Multi-strategies Boosted Mutative Crow Search Algorithm for Global Tasks: Cases of Continuous and Discrete Optimization

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Comparison with Advanced Algorithms

Table 1 Comparison results of CCMSCSA with seven advanced algorithms

	F1		**F2**		**F3**	
	Avg	Std	Avg	Std	Avg	Std
CCMSCSA	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
IGWO	1.5185E-259	0.0000E+00	3.1214E-89	1.6835E-88	1.2206E-30	6.6531E-30
OBLGWO	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ALCPSO	4.2652E-03	2.2578E-02	6.4337E+01	3.5239E+02	5.1430E-05	6.7293E-05
CESCA	6.5837E+00	2.4923E+00	4.5951E+03	2.8154E+03	2.1986E+01	8.0134E+00
OBSCA	1.4676E-88	5.6017E-88	4.3732E-24	2.3784E-23	5.1477E-22	2.2357E-21
m_SCA	0.0000E+00	0.0000E+00	1.0894E-210	0.0000E+00	1.1051E-162	2.2228E-162
BMWOA	7.0131E-03	5.9948E-03	2.9048E-01	1.0145E+00	8.5780E-03	9.3173E-03
	F4		**F5**		**F6**	
	Avg	Std	Avg	Std	Avg	Std
CCMSCSA	7.4273E+02	3.9646E+02	6.1468E+02	2.8934E+00	8.2255E+02	1.3121E+01
IGWO	6.2356E+03	2.7403E+03	6.1957E+02	2.6503E+00	8.8298E+02	1.4264E+01
OBLGWO	2.5543E+04	6.1498E+03	6.1444E+02	2.5150E+00	8.8721E+02	1.6479E+01
ALCPSO	4.9525E+02	8.1954E+02	6.1768E+02	2.5084E+00	8.2533E+02	1.0626E+01
CESCA	1.1185E+05	1.3934E+04	6.4210E+02	1.0939E+00	1.2140E+03	1.5457E+01
OBSCA	5.1473E+04	1.0805E+04	6.3209E+02	1.4177E+00	1.0652E+03	2.0172E+01
m_SCA	2.7365E+04	8.4627E+03	6.2072E+02	3.3615E+00	9.4460E+02	2.2669E+01
BMWOA	5.5273E+04	6.8344E+03	6.3300E+02	3.2483E+00	9.6701E+02	1.6621E+01
	F7		**F8**		**F9**	
	Avg	Std	Avg	Std	Avg	Std
CCMSCSA	1.3382E+03	1.3770E+02	1.4003E+03	5.2851E-02	1.6109E+03	7.2694E-01
IGWO	3.4101E+03	5.3149E+02	1.4005E+03	3.3850E-01	1.6116E+03	6.3208E-01
OBLGWO	3.4656E+03	5.2265E+02	1.4035E+03	5.9500E+00	1.6114E+03	6.5654E-01
ALCPSO	1.6216E+03	3.5409E+02	1.4006E+03	2.8628E-01	1.6118E+03	3.6579E-01
CESCA	8.8584E+03	3.1658E+02	1.6466E+03	2.2790E+01	1.6136E+03	1.6079E-01
OBSCA	6.2483E+03	4.7367E+02	1.4636E+03	1.3606E+01	1.6130E+03	1.9607E-01
m_SCA	4.2801E+03	6.0318E+02	1.4138E+03	9.8916E+00	1.6116E+03	6.0268E-01
BMWOA	4.8806E+03	5.2434E+02	1.4003E+03	1.0172E-01	1.6125E+03	3.5754E-01
	F10		**F11**		**F12**	
	Avg	Std	Avg	Std	Avg	Std
CCMSCSA	3.0894E+03	2.1338E+03	2.7598E+03	6.0241E+02	2.5000E+03	0.0000E+00
IGWO	2.3697E+04	2.5094E+04	3.4172E+03	1.2478E+03	2.6214E+03	2.9170E+00
OBLGWO	6.5251E+06	1.3733E+07	1.9337E+04	6.6964E+03	2.5000E+03	0.0000E+00
ALCPSO	1.1845E+04	1.6533E+04	3.1280E+03	8.1755E+02	2.6153E+03	1.7111E-02
CESCA	4.1939E+09	1.2090E+09	4.2560E+05	2.1034E+05	3.0381E+03	1.5329E+02
OBSCA	1.7816E+08	1.2878E+08	2.7126E+04	9.3815E+03	2.6902E+03	1.5690E+01
m_SCA	1.8744E+07	2.3381E+07	1.0456E+04	4.8796E+03	2.6390E+03	1.1239E+01

BMWOA	1.0019E+05	6.8297E+04	3.2969E+04	2.0050E+04	2.5006E+03	5.7507E-01
	F13		**F14**		**F15**	
	Avg	Std	Avg	Std	Avg	Std
CCMSCSA	2.6000E+03	0.0000E+00	3.5157E+03	8.4922E+02	4.7428E+03	3.7907E+03
IGWO	2.6000E+03	5.1180E-03	1.8076E+06	4.0783E+06	2.6668E+04	1.1153E+04
OBLGWO	2.6000E+03	2.2988E-07	9.5295E+05	2.5681E+06	5.7080E+04	3.8763E+04
ALCPSO	2.6359E+03	8.1704E+00	3.6056E+06	7.3666E+06	1.2436E+04	7.4456E+03
CESCA	2.6643E+03	1.9045E+01	1.8239E+07	3.3235E+06	1.4354E+06	3.6072E+05
OBSCA	2.6000E+03	2.3731E-04	1.6600E+07	6.0216E+06	4.4567E+05	1.6249E+05
m_SCA	2.6000E+03	5.0281E-04	3.4143E+06	7.1976E+06	4.5898E+04	1.6751E+04
BMWOA	2.6003E+03	2.1643E-01	4.0284E+05	4.4568E+05	5.5081E+04	5.5448E+04

	Overall Rank		
	Rank	+/=/-	AVG
CCMSCSA	1	~	1.1333
IGWO	3	14/1/0	3.6000
OBLGWO	2	9/6/0	3.0000
ALCPSO	4	12/2/1	3.9333
CESCA	8	15/0/0	8.0000
OBSCA	7	15/0/0	6.1333
m_SCA	5	14/0/1	4.4000
BMWOA	6	15/0/0	5.4000

Table 2 The p-values of CCMSCSA versus other advanced algorithms

	IGWO	OBLGWO	ALCPSO	CESCA	OBSCA	m_SCA	BMWOA
F1	1.7333E-06	1.0000E+00	1.7333E-06	1.7333E-06	1.7333E-06	1.0000E+00	1.7333E-06
F2	1.7344E-06	1.0000E+00	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F3	1.7322E-06	1.0000E+00	1.7311E-06	1.7311E-06	1.7311E-06	1.7311E-06	1.7311E-06
F4	1.7333E-06	1.7333E-06	4.4493E-05	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F5	1.4936E-05	7.4987E-01	1.7423E-04	1.7344E-06	1.7344E-06	4.7292E-06	1.7344E-06
F6	1.7344E-06	1.9209E-06	2.5364E-01	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F7	1.7344E-06	1.7344E-06	1.2506E-04	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F8	4.2843E-01	5.7924E-05	2.1630E-05	1.7344E-06	1.7344E-06	3.8822E-06	2.3038E-02
F9	7.2695E-03	4.0697E-02	1.9729E-05	1.7344E-06	1.7344E-06	5.2872E-04	1.7344E-06
F10	4.2857E-06	6.3391E-06	1.6046E-04	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F11	2.0671E-02	1.7344E-06	6.2683E-02	1.7344E-06	1.7344E-06	2.3534E-06	1.7344E-06
F12	1.7344E-06	1.0000E+00	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06	1.7344E-06
F13	1.7333E-06	6.2500E-02	1.7333E-06	1.7333E-06	1.7333E-06	1.7333E-06	1.7333E-06
F14	1.7300E-06	1.7300E-06	2.1619E-05	1.7333E-06	1.7333E-06	1.7333E-06	1.7333E-06
F15	1.7344E-06	1.7344E-06	7.5137E-05	1.7344E-06	1.7344E-06	1.7344E-06	3.1817E-06