

## Assignment 4 – Problem 3

Discuss how genetic algorithm is different from genetic programming.

### Genetic Algorithm:

GA, which is a subset of Evolutionary Computation is a metaheuristic algorithm used mostly for optimization problems. It is inspired by the biological evolution-mutation, selection, reproduction. These algorithms are population-based, fitness oriented and variation driven.

They represent an approach where a search is made to “evolve” a solution to the optimization problem and this solution will retain the “most fit” elements of the population. The approach has 6 phases- Initial population, Fitness calculation, Selection, Crossover, Mutation, Termination.

We choose a population where each individual is a solution to the chosen problem. Their fitness scores are calculated, and pairs of individuals are selected. A crossover point is selected, and these pairs are allowed to crossover. The resultant individual is mutated, which results in a change of gene value. This process is stopped when a terminating condition is met.

### Genetic Programming:

GP is also a subset of Evolutionary Computation. It is a heuristic search whose goal is to select a suitable program from a population of programs. And this selection is based on their fitness which is calculated by the ability to solve a computational problem. These selected programs are genetically reproduced through genetic operators- crossover, mutation. For example, replacing a part of program with a random part of another program. New generation programs are generated every iteration, and this is stopped when a pre-defined criteria is met.

### Differences:

- Individuals: GP differs from GA in terms of individuals in population. They are a bunch of solutions in GA whereas in GP, they are individuals(programs) when executed produce solutions.
- Representation: The major difference between Genetic Algorithm (GA) and Genetic Programming (GP) is the representation of the algorithm/program. GA is represented as a binary string of 0 and 1.

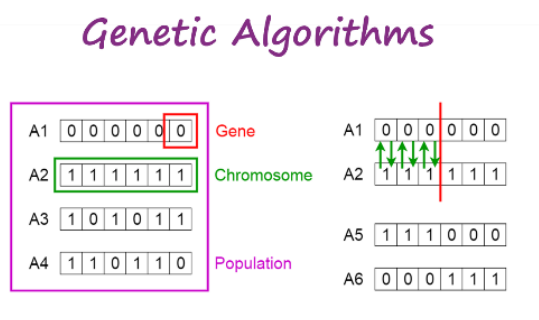


Image source: [towardsdatascience](https://towardsdatascience.com/genetic-algorithms-a-beginners-guide-to-evolutionary-computation-1a1e1e1e1e1e)

In GP, programs are represented as trees (nested mostly) in memory.

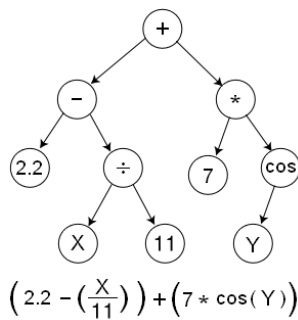


Image source: [Wikipedia](#)

- Size: Chromosomes of GA are of fixed length, they are bounded, whereas programs in GP are not fixed, they are flexible, and they can grow.
- Shape: GA have a fixed shape chromosomes but chromosomes (programs) in GP are represented as trees and hence have different shapes.
- States: Probability of invalid states occurring is more in GA and these must be handled whereas GP doesn't produce invalid states that often.
- Precedence: GA rely on operator precedence, but GP avoid these with their special structure.
- Usage: GA are used for optimizing parameters of solutions when their structure is known. GP is often used to discover both content and structure of solutions.