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Predicting Steel Plate Fault Detection by Metaheuristic-Optimized Multi-Level Classification Machine Learning

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Abstract

Steel plate fault detection is a vital material science problem and getting popular in mechanical engineering because of less cost and time. This study investigated a bio-inspired hybrid intelligence model that integrated an enhanced firefly algorithm (FA) with a least squares support vector machine (LSSVM) algorithm and decomposition to improve its predictive accuracy in classifying steel plate faults detection. The goal is to investigate the multiclass classification problem and propose an efficient method. The proposed model integrates the FA, metaheuristic intelligence, decomposition approaches, the one-against-one, and the LSSVM. This investigation uses a multi-class case in civil engineering - steel plate faults detection - to verify the model's effectiveness. In the steel industry, creating different defective products can impose a high cost for steel product manufacturers and result in failure risk for mechanical engineers. Moreover, an effective method to determine fault types will reduce maintenance costs and unexpected waste and improve the product's quality level. Thus, classifying the diagnosis of faults in steel plates plays a critical role in industrial production. Based on the provided data, the analytical results confirm that the proposed model has 91.085% predictive accuracy. To verify the applicability and efficiency of the proposed model, its predictive performance was compared to other multi-classification models and prior studies concerning the accuracy, precision, sensitivity, specificity, and area under the receiver operating characteristic curve. The proposed model exhibited higher predictive accuracy than the experimental and other single multi-class models. Therefore, the proposed bio-inspired hybrid model can be a promising tool in solving classification problems for the steel industry and mechanical engineering.

Keywords

multi-class classification, metaheuristic intelligence, machine learning, steel plates fault detection, steel industry.

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