CPSORCL: A ROBUST COOPERATIVE PSO AND CONTRASTIVE LEARNING-BASED FRAMEWORK FOR INTERACTIVE FEATURE SELECTION

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Abstract

Feature selection plays a critical role in improving the performance, interpretability, and computational efficiency of machine learning models, especially when dealing with high-dimensional datasets. Selecting the most informative subset of features helps reduce redundancy, eliminate noise, and enhance the predictive capability of classification models. However, traditional feature selection techniques often struggle to balance exploration and exploitation in the search space while simultaneously incorporating domain knowledge. To address these limitations, this study proposes CPSORCL: A Cooperative Particle Swarm Optimization Method with Random Contrastive Learning for Interactive Feature Selection**.** The proposed framework integrates swarm intelligence, contrastive feature relevance learning, and user-guided interaction to identify an optimal subset of predictive features.The CPSORCL approach combines Cooperative Particle Swarm Optimization (CPSO) **with a** Random Contrastive Learning (RCL) mechanism to improve the effectiveness of the feature selection process. In the CPSO component, multiple swarms cooperate to explore the feature subset search space, enabling better diversity and faster convergence compared to traditional PSO-based methods. Each particle represents a potential feature subset, and the cooperative learning strategy allows different groups of particles to share knowledge about promising solutions, thereby improving global optimization performance. To guide the optimization process, the proposed method incorporates a random contrastive learning-inspired feature scoring mechanism that evaluates features based on their ability to distinguish between instances belonging to the same and different classes. This contrastive scoring approach enhances the identification of discriminative features while reducing the influence of irrelevant attributes.In addition, CPSORCL introduces an interactive feature selection component that allows domain experts or users to influence the selection process by assigning preference weights to certain features. These preferences are integrated into the fitness evaluation function together with classification accuracy, feature relevance, and subset compactness. By combining algorithmic optimization with human knowledge, the framework enables a more flexible and explainable feature selection strategy.