

Introduction to Differential Evolution

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Differential Evolution

It is a stochastic, population-based optimization algorithm for solving nonlinear optimization problem

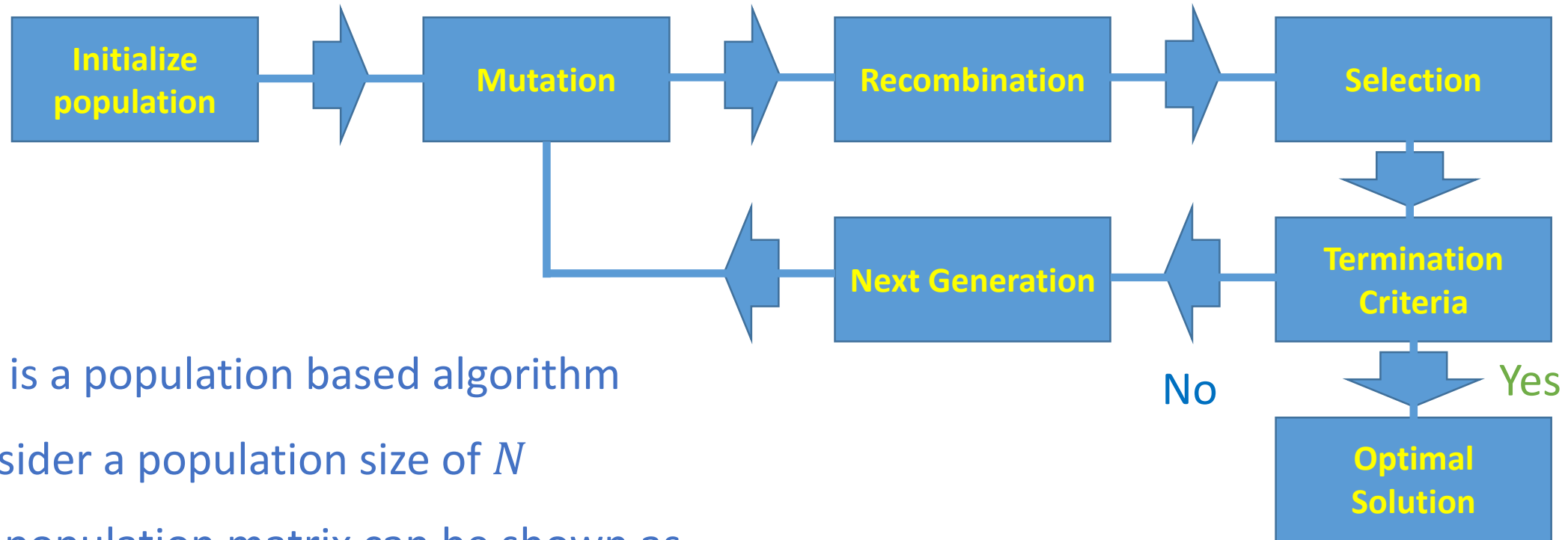
The algorithm was introduced by Storn and Price in 1996

Consider an optimization problem

Minimize $f(X)$

Where $X = [x_1, x_2, x_3, \dots, x_D]$, D is the number of variables

Evolutionary algorithms



This is a population based algorithm

Consider a population size of N

The population matrix can be shown as

$$x_{n,i}^g = [x_{n,1}^g, x_{n,2}^g, x_{n,3}^g, \dots, x_{n,D}^g]$$

Where, g is the Generation and $n = 1, 2, 3, \dots, N$

Initial population

Initial population is generated randomly between upper lower and upper bound

$$x_{n,i} = x_{n,i}^L + \text{rand}(\) * (x_{n,i}^U - x_{n,i}^L) \quad i = 1,2,3, \dots D \text{ and } n = 1,2,3, \dots N$$

Where x_i^L is the lower bound of the variable x_i

Where x_i^U is the upper bound of the variable x_i

Mutation

From each parameter vector, select three other vectors x_{r1n}^g , x_{r2n}^g and x_{r3n}^g randomly.

Add the weighted difference of two of the vectors to the third

$$v_n^{g+1} = x_{r1n}^g + F(x_{r2n}^g - x_{r3n}^g) \quad n = 1, 2, 3, \dots, N$$

v_n^{g+1} is called donor vector

F is generally taken between 0 and 1

Recombination

A trial vector $u_{n,i}^{g+1}$ is developed from the target vector, $x_{n,i}^g$, and the donor vector, $v_{n,i}^{g+1}$

$$u_{n,i}^{g+1} = \begin{cases} v_{n,i}^{g+1} & \text{if } \text{rand}() \leq C_p \text{ or } i = I_{rand} \\ x_{n,i}^g & \text{if } \text{rand}() > C_p \text{ and } i \neq I_{rand} \end{cases} \quad \begin{array}{l} i = 1, 2, 3, \dots, D \text{ and} \\ n = 1, 2, 3, \dots, N \end{array}$$

I_{rand} is a integer random number between [1,D]

C_p is the recombination probability

Selection

The target vector $x_{n,i}^g$ is compared with the trial vector $u_{n,i}^{g+1}$ and the one with the lowest function value is selected for the next generation

$$x_n^{g+1} = \begin{cases} u_{n,i}^{g+1} & \text{if } f(u_n^{g+1}) < f(x_n^g) \\ x_n^g & \text{Otherwise} \end{cases}$$

$$n = 1, 2, 3, \dots, N$$

THANKS