Please fill in the name of the event you are preparing this abstract for.	International Petroleum Technology Conference
Please fill in your 5-digit IPTC manuscript number and IPTC Control number.	IPTC-19087-MS 19IPTC-P-2766-IPTC
Please fill in your abstract title.	Towards Automatic Well Log Depth Matching by Leveraging Machine Learning Based Approaches

Please fill in your author name(s) and company affiliation.

Given Name	Surname	Company
Lin	Liang	Schlumberger-Doll Research, Cambridge, MA, USA
Timon	Zimmermann	École Polytechnique Fédérale de Lausanne, Switzerland
Thai	Le	The Pennsylvania State University, Cambridge, MA, USA
Smaine	Zeroug	Schlumberger-Doll Research, Cambridge, MA, USA

Abstract

Automatic well log depth matching is a critical element on the way towards developing a fully automated workflow for well log interpretation. We present a machine learning based method developed to learn from human or algorithmic processing of depth matching of gamma-ray logs, and that is able to provide a reliable automated prediction of depth shifting between two desynchronized logs of similar type.

Gamma-ray measurements are commonly used for depth-matching well logs acquired from various logging passes in a well. Existing approaches are either completely manual, or algorithm-assisted based on cross-correlation. None performs well without user intervention. We hence aim to develop a machine learning based solution that uses a clever data formation to alleviate the problem's difficulty. We use supervised learning through an artificial neural network that is trained on data labeled by manual depth-matching of field data with label-preserving data augmentation. A relaxed-accuracy criterion is adopted to improve the training effectiveness to deal with the unavoidable human errors during manual labeling. A stacking technique is employed to guarantee the robustness of this method.

This algorithm is based on a fully connected neural network with multiple hidden layers. The hyperparameters are optimized using the sequential model-based optimization method. The model is trained on a data set made of manually depth matching field data of limited extent and boosted by data augmentation techniques. Prediction from the trained model combining with the stacking options demonstrated excellent performance. Testing shows the algorithm makes very few mistakes and outperforms human capabilities on challenging scenarios. A key aspect of the developed framework is its generalization potential. Namely, it is agnostic of the signal type and therefore could be easily applied to other log data types, provided a sufficiently large volume of labeled data is available. We also developed a scheme to support the self-evolution of the system by adopting online training and aimed at facilitating the emergence of a fully automated depth matching workflow. The algorithm and workflow have been demonstrated on field data sets. Reliable results are obtained for different scenarios, including depth matching on gamma-ray logs with different spatial resolutions.

Compared to existing approaches, the proposed algorithm provides an automatic method for well log depth matching that enables a fully automated workflow for well log interpretation. The success of this machine learning based algorithm relies on a few important techniques, including an innovative way of abstracting the problem, a relaxed-accuracy function to better accommodate the ambiguity of some labels in the training data set, and a stacking technique for improving the robustness of the algorithm.