

# **GENETIC ALGORITHMS**

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# DEFINITION

*In computer science and operations research, a genetic algorithm (GA) is a metaheuristic inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on bio-inspired operators such as mutation, crossover and selection.*

# IDEA

In a genetic algorithm, a *population of candidate solutions* (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a *set of properties* (its chromosomes or genotype) which can be *mutated and altered*.

A typical genetic algorithm requires:

1. A genetic representation of the solution domain
2. A fitness function to evaluate the solution domain

# BUILDING BLOCKS

1. Initialization
2. Selection & Genetic operations
3. Termination

# INITIALIZATION

Initialize a population of solutions. Often, the initial population is generated randomly. Solutions may be "seeded" in areas where optimal solutions are likely to be

# SELECTION & GENETICS

Portion of the existing population is selected to breed a new generation.

Individual solutions are selected through a fitness-based process, where fitter solutions (as measured by a fitness function) are typically more likely to be selected.

Improve solutions through repetitive application of mutation, crossover, inversion and selection operators.

## FITNESS FUNCTION

The fitness function is defined over the genetic representation and measures the quality of the represented solution. The fitness function is always problem dependent.

In some problems, it is hard or even impossible to define the fitness expression; in these cases, a simulation may be used to determine the fitness function value of a phenotype.

## RECOMBINATION/CROSSOVER

*... is used to combine the genetic information of two parents to generate new offspring.*

## MUTATION



*... is used to maintain genetic diversity from one generation of a population of genetic algorithm chromosomes to the next. Mutation alters one or more gene values in a chromosome from its initial state*

# TERMINATION

The algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

Common terminating conditions are:

1. A solution is found that satisfies minimum criteria
2. Fixed number of generations reached
3. Allocated budget (computation time/money) reached
4. Successive iterations no longer produce better results

# DEMO

KNAPSACK