

A Novel Improved Rat Swarm Optimization Algorithm for Global Optimization

Rakshith H L¹, Mutthu T S², Yogeesh D R³, Vivek K⁴, Dr. Supreetha Patel T. P.⁵

B E, CSE, Kalpataru Institute of Technology, Tiptur, India¹

B E, CSE, Kalpataru Institute of Technology, Tiptur, India²

B E, CSE, Kalpataru Institute of Technology, Tiptur, India³

B E, CSE, Kalpataru Institute of Technology, Tiptur, India⁴

Associate Professor, CSE, Kalpataru Institute of Technology, Tiptur, India⁵

Abstract: This report explores the development and performance of the Rat Optimization Algorithm (ROA), a newly proposed nature-inspired metaheuristic optimization technique that simulates the social and hunting behaviors of rats. The algorithm introduces three main operators that represent how rats search, chase, and hunt prey, thereby balancing exploration and exploitation in complex optimization problems. To further enhance performance and prevent premature convergence, the Levy flight strategy is integrated into the algorithm, resulting in an improved version known as IROA. The proposed ROA and IROA are evaluated using twenty-two benchmark test functions and four real-world engineering optimization problems. Experimental comparisons demonstrate that the ROA achieves faster convergence, stronger robustness, and higher computational accuracy than other well-known algorithms such as PSO, WOA, WHO, and RSO. Overall, the study establishes ROA as an effective, stable, and versatile tool for addressing global optimization challenges across various engineering and computational domains. Both ROA and IROA were tested on twenty-two benchmark test functions—including unimodal, multimodal, and fixed-dimension multimodal functions—and four real-world engineering optimization problems. The experimental results demonstrate that ROA and its improved version outperform several established algorithms, such as Particle Swarm Optimization (PSO), Whale Optimization Algorithm (WOA), and Wild Horse Optimizer (WHO), in terms of solution quality, convergence rate, and robustness. The findings confirm that the proposed algorithm is a reliable, efficient, and powerful optimization approach, with strong potential for applications in engineering design, control systems, and other computational optimization domains.

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