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Deigning Chromosome Structure for Cellular Network

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Abstract— Genetic algorithm(GA) is widely fit to various kinds of problem but to fit a GA in any problem, it is important to design a good chromosome structure. It is also important to create a good fitness function which can be applicable to designed chromosome. The purpose of this article is to identify the parameter related to a cellular network and also identify how these parameters can be used to create chromosome for cellular network.

Keywords— GA, chromosome, fitness function, cellular network

I. INTRODUCTION

The whole idea of genetic algorithms is taken from the Darwin's theory of Biological gene. The genes are the important factor in natural genetic theory. Gene carries the information from one generation to other. Every generation bring some change and some common thing. The change arrives in gene due to environment and survival condition known as mutation.

Similarly the GA useful for optimization problems, is based on the Darwin's theory of "survival of the fittest." Individuals, from the population of potential solutions, reproduce and solutions are refined successively over the number of generations. The GA is used for various research problems in last two decade [4], [11].

The mobile information systems are available everywhere on earth. But it is being driven by the increasing demand to have information available for users anywhere and anytime. Due to increase in load on available radio frequency resources with the increase in mobile devices and users, the proper distribution of channels is required because the radio frequency spectrum is limited. There can be two types of channel distribution static/fixed channels and dynamic channels distribution. In fixed channel allocation, no of channels for each cell are fixed and few channels are reserved for hand off. In dynamic channel distribution, channels are allocated to each cell based on its current requirement. Further distribution can be classified as centralize or it can be distributed channel distribution. Centralized system has single central control known as Mobile Switching Center (MSC). MSC will decide how many and when should channels be assigned to each cell. Whereas, base station (BS) is an active entity in distributed system [8]. Here every base station participates for channels distribution. The rest of article organized as section II cover genetic algorithm, section III covers chromosome design, section IV show some simulation and finally conclusion is given in section V.

II. GENETIC ALGORITHM

Researchers of mobile computing have used GA [1]-[7],[10]-[13] for the channel allocation problem. Zomaya and Wright used it for channel allocation and compared it to a greedy borrowing heuristic [1]. Kassotakis et al. proposed Hybrid GA for reusing isochronous channels in multiple access telecommunication networks [12]. An evolutionary genetic DCA for resource management is proposed by Asvial et al. that aims to provide optimum channel allocation for specified interference constraints using minimum cost as a metric [13].

The general GA algorithm is given below:

```
GA( ){
Initialize population;
Evaluate population;
While termination criterion not reached
{
        select solutions for next population;
        perform crossover & mutation;
        evaluate population;  }
}
```

Every GA algorithm has four common steps: Initial population, selection, crossover and mutation. Initial population is first step in GA, It specify what are the gene structure i.e. chromosome. Then in second step selection which specify the individuals those will be moved in next step of GA. The selection process is carried through some criteria known as fitness value. Fitness value of an individual is calculated through fitness function. The crossover in GA is process of mating two individual and produce two new offspring. The mutation operation produces new gene by changing minutely

in it. This is similar to natural genetic mutation, where an animal mutate itself to fit in new climate. For example, giraffe developed its long neck so that it could eat leaves from high tree. In fig 1 the block diagram of genetic algorithm is given. As it clearly shown that GA is cyclic process where every generation bring new changes in gene which may be better result than previous generation.

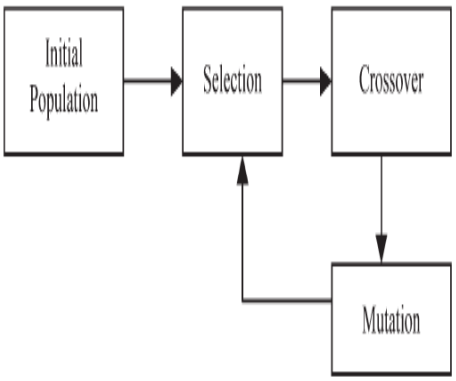

Fig 1: GA block diagram

III. CHROMOSOME DESIGN

After understanding basic GA, it is important to understand chromosome design. Chromosome for GA can be design in various ways. A chromosome may be binary or integer format but it is problem dependent. A good chromosome always reflects the actual problem. In case of cellular network it is identified that channel and sharing of channels are key factor for channel allocation problem. So we need to account number of channels in each cell with no of blocked host those are waiting for channel assignment. Chromosome of length 14 is identified in [1]-[2],[7],[10]. In fig 2 shows the arrangement of various factors in a chromosome.

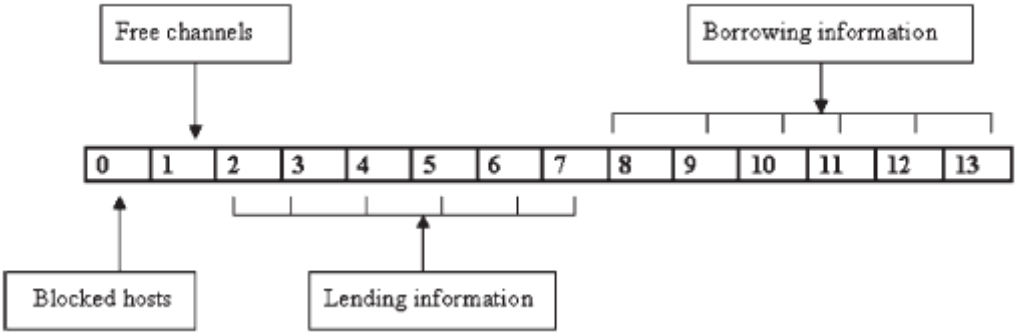

Fig 2: chromosome structure

This type of chromosome contains information regarding blocked host, second slot for free channels information, 3-7 slots for lending channels information and 8-13 slots for borrowing channels information. Each cell in the system is identified through this chromosome which has information of this system only. In addition to its information a cell need to have its neighbours' information in same format. Combination of its chromosome and its six neighbours' chromosome known as super-chromosome [1]-[2],[7],[10] which has complete information that require to balance channels in each cell. The lending information tells how many no of channels lend to its neighbouring cell (cell wise). The borrowing information tells how many no of channels are borrowed from its particular neighbour cell. In fig 3 a) show cell 1 has 11 users in it but numbers of free channels are ten. Therefore cell 1 will borrow one channel from neighbourhood to fulfil its requirement which is shown in fig 3b). Here cell 1 is borrowing one channel from cell 7.

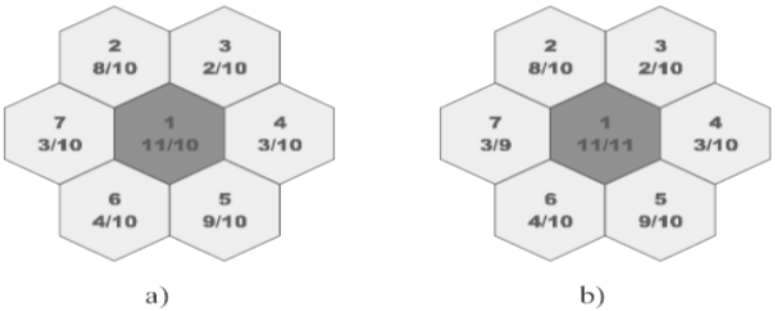

Fig 3: a)cell -1 before borrowing channel b)cell-1 after borrowing

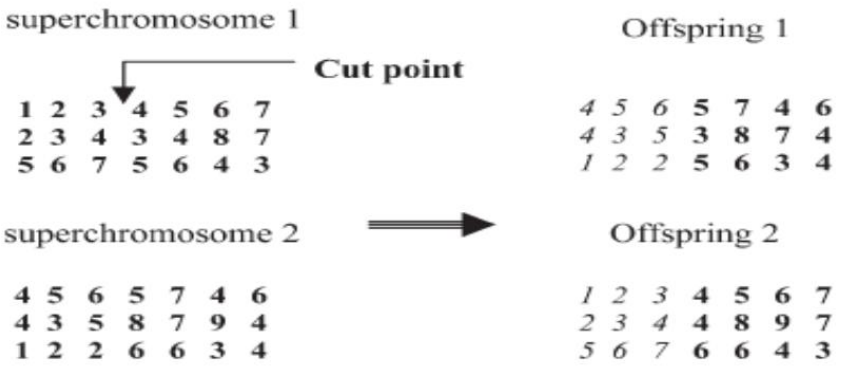

Fig 4: crossover operation

Fitness function is another important aspect to identify the goodness of chromosome. It tells the chances of survival of a population gene whether it is good to carry in next generation or not. In channel allocation there can be different fitness functions. In [1] a fitness is given by:

$$fitness = \beta * borrows + \gamma * hot\_cells + \alpha_0 * blocked\_now + \alpha_1 * blocked\_later. \quad (1)$$

The most important aspect of (1) is the term $\alpha_1 * blocked\_later$, which represents the number of hosts blocked at some future time. This could be built into the fitness function to allow the GA to find chromosomes that perform well under future load as well as current load.

The fitness function, used in [2] is as below:

$$Fitness = \alpha_c * current\_blocked + \alpha_n * next\_blocked + \beta * next\_free + \mu * hotcell + \lambda * transaction. \quad (2)$$

Here , α_c, α_n, β, μ, and λ are constant to match with environment.

Next_blocked and next_free are calculated by the behaviour variable of the cell and the host. Hot cell is taken into account when the cell has no free channel. Transaction is the number of blocked or free hosts of the cell. To include reliability in GA, the fitness function can be determined as RT (total reliability), RB and RC is given by the equations:

RT = RB x RC (3)

$$R_B = EXP\left[-\sum_{k=1}^{m}\lambda_k t_k\right]. \quad (4)$$

$$R_C = EXP\left[-\sum_{i=1}^{n}\mu_i t_i\right] \quad (5)$$

RB in the network for the session reliability of all BSs, where m is the number of BSs used in the network system for one whole session. This equation is due to the fact that the different BS with different failure rates (λ) are involved over the different time period in one session. Similarly, if the number of total channels used in one session is n, then RC is called the reliability of all these channels for that session. Where μ is the failure rate of the channel. The simple fitness function is proposed in [10]. The fitness function used in this model is as follows:

Fitness=blocked_hosts−reserved_channels−prime_channels. (6)

Here blocked_host means number of blocked host, reserved_channels means number of channels reserved for handoff. And prime_channels means channel allocated to this cell. There can be other fitness function but it should able to test chromosome how well it is.

IV. SIMULATION AND RESULTS

For simulation the different computer language and mathematical tools can be used. Number of iteration can be sufficient in number and it must be finite. System should be stopped either when system reach to maximum iteration or when there are no changes in population w.r.t. previous 5-10 generation. The test should be performed on various load mean when number of users will increase what will be the effect on system. To show the result the plot between the blocked host and generation [2]-[7], [10]-[13] can be possible. Fig 5 shows between blocked host and time[1]. Fig 6 shows graph between blocked host and clock [2] (showing graph of Fixed channel allocation and Improved Genetic algorithm channel allocation). Here author tried to compare two different algorithm FCA and IGA. The graph clearly state that IGA is giving better result than FCA A graph between reliability and generation is shown in fig 7. Reliability is increase with each generation as shown in fig 7. Here author tested the system by varying the number of mobile host 50,100,150 and 200. And last result of [10] shows in fig 8 where blocked host are plotted w.r.t. Generation number. This more common and useful plot, here it is clearly shown that number of blocked host reduced when generation no increase.

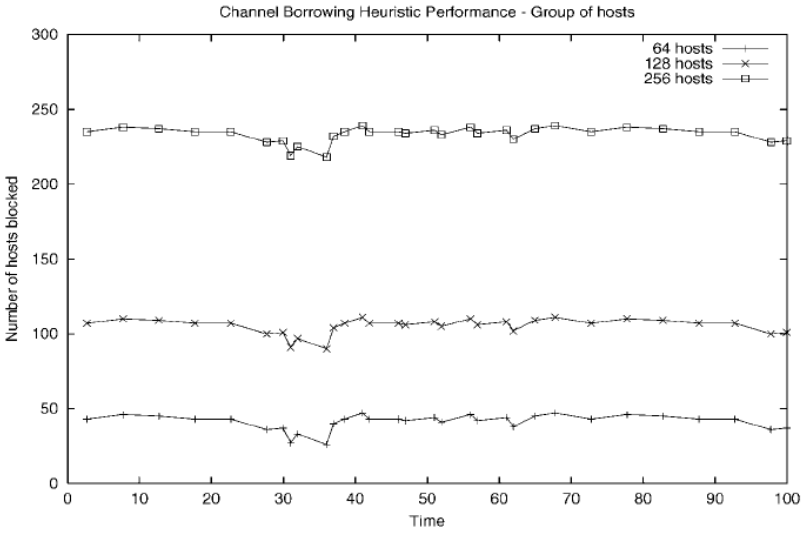

Fig 5 : graph between no. of host blocked and time

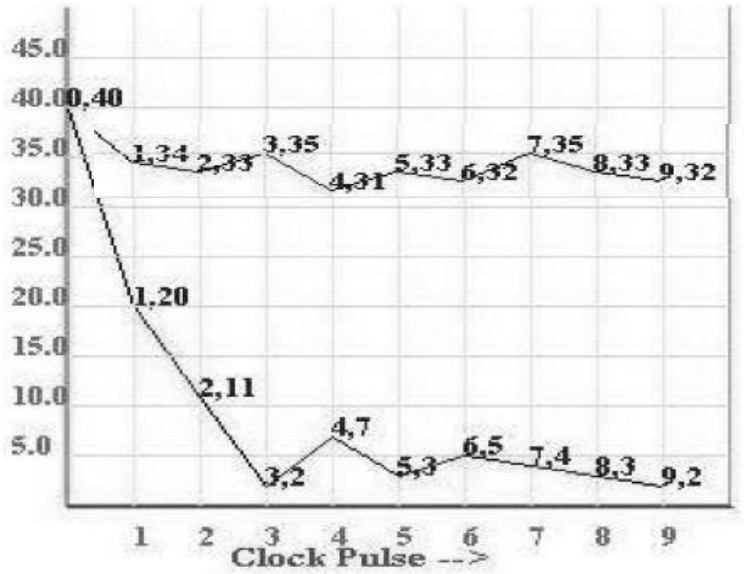

Fig 6: graph between blocked host and clock pulse

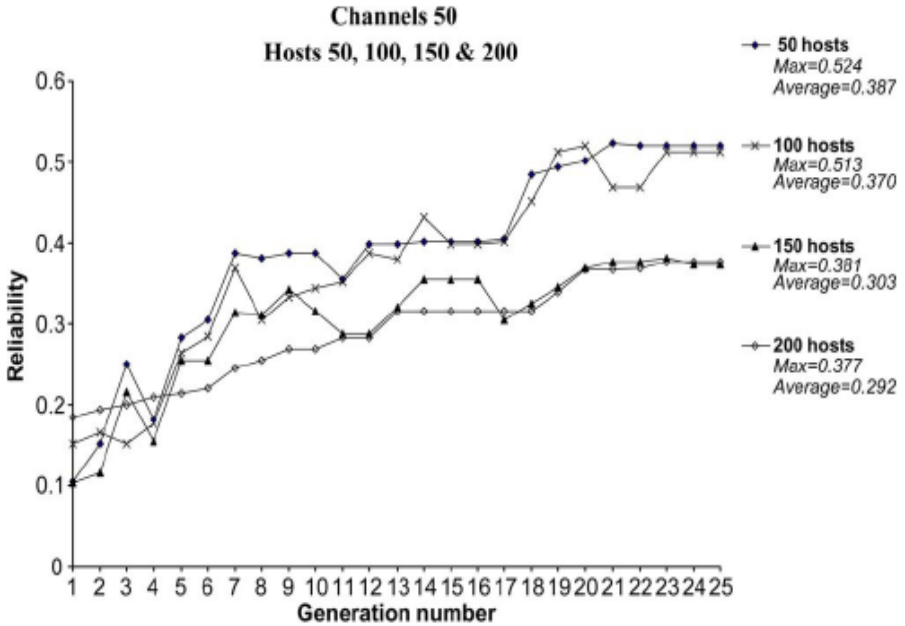

Fig 7: Graph between reliability and generation number

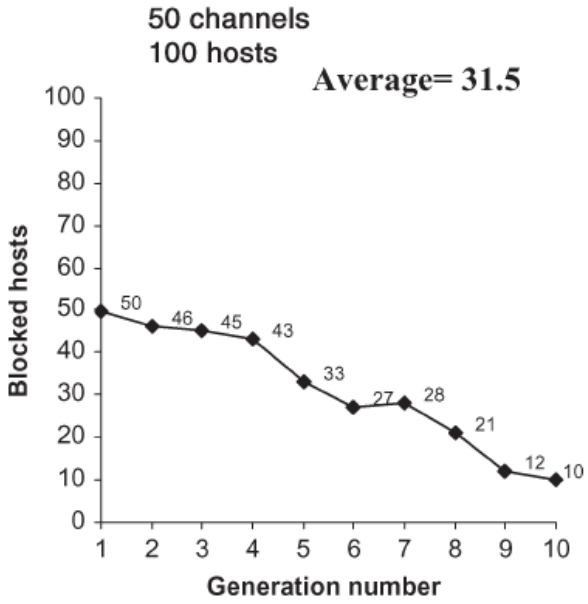

Fig 8: Graph between blocked host and generation number

V. CONCLUSION AND FUTURE DIRECTION

From this article it is concluded that a good chromosome is an essential thing to proceed with genetic algorithm. Also, it is identified how a chromosome can be structured for cellular mobile networks. This is a challenge to researcher how good chromosome is deigned and how good fitness function he has to use so that it give nearest approximate with optimum solution.

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