Artificial Intelligence Review (2023) 56:12439–12504
https://doi.org/10.1007/s10462-023-10428-0

HHO-EAS: a new metaheuristic bio-inspired of the win–win hunting synergy between the two predators crow and wolf

Mohamed Sassi[1,2,3] · **Rachid Chelouah**[3]

Published online: 20 March 2023

Abstarct
Harris Hawk Optimization (HHO) is a bio-inspired metaheuristic of Harris Hawk's pack hunting. Although having provided competitive results in some optimization problems in science and engineering, HHO has weaknesses for highly multimodal and high-dimensional optimization problems. In this article, we propose a new metaheuristic Harris Hawk Optimization Encirclement Attack Synergy (HHO-EAS) with the ambition to obtain better capabilities than HHO in solving highly multimodal and high-dimensional optimization problems. Our hybridization strategy is entirely bio-inspired by a win-win hunting synergy between two predators during the extremely difficult winter periods: the crow and the wolf. The smart exploratory faculties of crows combined with the ability of wolves to capture prey larger than themselves with speed and efficiency, allow these two predators to detect and catch good prey that is very rare and very difficult to hunt in harsh winter periods. In order to mathematically model this win-win hunting synergy with the encirclement and attack equations and integrate it into HHO, we used fuzzy logic to create a Mamdani-like fuzzy inference system (FIS). HHO-EAS was tested firstly with HHO, GWO and PSO on a general benchmark of 19 well-known functions and secondly with HHO on a specific benchmark of the 20 most complex functions of CEC 2017. The experimental results obtained on these two benchmarks demonstrate the superiority of HHO-EAS over HHO for highly multimodal and high-dimensional optimization problems and validate our fully bio-inspired hybridization strategy.

Keywords Metaheuristic · Synergy · Crow · Wolf · HHO · HHO-EAS · Rabbit escaping energy · Fuzzy logic · Encirclement · Attack · Exploration · Exploitation · Balance

✉ Mohamed Sassi
mohamed.sassi@gendarmerie.interieur.gouv.fr

[1] Pôle Judiciaire de la Gendarmerie Nationale, Pontoise, France

[2] Director of the Bureau of the Investigation Information Systems, Pontoise, France

[3] ETIS Laboratory CNRS, UMR8051, University of CY Cergy, Paris, France