Genetic algorithm

Genetic algorithms, introduced by John Holland [REFERENCE: http://www.csjournals.com/IJITKM/PDF%203-1/55.pdf] in [YEAR], belonging to the class of evolutionary algorithms are meta-heuristics based that imitate the biological process of reproduction and natural selection [REFERENCE: https://www.whitman.edu/Documents/Academics/Mathematics/2014/carrjk.pdf]. These algorithms are commonly used on search problems and functions optimizer, and it has been applied in a broad range of known problems [REFERENCE: https://link.springer.com/article/10.1007%2FBF00175354]. One of the greatest barrier of software design, that is to fully understand the structure of complex problems can be solved mimicking natural selection, the specification of every feature of the problems and how to deal with them are not an impediment to search for a solution using this approach. [REFERENCE: https://www.jstor.org/stable/24939139?seq=1#page\_scan\_tab\_contents].

Given its nature, genetic algorithms has been used to find solution for hard problems, like the Travelling Salesman Problem (TSP), VRP, ARP [REFERENCE: ???] and many other problems that due to its complexity don’t have an algorithm to give exact solutions. This is possible because these algorithms tends to explore a far greater range of potential solutions in the search space [REFERENCE: [https://www.jstor.org/stable/24939139?seq=1#page\_scan\_tab\_contents](https://www.jstor.org/stable/24939139?seq=1" \l "page_scan_tab_contents)].

Because genetic algorithms are based on biological evolution, the terminology used are the same as the one used in biology, although representing fairly simpler concepts than their biological counterpart. To move forward on understanding genetic algorithms, a few concepts with its nomenclature must be defined, this are the most common components find in most genetic algorithms implementations:

* Gene: each piece that compounds a chromosome;
* Chromosome: is a candidate solution for the problem, is the representation of the phenotype on a data structure that can be understood by the algorithm;
* Fitness function: a function to measure the fitness of a solution, this is the function that must be maximized or minimized depending on the algorithm objective;
* Population: a set of chromosomes that are used to evolve to the next population;
* Crossover: combination of chromosomes to generate offspring for the next generation;
* Mutation: random changes of genes in the chromosome.

Parameters:

* Population size
* Mutation rate
* Crossover rate

In principle, a population of individuals selected from the search space, often in a random manner, serves as candidate solutions to optimize the problem [3]. The individuals in this population are evaluated through ("fitness") adaptation function. A selection mechanism is then used to select individuals to be used as parents to those of the next generation. These individuals will then be crossed and mutated to form the new offspring. The next generation is finally formed by an alternative mechanism between parents and their offspring [4]. This process is repeated until a certain satisfaction condition [REFERENCE: Selection Methods for Genetic Algorithms].

# Initialization

The implementation of a genetic algorithm begins with a population with random chromosomes. The size of the population depends on the previous selected size for the population. This size is preserved through the entire life of the algorithm. The initialization can be done totally random or applying some previous knowledge of the problem, in this case, some chromosomes can be included with known genes that makes sense to the problem [REFERENCE: http://www.csjournals.com/IJITKM/PDF%203-1/55.pdf], this can lead the algorithm to converge faster to areas where optimal solutions are more likely to be found. From this early step, the evolutionary process begins.

# Selection

A subset of the population is then selected and will be used to breed a new generation, that said, this step is critical since it need to select good individuals trying to keep the diversity of the selected chromosomes. The subset size is also a parameter that need to be set into the algorithm and no size is specified.

The selection step can take place using a variety of techniques. Some methods focus on the fitness of the individual, where chromosomes with best fitness are the one to be selected. Other methods are based on randomness selection or combination of these techniques. No method is guarantee to be the best one, and the choice must be problem specific.

There are many selection methods, the most known and used are roulette wheel and tournament selection [REFERENCE: https://www.ijecs.in/index.php/ijecs/article/download/2562/2368/]. To give a brief explanation of the different selection methods, and how they work, some of the most studied selection are shown below.

# Reproduction

1. Crossover
2. Mutation

# Termination

The word fitness come from the evolutionary theory [REFERENCE: https://www.whitman.edu/Documents/Academics/Mathematics/2014/carrjk.pdf].