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Survey of using grasshopper algorithm

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Abstract

The metaheuristic optimization algorithm is used to explain a large region solution space. One of these algorithms is a grasshopper which divides the search process into exploitation and exploration. This article focuses on research efforts directed at gaining a clear understanding of the behavior of grasshoppers and it is using optimization algorithms. It is concluded that the benefits have been effective in answering global unrestricted and restricted optimization issues, easy development, high accuracy, and obtaining a good solution. However, the disadvantages of the GOA algorithm are simple to fall into local optimum and slow convergence speed.

Introduction

Grasshopper algorithm belongs to the class of metaheuristic optimization algorithms. It mimics the behavior of natural grasshoppers. Grasshoppers are insect pests, and they are regarded as pests that harm crop production and agriculture. Grasshoppers are associated with one of the hugest swarms of all creatures. However, they are usually observed separately in nature. No way can farmers believe the huge size of the swarm when it comes. The swarming behavior of a grasshopper is established in both nymph and adulthood, including this aspect is distinct. An enormous number of grasshoppers move and leap like rolling cylinders. During the route, they eat approximately all grains and vegetables. When they grow into an adult they can shape a swarm in the air. In this way the grasshoppers leave over immense spaces. A crucial feature of the nymph stage of the grasshopper's life cycle is that they look like adult grasshoppers without wings. Furthermore, they shed their skin five or six times to grow into adults. The magnificent characteristic of an adult grasshopper in the final step of the life cycle is that the wings will completed in about month. Moreover, at that step, the adult female grasshopper is ready to lay eggs. [1].

Grasshopper Optimization Algorithm

The mathematical model used to mimic of grasshopper swarming behavior is given below [2]

$$X_i = Z_i + H_i + A_i \tag{2-1}$$

Considering that X_i explains the location of the i-th grasshopper interaction, H_i is the pressure force on the i-th locusts, and A_i revaluation wind adveti.

$$Z_i = \sum_{\substack{j=1 \\ j\neq i}}^{N} z\left(d_{ij}\right) \widehat{d_{ij}} \tag{2-2}$$

where is the space between the i-th and the j-th grasshopper, calculated as $d_{ij} = \left|X_j - X_i\right|$,z is a function to explain the strength of social forces, as shown in E.g.(2.3), and $\widehat{d_{ij}} = \frac{X_j - X_i}{d_{ij}}$ is a unit vector from the i-th grasshopper to the j-th grasshopper. The z function, which shows the social forces, is calculated as follows:

$$Z(r) = fe^{\frac{-r}{l}} - e^{-r} \tag{2-3}$$

where f is the power of attraction and l is the scale of attraction length. The gravity power H is computed as follows:

$$H_i = -g\widehat{e_g} \tag{2-4}$$

Where g is the gravitational constant and $\widehat{e_g}$ reveals a unity vector in the direction of the Centre of earth. The A component in Eq. (2.1) is computed as follows:

$$A_i = -u\widehat{e_w} \tag{2-5}$$

Where u is a constant shift and $\widehat{e_w}$ is a unity vector in the direction of wind replacement Z, H, and A in Eq.(2.1), this equation can be developed as follows:

$$X_i = \sum_{\substack{j=1 \\ j\neq 1}}^{N} z\left(\left|x_j - x_i\right|\right) \frac{x_j - x_i}{d_{ij}} - g\widehat{e_g} + u\widehat{e_W} \tag{2-6}$$

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Although, this mathematical model cannot be taken immediately to solve optimization troubles, mainly because the locusts rapidly stretch out the comfort zone and the swarm does not meet a specified point. An adjusted version of this equation is proposed as follows to solve optimization issues:

$$X_i^d = c\left(\sum_{\substack{j1 \\ j\neq 1}}^{N} c\left(\frac{ub_d - lb_d}{2}\right) z\left(\left|x_j^d - x_i^d\right|\right) \frac{x_j - x_i}{d_{ij}}\right) + \widehat{T_d} \quad (2\text{-}7)$$

where $ub_d$and lb_d acts for the upper bound and the lower bound in the Dth dimension, separately. $\widehat{T_d}$ acts for the usefulness of the Dth measurement in the goal grasshopper (best answer existed until now), and c is a reducing coefficient which is utilized to lessen the consolation, appeal and the attracting force is regarded to be zero, supposing which the wind route is on the way to an aim (T_d) in mathematical problem (2-7). Parameter c is applied two times in the problem (2-7) to rule the hurry amount of grasshoppers and to steady their research and utilization. The outside c from the left manages the motion of grasshoppers on the way to the aim and steadies the utilization and research of the total population all over the aim. For the moment, the internal c lessens the effect of the consolation zone, attractiveness zone, and disgust forces betwixt grasshoppers to reduce the distance the area which the grasshoppers should search and utilize.
Parameter c decreases the consolation zone which is in proportion to the number of iterations.

$$c = cmax - l\frac{cmax - cmin}{L} \quad (2\text{-}8)$$

where $cmax$, $cmin$ represents the highest and lowest value, individually, l points out the contemporary repetition, and L is the highest numeral of repetition.

The important steps of the GOA algorithm are presented in Figure 1

Initialize the swarm X_i $(i = 1,2, \dots, n)$
Initialize cmax, cmin and maximum number of iterations
Calculate the fitness of each search agent
$T =$ *the best search agent*
while $(l <$ *Max number of itearations*$)$
    Update c using Eq (2.8)
    for *each search agent*
        Normalize the distances between grasshoppers in [1,4]
        Update the Position of the current search agent by the equation (2.7)
        Bring the current search agent back if it goes outside the boundaries
    end for
    Update T if there is a better solution
    $l = l + 1$
end while
Return T

Figure 1 Steps of Grasshopper optimization algorithm

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Related Work

Tabel1 contains the work that has been done till January 2022 using the grasshopper algorithm.

Table 1 Summary of the research contributions on Grasshopper algorithm

Research name	Researcher	Year	The scale of using the algorithm	Results
[3]	Abhishek G. N. … et al	2017	It was used in the test to solve engineering improvement problems in terms of performance measurement test	It gave accurate results in solving these problems, as the results showed that the GOA algorithm usefully balances the two properties of exploration and exploitation that characterize grasshoppers to push them towards the optimum level. Constrained It has been found that the results given by the algorithm are close to the actual solution, which is the exact solution to the problem. Therefore, GOA can be used in restricted and unconstrained optimization, and the algorithm can also be developed to make it serve multi-objective problems.
[2]	Shahrzad S.S….et al	2017	It was used in simulation to solve optimization problems ١	Achieved highly accurate optimization results.
[4]	Praveen T….et al	2017	used in classification	Proven to be effective in terms of accuracy in classifying cancer types.
[5]	Baran H.S….et al	2018	It was used in the design of the AVR system	It gave an effective and quick search for the controller for the parameters and compared them with the controllers and gave the best presentation contrasted to the ZN, DE and ABC algorithms. The reliability analysis gave that the GOA algorithm has the least exchange in the final potential difference with greater show correlate with the previous algorithms in terms of the maximum bypass, stability time and peak time. Therefore, the researchers recommend using this algorithm in this range.
[6]	H. Kurdi, et al	2018	used to reduce the energy consumed in cloud computing	The results showed that the algorithm was significantly superior to other algorithms
[7]	S. S. Guo,…et al	2019	used in the design	١ It gave good results, bearing in mind that the convergence speed was slow

[8]	H. Hichem., M…. et al	2019	In improving the performance of machine learning, the researcher proposed a new method for the first GOA based on SIGMOND (BGOA-S) and V-shaped transfer functions (BGOA-V), Another way is BGOA-M that process random mutation to obtain the desired improvement.	It accomplished the top consequences correlated with farther algorithms, where those solutions were better accuracy and higher stability.
[9]	Marcin S.W….et al	2020	Used in the test to calculate switching angles in the selective harmonic elimination for the VSI drive	The GOA algorithm gives better and faster results than the previously used algorithm, which is PSO, in that it is more efficient and more likely to converge. GOA requires that the data volume be less than the usual use to give satisfactory results .
[10]	Hernan P…. et al	2020	It was used in the design to solve backpack problems	Satisfactory results and superiority of other random methods when they are evaluated compared with other modern algorithms.
[11]	Bustani H. W… et al	2020	Used with photovoltaic systems	The results showed that the suggestive approach created the maximum tracking regulation with the shortest time, contrasted with the previously used algorithms.
[12]	Reyhaneh Y…. et al	2020	in improving performance	Best results for feature selection.
[13]	Ibrar U…. et al	2020	used to solve energy problems	Reducing energy consumption by converting some loads into low-demand load hours without violating their operation, and leads to increased consumer comfort.
[14]	Garba A. S….et al	2020	In the rating to improve performance choose fs	Best choice for FS.
[15]	Abhishek G. N….et al	2020	Used to improve mechanical systems from Where to reduce the weight of the rubber spring used In the railroad car where several Limitations to	They solved the problems facing these systems and transformed them from restricted to unconstrained problems by reducing the weight of these systems, as they gave the least weight for the spring (5.6 kg, the normal weight with the algorithm gave a weight of 5.5 kg) the results were somewhat acceptable in this range.

			implement it in terms of skew and strain Permissible shear and outer diameter limits	
[16]	Dana M. U….et al	2020	Used in scheduling to reduce energy consumption	It gave effective results in reducing energy consumption. These results were compared with GA. The results showed that the proposed algorithm gives power consumption of 819.04 kilowatts, while GA gives consumption of 932.69 kilowatts, and the algorithm is also successful in scheduling, so it can be said that it is more efficient than GA.
[17]	Hangwei F. H….et al	2020	It was used in maintenance to solve engineering problems	It has the best performance compared to other algorithms.
[18]	Xie Z….et al	2021	It was used in the optimization of the short-term ydrothermal scheduling ptimization problem	The GOA algorithm gave more infallible results to the specific problem with the powerful show in less computational time than modern technologies.
[19]	M. A. El-Shorbagy ,…et al	2021	It was used to solve data collection problems.	It gave results that outperform other algorithms in this field.
[20]	Mohammed A. A. … et al	2018	To reduce the average composition file and waiting time and to enhance the usage of the virtual machine and server.	The obtained results showed that the algorithm is higher to other algorithms on this scale
[21]	Sharmila V. S. … et al	2021	used to solve the problem of optical communication	The suggestion protocol accomplished greater data transmission show concerning Transfer rate, packet conveyance percentage, end-to-end delay. In addition to routine expenses as well as showing.
[22]	Peng Q. H…. et al	2021	used to predict The closing prices of the Shanghai Stock Exchange Index	The experimental results showed that the algorithm was superior to the comparison algorithms in terms of The average values and the expected model contain the minimum expected errors. And therefore, The algorithm is effective for optimization.

Results and recommendation

Grasshopper algorithm has been used in many aspects like minimization, searching, classification, enhancing, etc., and gives good results compared with other algorithms. It is fast and good at searching. It has effective in solving unrestricted and restricted optimization issues, easy development, high accuracy, and obtaining a good solution. However, the disadvantages of the GOA algorithm are simple to fall into local optimum and slow convergence hurry. So we see that it should be hybrid with other swarm algorithms to give the best results.

References

[1] L. Abualigah, A. Diabat (2020) A comprehensive survey of the Grasshopper optimization algorithm: results, variants, and applications.
doi.org/10.1007/s00521-020-04789-8.
[2] Saremi S, Mirjalili S, Lewis A (2017) Grasshopper optimisation
algorithm: theory and application. Adv Eng Softw 105:30–47.

[3] A. G Neve, G. M Kakandikar and O. Kulkarni (2017) Application of Grasshopper Optimization Algorithm for Constrained and Unconstrained Test Functions. Int J Swarm Intel Evol Comput, an open access journal ISSN: 2090-4908 Volume 6 • Issue 3 • 1000165.
[4] P. Tumuluru, Dr. B. Ravi (2017) GOA-based DBN: Grasshopper Optimization Algorithm-based Deep Belief Neural Networks for Cancer Classification. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24 (2017) pp. 14218-14231.

[5] B. Hekimoğlu, S. Ekinci (2018) Grasshopper optimization algorithm for automatic voltage regulator system. 5th International Conference on Electrical and Electronics Engineering 978-1-5386-6392-9/18/$31.00.
[6] H. Kurdi, S. M. Alismail and M.M.I hassan (2018) A Locust-Inspired Scheduling Algorithm to Reduce Energy Consumption in Cloud Datacenters. IEEE Acsess. Vol.(6), 2018,pp.35435-35448.
[7] S. S. Guo, J. S. Wang, (Member, IEEE), W. Xie, M. W. Guo, AND L. F. Zhu (2019) Improved Grasshopper Algorithm Based on Gravity Search Operator and Pigeon Colony Landmark Operator. DOI 10.1109/ACCESS.2020.2967399, IEEE.

[8] H. Hichem, M. Elkamel, M. Rafik, M. T. Mesaaoud, C. Ouahiba (2019) A new binary grasshopper optimization algorithm for feature selection problem. Univ Khenchela, Fac. ST, Lab., BP 1252 El Houria, 40004 Khenchela, Algeria.
[9] M. Steczek, W. Jefimowski and A. Szela (2020) Application of Grasshopper Optimization Algorithm for Selective Harmonics Elimination in Low-Frequency Voltage Source Inverter. Energies 2020, 13, 6426; doi:10.3390/en13236426.
[10] H. Pinto, A. Pe~na, L. Causa, M. Valenzuela, and G. Villavicencio (2020) A K-means Grasshopper Algorithm applied to the Knapsack problem, Conference Paper, April 2020.
[11] B. H. Wijaya, R. K. Subroto, K. L. Lian, and N. Hariyanto (2020) A Maximum Power Point Tracking Method Based on a Modified Grasshopper Algorithm Combined with Incremental Conductance. Energies 2020, 13, 4329; doi:10.3390/en13174329.
[12] R. Yaghobzadeh, S. R. Kamel, M. Asgari, H. Saadatmand (2020) A Binary Grasshopper Optimization Algorithm for Feature Selection. ISSN: 2278-0181 Vol. 9 Issue 03, March-2020.

[13] I. Ullah, I. Hussain and M. Singh (2020) Exploiting Grasshopper and Cuckoo Search Bio-Inspired Optimization Algorithms for Industrial Energy Management System: Smart Industries. Electronics 2020, 9, 105.
[14] G. A. Sharifai, Z. Zainol (2019) Feature Selection for High-Dimensional and Imbalanced Biomedical Data Based on Robust
Correlation Based Redundancy and Binary Grasshopper Optimization Algorithm. Tel.: +60-111-317-0481 or +60-194-004-327
[15] A. G. Neve, Ganesh M. Kakandikar, O. Kulkarni and V. M. Nandedkar (2020) Optimization of Railway Bogie Snubber Spring with Grasshopper Algorithm. K. S. Raju et al. (eds.), Data Engineering and Communication Technology, Advances in Intelligent Systems and Computing 1079.

[16] M. Utama, T. Baroto, D. S. Widodo (2020) Energy-Efficient Flow Shop Scheduling Using Hybrid Grasshopper Algorithm optimization. Jurnal Ilmiah Teknik Industri p-ISSN 1412-6869 e-ISSN 2460-4038.
[17] H. F. Hong Ni, R. Zhao, and X. Zhu (2020) An Enhanced Grasshopper Optimization Algorithm to the Bin Packing Problem. Journal of Control Science and Engineering, Volume 2020, Article ID 3894987, 19 pages.
[18] X. Zeng, A.T. Hammid, N.M. Kumar et al. (2021) A grasshopper optimization algorithm for optimal short-term hydrothermal scheduling. Energy Reports 7 (2021) 314–323.

[19] M. A. El-Shorbagy, A. Y. Ayoub (2021) Integrating Grasshopper Optimization Algorithm with Local Search for Solving Data Clustering Problems, International Journal of Computational Intelligence Systems. Vol. 14(1), 2021, pp. 783–793.
[20] M. Al. Ala'anzy, M. O. Zurina, M. A. Alrshah (2018) Locust Inspired Algorithm for Cloudlet Scheduling in Cloud Computing Environments. Digital Object Identifier 10.1109/ACCESS.2018.2839028.
[21] S. Vadivel, S. Konda, et al(2021) Dynamic Route Discovery Using Modified Grasshopper Optimization Algorithm in Wireless Ad-Hoc Visible Light communication Network, Electronics 2021, 10, 1176. https://doi.org/10.3390/electronics10101176,www.mdpi.com/journal/electronics
[22] P.Qin,Z.Yang, et al.(2021)The Improving Grasshopper Optimization Algorithm and its Application, Springer.