NUMERICAL DATA FOR WIND TURBINE MICROSITING INSPIRED BY HUMAN DYNASTIES BY USE OF THE DYNASTIC OPTIMIZATION ALGORITHM (DOA)

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ABSTRACT

This work presents the newly formulated Dynastic Optimization Algorithm, DOA as applied to the wind turbine micrositing problem. The data is acquired by the use of the standard MATLAB software at a wind speed of 12 m/s. The values of the efficiency of the algorithm, cost per installation of per unit turbine, and total dissipated power at each number of turbines installed are discussed.

This algorithm is applied to two test functions and the results are described therein. It has been well-demonstrated that the proposed DOA exhibits superior performance over GA and DEA for test functions by hitting the minima very often and with higher precision. On the other hand DOA performance on WTM problem is also encouraging.

KEYWORDS

Dynastic Optimization Algorithm (DOA), Metaheuristic Algorithms, Genetic Algorithm (GA), Differential Evolution Algorithm (DEA), Wind Turbine Micrositing (WTM).

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1. INTRODUCTION

This work is inspired by the works of Grady, Hussaini, and Abdullah (2005), Mosetti, Poloni, and Diviacco (1994), Emami and Nougreh (2010) and Marmidis, Lazarou, and Pyrgioti (2008).

The data in this article has been compared with similar results of Mittal (2010), Rajper and Amin (2012) and Massan, Wagan, & Shaikh (2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA, which is the base paper supporting this data. Comparison was also made to similar studies (Massan, Wagan, & Shaikh, 2017; Massan *et al.*, 2015; Massan *et al.*, 2017a, 2017b).

The effect of wind speed on the resultant power output on an ascending number of turbines arranged by the metaheuristic method of the Dynastic Optimization Algorithm in a wind farm is evaluated. A new metaheuristic algorithm for wind form micrositing known as “Dynastic optimization algorithm” (DOA) was discussed in Massan, Wagan, and Shaikh (2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA, and the important data about the power produced, cost per unit turbine installation and efficiency of DOA are shared in this data article. The complete methodology of DOA can be found in Massan, Shaikh, & Wagan (2020). The data is summarized in Table 1 and Figures 1-3.

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2. OBJECTIVES

The work describes the data obtained for a novel algorithm that has been presented in Massan, Wagan and Shaikh (2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA and puts it forward for wider scientific use. It is evident that it shall prove to be useful while comparing with other algorithms as applied to this problem and other similar problems.

3. EXPERIMENTAL DESIGN, MATERIALS AND METHODS

The method is described in Massan, Shaikh, and Wagan (2020) and the following parameters have been used to carry out the simulations.

Using the below defined parameters from Massan, Wagan and Shaikh (2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA, and the methodology from Massan, Shaikh, and Wagan (2020), the numerical data concerning the power produced in (Kwh), cost per unit turbine installation (dimensionless), and the efficiency (per unit) of DOA application is shared in table 1 for the installation of 100 turbines.

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4. DATA ANALYSIS

The data was acquired by use of a Corei7 laptop (7th generation) and the runtime was less than 8 hours for Matlab 2017, student version. The data format is raw and analyzed. The parameter values are as per the given Table 1.

Table 1. Parameters used for DOA implementation.

α = 0.09437,	
a = 0.326795,	
C_T = 0.88,	
r_r = 40m,	
U_0 = 12m/s, 10 m/s, 8 m/s and 6m/s,	
X = 200m	
Z_0 = 0.3,	
Z = 60m,	
The configuration of DOA being,	
Niter, Number of iterations	10,000
Np, Number of population	100
r_r, Ratio of rulers	0.05
r_w, Ratio of workers	0.55
r_e, Ratio of explorers	0.4
rad_w, Radius of workers	0.4

The value of the data is that it depicts the actual implementation of a new algorithm for the computation of the WTM problem. It shall save the computation time for other researchers and shall be a viable source of comparison of other similar research and application of other algorithms.

This algorithm is competing with other algorithms such as the GA and DEA which are in wide use. The results are obtained by the use of the same code as used by Mittal (2010) and the data analysis methods utilized in Sultan, Shaikh, and Chowdhry (2020).

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The submission of results of a new algorithm in this domain opens new avenues for research and provides a base for comparison with standard benchmark algorithms. These results shall provide the basis of scientific testing of the DOA algorithm.

Table 2. Dynastic Optimization Algorithm, Results of power, cost, and efficiency per unit turbine.

# of Turbines	Power by DOA	Cost by DOA	Efficiency by DOA
1	518.4	0.001927894	1
2	1,036.80	0.001924553	1
3	1,555.20	0.001919021	1
4	2,073.60	0.001911358	1
5	2,592.00	0.001901641	1
6	3,110.40	0.00188997	1
7	3,628.80	0.001876462	1
8	4,147.20	0.00186125	1
9	4,665.60	0.001844484	1
10	5,184.00	0.001826323	1
11	5,702.40	0.001806936	1
12	6,220.80	0.0017865	1
13	6,739.20	0.001765195	1
14	7,257.60	0.001743204	1
15	7,776.00	0.001720706	1
16	8,294.40	0.00169788	1
17	8,812.80	0.001674896	1
18	9,328.22	0.001652447	0.999680735
19	9,845.28	0.00162982	0.999561186
20	10,359.23	0.001607955	0.999153779
21	10,880.17	0.001585428	0.999427594
22	11,394.89	0.001564361	0.999130908
23	11,909.58	0.001543903	0.998857632
24	12,429.13	0.001523553	0.998998052
25	12,805.65	0.00152085	0.988090649
26	13,453.78	0.00148705	0.998173546

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# of Turbines	Power by DOA	Cost by DOA	Efficiency by DOA
27	13,969.90	0.001469687	0.998078289
28	14,485.15	0.001453366	0.997929592
29	14,996.40	0.001438399	0.997525317
30	15,514.40	0.00142376	0.997582357
31	16,027.31	0.001410575	0.997318922
32	16,559.21	0.001396744	0.99821631
33	17,053.30	0.001387048	0.996849034
34	17,562.23	0.00137699	0.996404884
35	18,066.46	0.001368154	0.995726221
36	18,573.76	0.001359898	0.995250507
37	19,097.40	0.001351271	0.995652038
38	19,596.40	0.00134515	0.994781272
39	20,131.35	0.0013373	0.995733981
40	20,640.35	0.001331884	0.995387307
41	21,144.41	0.001327386	0.994825064
42	21,664.12	0.001322477	0.995008576
43	22,179.64	0.001318368	0.994995257
44	22,666.38	0.001316417	0.993721187
45	23,181.67	0.001313211	0.993727436
46	23,667.78	0.001312025	0.992509534
47	24,178.36	0.001309801	0.992348055
48	24,685.19	0.001308089	0.992042415
49	25,194.62	0.001306513	0.991851631
50	25,697.39	0.00130552	0.991411503
51	26,203.16	0.001304578	0.991102259
52	26,719.00	0.001303325	0.991178533
53	27,210.82	0.001303398	0.99037745
54	27,748.88	0.001301409	0.991258057
55	28,193.69	0.001303894	0.988835927
56	28,753.09	0.001301182	0.990447563
57	29,130.48	0.001306762	0.985843065

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# of Turbines	Power by DOA	Cost by DOA	Efficiency by DOA
58	29,687.59	0.001304321	0.987374528
59	30,242.16	0.001302135	0.988771037
60	30,741.34	0.001302418	0.988340485
61	31,278.57	0.001301147	0.989126935
62	31,640.64	0.00130715	0.984438589
63	32,200.11	0.001304997	0.985943057
64	32,642.62	0.00130761	0.98387515
65	33,123.50	0.001308655	0.983009914
66	33,632.55	0.001308591	0.982994074
67	34,173.13	0.001307335	0.983886443
68	34,195.85	0.001325909	0.970061967
69	35,102.20	0.001310625	0.981341563
70	35,651.06	0.001309114	0.982447598
71	36,224.84	0.001306755	0.984199447
72	36,637.20	0.001310223	0.981577858
73	37,072.03	0.001312822	0.979621874
74	37,613.83	0.001311622	0.980507256
75	38,080.59	0.001313042	0.979439083
76	38,671.75	0.001310201	0.981556231
77	39,084.93	0.001313401	0.979159875
78	39,661.54	0.00131111	0.98086661
79	39,516.82	0.001332779	0.964916909
80	40,750.09	0.0013088	0.982592726
81	41,107.04	0.001313651	0.97896282
82	41,465.55	0.001318369	0.975458058
83	42,185.95	0.001311657	0.980448512
84	42,506.64	0.001317444	0.976140856
85	43,123.26	0.001314065	0.978650658
86	43,316.21	0.001323602	0.971598857
87	43,863.89	0.001322274	0.972574453
88	44,328.75	0.001323446	0.971712521

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# of Turbines	Power by DOA	Cost by DOA	Efficiency by DOA
89	44,977.38	0.001319182	0.974852994
90	45,593.26	0.001315985	0.977221701
91	45,646.31	0.00132906	0.967607595
92	46,039.29	0.001332196	0.965330019
93	46,885.14	0.001322381	0.972494843
94	47,024.66	0.001332634	0.965012274
95	47,563.55	0.001331552	0.965796586
96	48,202.02	0.001327745	0.968565566
97	48,753.12	0.001326411	0.969539892
98	48,430.18	0.001349021	0.953290011
99	49,256.42	0.001339927	0.959759948
100	49,831.45	0.001337843	0.961254806

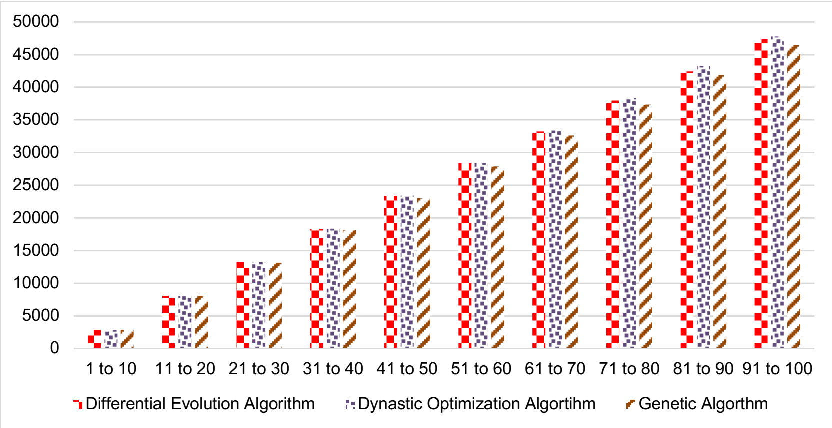

Figure 1. Comparison of mean power (kWh) produced by DEA (Massan *et al.*, 2017a, 2017b), DOA (Massan, Wagan, & Shaikh, 2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA and GA (Rajper & Amin, 2012) versus number of turbines.

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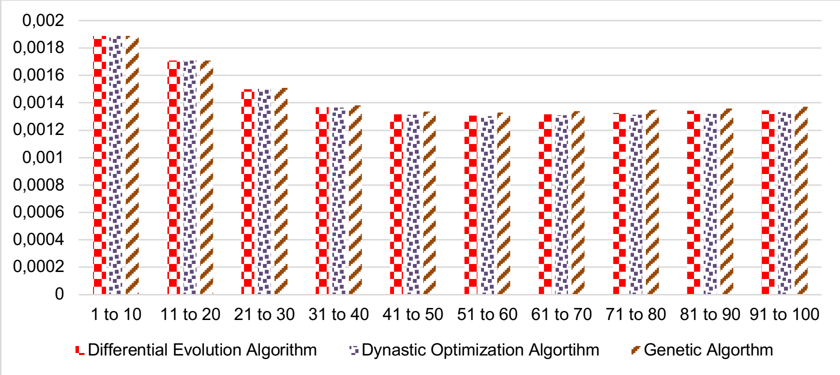

Figure 2. Comparison of mean cost per unit turbine (dimensionless) by DEA (Massan *et al.*, 2017a, 2017b), DOA (Massan, Wagan, & Shaikh, 2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA and GA (Rajper & Amin, 2012) versus number of turbines.

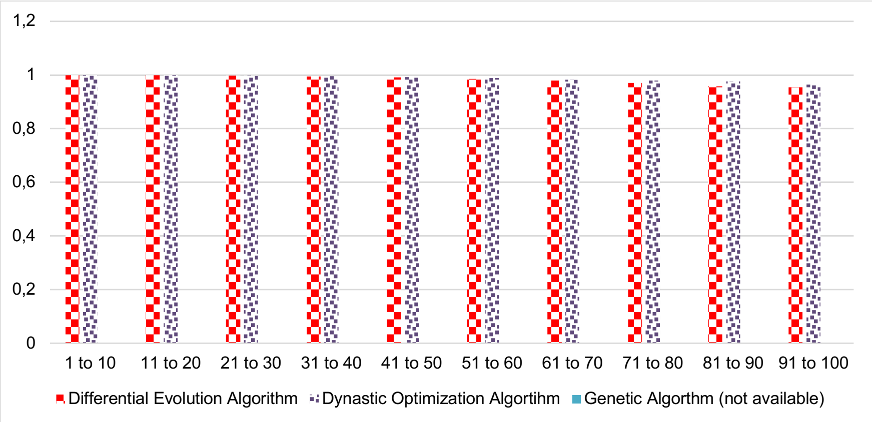

Figure 3. Comparison of efficiencies (per unit) by DEA (Massan *et al.*, 2017a, 2017b), DOA (Massan, Wagan, & Shaikh, 2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA and GA (Rajper & Amin, 2012) versus number of turbines.

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5. TEST FUNCTIONS

This algorithm was applied to the following two test functions and the comparative graphs are obtained herewith,

The DOA, DEA and GA were applied to the following test functions,

Booths's (f_1) and

$$f_1(x_1, x_2) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2$$

the Bohachevsky's (f2) functions

$$f_2(x_1, x_2) = -x_1^2 + 2x_2^2 - 0.3\cos(3\pi x_1) - 0.4\cos(4\pi x_2) + 0.7$$

The following figures were obtained,

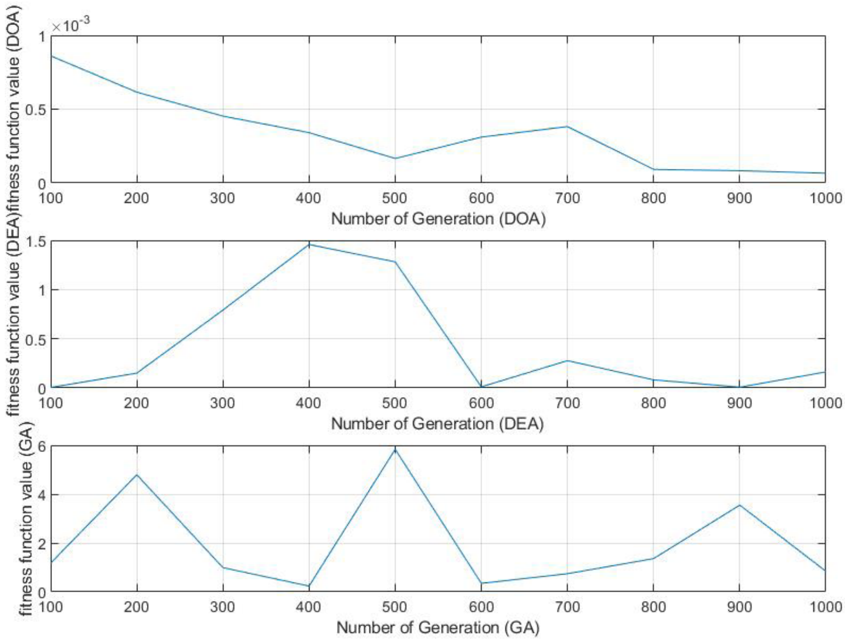

Figure 4. Comparison of minima attained versus number of generations by all methods for Booth's function.

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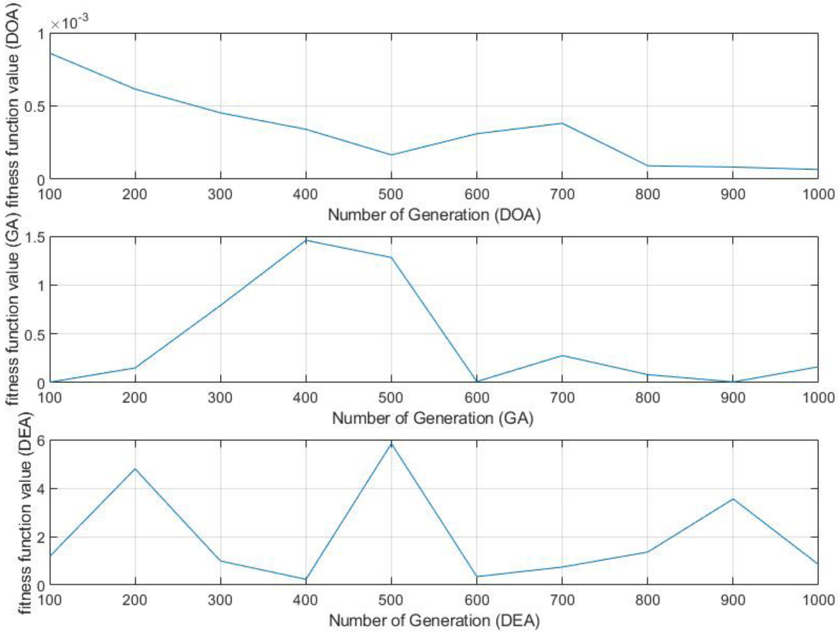

Figure 5. Comparison of minima attained versus number of generations by all methods for Bohachevsky's function.

The minimum value of the Booth's function is 0 at (1,3) and the minimum value of the Bohachevsky's function is 0 at (0,0).

The DOA approaches the minima of f1 and f2 more frequently and with comparatively much higher precision than GA and DEA as demonstrated through Figures 4 and 5 for a several values of generations.

6. RECOMMENDATIONS

In view of the encouraging results of the DOA algorithm it is now possible to depict that it is a viable algorithm that may be used in different fields of technology. The values of the test functions also depict encouraging results for this algorithm.

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7. CONCLUSION

The potential power saving, cost saving and efficiency benefits of proposed DOA (Massan, Wagan, and Shaikh, 2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA are shown in Figures 1-3, respectively against Differential Evolution Algorithm (Massan *et al.*, 2017a, 2017b) and genetic algorithm data (Rajper & Amin, 2012). The encouraging performance of DOA over GA and DEA is evident from the exhaustive comparison in Massan, Wagan, and Shaikh (2020). The nature-inspired algorithms use the best combination and evolution strategy in a given situation. In this work, a new metaheuristic algorithm is developed by using social behavior in human dynasties. The motivation, conceptual framework, mathematical model, pseudocode and working of the algorithm are described in this paper and the adjoining papers. The proposed dynastic optimization algorithm (DOA and the data shared in this article.

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