Deep learning for coal seam gas reservoirs exploration

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Deep Learning (DL) approaches have the unique ability to automatically extract features and perform robust predictions and classifications on, large, high-dimensional datasets. The DL approach is valuable for geological problems, where most datasets exhibit non-linear relationships obtained from multiple sources and consist of many heterogeneous observations.

The Autoencoder Neural Networks (AE NNs) is an unsupervised DL method, developed for dimensionality reduction and to facilitate efficient learning from big datasets. AE NNs outperform traditional approaches, such as, Principal Component Analysis (PCA), because of their inherent non-linear transformation ability. Furthermore, their good generalization performance and ability to create an accurate reduced representation of datasets makes them an attractive tool for interrogating geological and geophysical problems.

Ultra-deep coal seams of the Cooper Basin, Australia, have been chosen for this case study because of their potential prospectivity. However, detecting commercially prospective reservoirs is challenging because of the complexities in reservoir and geomechanical properties associated with ultra-deep coals. In this study, we use a dataset of 30 physical parameters estimated from wireline and mudlog wells data for each target coal seams (approximately 1000) located in the Cooper Basin. A two-stage workflow is proposed for the identification of deep coal seam types from well log data: 1) AE NNs is used for extracting features and reducing dimensions of input dataset; 2) Clustering techniques are then used to determine natural groupings of depth intervals associated with various coal seams. The AE NNs revealed dependencies between parameters more efficiently and accurately compared to PCA. Furthermore, the AE NNs-based clustering showed improved spatial separation of clusters along with significant distinct thermal maturity trends in different coal types.

The workflow enables domain experts to explore the hidden non-linear processes and relationships of coal seams parameters, as well as automatically identify various coal seam types from well logs.

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References
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