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Original Article

Slope stability prediction of circular mode failure by machine learning models based on Bayesian Optimizer

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Abstract: Assessing the stability of slopes is one of the crucial tasks of geotechnical engineering for assessing and managing risks related to natural hazards, directly affecting safety and sustainable development. This study primarily focuses on developing robust and practical hybrid models to predict the slope stability status of circular failure mode. For this purpose, three robust models were developed using a database including 627 case histories of slope stability status. The models were developed using the random forest (RF), support vector machine (SVM), and extreme gradient boosting (XGB) techniques, employing 5-fold cross validation approach. To enhance the performance of models, this study employs Bayesian optimizer (BO) to fine-tuning their hyperparameters. The results indicate that the performance order of the three developed models is RF-BO > SVM-BO > XGB-BO. Furthermore, comparing the developed models with previous models, it was found that the RF-BO model can effectively determine the slope stability status with outstanding performance. This implies that the RF-BO model could serve as a dependable tool for project managers, assisting in the evaluation of slope stability during both the design and operational phases of projects, despite the inherent challenges in this domain. The results regarding the importance of influencing parameters indicate that cohesion, friction angle, and slope height exert the most significant impact on slope stability status. This suggests that concentrating on these parameters and employing the RF-BO model can effectively mitigate the severity of geohazards in the short-term and contribute to the attainment of long-term sustainable development objectives.

Keywords: Slope stability; Circular failure; Machine learning; Bayesian optimizer; Hybrid models

Abbreviation	Explanation
AC	Accuracy
ADB-DT	Adaptive boosted decision tree
ANN	Artificial neural network
AutoML	Automated machine learning
BP	Back-propagation
BC	bagging classifier
BO	Bayesian optimizer
c	Cohesion
DT	Decision tree
DTR	Decision tree regression
ETR	Extra tree regression
XGB	Extreme gradient boosting
ELM	Extreme learning machine
XRT	Extremely randomized tree
FN	False negative
FP	False positive
φ	Friction angle
GNB	Gaussian naive bayes
GP	Gaussian process

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