Industrial Waste

Predictive modeling for sustainable high-performance concrete from industrial wastes: A comparison and optimization of models using ensemble learners

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JOURNAL OF CLEANER PRODUCTION
Volume
292
Article Number
126032
DOI
10.1016/j.jclepro.2021.126032
Published
APR 10 2021
Early Access
FEB 2021
Indexed
2021-03-22
Document Type
Article

Abstract

The cementitious matrix of high-performance concrete (HPC) is highly complex, and ambiguity exists with its mix design. Compressive strength can vary with the composition and proportion of constituent material used. To predict the strength of such a complex matrix the use of robust and efficient machine learning approaches has become indispensable. This study uses machine intelligence algorithms with individual learners and ensemble learners (bagging, boosting) to predict the strength of (HPC) prepared with waste materials. This is done by employing Anaconda (Python). Ensemble learner bagging, adaptive boosting algorithm, and random forest as modified bagging algorithm are employed to construct strong ensemble learner by incorporating weak learner. The ensemble learners are used on individual learners or weak learners including support vector machine and decision tree through regression and multilayer perceptron neural network. The data consists of 1030 data samples in which eight parameters namely cement, water, sand, gravels, superplasticizer, concrete age, fly ash and granulated blast furnace slag were chosen to predict the output. Twenty bagging and boosting sub-models are trained on data and optimization was done to give maximum R-2. The test data is also validated by means of K-Fold cross validation using R-2, MAE, and RMSE. Moreover, evaluation of ensemble models with individual one is also checked by

statistical model performance index (e.g., MAE, MSE, RMSE, and RMLSE). The result suggested that the individual model response is enhanced by using the bagging and boosting learners. Overall, random forest and decision tree with bagging give the robust performance of the models with R-2 = 0.92 with the least errors. On average, the ensemble model in machine learning would enhance the performance of the model.

Keywords
Author Keywords
Concrete strengthMachine learningPredictionArtificial intelligenceSupervised machine learningEnsemble model in concreteWaste materials
Keywords Plus
SELF-COMPACTING CONCRETECOMPRESSIVE STRENGTHNANO SILICABOTTOM ASHRESISTANCESLUMPSLAG