GRASSHOPPER OPTIMIZATION ALGORITHM (GOA): A NOVEL ALGORITHM OR A VARIANT OF PSO?

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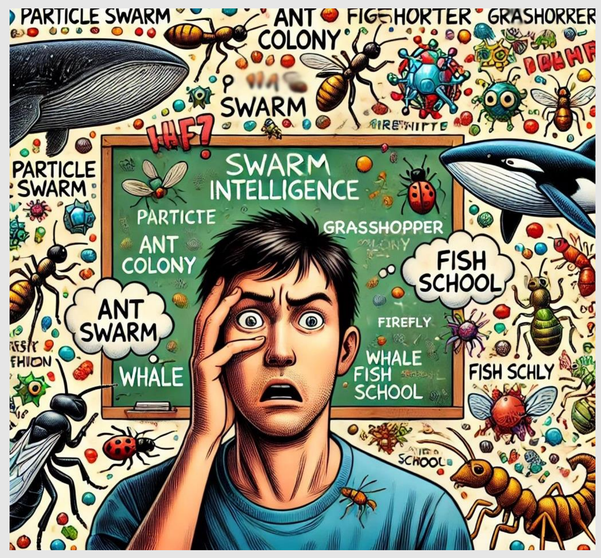
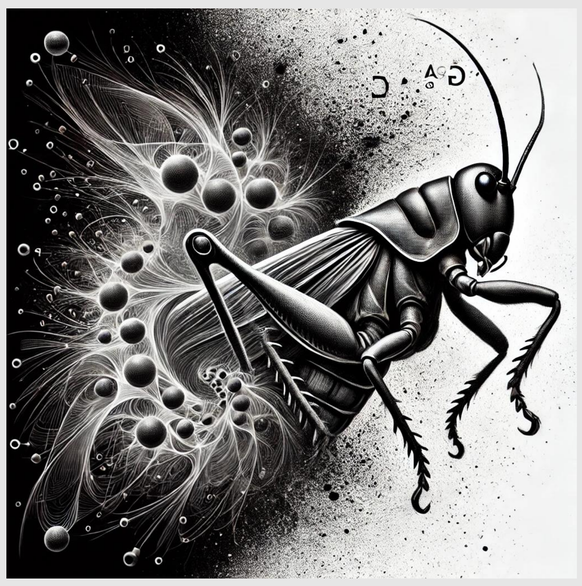


Abstract

In the world of new optimization methods, there is a concern that various methods, despite having different names, are quite similar. This raises a crucial question: Does the introduction of a new source of inspiration justify assigning a new name to an optimization algorithm, especially when its functionality closely mirrors or simplifies an existing, well-known method? We took a closer look at the Grasshopper Optimization Algorithm (GOA), investigating its concepts and comparing them to different versions of Particle Swarm Optimization (PSO). Our findings lead to a noteworthy conclusion:

GOA, despite its branding as a novel algorithm, is not a new algorithm, but can be viewed as a derivative of PSO.



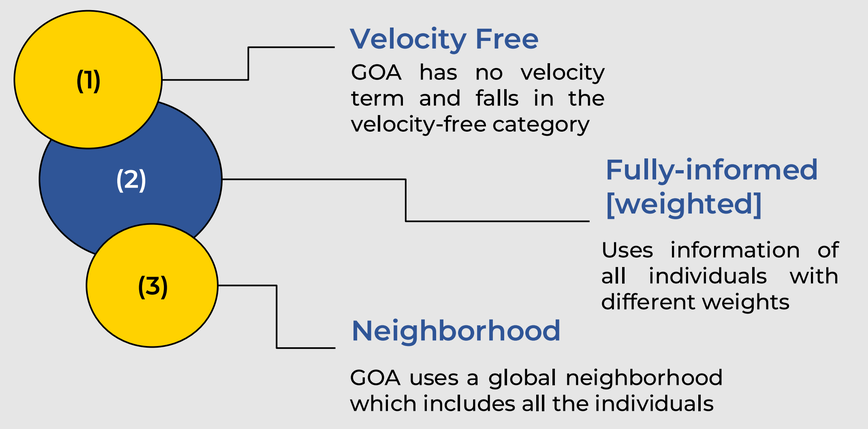
How Does GOA Compare to PSO?

GOA equations[1]:

$$x_i^{t+1} = c_t^2 \frac{u-l}{2} \odot \left(\sum_{\substack{j=1 \\ j \neq i}}^{N} S\left(\|x_j^t - x_i^t\|\right) \frac{x_j^t - x_i^t}{d_{ij}} \right) + g^t$$

$$S(d) = f \exp\left(-d/a\right) - exp(-d)$$

g_t	The best solution found by the grasshoppers at iteration t
c_t	Decreases linearly over T timesteps from a value c_{max} to c_{min}
u, l	Upper bound and lower bound of the position vector
d_{ij}	The Euclidean distance between the grasshopper i and j ($d_{ij} = \|x_j^t - x_i^t\|$)
S	The social interaction function that modulates the attractive behavior of the swarm ($S(d) > 0$) versus the repelling behavior ($S(d) < 0$)



Mathematical Comparison

(1) BBPSO[2]:

$$x_i^{t+1} = g^t + \alpha m_i^t \gamma$$

m_i^t	Reflects the contribution of each neighboring particle by its distance to the target particle
α	A random number drawn from the standard normal distribution $N(0,1)$

(2) FiPSO [wdFIPS][3]:

$$m_i^t = \sum_{k=1}^{N} W_{ki}^t \frac{\varphi\left(x_k^t - x_i^t\right)}{N}$$

W_{ki}^t	Weights determining the contribution of particle k to the position of particle i
φ	A random number drawn from the uniform distribution

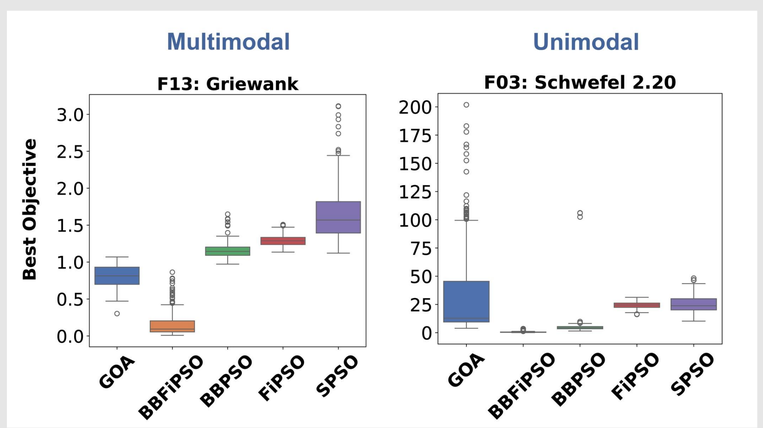
Turning the stochastic problem to a deterministic one and defining weights as follows:

$$W_{ki}^t = \frac{S\left(\|x_k^t - x_i^t\|\right)}{d_{ik}}$$

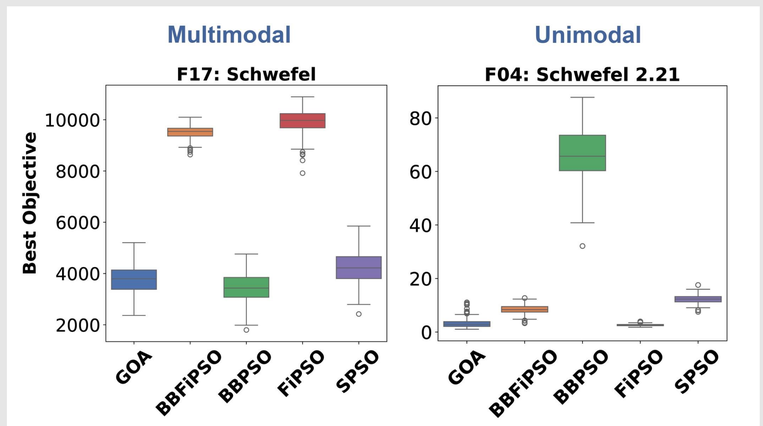
$$x_i^{t+1} = g^t + \frac{\alpha\beta}{N} \sum_{k=1}^{N} S\left(\|x_k^t - x_i^t\|\right) \frac{\left(x_k^t - x_i^t\right)}{d_{ik}}$$

Performance Comparison

Each algorithm was evaluated using 200 independent runs, in a 30-dimensional search space, using 100 individuals.



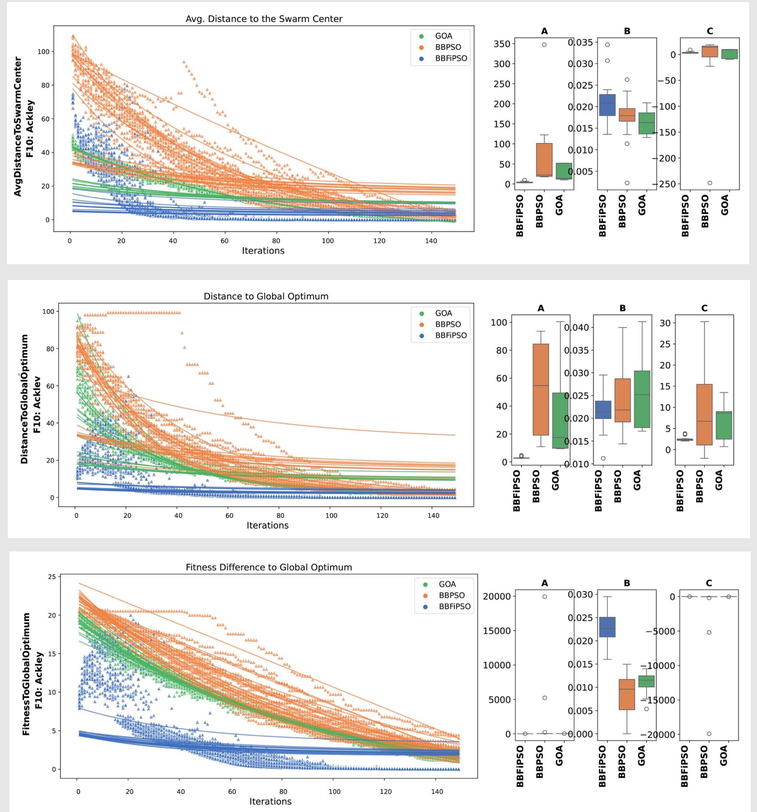
In most cases, there is no significant improvement in terms of effectiveness between GOA and BBFiPSO (p=1), or BBFiPSO outperforms GOA.



For the other cases, there is no significant improvement in terms of effectiveness between GOA and BBPSO (F17), and GOA and FiPSO (F04).

Behavioral Comparison

By quantifying the exploration and exploitation of GOA and PSO variants and plotting calculated measures of several runs for each algorithms, we show that they have similar search behavior.



Conclusion

We have presented one of the highly cited swarm intelligence algorithms in terms of PSO. We performed a comparative analysis between GOA and PSO and its variants, which showed that GOA and BBFiPSO share a similar approach. We find that BBFiPSO has greater capabilities to converge to an optimal or near-optimal solution.

Future work will investigate the behavioral similarities between GOA and PSO variants by characterizing the search behavior of these algorithms[4].

References

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