

Research on fuzzy clustering algorithm using Whale Optimization Algorithm (WOA)

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Abstract: This study proposes a novel fuzzy clustering algorithm enhanced by the Whale Optimization Algorithm (WOA) to address the limitations of traditional clustering methods, such as sensitivity to initialization and convergence to local optima. The standard Fuzzy C-Means (FCM) algorithm, while widely used, often suffers from these drawbacks, particularly when handling complex, high-dimensional, or noisy datasets. By integrating WOA—a metaheuristic inspired by the bubble-net hunting behavior of humpback whales—the proposed method optimizes the initial cluster centroids, thereby improving the quality and stability of the final clustering solution. The algorithm employs WOA's exploration and exploitation capabilities to search for near-optimal centroid positions before applying the iterative FCM process. Experimental evaluations on benchmark datasets demonstrate that the WOA-based fuzzy clustering approach achieves superior performance compared to standard FCM and other metaheuristic-based clustering variants. Key metrics, including clustering accuracy, convergence speed, and inter-cluster separation, show significant improvement. The results confirm that the proposed hybrid method provides a robust and effective solution for complex data clustering tasks.

Keywords: fuzzy clustering, Whale Optimization Algorithm, WOA, optimization algorithm