Modified Harmony Search Combing Artificial Bee Colony Operator With Levy Flight For Function Optimization Problem

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Introduction

A modified harmony search (HS) combing artificial bee colony (ABC) operator with Levy flight (HS-ABC-LF) is proposed to address the bottlenecks of HS, such as slow convergence speed and easily jump into the local optimum. The modifications of the HS-ABC-LF could be classified into the two aspects. An improved equation is proposed in the new harmony generation phase to ensure that the generation process is organized by a linear adjustment method. On the other hand, an ABC operator and Levy flight approach are employed to help jump out the local optimum faster. Experimental results with ten classic test function reveal that, compared with other three HS variants, the HS-ABC-LF enhances the global search capability and accelerate the faster convergence speed.

Methods

➢An adaptive equation is proposed to generate a new harmony phase to ensure a linear adjustment principle follows generating process.

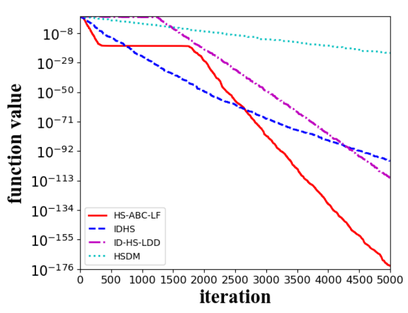
➢An operator from the standard ABC algorithm is applied in this HS-ABC-LF framework to overcome the drawback of the standard HS, which is the temporary stay always occurs to impact the algorithms convergence speedand accuracy.

➢A Levy flight is also used in this novel hybrid algorithm to increase the changes and expand the collection scope for jumping out of the local optimum.

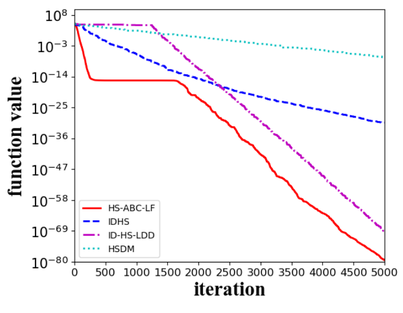
➢ 10 classic functions are employed as a brandmark to reveal the feasibility and robustness of the HS-ABC-LF.

Experimential Results

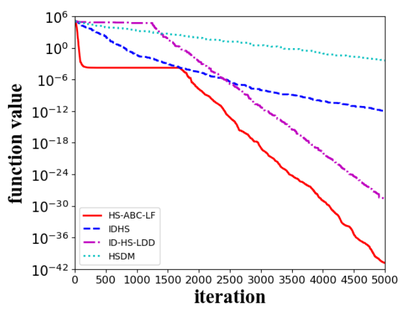
1. Partial Experimential Results （F1 and F7）



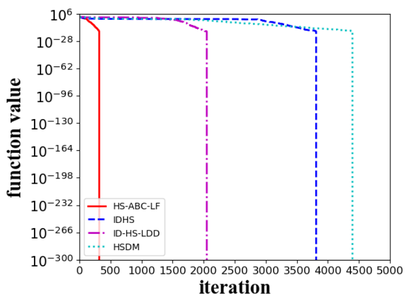
(a)F1 under 10 dimensions dimensions



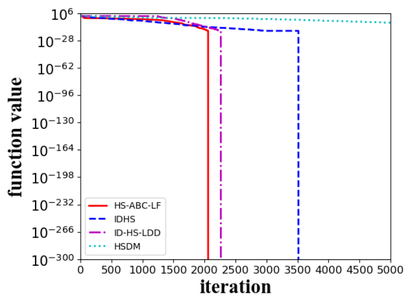
(b)F1 under 30 dimensions



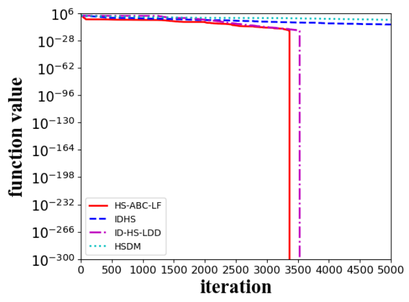
(c)F1 under 50



(a)F7 under 10 dimensions



(b)F7 under 30 dimensions



(c)F7 under 50 dimensions

2. Statistic data

	Dim	HS-ABC-LF MEAN±SD	IDHSLDD MEAN±SD	IDHS MEAN±SD	HSDM MEAN±SD
F1	10	1.80E-111±9.56E-111	1.29E-110±4.89E-110	7.60E-04±4.10E-03	1.16E-21±1.53E-21
	30	2.16E-70±5.96E-70	1.99E-69±4.62E-69	7.90E-29±1.20E-28	2.49E-07±1.52E-07
	50	2.52E-34±9.21E-34	1.18E-28±2.13E-28	2.74E-12±8.46E-12	3.58E-03±2.42E-03
F2	10	0.00E+00±0.00E+00	6.15E-02±1.25E-01	1.90E+01±7.44E+01	1.44E-01±1.78E-01
	30	0.00E+00±0.00E+00	7.00E-02±1.45E-01	8.16E-01±4.17E+00	8.85E-02±1.09E-01
	50	0.00E+00±0.00E+00	5.30E-02±1.30E-01	0.00E+00±0.00E+00	9.62E-02±1.04E-01
F3	10	0.00E+00±0.00E+00	1.08E+00±1.56E-01	0.00E+00±0.00E+00	6.39E-02±3.92E-02
	30	0.00E+00±0.00E+00	5.59E+00±2.67E-01	5.85E-29±9.81E-29	1.46E+00±2.03E-01
	50	1.81E-24±5.65E-24	1.04E+01±2.79E-01	1.40E-12±2.48-12	5.41E+00±4.71E-01
F4	10	1.35E-31±2.18E-47	6.04E+00±7.18E-01	1.01E-08±3.77-08	5.35E-01±2.85E-01
	30	1.35E-31±2.18E-47	2.66E+01±7.00E-01	9.60E-14±2.66E-13	6.44E+00±1.11E+00
	50	1.50E-31±4.94E-32	4.62E+01±6.63-01	2.57E-07±6.29E-07	2.27E+01±2.30E+00
F5	10	3.32E-79±1.78E-78	1.30E-57±3.73E-57	6.30E-02±1.65E-01	1.14E-12±1.16E-12
	30	9.77E-39±2.79E-38	2.30E-37±3.98E-37	2.59E+00±4.73E+00	2.16E-04±1.67E-04
	50	3.68E-30±8.66E-30	2.13E-28±5.58E-28	8.29E+00±1.35E+01	2.19E-02±1.02E-02
F6	10	0.00E+00±0.00E+00	0.00E+00±0.00E+00	1.97E-03±1.01E-02	3.78E-14±1.80E-13
	30	0.00E+00±0.00E+00	0.00E+00±0.00E+00	0.00E+00±0.00E+00	8.65E-07±4.54E-07
	50	0.00E+00±0.00E+00	0.00E+00±0.00E+00	4.14E-07±8.57E-07	4.87E-03±2.48E-03
F7	10	7.05E-75±2.48E-74	4.53E-58±6.04E-58	5.82E-04±1.76E-03	6.66E-13±6.64E-13
	30	4..75E-38±1.69E-37	1.22E-36±1.35E-36	4.27E-20±5.36E-20	5.98E-05±2.36E-05
	50	1.52E-22±6.56E-22	1.13E-27±1.21E-27	6.37E-10±1.00E-09	1.30E-02±3.42E-03
F8	2	-2.06261E+00±5.84E-08	-2.06258E+00±6.57E-05	-2.05631E+00±1.23E-02	-2.06241E+00±1.59E-04
F9	2	-1.867289E+02±5.23E-03	-1.859174E+02±1.58E+00	-1.867193E+02±2.69E-02	-1.830507E+02±3.39E+00
F10	2	-1.00E+00±0.00E+00	-1.00E+00±0.00E+00	-8.31E-01±1.56-01	-1.00E+00±0.00E+00

3.Analysis of Experimental Results

Experimental results indicate that the HS-ABC-LF has better global search abilities and faster convergence speed. For unimodal functions F1-F3, no matter 10, 30 or 50 dimensions, the HS-ABC-LF has better performance than the other three. For multimodal functions F4-F7, it further proves that the HS-ABC-LF can jump out of the local optimum for getting the global optimum by a faster convergence speed under different dimensions (10, 30, or 50) in majority cases (expect F7 under 50 dimensions condition). For other three multimodal functions for F8-F10 under two dimensions condition, the HS-ABC-LF has better performance keeps fairly good performance.

Conclusions

Focusing on the shortcoming of the standard HS, a novel hybrid HS algorithm,namely HS-ABC-LF, is proposed from following two viewpoints. On the one hand, a new control mechanism is given to ensure a new harmony generation process followed by the linear adjustment. On the other hand, an ABC operator and Levy flight approach are used to help the proposed HS-ABC-LF jump out of the local optimum and accelerate the convergence speed and accuracy.

Meanwhile, ten classic test functions, including the unimodal function and multimodal function, are selected to prove the feasibility and robustness of the proposed hybrid algorithm compared with other three different HS variants under dimensions. The experiment results reveal that the proposed HS-ABC-LF has better feasibility and robustness to obtain the global optimum with a faster convergence speed than that of three HS variants.