An Effective Approach to Predict Spatial Distribution of Lithology Using Combined Machine Learning Algorithms: A Case Study from the Ok Tedi Mine, Papua New Guinea

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Abstract

There is a growing interest in the use of artificial intelligence (AI), particularly machine learning throughout the different industries including the mineral exploration and mining industry. The primary goal of machine learning is simply to understand the nature of learning, and to build learning capability in computers. Machine learning facilitates computers to understand the structure of data and build models that can be understood and utilized by people to, for example, make predictions. In this study, we discuss an approach in applying machine learning for the prediction of lithology in mines and advanced exploration prospects. We implemented several algorithms including the decision tree, support vector machines (SVM), k-Nearest Neighbor, and ensemble methods to predict lithology along drill holes and compared their prediction performances using 759356 drill hole assay data points from the Ok Tedi Mine in Western Province, Papua New Guinea. We split the data into training (75-80%), validation (15%) and testing (15-30%) sets in building the different models and in assessing their performances. Our results indicated that the ensemble method boosted with bootstrap aggregation (bagging) has the best prediction performance with a correct prediction accuracy of 95-97%. Using the predicted results from the bagged ensemble method, we then implemented an artificial neural network (ANN) to predict lithology distribution throughout 3D space. Our predicted lithology distribution model compares reasonably well with the geology model generated by Seequent's Leapfrog Geo commercial software through its radial basis function (RBF). The developed code was compiled into a user-friendly desktop application with efficient 3D visual ization capabilities. This in-house desktop application can be of help in areas of undefined, missing, or uncertain drill hole data and it can also assist in drill hole data interpretations and provide predicted lithology distribution models that can be comparable to the models generated from Leapfrog. The results obtained seems promising for the use of the machine learning in the mineral exploration and mining space; however, this technology is still in its infancy and warrants care in its usage.

Keywords: Ok Tedi, lithology, predictive geological modeling, machine learning

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