Development of Support Vector Machine learning algorithm for real time update of resource estimation and grade classification

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ABSTRACT

This paper presents the development and implementation of a theoretical mathematical-statistical framework for sequential updating of the grade control model, based on a support vector machine learning algorithm. Utilising the Zambujal orebody within the Neves-Corvo Cu deposit in Portugal, parameters that can be measured in real time, used in visualisation, modelled for resource estimation, and used for process control visualisation and optimisation are considered.

The methodology broadly comprises of three steps. Firstly, the provided dataset is used to develop a virtual asset model (VAM) representing the true 3D grade distribution in order to simulate the mining method. Then ore quality parameters are established simulating real time monitoring sensor installation at: (a) stope development and rock face monitoring (face imaging and drillholes); and (b) transport monitoring (muck pile, LHD/scooptram). Next, the acquired data was assimilated into the models as part of the sequential model update

Two different mining methods and the monitoring information that can be acquired during the ore extraction are analysed: (a) drift and fill mining and (b) bench and fill mining, which are widely implemented at the Neves-Corvo mine. Selected study zones were chosen such as to contrast mining through the high/low grade zones with different degrees of heterogeneity, which demonstrate the performance of resource estimation and classification models developed in heterogeneous mining stopes.

The grade accuracy and error in the resource model, and high/low grade ore classification accuracy and error are evaluated as performance metrics for the proposed methods.

In drift and fill mining, drillhole and face sampling data collection was simulated in a real-time manner and fed into the support vector machine (SVM) regressor to update the resource estimation model in both a high grade and low grade drift scenarios. In each scenario, six drift and fill mining steps were simulated sequentially and the posterior resource

models, after integrating real time mining data, have shown significant improvement of bias correction in both updating planned resources and reconciling extracted ore.

In bench and fill mining, grade classification based on random sampling data from muck pile was demonstrated, considering scoop by scoop derived monitoring data. Three different classifiers (mean, median, and Bayesian) were tested and shown very good performance. In the case study presented here, a sequence of 15 blasting steps was simulated with each step requiring 112 scooping operations to transport the blasted ore. Using the real time monitored information, it was shown that at each blasting step over 85% of the scoops can be labelled correctly using the proposed methods and with an accuracy of over 95%.