Genetic Algorithm- A Literature Review

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Abstract: **Genetic Algorithm (GA) may be attributed as method for optimizing the search tool for difficult problems based on genetics selection principle. In additions to Optimization it also serves the purpose of machine learning and for Research and development. It is analogous to biology for chromosome generation with variables such as selection, crossover and mutation together constituting genetic operations which would be applicable on a random population initially.GA aims to yield solutions for the consecutive generations. The extent of success in individual production is directly in proportion to fitness of solution which is represented by it, thereby ensuring that quality in successive generations will be better. The process is concluded once an GA is most suitable for the issues that need optimization associated with some computable system.. John Holland may be regarded as funding father of original genetic algorithm and is attributed to year 1970's as funding date .Additionally a random search method represented by Charles Darwin for a defined search space in order to effetely solve a problem. In this paper, what is genetic algorithm and its basic workflow is discussed how a genetic algorithm work and what are the process is included in this is also discussed. Further, the features and application of genetic algorithm are mentioned in the paper.**

Keywords- Genetic Algorithm, Inheritance, Mutation, Selection, Crossover

I. INTRODUCTION

One may consider the biological evolution aspect and Natural selection theory as basis of defining genetic algorithm, with application for search optimization in computing and artificial intelligence Large and unorganized data search is most effective using genetic algorithms. Generally complex issues which are constrained and unconstrained are effectively solved using genetic algorithm. Genetic algorithm is mostly used for machine learning and problem optimization purposes and many others also. Optimization is the technique to make something better than other technique .In optimization some sets of input are provided and based on the input we get the output.

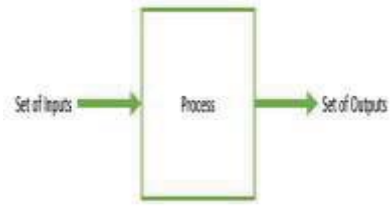

Fig. 1. Processing of a Data

In optimization we need to give insert in way so that it can provide the "best" output. The precision of "best" depends on the different types of the problem [3]. If we consider mathematical terms, it refers to minimizing or maximizing more than one object functions, by supplying different input guideline. The set of all possible inputs and values provider the possible solution to make up the search space. In this search space, there are point or more than one point lies which give the optimal solution. The focus of optimization is to discover that point or set of points in the search space.

II. LITERATURE REVIEW

Genetic algorithm is of great use in order to find out shorted path by application of path encoding in graph converting into chromosomes. The approach was well tested by gen metal (1997) for a wide size range of nuclear (6 to 70) and from varied edges (10 to 211).The final result by the application of genetic algorithm can be used to find optimal result instantly and with a very high accuracy.

Application of genetic algorithm as a method of search for optimization problem in diverse manner was examined by Jang Sung Chun (1998). Evolutionary algorithm and genetic algorithm were compared on varied problems of optimization and the outcomes resulted the outer performance of genetic algorithm.

III. GENETIC ALGORITHM AND ITS WORKFLOW

Genetic Algorithms (GAs) are generally search based algorithms established on the concepts of natural selection and heredity. GA is a sub division of a much bigger area of computation which is called as Evolutionary computation. In GAs, for a given problem, we have a varied and numerous solutions.

The solutions obtained then go through recombination as well as process of mutation (similar to biological genetics), lead to generating new offspring's and the process get replicates for multiple generations [4]. Each single is given a unique fitness vale which is decided by the value of its objective function and the individuals who are more fir have a greater possibility of mating to produce further Fit individuals. This process ensures to create Fitter individuals or better solutions in succeeding generations, which continues till it reach final destination criterion.

Genetic algorithms to a great extent are probability based criterion in nature, on the contrary they work well as against local random search (Which uses random solutions, unable to identify best possible solutions), due to the fact that historic data gets into it making it complex and sophisticated in nature

Operations perform in GA:

- Selection
- Crossover
- Mutation

a) Selection (Encoding of a Chromosome)

A chromosome will be in a format that hold information related to solution that it personify. Widely used way of encoding is a binary string format. After that chromosome will look like this.

Chromosome 1 1101100100110110

Chromosome 2 1101111000011110

Fig. 2. Chromosomes

Every one of the chromosomes can be plot by a binary string. Each of the bit accommodate in the string is also responsible containing some aspects or standard of the solution.

b) Crossover

Once we are confirmed on the selected coding to be used, we can move forward to crossover operation. Crossover functions on part portion of genes from parent chromosomes which results in creation of a new offspring [5]. The simplest process for this to be executed is the selection of a crossover point in random manner, taking range from first parent point till this point . The illustration of cross over point cab be shown as below diagram:

Chromosome 1	11011 | 00100110110
Chromosome 2	11011 | 11000011110
Offspring 1	11011 | 11000011110
Offspring 2	11011 | 00100110110

Fig. 3. Crossover of Chromosome

There are many different ways to make crossover, like as we can select many other crossover points. Crossover can be more complex and intricate. It depends mainly on encoding of chromosome. For improving the performance of genetic algorithm select crossover for the special problems.

a) Mutation

After the crossover is performed, next step is mutation. Mutation is deliberate to stop falling of all solution in the population into a local optimum of the solved problem. Offspring results from crossover randomly changes by mutation operation. In binary encoding, we can switch some randomly selected bits from 0 to 1 or 1 to 0.Mutation can be adorn as given below:

Original offspring 1	1101111000011110
Original offspring 2	1101100100110110
Mutated offspring 1	1100111000011110
Mutated offspring 2	1101101100110110

Fig.4: Mutation of Offspring

The process of mutation (as well as crossover) totally depends on the encoding of chromosomes.

b) Crossover and Mutation Probability

Genetic algorithm consist of two basic parameters namely crossover probability and mutation probability.

c) Crossover probability

This may be attributed to the extent of frequency of crossover. If offspring's are duplicate of parents that means there is no crossover. In case of crossover, the two part of parent's crossover result into an offspring. A probability of 100% will be there for offspring from crossover. On the other hand, if whole of new generation is produced as carbon copy of chromosomes from earlier population (doesn't necessarily indicate that new generation will be same) then it will be 0%.Basically crossover is done so that chances of new chromosomes consisting of good character of the old chromosomes so that new crossover will be batter then old one.

It is batter to left some portion of old population in order for survival till the next generation.

d) Mutation probability

It may be described as the chance of chromosome parts to get mutated. In the absence of mutation, offspring are produced with no change immediately preceding crossover.

The value of mutation probability is in direct proportion to chromosome change. If value is 100%,
then there would be whole chromosome change, for 0% value no chromosome change is there. Mutation process helps in preventing GA from the downfall into local extremes [6]. The frequency of occurrence of mutation should be low, otherwise GA will transform into a random search

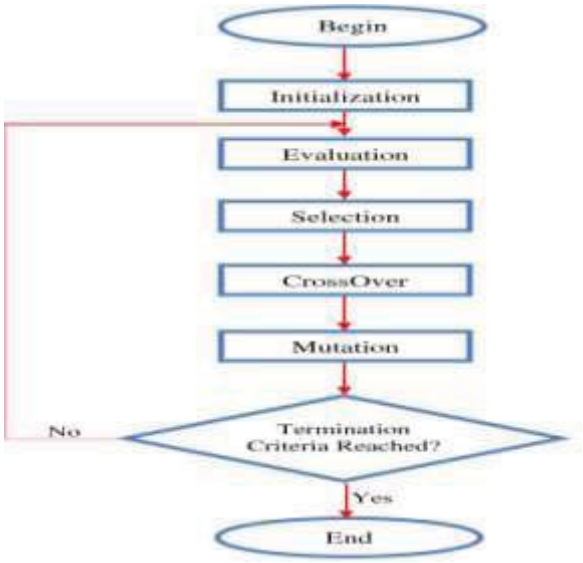

Fig. 5. Genetic Algorithm Flow Chart

First step aims at certain of the initial population and after that analyzing fitness factor of all the chromosomes by the application of fitness function.
Seceding first step, chromosomes possessing fitness values similar to threshold will be selected as next generation parent.noe check this criteria, if it lies within the specified criteria then we need to stop, else any of two strings can be selected from initial population and after that crossover can be performed on it leading to offspring formation and again checking the criteria of star function, if yes then we need to stop, else the process need to be continued until the problem is solved satisfactorily.

IV. ADVANATGES

A number of advantages made GAs to be applicable in multiple areas -

- No need of Imitative information (which don't exist for most of the real life problems)
- A more comprehensive and optimum in comparison to the primitive methods
- Possess a well aligned capabilities
- Enhancing both continuous as well as distinct functions along with multi-purpose problems
- Aims at delivering Best solutions instead of a single solution
- Having a satisfactory answer for the problems, which improves with time
- Works best in cases of large search space area possessing multiple parameters into it.

V. APPLICATIONS

A. *Network Routing Protocol-*

By using optimum coding scheme, route for shortest path can be found for Length of chromosomes is directly proportional to quantity of nodes for a network. By using Dijkstra's algorithm. Search can be done for optimal and shortest path using MATLAB environment. The algorithm effectively solved 10 nodes network as source node for first time. Additionally for tackling same problem developed GA is used. The results obtained were same as using Djikstra's algorithm signifying the potential of this proposed algorithm. For future applications, more research need to be done on decreasing chromosome length for developed GA especially for cases involving multi node networks [8].

B. *Image Processing-*

Image processing is critical area where genetic algorithm proved to be a boon and it is deemed to the
most successful technique for large space Multiple variables ranging from image contrast, enhancing detail to advanced filters and deformable parameters are effectively solved by application of this paradigm. A comprehensive and vigorous search can be performed using this algorithm eradicating trap in local extremes and also to derive optimum global search results. Optimization results are dependent upon chromosome encoding patterns, involvement of fitness function as well as genetic operators. However, image segmentation quality can be enhanced by parameter selection in an optimized manner. Image enhancement denotes better digital image quality, which is not concerned with source of degradation

C. *Data Mining-*

Inventory management is one of the critical areas in supply chain management. Several methods in inventory management can be used supply chain cost by effectively controlling the inventory, thereby ensuring that members of supply chain won't be affected by discrepancies in stock levels which may be short or excess. One of the major issues is drastic change in stock level while considering the implementation. This paper aims at finding optimum approach in order to minimize supply chain cost

D. Computer Games-

Genetic algorithm finds its application for computer games. It creates a realistic experience for players, main aim for player is to discover sequence of steps which if repeated in different games, will create a winning situation for players, there won't be any challenge. On the contrary, by using genetic algorithm technique effectively player can avoid repetition of past mistakes, the game would be more popular among other players.

Genetic algorithms require the following components:

- The way for displaying challenges expressed in the form of solutions (Like Synchronizing soldiers for an attack in a strategy based game)
- A function based on evaluation or fitness to know the quality of an occurrence (example computation of destruction done to opposition in such situation of attack)

In order to measure the quality for an entity the fitness function incorporates a mutated function, which in-turn can be customized to the issue domain. In many instances specially containing code optimization, the fitness function can be attributed as system timing function. After defining Fitness function as well as genetic representation, a genetic algorithm will incorporate initial members which were discussed previously, and after that improving with the mutation application in a repetitive manner, crossover, reversal and selection operators (synonymous to the problem domain)

Practical obstacles and challenges of Genetic Algorithm:
Despite of having multiple useful hypothetical cases found to be efficient for optimum solutions for cell formations problems, the practical aspects instead of theoretical approach , genetic algorithm use is still not clear [9]. Feedback from industrial engineers and researchers shows a big gap. Below are some important points to realize practical blockades and challenges encountered by industrial engineers and researchers for bridging this gap

1. GA output may be considered as an approach on probability and there is a not standard set rule governing GA .This shows that solution is not guaranteed as per our requirement. Instead, we need to consider that whatever solutions we get are best possible which are delivered by GA

2. Multiple variable parameters work with random numbers in GA .For example probabilities of crossover and different types of mutation, probability of selection and method of selection and number of iterations.

3. An advantage as well as disadvantage of GA is that it aims at solving through evolution. Evolution is not in uni-direction, for natural life it evolves away from bad situation and not towards a good solution. It can lead to evolution of species into evolutionary dead end. GA can provide sub-optimal solution and we not be aware of it.. Convergence principle is a big phenomenon in GA For example in order to start GA search by giving an input by user for getting results, certain values are obtained which are the optimal solution at that particular point of time. This too proves to be a major setback. But the result obtained may not be the optimal one and better results could be possible in real life situation

The cause is that, sometimes in a search process of GA there may be a local optimal point as descent in the local optimal point it can't go further to search for global optimal. Which is actually required by us. This property of descent within the local optimal space is known as convergence. This is a pitfall in GA searching procedure

VI. CONCLUSION

Theoretical concepts of Genetic Algorithms are discussed in detail in the introduction part initially. It is analogous to biology for chromosome generation with variables such as selection, crossover and mutation together constituting genetic operations which would be applicable on a random population initially. The genetic algorithm may be described as a population oriented search and optimization approach that resembles the natural evolution process. Genetic algorithm functioning is closely effected by two main natural evolution concepts – First in natural selection and other is genetic dynamics involving different genetic operations like crossover, mutation etc. Genetic Algorithms are highly applicable in immeasurable applications like Search, Optimization, Decision Making, Machine Learning, Robotics and many more .In this paper we discussed the basic work flow chart of genetic algorithm and all the function of it in detail after that some advantages of using genetic algorithm are discussed and some genetic algorithm application are discussed and in last the issues and challenges are discussed.

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