Adaptive harmony search algorithm utilizing differential evolution and opposition-based learning

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Introduction

An adaptive harmony search algorithm utilizing differential evolution and opposition-based learning (AHS-DE-OBL) is proposed to overcome the drawbacks of the harmony search (HS) algorithm. First, the differential harmonies in the population are used to randomly perturb individuals to improve the fin-tuning ability. Then the search domain is adaptively adjusted to accelerate the algorithm convergence. Finally, an opposition-based learning strategy is introduced to prevent the algorithm from falling into a local optimum.

Main ideas

1. Dynamic search domain adjustment strategy

Initial:

$$x_{U_{new,j}} = U$$
$$x_{L_{new,j}} = L$$

During iteration:

$$x_{maxbound,j} = \max\left(HM(:,j)\right)$$
$$x_{minbound,j} = \min\left(HM(:,j)\right)$$
$$x_{U_{new,j}} = \left(1 - \frac{gn}{NI}\right) \times x_{U_{new,j}} + \left(\frac{gn}{NI}\right) \times x_{maxbound,j}$$
$$x_{L_{new},j} = \left(1 - \frac{gn}{NI}\right) \times x_{L_{new,j}} + \left(\frac{gn}{NI}\right) \times x_{minbound,j}$$

Where $x_{U_{new,j}}$ and $x_{L_{new},j}$ are the upper and lower boundary values of the new search domain of the jth dimension. $x_{maxbound,j}$ and $x_{minbound,j}$ are the maximum and minimum values of the jth dimension in the candidate solution set.

2. The parameter generation strategy based on differential evolution

$$bw_j = x_{best,j} - x_{rand1,j} + x_{best,j} - x_{worst,j}$$

Where $x_{best,j}$ is the value of the jth dimension of the best solution in the current candidate solution set. $x_{rand1,j}$ is the value of jth dimension of a random solution in the current candidate solution set. $x_{worst,j}$ is the value of the jth dimension of the worst solution in the current candidate solution set.

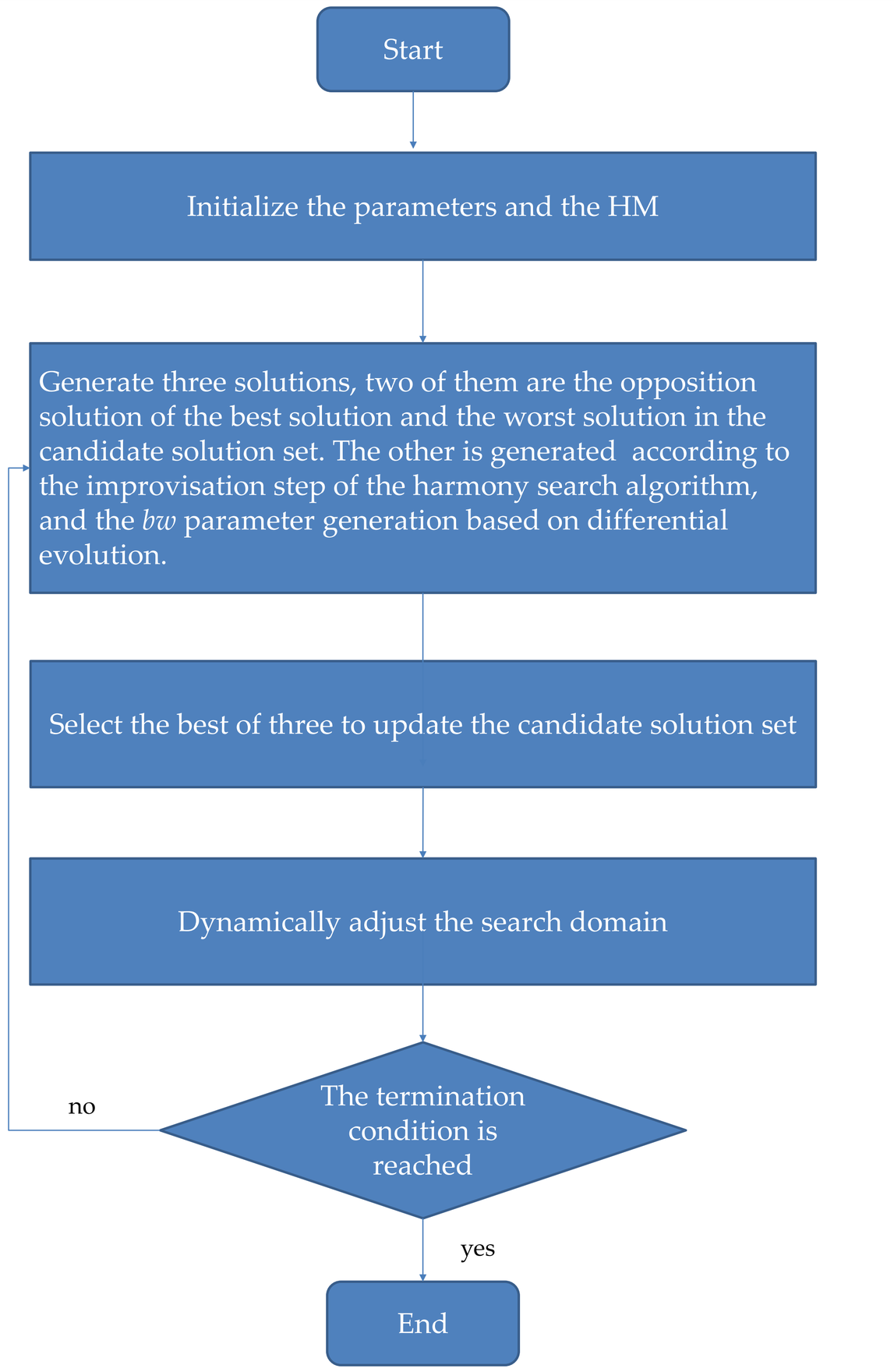
3. New harmony generation strategy based on opposition-based learning

$$x' = L + (U - x_{worst})$$

$$x'' = L + (U - x_{best})$$

Where x' and x'' express the opposition solution of the best solution and the worst solution in the candidate solution set respectively.

Algorithm steps



Results

To verify the performance of AHS-DE-OBL, it was compared with IHS, GDHS, ID-HS-LDD using ten benchmark functions. Each algorithm was run 30 times independently with 7000 iterations per run.

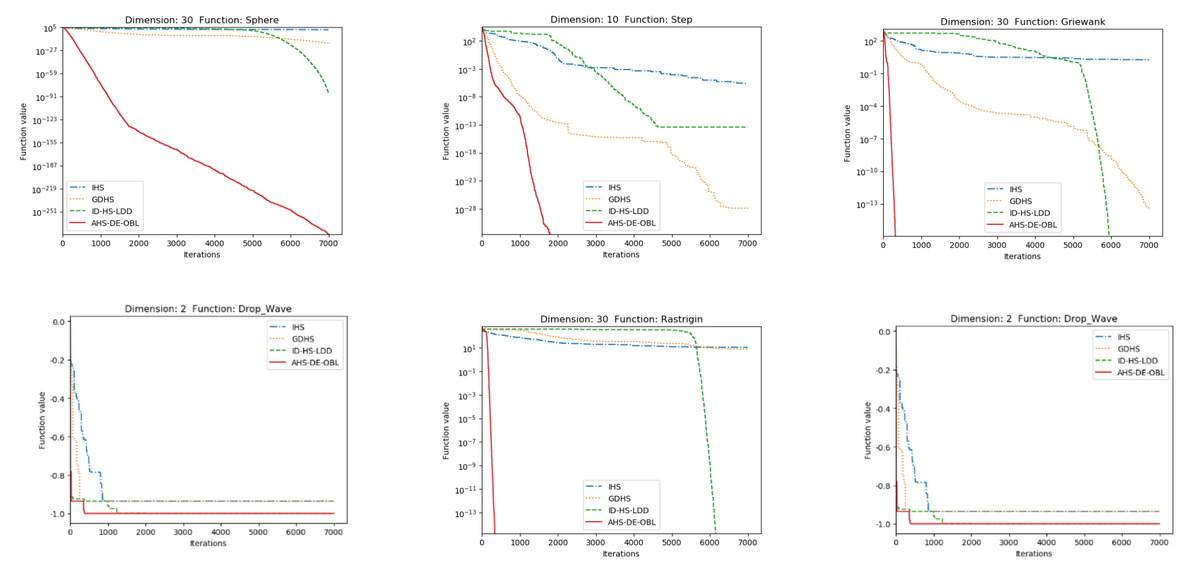


Figure 1. Experimental result

The experimental results show that the proposed algorithm has a better global search ability and faster convergence speed than other selected improved harmony search algorithms.