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New Approach to Standard Genetic Algorithm

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ABSTRACT
Genetic algorithm (GA) uses the principle of natural selection of Darwin to find the most suitable formula for prediction or pattern matching. Shortly, it is said that GA is a programming technique that uses the genetic evolution to solve a problem. The problem that should be solved is the input of evolution and its solution are encoded according to the problem. The main problem of this algorithm is that after passing through some generations, it may be produced some chromosomes that had been produced in previous generations. To from this disadvantage, All individuals in this work divided into two categories, namely, male (chromosome) and female (ovum). In crossover operation, only one chromosome and one ovum can be existed and under some conditions these two individuals recombine with each other. In this work, a new approach has been invented and the results of implementation and evaluations show the technique efficiency in proportion to standard genetic algorithm**.**

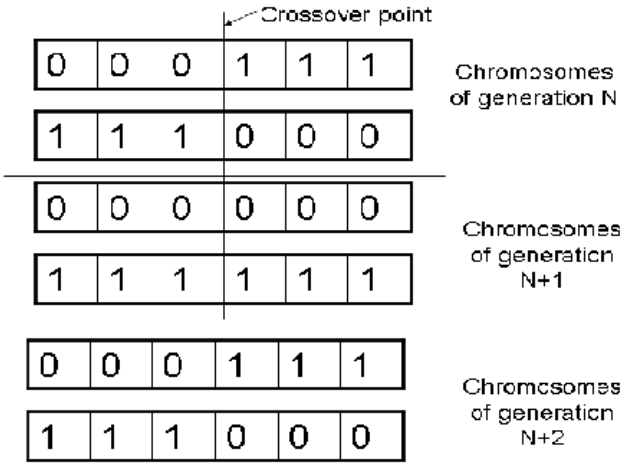
Keywords
chromosome, ovum, ancestor

1. INTRODUCTION
Genetic algorithm engine creates a primary population. Every individuals of population is evaluated based on a collection of data, namely fitness, and the most appropriate ones are selected and moved to next generation. It is observed by passing through a large number of generations GA is gone toward more exact solutions. The advantage of genetic algorithm on contrast to other soft computing methods is in significance of the final results. The technology of GA is constantly improving[1,6].

GA is a research technique in computer science to find an efficient solution. GA is also one kind of evolutionary algorithm that is inspired from the biology science like crossover, mutation, and selection[4]. In general the solution will be shown in binary but there are also other ways to show them. Evolution starts from a collection of entirely random individuals and will be repeated in the next generations. One solution of a problem is shown by a string of parameters that are called chromosome. Each parameter is also called genome. At first, several individuals are randomly generated for the first generation. In each generation each individual is evaluated by fitness function, this function completely depends on the kind of problems. The generation of the next generation from the current one is done through the genetic function including selection, crossover, and mutation. GA can be stopped according to following conditions[2,5,6].

- The optimum is reached
- Maximum number of fitness is obtained
- After a specific generation

In the GA explained above, it is observed that by passing through a number of generations, some chromosomes may be produced that are the same as the chromosomes in the previous generations. It is clear that these chromosomes are not good ones because they were deleted in the previous generations because of low fitness value. The main problem of these chromosomes is increasing calculations of each generation because GA operators are applied on chromosomes that were produced and deleted in the previous generations. This action also causes decreasing of convergence speed toward problem solutions. Assume two individuals in generation N; produce two offspring by applying crossover and mutation. Now in generation N+1, if these two offspring recombine together, it may be produced chromosomes that are similar to ones in generation N, consider the figure 1.



Figure(1). Producing of repeated chromosomes

It is clear that these chromosomes in generation N+2 are not an optimal solution because if they were the solution of problem, GA was stopped at generation N. In this paper, by using extra fields in the structure of each individual producing of these chromosomes has been avoided. The extra fields include the following characteristics.

- A field that shows the individual is chromosome or ovum.
- A field that shows each individuals has been produced from which individuals in previous generation.(father & mother)
- A field that shows individuals that constitute the current individuals have been produced from which individual in previous generation.(grandfather & grandmother)
- The parent of grandfather and grandmother of chromosome or the third ancestor of individuals.

The structure of each proposed individuals is shown in fiure2.

The reminder of this paper is divided into 3 sections. In section2, the proposed approach is described. The evaluation results of new approach are shown in section3. Finally, in last section the future work is described and some conclusions are drawn.

2. THE PROPOSED APPROACH

GA explained above has been inspired from the nature and there is this idea that the more the problem approaches the nature, the more suitable solutions are provided [1, 5, 6]. In this work, researchers have applied new approach and law on chromosomes in order to solve problem and increase the speed of convergence.

2.1 individuals' structure

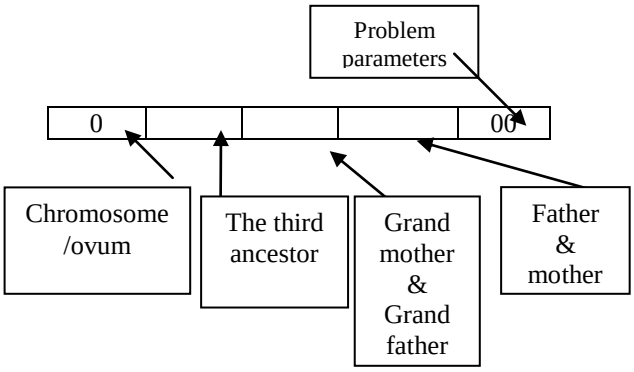
In this article we use other definitions of individuals of standard GA. We divided these individuals into two categories: ovum (female), chromosome (male). An extra field has been used to distinguish them from each other. If this bit equals 0, it indicates ovum and if it equals 1, it represents chromosome. In the crossover operation just the ovum and chromosome are recombined and there is no permission for recombination of ovum with ovum or chromosome with chromosome. Also if the produced chromosome and ovum in the current generation are produced from the same ovum and chromosome (the same parent) in the previous generation, there is no permission for crossover of these individuals in the present generation and also there is no permission to recombine of these individuals with produced ovum and chromosome from the other. So in each generation a unique number is given to each ovum and chromosome and crossover of this ovum and chromosome results in the registration of these two numbers in the produced ovum and chromosome. Using this structure, we can avoid from recombination of ovum and chromosome that are produced from the same parent or doesn't have permission for recombination.

As these ovum and chromosome have no permission to recombine with each other, there is no permission to recombine of these ovum and chromosome with offspring that are produced from another one in the next generation. To develop it, we can have put up to three stage of parent in the structure of each ovum and chromosome.

If the parent of chromosome or an ovum are the same as the other one, this shows brother- sister relationship. If chromosome parents equal the grandparent of the other ovum, this shows the uncle, aunt, niece, nephew relationships. By using these equalities we can prevent from forbidden ovum and chromosome crossover. The structure of each individual is shown in figure2.

*2.*2The Proposed GA Population

Genetic population in this work is a collection of chromosomes and ovums explained above. The primary population doesn't have any information about parents and permits any kind of ovum and chromosome recombination. The issue which we concern here is the proportion of ovum of each population to its chromosome. The results of performance and evaluation indicate that with the probability between %42 to %47 of chromosome to %53 to %58 of ovums, the rate of convergence is very high. We have used these amounts to produce ovum and chromosome in each population. The present produced population includes ovums and chromosomes that have produced from the ovums and chromosomes of the previous generation. So it should include some information like parent, grandparent, and grand grandparent or the third ancestor.



Figure(2). the structure of individuals

2.2 the proposed GA selection

In the proposed GA, we have used roulette wheel. In this article ovums are separated from chromosomes and for each group we have used a separated roulette wheel. In our approach each chromosome is able to recombine with several ovums and each ovum can only recombine with one chromosome. So in the

roulette wheel belonging to ovums, each ovum only can be selected one time, but chromosomes in the roulette wheel can be selected several times. Thus in the intermediate population each chromosome has a chance to recombine with several ovums. The simulated code of selection has been represented in algorithm1 and algorithm2.

```
Select (Chromosome)
Move Chromosome to the intermediate generation to crossover
```

Algorithm(1). Pseudo code relating to chromosome selection

```
Select(ovum)
if parent (ovum) = = parent (chromosome) OR
parent (ovum) = = grand parent (chromosome) OR
 parent (ovum) = = grand-grand parent (chromosome) OR
      chromosome = = ovum OR
     vice versa
  then
     Repeat from first line 'select another ovum'
  else
     DELETE(ovum)
     move ovum to the intermediate generation to be crossover with chor that selected in algorithm1
```

Algorithm(2). Pseudo code relating to ovum selection

First, algorithm1 selects one chromosome, after that algorithm 2 select one ovum that satisfies crossover conditions. If selected chromosomes or ovums have the following conditions, they have no permission to recombine.

- parent (ovum) = = parent (chor)
- parent (ovum) = = grand parent (chor)
- parent (ovum) = = grand-grand parent (chor)
- ovum be in the previous generations of chor
- chor be in the previous generations of ovum
- parent (chor) = = parent (ovum)
- parent (chor) = = grand parent (ovum)
- parent (chor) = = grand-grand parent (ovum)
- chor=ovum

Selection operation is done N/2 times in which N indicate the number of population of each generation. The evaluation results indicate that recombination of chromosomes and ovums that have these characteristics causes producing some individuals in some generations that also have been produced in the previous generations.

2.3 The Proposed GA Crossover

After selecting the appropriate ovums and chromosomes to recombine[2, 3, 5, 7], this algorithm is done. We have used one-point and two-point crossover in this work. The analysis of the results indicates that two-point crossover has a better rate on convergence than one-point crossover; also there is no mathematical reason for this assertion. In the crossover operation, in addition to changing the location of ancestor of ovums or chromosome fields to the next level fields, updating and probability of being ovum and chromosome have been considered too. The simulated code for crossover has been shown in algorithm3.

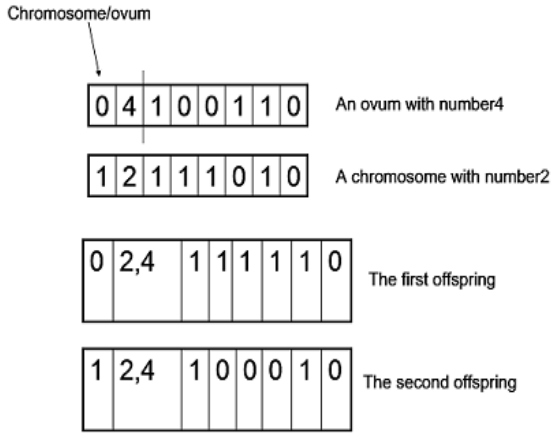
```
Childs=make new structures
Childs .gens = crossover (chromosome , ovum)
Childs. parent = chor. number U ovum. number
Childs . grandparent = chor. parent U ovum. parent
Childs . grand - grandparent = chor. grandparent U ovum. grandparent
Childs . type = Round (random(1))
```

Algorithm(3) recombination of chromosome with ovum

In this algorithm, a structure like figure 2 is created, named childs. This structure is used to produce new individuals in next generation. After creating the structure, the selected chromosomes and ovums are recombined into these structure and the following process are done to validate an individual in our approach.

- A random number between 0 and 1 is created that determines the sexual of individual.
- The numbers of selected chromosome and ovum are put in parent field of structure.
- The parents of selected chromosome and ovum are put in grandparent field of structure.
- The grandparents of selected chromosome and ovum are put in grand-grandparent field of structure.

These processes are shown in figure (3).



Figure(3).recombination operation in proposed approach

2.4 The Proposed GA Mutation

After the crossover operation, mutation is performed on the related ovum and chromosome. Mutation in this work has not difference with standard genetic algorithm and probability of mutation is 0.001.

3. THE EVALUATION RESULTS

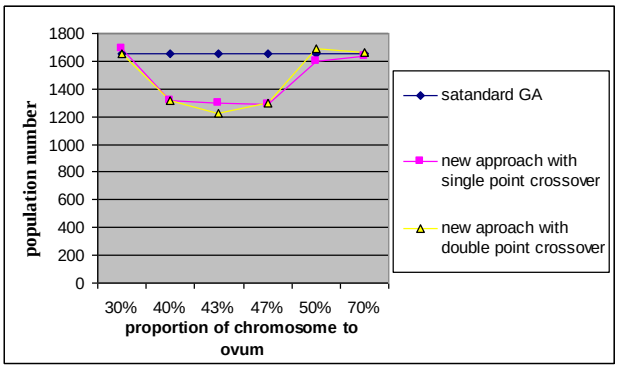
To evaluate our approach, the following objective function has been used to maximize its answer.

$$F(x) = 3\sin(x) - \cos(x) + \cos(x)\sin(x) \qquad (1)$$

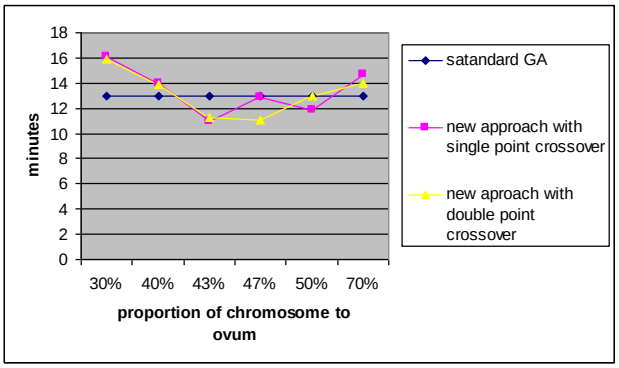
Also, we have used TSP [2] and graph partitioning [3, 4], that are NP-hard problems, to compare research approach to standard GA. We observe that in our approach the convergence speed is depending on the percents of chromosomes to ovums in population. According to this observation, the proportions of chromosome to ovum are divided into three categories.

- When the number on chromosome is %45 of the population, the most rate of speed exists in convergence and almost all the chromosomes and ovums have taken part in crossover and have an appropriate genetic diversity, because in our approach each chromosome can be recombined with several ovums.
- When the number of chromosome are more than the number of ovums. For example, when the number of chromosome is 70% of the total population, at most 30% of them have part in crossover operation and as a result 40% of the populations of the present generation have not taken part in crossover operation that causes the lower amount of genetic diversity and decrease in rate of convergence, because in our approach each ovun can be recombined with only one chromosome.
- When the number of chromosomes are less than the number of ovums. In this case, there is no specific problem in crossover because of recombination of each chromosome with several ovums. But the next generation will include ovums and chromosomes that lower the probability of their recombination permission significantly and the rate of convergence of the algorithm to reach the answer becomes low and in some problems becomes divergence.

The evaluated results of our approach with one point & two point crossover relating to formula (1) have been shown in figure4. In this figure axes y shows the proportion of chromosome to ovum and axes x shows the generation number. As it is observed, in our approach generation number to reach the solution has been decreased dramatically, specially, when the proportion of chromosome is 45%. Figure 5 shows running time of standard GA and proposed approach to solve formula (1).

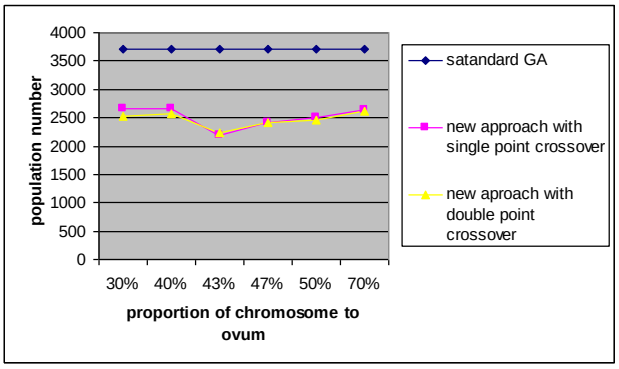


Figure(4). Reducing of population number for formula(1)

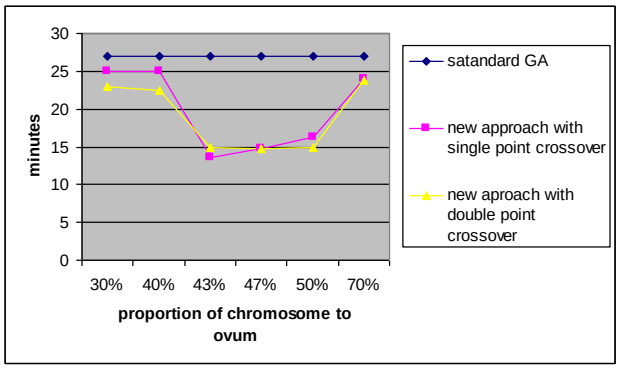


Figure(5). Reducing of running time for formula(1)

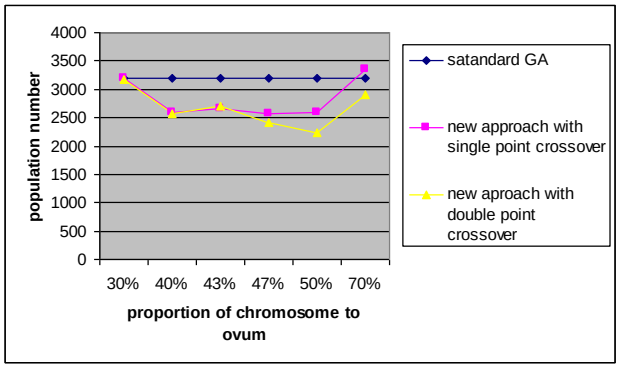
The evaluated results of TSP [2] and graph partitioning are shown in figure (6) to figure (9).



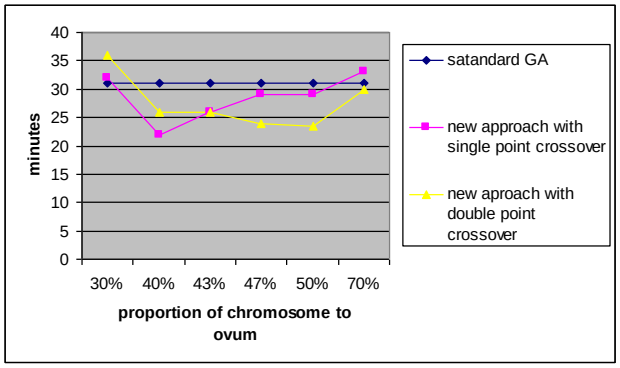
Figure(6). Reducing of population number for TSP



Figure(7). Reducing of running time for TSP



Figure(8). Reducing of population number for graph partitioning



Figure(9). Reducing of running time for graph partitioning

4. CONCLUSION AND FUTURE STUDIES

In this article improvements have been done on standard genetic algorithm. As this algorithm has been inspired from the nature, this article is also using the natural rules to improve it and has compared different populations in general conditions. One of the future activities that can be done is creating adaptable population that the number of chromosome of each population changes in different condition so as to result in more speed in convergence. Exact surveying the crossover operation, mutation and selection in nature and using these algorithms more exactly can be the future activities that can be done. Regarding this fact that mutation has a significant effect on genetic diversity and in genetic algorithm, the result of this operation is completely random. By changing this activity to another conscious activity, the pass if reaching to the efficient solution became smoother and it needs to be studied exactly.

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