Lesson 3: Genetic Algorithms in AI

3.1 Introduction

A genetic algorithm is used to solve complicated problems with a greater number of variables & possible outcomes/solutions.

The combinations of different solutions are passed through the Darwinian based algorithm to find the best solutions.

The poorer solutions are then replaced with the offspring of good solutions.

It all works on the Darwinian theory, where only the fittest individuals are chosen for reproduction. The various solutions are considered the elements of the population, and only the fittest solutions are allowed to reproduce (to create better solutions). Genetic algorithms help in optimizing the solutions to any particular problem.

The whole process of genetic algorithms is a computer program simulation in which the attributes of the problem & solution are treated as the attributes of the Darwinian theory.

3.2 Working on Genetic Algorithms

The working of a genetic algorithm in AI is as follows:

- The components of the population, i.e., elements, are termed as genes in genetic algorithms in AI. These genes form an individual in the population (also termed as a chromosome).
- A search space is created in which all the individuals are accumulated. All the individuals are coded within a finite length in the search space.
- Each individual in the search space (population) is given a fitness score, which tells its ability to compete with other individuals.
- All the individuals with their respective fitness scores are sought & maintained by the genetic algorithm & the individuals with high fitness scores are given a chance to reproduce.
- The new offspring are having better 'partial solutions' as compared to their parents. Genetic algorithms also keep the space of the search space dynamic for accumulating the new solutions (offspring).
- This process is repeated until the offsprings do not have any new attributes/features than their parents (convergence). The population converges at the end, and only the fittest solutions remain along with their offspring (better solutions). The fitness score of new individuals in the population (offspring) are also calculated.

3.3 Key Terminologies in Genetic Algorithms

3.3.1 Selection Operator

This operator in genetic algorithms in AI is responsible for selecting the individuals with better fitness scores for reproduction.

3.3.2 Crossover Operator

The crossover operator chooses a crossover site from where the merge will happen. The crossover sites in both the individuals available for mating are chosen randomly and form new individuals.

3.3.3 Mutation Operator

This operator in the genetic algorithm is responsible for embedding random genes in the offspring to maintain diversity and avoid premature convergence.

3.3.4 Premature Convergence

If a problem is optimized quickly, it means that the offspring were not produced at many levels. The solutions will also not be of optimal quality. To avoid premature convergence, new genes are added by the mutation operator.

3.3.5 Allele

The value of a particular gene in a chromosome is termed as an allele. The specified set of alleles for each gene defines the possible chromosomes of that particular gene.

3.4 Benefits and uses of Genetic Algorithm

Some of the benefits and uses of genetic algorithms are:

1. The solutions created through genetic algorithms are strong & reliable as compared to other solutions.
2. They increase the size of solutions as solutions can be optimized over a large search scale. This algorithm also can manage a large population.
3. The solutions produced by genetic algorithms do not deviate much on slightly changing the input. They can handle a little bit of noise.
4. Genetic algorithms have a stochastic distribution that follows probabilistic transition rules, making them hard to predict but easy to analyze.
5. Genetic algorithms can also perform in noisy environments. It can also work in case of complex & discrete problems.
6. Due to their effectiveness, genetic algorithms have many applications like neural networks, fuzzy logic, code-breaking, filtering & signal processing.

Lesson 3: Review Questions

1. Discuss the basic processes which are involved in genetic algorithms.
2. Describe how a genetic algorithm works. Use an example
3. Compare genetic algorithm with other algorithms used in AI.