Genetic Algorithm

- Genetic Algorithm (GA) is a search-based **optimization** technique based on the principles of **Natural Genetics** and **Natural Selection**.
- It finds the **optimal Solution**.
- It is based on **survival of the Fittest.**

Optimization

- Optimization is the process of **making something better**.

- Optimization refers to finding the values of inputs in such a way that we get the "best" output values.

Search space

- The set of all possible solutions .
- In this search space, lies a point or a set of points which gives the optimal solution.
- The aim of optimization is to find that point or set of points in the search space.

Genetic Algorithm Reproduction

- Reproduction in Genetic Algorithm is done by applying the GA Sophisticated Operators.
  - Selection
  - Cross Over
  - Mutation

Selection

- From the set of Solutions, a number of fitter individuals are selected.
- Fitness is calculated using Fitness Function/Objective Function.

Cross Over

- In this more than one parent is selected and one or more off-springs are produced using the genetic material of the parents.
- Example:: One Point Cross Over

Mutation

- Mutation is the part of the GA which is related to the "exploration" of the search space.
  - *"In Natural Genetics Mutation happens when Children have feature that are present in Non of the parents"*

The process of genetic algorithm is show in Fig.1.

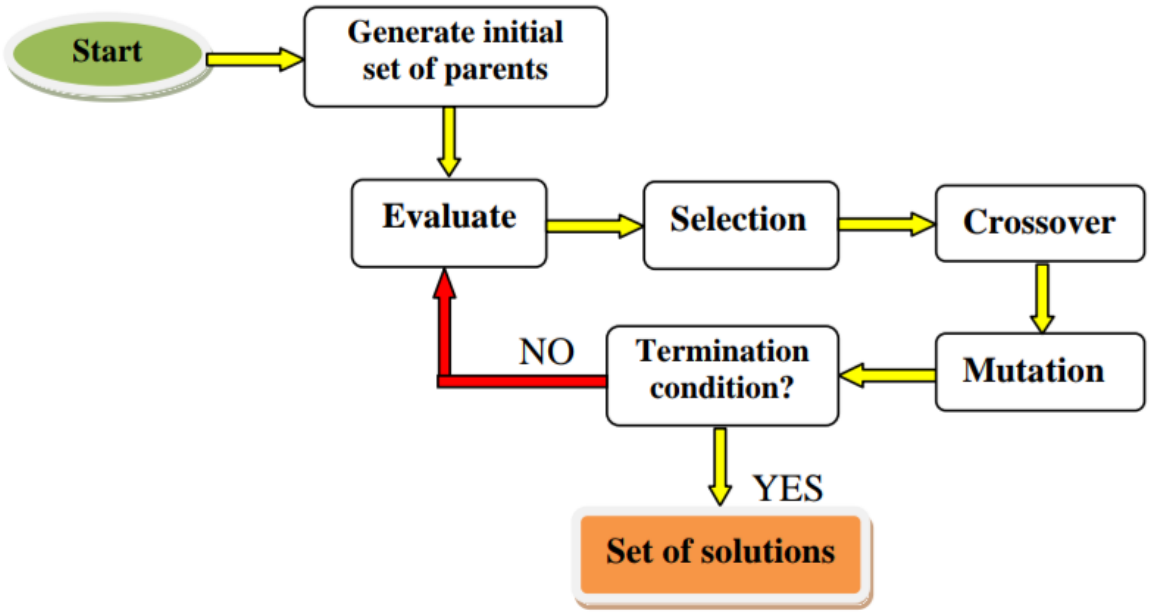


Fig.1 Process of genetic algorithm

Five phases are considered in a gen
algorithm.

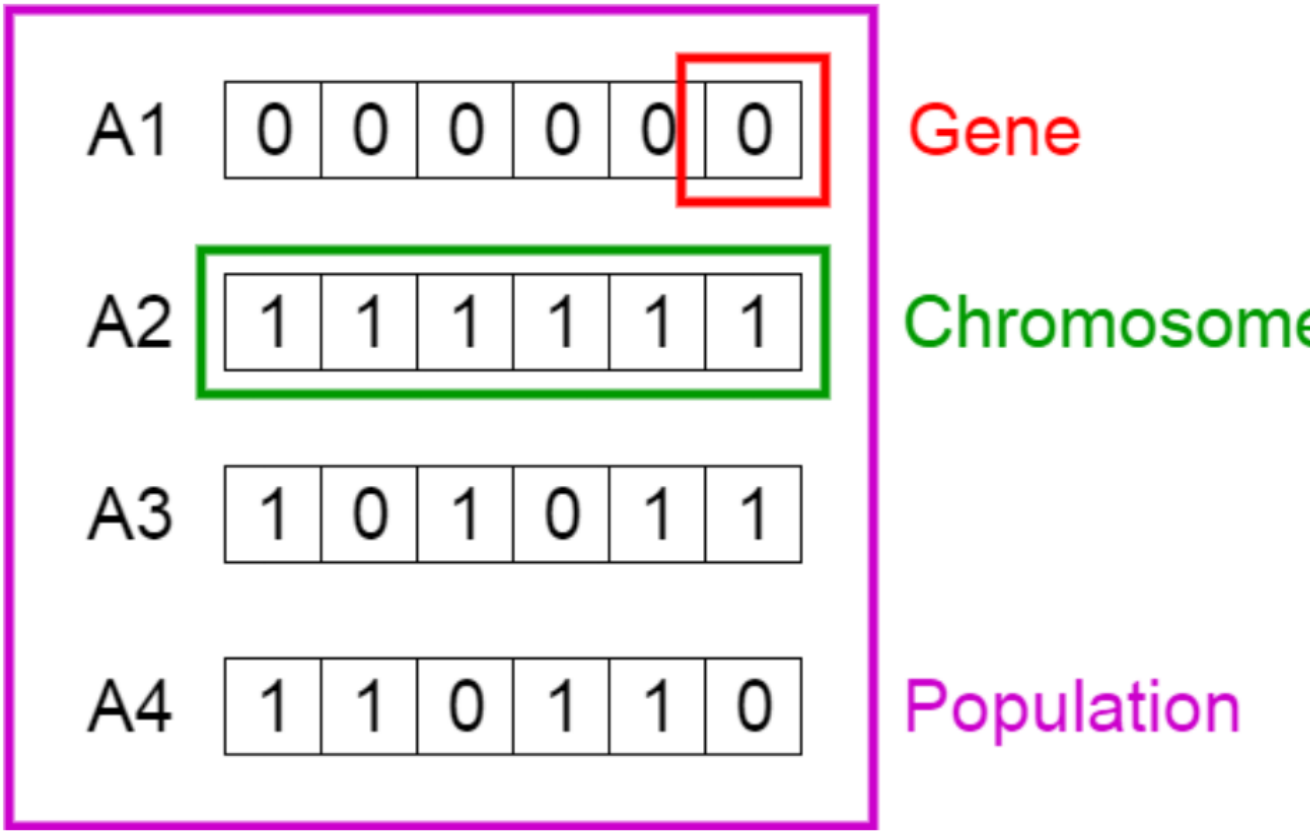
1. Initial population
2. Fitness function
3. Selection
4. Crossover
5. Mutation

Initial Population

The process begins with a set of individuals which is called a **Population**. Each individual is a solution to the problem you want to solve.

An individual is characterized by a set of parameters (variables) known as **Genes**. Genes are joined into a string to form a **Chromosome** (solution).

In a genetic algorithm, the set of genes of an individual is represented using a string, in terms of an alphabet. Usually, binary values are used (string of 1s and 0s). We say that we encode the genes in a chromosome.



Population, Chromosomes and Genes

Fitness Function

The **fitness function** determines how fit an individual is (the ability of an individual to compete with other individuals). It gives a **fitness score** to each individual. The probability that an individual will be selected for reproduction is based on its fitness score.

Selection

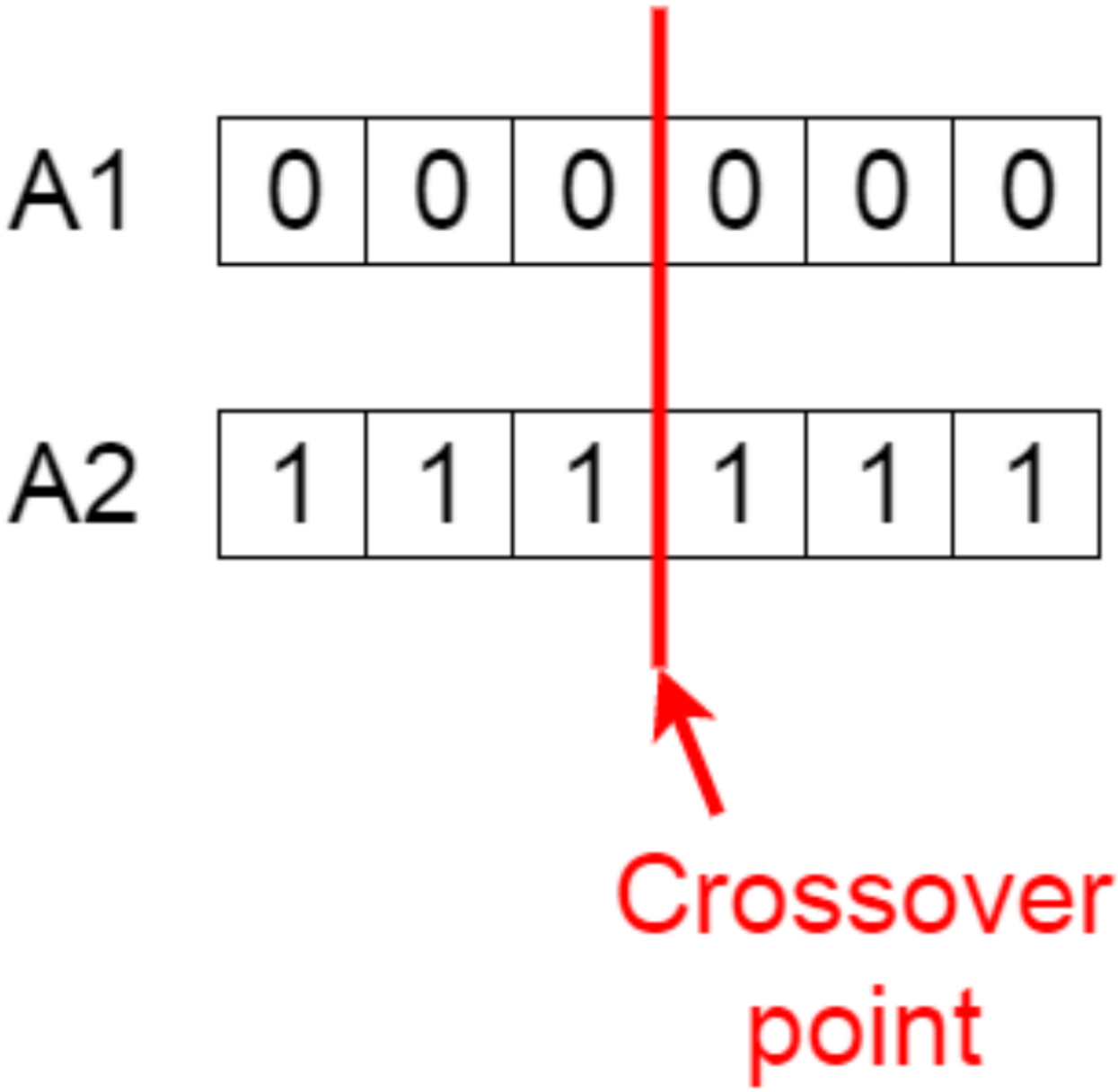
The idea of **selection** phase is to select the fittest individuals and let them pass their genes to the next generation.

Two pairs of individuals (**parents**) are selected based on their fitness scores. Individuals with high fitness have more chance to be selected for reproduction.

Crossover

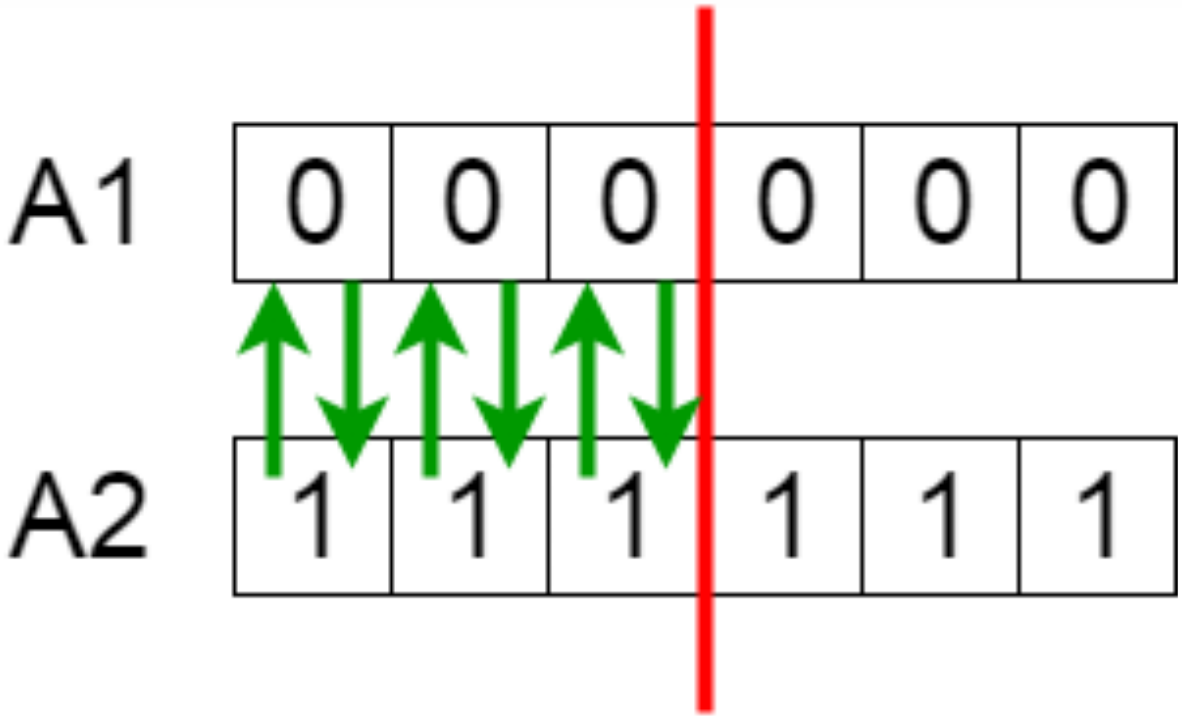
Crossover is the most significant phase in a genetic algorithm. For each pair of parents to be mated, a **crossover point** is chosen at random from within the genes.

For example, consider the crossover point to be 3 as shown below.



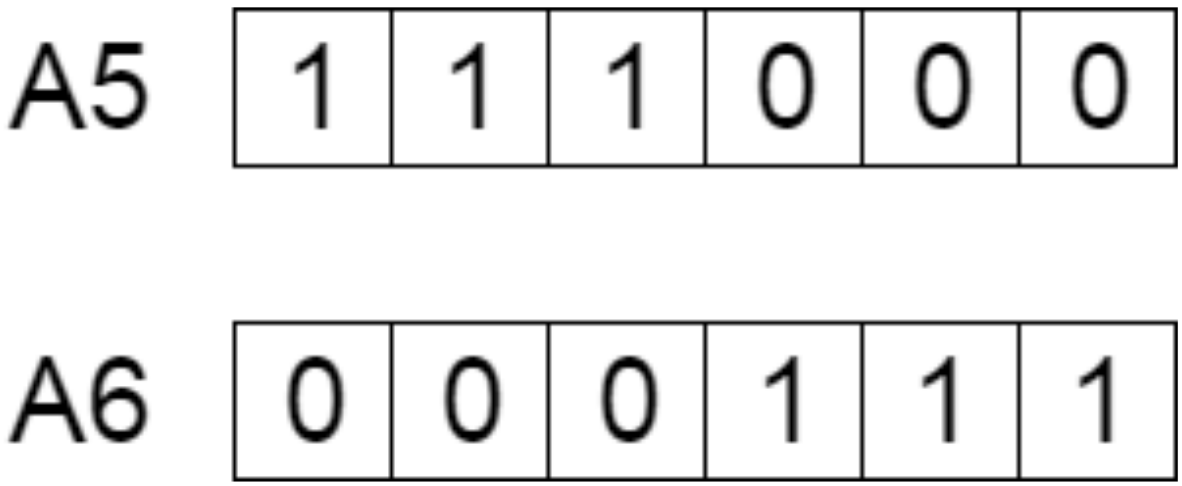
Crossover point

Offspring are created by exchanging the genes of parents among themselves until the crossover point is reached.



Exchanging genes among parents

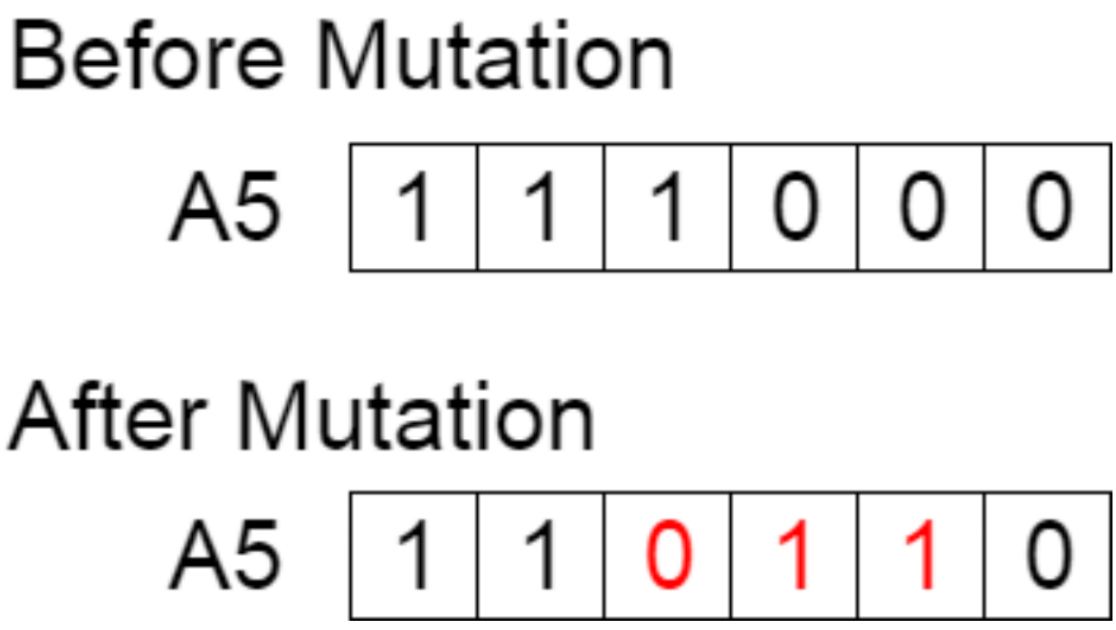
The new offspring are added to the population.



New offspring

Mutation

In certain new offspring formed, some of their genes can be subjected to a **mutation** with a low random probability. This implies that some of the bits in the bit string can be flipped.



Mutation: Before and After

Mutation occurs to maintain diversity within the population and prevent premature convergence.

Termination

The algorithm terminates if the population has converged (does not produce offspring which are significantly different from the previous generation). Then it is said that the genetic algorithm has provided a set of solutions to our problem.