank is assigned to them. The best individual gets rank n and the worst individual gets rank 1.Each individual is assigned a weight inversely proportional to the rank.

(iii)**Tournament selection**

In tournament selection, several tournaments are played among a few individuals. The individuals are selected at random from the population then those 'n' individuals compete against each other. The one with the highest fitness wins and participate in crossover. No of individuals are taken as tournament size. The selection pressure can be adjusted by changing the tournament size.

Ex: Consider 4 individuals **P,Q,R,S** are randomly selected from the population. Two are eliminated and two become the parents of a child in the next generation. Selection of parents continues until a new population is completed.

Fitness (P)>Fitness (Q)

Fitness(S)>Fitness(R)

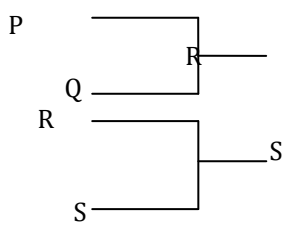

Fig1: Example of Tournament selection

(iv) **Steady state selection**

In this method a few good chromosomes are used for creating new offspring in every iteration, then bad chromosomes are removed and new offspring is placed in their places.The rest of population migrates to the next generation without going through the selection process.

(v) **Elitism Selection**

In this method, arranging the chromosomes in the decreasing order to their fitness value. Then apply the selection with each two chromosomes in the arranged set. In this method selection is between strong chromosomes or weak chromosomes. This means there is no chance to apply GA between week and strong chromosomes.

Step-4: **Crossover**

Crossover is an important random operator in CGA and the function of the crossover operator is to generate new or 'child' chromosomes from two 'parent' chromosomes by combining the information extracted from the parents.

Several possible crossover strategies

- **Single point**-In single-point crossover, a random position in the bit string is selected at which swapping occurs

  Ex: Chromosome1 **11011 | 00100110110** Offspring 1 **11011 |** 11000011110
  Chromosome2 11011 | 11000011110 Offspring 2 11011 **| 00100110110**
- **Two point**- in two point crossover, two positions are selected and segments are swapped.

  Ex: Chromosome1 **11011 | 00100 | 110110** Offspring 1 10101 **| 00100 | 011110**
  Chromosome2 10101 | 11000 | 011110 Offspring 2 **11011 |** 11000 **| 110110**
- **Uniform**-in uniform cross over individual bits are chosen at random for swapping.

  Ex: Chromosome1 **11011 | 00100 | 110110** Offspring 101**11 | 00**000**| 110**110
  Chromosome2 10101 | 11000 | 011110
- **Scattered**- in this method, creates random vector and then selects the genes where the vector is 1 from first parent and the genes where the vector is 2 from second parent and combines the genes to form the child.

Ex:P1=[a b c d e f g h] P2=[1 2 3 4 5 6 7 8] Random vector =[1 1 0 0 1 0 0 0] Child=[a b 3 4 e 6 7 8]

Step-5: **Mutation**

It operates independently on each individual by probabilistically perturbing each bit string.

The different methods of mutation are Flipping, Interchanging, Reversing.

Step-6: **Terminating condition**

Starting with initial population, the evolution process is repeated until the satisfaction of the end condition.

Different methods are used for stopping criteria are Generations, Time limit, Fitness limit, Function tolerance.

3. Problem statement

Efficient bandwidth allocation and bandwidth optimization algorithms are required to ensure QOS requirements for each type of traffic in ATM networks. Bandwidth optimization is achieved in terms minimizing the delay function. GA is optimizes to find the best values of fi such that the overall delay is minimized.

In this paper, consider fitness function is the time delay from source node to destination node,Consider ATM network model [2]

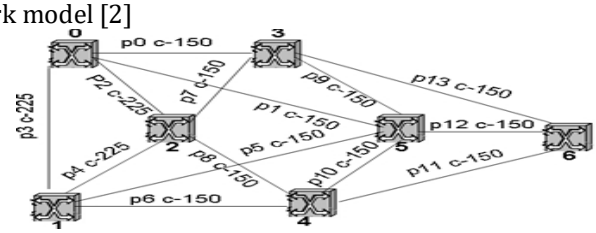

Fig2: Network model

The algorithms were applied to the network model (Fig2).The traffic matrix for the nodes is given in Table1 has been considered for the evaluation of the algorithms and the flow capacities have also been listed in the network model.

Table 1: Traffic specification

Link id	1	2	3	4	5	6	7	8	9	10
1	0	15	10	0	0	0	0	0	0	0
2	15	0	3	8	0	0	0	0	0	0
3	10	3	0	0	9	0	0	0	0	0
4	0	8	0	0	0	7	5	0	0	0
5	0	0	9	0	0	6	2	0	0	0
6	0	0	0	7	6	0	0	12	0	0
7	0	0	0	5	2	0	0	0	10	0
8	0	0	0	0	0	12	0	0	0	8

9	0	0	0	0	0	0	10	0	0	8
10	0	0	0	0	0	0	0	8	8	0

4. Results and Discussions

In this paper, consider different Selection method analysis are Roulette Wheel, Stochastic Universal Sampling and Tournament Selection. These methods are implemented using GA tool with MATLAB.

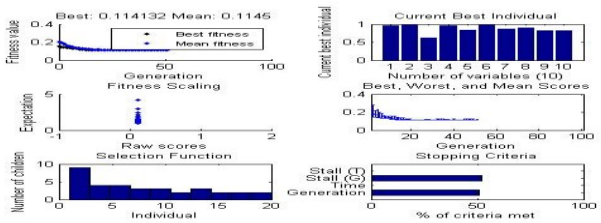

Fig3: Result of Stochastic selection method

The above graphs illustrates stochastic selection method , in this method GA uses scattered cross over rank fitness scaling ,mutation is uniform and population size is 20.the best fitness value is 0.1141

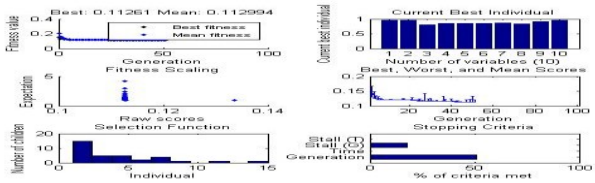

Fig4: Result of Tournament selection method

The above graphs illustrates tournament selection method , in this method GA uses scattered cross over ,rank fitness scaling ,mutation is constrain dependent and population size is 20.the best fitness value is 0.11261.

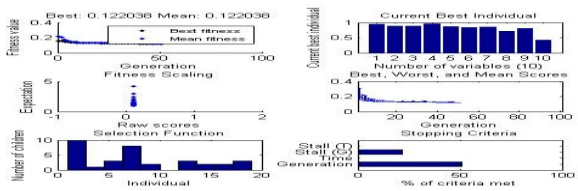

Fig5: Result Roulette wheel selection method

The above graphs illustrates roulette wheel selection method , in this method GA uses scattered cross over ,rank fitness scaling, mutation is constrain dependent and population size is 20.the best fitness value is 0.1220.

Table2: comparison of various selection methods with different population size.

Population size--→	**10**	**20**	**30**	**50**	**100**	**200**	**500**	**10000**
Stochastic uniform selection	0.1322	0.114	0.109	0.105	0.103	0.101	0.101	0.1007
Routlette wheel selection	0.1376	0.122	0.1135	0.1088	0.104	0.1024	0.1019	0.1004
Tournament selection	0.1354	0.1126	0.117	0.1052	0.1042	0.1025	0.1008	0.1003

Conclusion

In this paper discussed different types of selection methods in GA and also analyzed results with different population size. This analysis is useful for achieving bandwidth optimization in ATM networks.

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