

Federated SCFGWO for Secure and High-Accuracy Brain Tumor Detection Across Multi-Center MRI

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Privacy preservation and security concerns in medical imaging have led to the implementation of federated learning (FL) as an alternative to centralized machinelearning approaches. This study introduces a novel Sine and Cosine Fitness Grey Wolf Optimization (SCFGWO) algorithm integrated into an FL framework to enhance the accuracy and efficiency of brain tumor detection across multi-center MRI datasets. SCFGWO addresses traditional Grey Wolf Optimization (GWO) limitations, such as early convergence and local optima, by incorporating adaptive sine- cosine strategies for improved global exploration and local exploitation. Compared to existing methods, the proposed SCFGWO-based framework achieves superior accuracy (97.2%), Dice Similarity Coefficient (0.94), and Intersection over Union (0.90) while maintaining computational efficiency (0.015s per slice). Innovative privacy-preserving methods, including differential privacy and homomorphic encryption, ensure data security across the dataset. These contributions establish SCFGWO as a robust optimization tool for federated learning applications in medical imaging, offering improved performance and enhanced data security.

Keywords: *Federated learning, Sine and Cosine Fitness, Grey Wolf Optimization (SCFGWO), brain tumor segmentation, multi-center MRI datasets, homomorphic encryption, optimization algorithms, adaptive optimization, medical imaging performance*