soma.roy@gail.co.in

Table-1: Metric of accuracy: R^2 and MSE

Method	Actual sonic vs Predicted sonic logs		Actual density vs Predicted density logs	
	MSE (%)	R^2	MSE (%)	R^2 coefficients
LR	0.8293	0.6178	0.8221	0.8221
RR	0.8293	0.6178	0.8220	0.8220
LO	0.8286	0.6181	0.8219	0.8219
NN	0.6393	0.7053	0.3220	0.9032
LR: Linear regression, RR: Ridge regression, LO: LASSO, NN: Neural Network				

Conclusions

This study proposes four different regression algorithms and machine learning as a tool for predicting the sonic log in open-hole wells based on other available common logs. Strict steps including data normalization, training set selection, and testing are very important for deciding the prediction power, the generalization capability, and the complexity of the derived regression model. The four different regressors we used were: Linear, Ridge, Lasso and neural network. For training phase, we tested the model on a validation set and saw that all three methods provide very similar results. We then tested the robustness of the model on a blind dataset. Finally we predicted DT using all four different regression algorithms. There are zones within the blind dataset where the prediction is not of very high accuracy. It would be interesting to understand the geological framework and its effect on prediction. We can also try by chopping the data into different lithological zones based on geologic picks before training and predicting. The method presented here is not limited to modeling DT logs only. It can be extended, with appropriate modifications of the algorithm, in any area of well logging studies, where missing log values are needed.

References

1. de Wit, Ralph WL, Andrew P. Valentine, and Jeannot Trampert. "Bayesian inference of Earth's radial seismic structure from body-wave traveltimes using neural networks. " Geophysical Journal International 195.1 (2013): 408-422.

2. Bergen, K. J., Johnson, P. A., Maarten, V., & Beroza, G. C. (2019). Machine learning for data-driven discovery in solid Earth geoscience. Science, 363(6433), eaau0323.

3. Bianco, Evan. "Geophysical tutorial: Well-tie calculus." The Leading Edge 33.6 (2014): 674-677.

Acknowledgement

We extend our sincere thanks to GAIL (India) Limited for giving permission to publishing this paper. We would also extend our sincere thanks to Sundeep Sharma, Geophysicist, Devon Energy, Oklahoma City, USA for various technical discussions and his help in creating various modules and frame for machine learning model. We also appreciate Dr. Dharmendra Singh, Sr. Manager (Petrophysics) for his valuable discussion, input and proof reading of the paper.