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).
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 Dynamic 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.
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.
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.**

| Parameter                | Value       |
|--------------------------|-------------|
| $\alpha$                 | 0.09437     |
| $\alpha'$                | 0.326795    |
| $C_T$                    | 0.88        |
| $r_r$                    | 40 m        |
| $U_0$                    | 12 m/s, 10 m/s, 8 m/s and 6 m/s |
| $X$                      | 200 m       |
| $Z_0$                    | 0.3         |
| $Z$                      | 60 m        |

The configuration of DOA being,

- $N_{iter}$, Number of iterations: 10,000
- $N_p$, 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).
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  | 1.0               |
| 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    | 0.00150285  | 0.988090649       |
| 26            | 13,453.78    | 0.00148705  | 0.998173546       |
| # 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   | 0.00130398  | 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      |
| # 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      |
| # 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) versus number of turbines. 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 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.
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 \((f_2)\) 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,

![Comparison of efficiencies (per unit) by DEA (Massan et al., 2017a, 2017b), DOA (Massan, Wagan, & Shaikh, 2020) and GA (Rajper & Amin, 2012) versus number of turbines.](image)

![Comparison of minima attained versus number of generations by all methods for Booth’s function.](image)

**Figure 4.** Comparison of minima attained versus number of generations by all methods for Booth’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.
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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