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Liquefaction Potential Prediction of Chi-Chi Earthquake Based on Standard Penetration Test Data Using Gradient Boosting Classifier

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Abstract : Soil liquefaction, triggered by increased porewater pressure, poses a significant threat to infrastructure stability in seismically active regions, and its forecasting remains challenging due to intricate nonlinear interactions. This study uses a dataset of 540 samples that includes seismic parameters and standard penetration test (SPT) results to evaluate liquefaction prediction. SPT N60 values, soil fine content (FC), ground water table (GWT), effective stress of overburden (ESO), peak ground acceleration (PGA), and earthquake magnitude (Mw) are key inputs. A gradient boost classifier (GBC) machine learning (ML) model was utilized to classify liquefaction events. The model's performance was evaluated using metrics such as accuracy, precision, recall, F1-score, confusion matrix analysis, sensitivity analysis, feature importance ranking, and Shapley Additive Explanations (SHAP). According to these evaluations, the most significant variables in predicting liquefaction were PGA, SPT-N60, and GWT. The robustness of the GBC model was further validated through precision-recall curves and k-fold cross-validation, and it achieved an impressive 99.38% prediction accuracy. These results highlight the potential of the GBC technique to advance the reliability of liquefaction forecasting.

Keywords : liquefaction, standard penetration test, gradient boost, machine learning, SHAP
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