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Hybrid Harris hawks-optimized random forest model for detecting multi-element geochemical anomalies related to mineralization

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Reliable recognition of geochemical anomalies linked to ore deposits is one of the most significant challenges in mineral exploration. Several advanced machine learning (AML) algorithms have recently been applied to recognize multi-element geochemical anomalies. Performance of the AML algorithms are extremely dependent to values of their hyperparameters. Because, conclusions of their application can significantly be differed tuning hyperparameters. Tuning hyperparameters through trial-and-error way is a labor-intensive and time-consuming procedure which is not mostly eventuated to reliable results. In this regard, applying an AML model decreases training time and assists to achieve optimized values of hyperparameters yielding reasonable potential maps. Hence, execution of an AML model mitigates the biasness problem and uncertainties with recognition of multi-element geochemical anomalies. In this study, Harris hawks optimization (HHO) algorithm was employed to optimize known hyperparameters of the random forest (RF) method for detecting multi-element geochemical anomalies related to mineralization occurrences in the Feyzabad district of the Razavi Khorasan province, NE Iran. This research demonstrates that Harris hawks optimized random forest (HHORF) model is a vigorous procedure to identify multi-element geochemical anomalies. Because, the HHORF model has recognized 86.53% mineralization occurrences through 30% corresponding area while the RF method has catched 80.14% mineralization occurrences up via same corresponding area.

Keywords Advanced machine learning model, Random forest, Multi-element geochemical anomaly recognition, Au-Cu mineralization, Nature-inspired optimization techniques

Decreasing uncertainty of multi-element geochemical anomaly mapping is a challenging procedure. Decreasing uncertainty is so necessary for geochemical anomaly mapping in a study area. Because, recognition of multi-element geochemical anomalies can facilitate to detect hidden deposits[1]. In regional scale, multi-element geochemical anomaly detection is performed employing stream sediments geochemical data. The stream sediments geochemical data is extremely under efficacy of complex geological features[2–5]. Hence, this data is a nonlinear multivariate input which requires capable processing models[5,6]. Whereas, traditional procedures have not necessary capability to process them but advanced machine learning (AML) frameworks are appropriate substitutes to perform this task[1,3,7–14]. Among applied machine learning models, random forest (RF), artificial neural networks and support vector machine were the most useful methods for multi-element geochemical anomaly detection[15–17]. The RF method is a developed form of decision trees which can be applied for classification and regression[18–21]. Three known hyperparameters of the RF comprising number of trees (NT), number of splits (NS) and depth (D) extremely need to be optimized for reduction of uncertainties in multi-element geochemical anomaly detection. Although, applied ML models have better conclusions than traditional methods but majority users tune their hyperparameters through performing trial-and-error procedure. While, applying trial-and-error is an onerous and time-consuming way which can not be eventuated to reliable results[22–24]. Fortunately, numerous nature-inspired optimization techniques have been designed to remove trial-and-error procedure of tuning stage of the ML hyperparameters in recent decade. These techniques commonly inspire by the social life behavior of creatures. In this regard, firefly algorithm[25,26], dolphin echolocation[27,28], cuckoo search[29], bat algorithm[30], whale optimization algorithm[24] and grey wolf optimizer[31], wild horse optimizer[32], Harris hawks optimization (HHO) algorithm[23] and so on were introduced to optimize ML models applied in medical,

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