Prediction of Underground Mine Stope Stability: a Case Study Based on Supervised Learning Methods

Lucas de A. G. Paixão[1]
[1] Universidade Federal da Bahia

Abbreviated abstract: Historically, mining industry has adopted Mathews and Potvin's Stability Graph as a means to evaluate stope stability. However, due to the excessive simplification, the graph is unable to grasp the nature of the problem adequately, with statistical procedures becoming favored in the last few years as an alternative. This work proposes the application of different supervised learning models to predict stope stability, showing that the models can be reasonably used even when dealing with imbalanced datasets.

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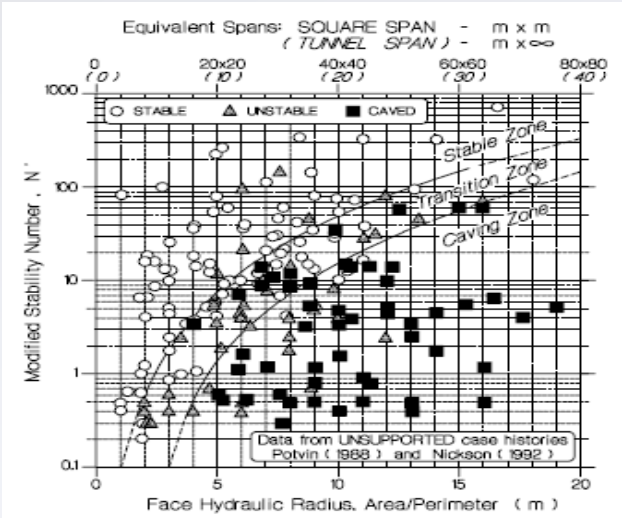
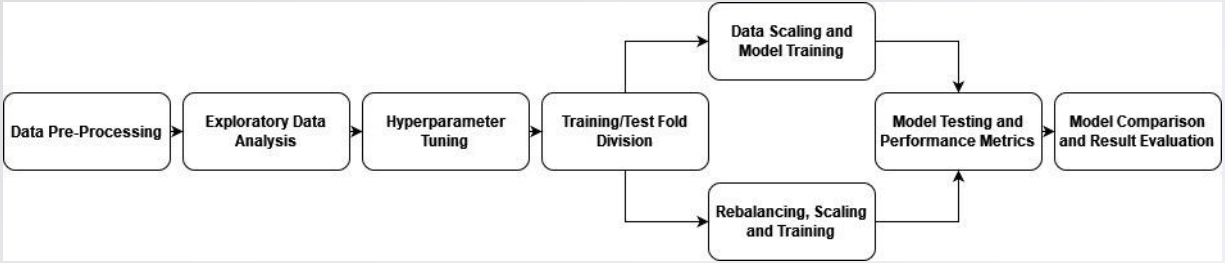
History of the Problem

- **The problem**: underground stope stability as a risk for the mining industry operations;
- **First solutions proposed**: Stability Graphs by Mathews et al. (1980) and Potvin (1988);
- **Issues**: excessive simplification of the phenomenon;
- **Notable Works**: Germain and Hadjigeorgiou (1997); Henning and Mitri (2007); Papaioanou and Suorineni (2015); Qi et al. (2018).
- **Tendency observed**: use of statistical models as alternative;



Materials and Methods



Dataset

- 340 observations
- IR = 15.2

Predictors

- RQD;
- Hydraulic radius
- Depth;
- Stope direction;
- Stope dip;
- Stope undercut width;
- Stability factors (factor A, factor B, factor C);

Response

- Stope stability (binary);

Models

- Logistic regression;
- K-nearest neighbors;
- Discriminant Analysis;
- SVM;
- Decision Trees;
- Random Forests;

Rebalancing Algorithm

- SMOTE;
- $0.1 \leq IR^{-1} \leq 1$;

Hyperparameter Tuning

- *GridSearch*

Training Data Scaling

- *z-score;*

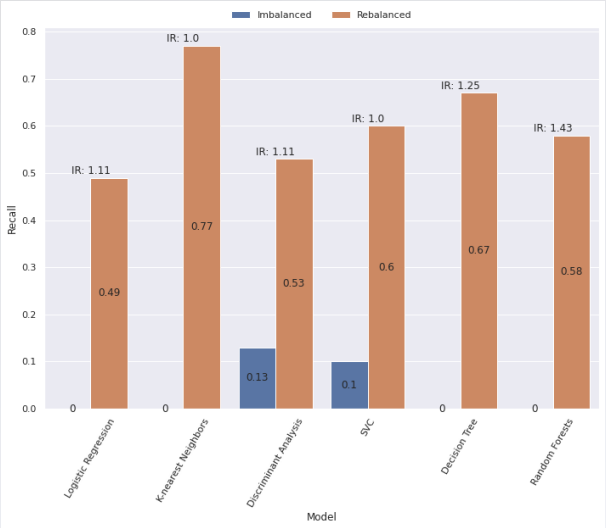
Validation Strategy

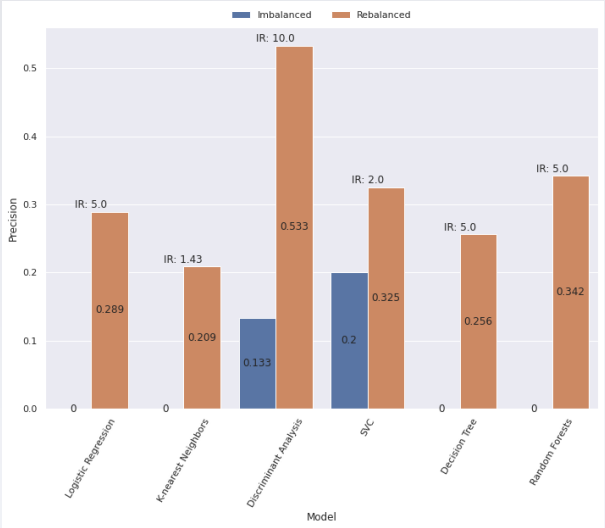
- K-fold Cross Validation with five folds;

Evaluation Metrics

- Recall;
- Precision;
- F1-Score;
- AUC;

Results and Conclusions





Results and Conclusions