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

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Feature Selection Experimental Results and Analysis

Table 1 Comparison results of CCMSCSA with other binary metaheuristic algorithms on fitness values

Function	Metri	CCMSCS	BGWO	BGSA	BALO	BBA	BSSA
Breast cancer	Avg	9.259E-02	9.767E-02	9.916E-02	9.160E-02	1.577E-01	9.359E-02
	Std	7.963E-03	9.635E-03	1.078E-02	1.309E-02	1.423E-02	1.555E-02
Heart	Avg	6.370E-02	8.097E-02	7.662E-02	5.909E-02	1.349E-01	7.470E-02
	Std	3.536E-02	4.177E-02	3.466E-02	2.245E-02	4.414E-02	3.590E-02
Heart EW	Avg	7.662E-02	8.801E-02	8.795E-02	8.366E-02	1.743E-01	8.328E-02
	Std	2.238E-02	3.480E-02	1.766E-02	3.646E-02	4.783E-02	3.242E-02
Lymphography	Avg	1.806E-02	2.411E-02	2.382E-02	1.927E-02	6.903E-02	1.967E-02
	Std	5.114E-03	2.607E-02	2.712E-02	1.945E-02	6.005E-02	2.279E-02
Vote	Avg	2.279E-02	2.298E-02	2.237E-02	1.742E-02	4.840E-02	1.977E-02
	Std	1.621E-02	2.735E-02	2.496E-02	1.755E-02	3.973E-02	1.643E-02
Australian	Avg	9.259E-02	9.767E-02	9.916E-02	9.160E-02	1.577E-01	9.359E-02
	Std	1.718E-02	2.580E-02	1.976E-02	1.883E-02	3.545E-02	1.686E-02
Dermatology	Avg	1.897E-02	9.706E-03	9.265E-03	9.559E-03	3.138E-02	1.603E-02
	Std	2.812E-03	2.703E-03	1.211E-03	1.867E-03	1.390E-02	4.069E-03
Glass	Avg	1.225E-01	1.292E-01	1.351E-01	1.209E-01	1.696E-01	1.262E-01
	Std	6.097E-02	5.247E-02	4.965E-02	3.794E-02	7.179E-02	5.034E-02
JPN data	Avg	3.754E-02	4.319E-02	3.944E-02	3.804E-02	7.321E-02	3.765E-02
	Std	3.149E-02	4.903E-02	3.194E-02	3.901E-02	5.559E-02	4.057E-02
Segment	Avg	2.938E-02	2.464E-02	2.505E-02	2.423E-02	4.219E-02	2.880E-02
	Std	3.752E-03	4.763E-03	7.624E-03	6.751E-03	9.606E-03	5.232E-03

Table 2 Comparison results of CCMSCSA with other binary metaheuristic algorithms on the number of features selected

Function	Metri	CCMSCS	BGWO	BGSA	BALO	BBA	BSSA
Breast cancer	Avg	5.9	3.8	5.8	4.8	5.3	5.8
	Std	0.4714	1.2517	1.075	0.56765	0.99443	1.2517
Heart	Avg	6.5	5.5	6.2	5.3	4.4	5.7
	Std	0.84984	1.4337	1.4757	1.8288	1.1738	1.6364
Heart EW	Avg	6.2	5.5	6.4	6.2	6	6.1
	Std	1.4757	1.354	2.0656	0.91894	1.2472	1.1005
Lymphography	Avg	6.5	4.1	4.3	4.8	8.4	4.8
	Std	1.8409	1.1972	1.6364	1.5492	2.0656	2.044
Vote	Avg	5.3	3.3	3	2.6	6.7	4.3
	Std	1.9465	1.3375	1.8856	1.2649	1.3375	2.4967
Australian	Avg	5.9	3.8	5.8	4.8	5.3	5.8
	Std	1.6633	1.9889	1.6865	1.5492	1.6364	2.1499

Dermatology	Avg	12.9	6.6	6.3	6.5	15.2	10.9
	Std	1.912	1.8379	0.82327	1.2693	1.6865	2.7669
Glass	Avg	4.3	4.2	4.3	4	4.1	4.4
	Std	1.1595	1.2293	0.82327	0.66667	0.99443	0.96609
JPN data	Avg	2.6	2.7	2.9	2.7	4.8	2.7
	Std	0.84327	0.94868	0.99443	1.4944	1.6193	0.67495
Segment	Avg	7.1	5.3	5.3	5.3	7.3	6.1
	Std	1.5951	1.0593	1.1595	1.4944	1.767	1.6633

Table 3 Comparison results of CCMSCSA with other binary metaheuristic algorithms on KNN error rate

Function	Metric	CCMSCS	BGWO	BGSA	BALO	BBA	BSSA
Breast cancer	Avg	7.528E-02	8.852E-02	8.257E-02	7.838E-02	2.423E-01	7.671E-02
	Std	9.990E-03	1.313E-02	9.990E-03	1.513E-02	4.675E-02	1.842E-02
Heart	Avg	4.074E-02	6.296E-02	5.556E-02	4.074E-02	2.741E-01	5.556E-02
	Std	3.683E-02	4.636E-02	3.599E-02	2.733E-02	1.554E-01	4.001E-02
Heart EW	Avg	5.556E-02	7.037E-02	6.667E-02	6.296E-02	2.963E-01	6.296E-02
	Std	2.619E-02	4.076E-02	2.342E-02	3.924E-02	1.145E-01	3.514E-02
Lymphography	Avg	0.000E+00	1.339E-02	1.250E-02	6.250E-03	2.418E-01	6.667E-03
	Std	0.000E+00	2.831E-02	2.635E-02	1.976E-02	2.159E-01	2.108E-02
Vote	Avg	6.559E-03	1.333E-02	1.368E-02	9.785E-03	1.054E-01	6.667E-03
	Std	1.383E-02	2.811E-02	2.400E-02	1.576E-02	1.038E-01	1.406E-02
Australian	Avg	7.528E-02	8.852E-02	8.257E-02	7.838E-02	2.423E-01	7.671E-02
	Std	2.217E-02	3.119E-02	2.241E-02	2.117E-02	8.542E-02	2.318E-02
Dermatology	Avg	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.715E-02	0.000E+00
	Std	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.718E-02	0.000E+00
Glass	Avg	1.038E-01	1.115E-01	1.171E-01	1.038E-01	2.653E-01	1.071E-01
	Std	6.467E-02	5.303E-02	5.450E-02	3.785E-02	1.475E-01	5.182E-02
JPN data	Avg	2.583E-02	3.125E-02	2.625E-02	2.583E-02	2.461E-01	2.542E-02
	Std	3.338E-02	5.312E-02	3.391E-02	4.452E-02	1.647E-01	4.412E-02
Segment	Avg	1.126E-02	1.126E-02	1.169E-02	1.082E-02	5.584E-02	1.342E-02
	Std	4.654E-03	3.651E-03	7.372E-03	6.534E-03	4.288E-02	4.764E-03