Using artificial intelligence (AI) to increase gas supply

Ruizhi Zhong[1], Nathaniel Chand[1]

1 Centre for Natural Gas, The University of Queensland, St Lucia, QLD, Australia

Introduction

What is artificial intelligence (AI)? AI is a broad area that contains any computer systems that can perform tasks without human intervention.

Machine learning is the subset of AI with algorithms and technologies to learn from the data without explicated programmed.

One of the biggest indicators of gas production is permeability. Traditional methods (well test and laboratory test) to obtain permeability is costly, resources-intensive, and possibly time consuming.

Drilling optimising can increase rate of penetration (ROP) and reduce operating costs during drilling.

Machine Learning offer a faster, cheaper and easier way to identify production indicators and increase the drilling efficiency.

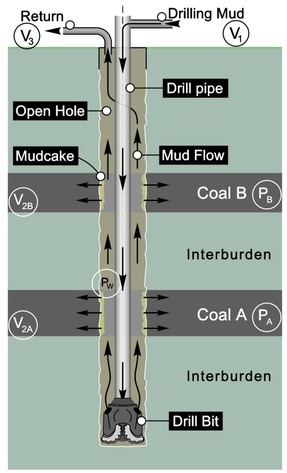

Figure 1. Schematic of drilling fluid circulation in coal seam gas wells.

Project Workflow

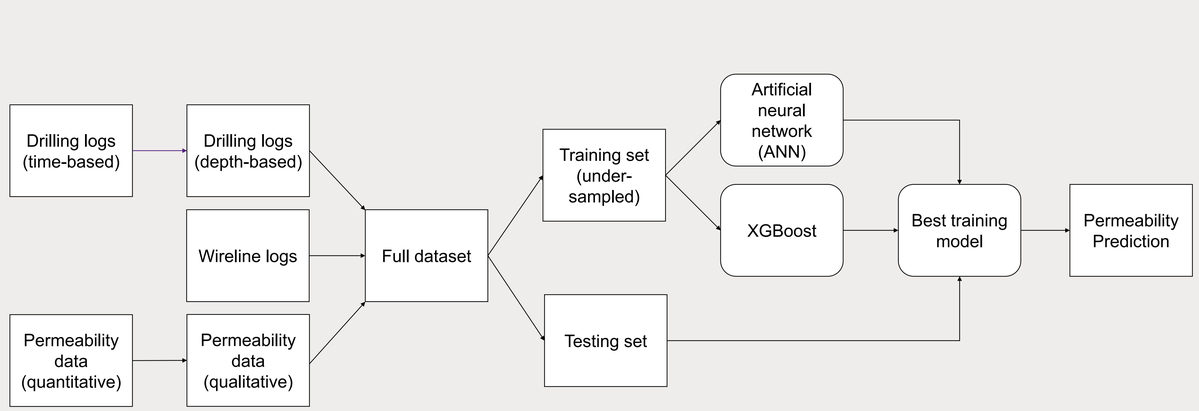

Figure 2a. Flowchart of permeability prediction

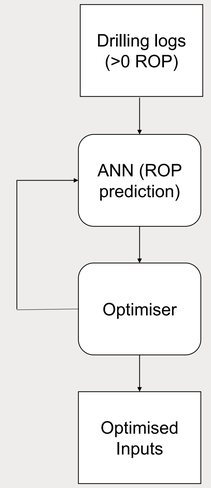

Figure 2b. Flow chart of ROP optimisation

Methodology

Data processing

- Join and filter logs
- Calculate fluid loss
- Address class imbalance

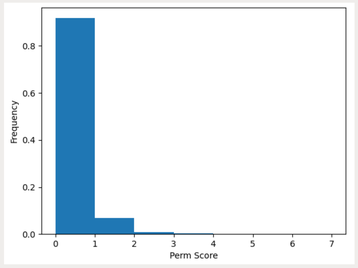

Figure 3. Distribution of permeability scores.

Data balancing techniques

- Class weighting
- Undersampling (reduce sample size of majority classes)
- Oversampling (increase sample size of minority classes)

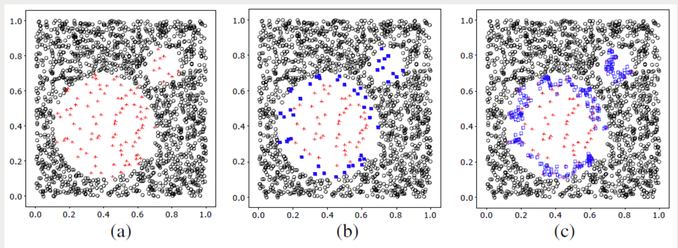

Figure 4. Synthetic Minority Oversampling Technique (SMOTE) .

Machine learning algorithms

- Artificial Neural Network (ANN)
- Extreme Gradient Boosting (XGBoost)

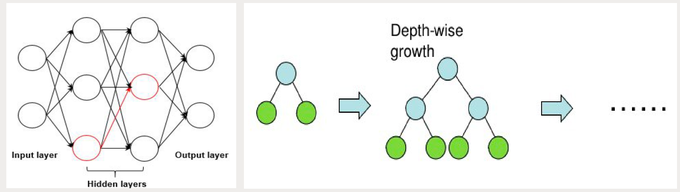

Figure 5. (Left) Artificial Neural Network (ANN); (Right) Extreme Gradient Boosting (XGBoost).

Model evaluation

- Cross-validation – split data into n groups.

	Split 1	Split 2	Split 3	Split 4	Split 5	Results	Result
Fold 1	**Valid.**	Train	Train	Train	Train	Error 1	**Mean Error**
Fold 2	Train	**Valid.**	Train	Train	Train	Error 2	
Fold 3	Train	Train	**Valid.**	Train	Train	Error 3	
Fold 4	Train	Train	Train	**Valid.**	Train	Error 4	
Fold 5	Train	Train	Train	Train	**Valid.**	Error 5	

- Confusion matrices

		Predicted Condition		
		Class 0	Class 1	Class 2
Actual Condition	Class 0	% Correct	% False 1	% False 2
	Class 1	% False 0	% Correct	% False 2
	Class 2	% False 0	% False 1	% Correct

Results and Conclusions

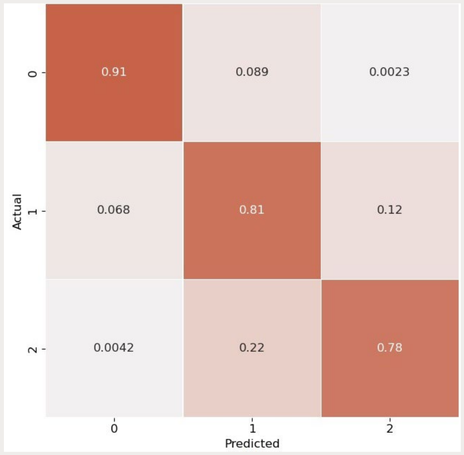

Figure 6: Results of permeability classification.

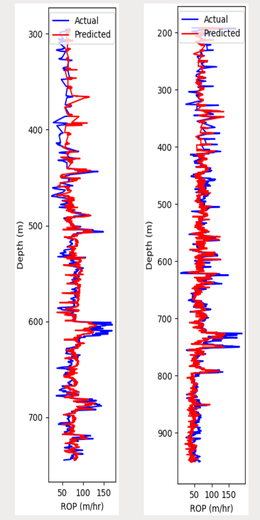

Figure 7. Results of ROP prediction.

Conclusions

(1) Flag-based permeability results are good. Results can be possibly improved with better quality data from logging-while-drilling (LWD) data.

(2) After applying data balancing techniques, results are balanced with overall accuracy of >80%.

(3) ROP prediction results are promising. The next step involves the application of optimisation methods (e.g., differential evolution or particle swarm optimisation).

r.zhong@uq.edu.au

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