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Enhanced GWO for Medical and Complex Optimization

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Introduction

This article introduces an enhanced Grey Wolf Optimizer (GWO) tailored for feature selection in complex clinical datasets. It addresses the challenge of high-dimensional data by improving GWO's balance between exploration and exploitation, leading to more accurate and efficient identification of relevant features for medical diagnosis and prognosis. The method demonstrates superior performance compared to traditional approaches, offering a promising tool for data-driven clinical decision support [1].

This research presents an advanced deep learning framework integrated with an improved Grey Wolf Optimizer (GWO) for the early and accurate detection of breast cancer. The enhanced GWO refines the training process of the deep learning model, optimizing its parameters to improve diagnostic precision. This synergy between deep learning and an optimized metaheuristic offers a robust solution for medical image analysis, providing better performance in identifying cancerous tissues [2].

This study proposes an adaptive Grey Wolf Optimizer (GWO) specifically designed for feature selection in various medical diagnostic tasks. The adaptive nature of the algorithm allows it to dynamically adjust its search parameters, leading to more optimal subsets of features. This improvement contributes to higher accuracy and reduced computational burden in medical classification problems, making diagnoses more reliable and efficient [3].

This research introduces a modified Grey Wolf Optimizer (GWO) specifically developed to assist in the diagnosis of COVID-19 from X-ray images. The modification aims to enhance the optimizer's ability to extract and select crucial features from complex radiographic data, thereby improving the accuracy and speed of automated diagnostic systems. The approach shows promise in providing timely and reliable support for medical professionals during pandemics [4].

This paper introduces an enhanced Grey Wolf Optimizer (GWO) designed to optimize the weights of deep neural networks, specifically for medical image classification tasks. By fine-tuning network parameters, the improved GWO helps in achieving higher accuracy and better generalization capabilities in classifying medical images. This method offers a pathway to more precise AI-driven diagnostic tools [5].

This work proposes an improved Grey Wolf Optimizer (GWO) that addresses some of the limitations of the original algorithm, particularly in balancing exploration and exploitation for global optimization and various engineering design problems. The enhancements contribute to faster convergence and more robust solutions across a diverse set of benchmark functions and real-world applications, showcasing its versatility and efficiency [6].

This paper introduces an ensemble deep learning model enhanced by an improved Grey Wolf Optimizer (GWO) for the accurate diagnosis of liver disease. The GWO component is crucial for optimizing the ensemble's hyperparameters, leading to a more robust and precise diagnostic system. This approach leverages the strengths of both deep learning and metaheuristic optimization to provide reliable decision support in complex medical scenarios [7].

This research proposes a novel hybrid approach for feature selection in medical datasets, combining the Grey Wolf Optimizer (GWO) with a multi-objective evolutionary algorithm. This hybrid method effectively balances the trade-off between maximizing classification accuracy and minimizing the number of selected features, offering a powerful tool for developing compact and highly accurate diagnostic models [8].

This paper introduces a chaotic Grey Wolf Optimizer (GWO) that incorporates an improved search mechanism to enhance its global optimization capabilities. By integrating chaotic maps, the algorithm achieves a more effective balance between exploration and exploitation, preventing premature convergence and improving the quality of solutions found across various benchmark functions. This modification contributes to making GWO a more powerful and reliable optimization tool [9].

This study presents an enhanced Grey Wolf Optimizer (GWO) that integrates adaptive weighting and an elite strategy to improve its performance in solving global optimization problems. The adaptive weighting mechanism helps balance the search process, while the elite strategy preserves promising solutions, leading to faster convergence and better solution quality on complex optimization landscapes [10].

Description

The Grey Wolf Optimizer (GWO) has seen significant enhancements, improving its core functionalities like balancing exploration and exploitation for global optimization and addressing engineering design problems [6]. These improvements contribute to faster convergence and more robust solutions across diverse applications. GWO modifications also extend to incorporating an improved search mechanism for global optimization through chaotic maps, preventing premature convergence and refining solution quality [9]. Further enhancements involve integrating adaptive weighting and an elite strategy to boost performance in global optimization, achieving quicker convergence and better solution quality on complex landscapes [10].

In medical applications, GWO has been tailored for critical diagnostic tasks. An advanced deep learning framework, powered by an improved GWO, facilitates the early and accurate detection of breast cancer. This optimizes deep learning param-

eters for enhanced diagnostic precision in medical image analysis [2]. A modified GWO assists in diagnosing COVID-19 from X-ray images, focusing on extracting and selecting crucial features from radiographic data to improve the accuracy and speed of automated diagnostic systems [4]. Similarly, an ensemble deep learning model, refined by an improved GWO, focuses on accurate liver disease diagnosis by optimizing hyperparameters for a more precise diagnostic system [7].

Feature selection is another key area where GWO modifications show promise. An enhanced GWO is specifically tailored for feature selection in complex clinical datasets, balancing exploration and exploitation to identify relevant features for medical diagnosis and prognosis [1]. An adaptive GWO is designed for feature selection in various medical diagnostic tasks, dynamically adjusting search parameters for optimal feature subsets, which leads to higher accuracy and reduced computational burden [3]. A novel hybrid approach combines GWO with a multi-objective evolutionary algorithm for feature selection in medical datasets. This effectively balances maximizing classification accuracy with minimizing the number of selected features, yielding compact and highly accurate diagnostic models [8].

Beyond feature selection, GWO also plays a role in optimizing deep learning models directly. An enhanced GWO is employed to optimize the weights of deep neural networks for medical image classification tasks [5]. By fine-tuning network parameters, this GWO improves accuracy and generalization capabilities in classifying medical images, offering a pathway to more precise AI-driven diagnostic tools [5]. The integration of GWO with deep learning, as seen in breast cancer detection and liver disease diagnosis [2, 7], underscores its value in refining training processes and optimizing model parameters for superior diagnostic performance.

Several studies emphasize the importance of advanced GWO techniques to overcome limitations of the original algorithm. Adaptive mechanisms [3], chaotic map integration [9], and hybrid approaches [8] are examples of how researchers are refining GWO. These developments ensure GWO remains a powerful and reliable optimization tool, capable of handling high-dimensional data and complex optimization landscapes while achieving robust and efficient solutions across various real-world problems [1, 6, 10].

Conclusion

This collection of research highlights the substantial advancements and broad applicability of the Grey Wolf Optimizer (GWO), particularly in addressing complex challenges within medical and computational domains. Many studies introduce enhanced GWO versions that strategically improve the balance between exploration and exploitation. This leads to more accurate and efficient feature selection, a critical step for processing high-dimensional clinical datasets and making data-driven medical diagnoses. GWO has been tailored to identify relevant features for general medical diagnosis and prognosis, and its application extends to specific disease detection, such as early and accurate breast cancer diagnosis by optimizing deep learning frameworks, and aiding COVID-19 diagnosis from X-ray images. Furthermore, an improved GWO has optimized deep neural network weights for medical image classification and enhanced ensemble models for liver disease diagnosis. Beyond clinical applications, the enhanced GWO showcases superior performance in global optimization and diverse engineering design problems. Modifications like incorporating chaotic maps, adaptive weighting, and elite strategies prevent premature convergence, ensuring faster convergence and more robust solutions across complex optimization landscapes. These collective efforts underscore GWO's continuous evolution as a versatile and powerful metaheuristic, providing robust solutions for both advanced clinical decision support and general optimization challenges.

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Conflict of Interest

None.

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