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Channel Characterization Using Support Vector Machine

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Summary

Rapid growth in the size of seismic data and the number of attributes cause to increase the significance of pattern recognition techniques in interpreting the seismic data. Unsupervised methods include k-means, self-organizing maps (SOM) and generative topographic maps (GTM) let interpreters do a preliminary interpretation and conclude relatively suitable information with no much primary data from studied area. On the other hand, utilizing supervised learning such as neural networks (NN) and support vector machines (SVM) by interpreters require some primary information from studied area to seed the existent facies and use these seeded samples as the input to the algorithm. In this study, to detect channel facies of one of the southwest hydrocarbon fields of Iran, we used k-means and SVM to train the second algorithm by using the extracted primary information from the first algorithm. Results show that the existent channels in the studied area have two different facies that can be detected by applied algorithms.

Introduction

Channels have an important role in exploration and development of oilfields, and thereby, the interpreters are concerned about these types of facies. Due to the enlargement of 3D seismic data over recent years, the pattern recognition techniques have been employed to facilitate the detection of these facies. The *k*-means algorithm (Jancey, 1966) is one of the first pattern recognition algorithms which was considered to analyze the seismic data, and it is used up to now (Coléou *et al.*, 2003; Sabeti and Javaherian, 2009; Zhao *et al.*, 2015). The SVM can be named as another used algorithm in the interpretation of seismic data (Zhao *et al.*, 2015; Zhao *et al.*, 2016). In this study, after introducing the used seismic attributes, primary information about the channels was extracted by the unsupervised *k*-means algorithm, and finally, more accurate information was achieved by SVM.

Method

The studied area relates to a time slice at 1.8 second from a seismic data acquired over an oilfield in the southwest of Iran. The input of pattern recognition algorithms is a multi-attribute matrix so that each sample of input matrix has some seismic attributes and the amount of these attributes should be as least as possible (Zhao *et al.*, 2015). In this study, acoustic impedance (Figure 1(a)) and spectral decomposition (Figure 1(b)) were utilized to investigate the lithology and types of fluid, respectively. Also, root-mean-square amplitude and grey-level co-occurrence matrix were employed to determine the lateral variation (Figure 1(c)) and the distribution of data (Figure 1(d)), respectively.

To obtain initial information from the studied area, the *k*-means algorithm should be executed, firstly. As the aim of this study is classifying the channel facies due to their different properties initially, *k*-means was used to cluster the data in three different clusters ($k = 3$) (Figure 2(a)) and then the output of this algorithm was used to seed the time slice in order to use as the input of SVM (Figure 2(b)). After that, 15% of seeded samples were selected as test data, and the others were used to train the algorithm. At the end, the test data were employed to investigate the accuracy of training (Figure 3). After ensuring the accuracy of training, by entering the unseeded data into the algorithm, the time slice was seeded by trained parameters (Figure 4).

Conclusions

Current study not only indicates the ability of SVM to analyze the seismic facies but also presents that the obtained information through unsupervised algorithms can be used as a valuable guidance to seed the input data of supervised algorithms.
According to the results, time slice at 1.8 s which belongs to Sarvak Formation, has two wide channel branches including separable facies and interior sediments of these branches have different characteristics and properties.

Acknowledgements

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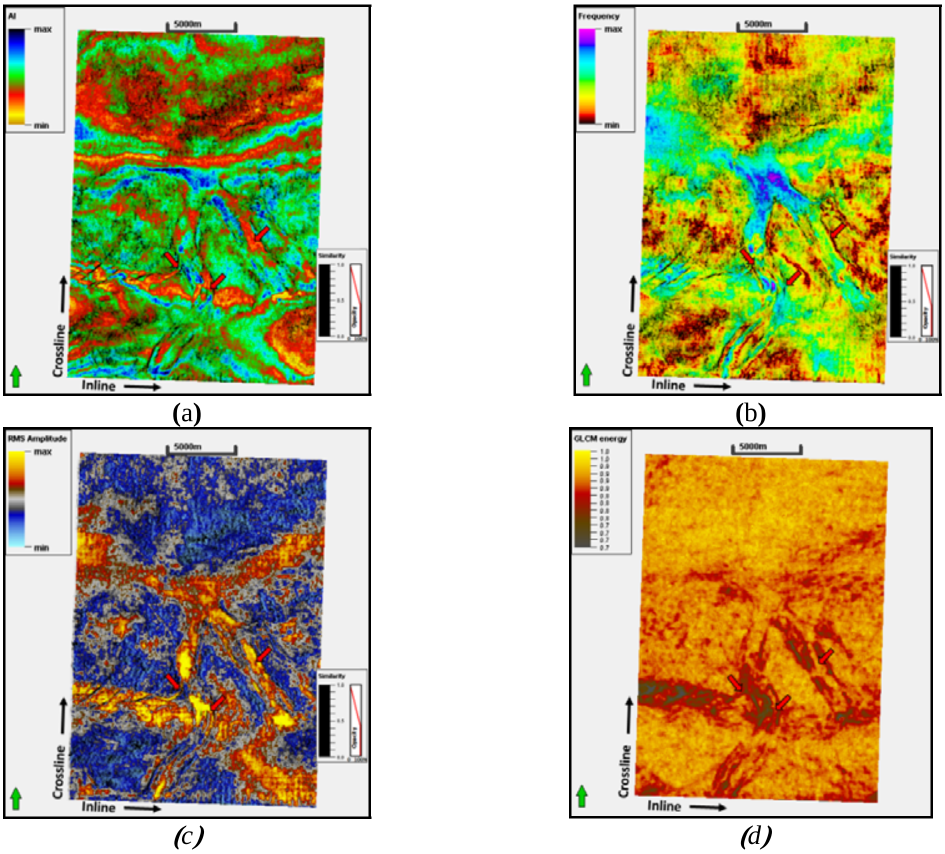

Figure 1 *Volume time slice at 1.8 s through (a) acoustic impedance, (b) spectral decomposition with frequency of 15 Hz, (c) root-mean-square amplitude, the structure of channel facies have been marked with similarity attributes, (d) grey-level co-occurrence matrix energy attribute. Red arrows show two studied broad channels.*

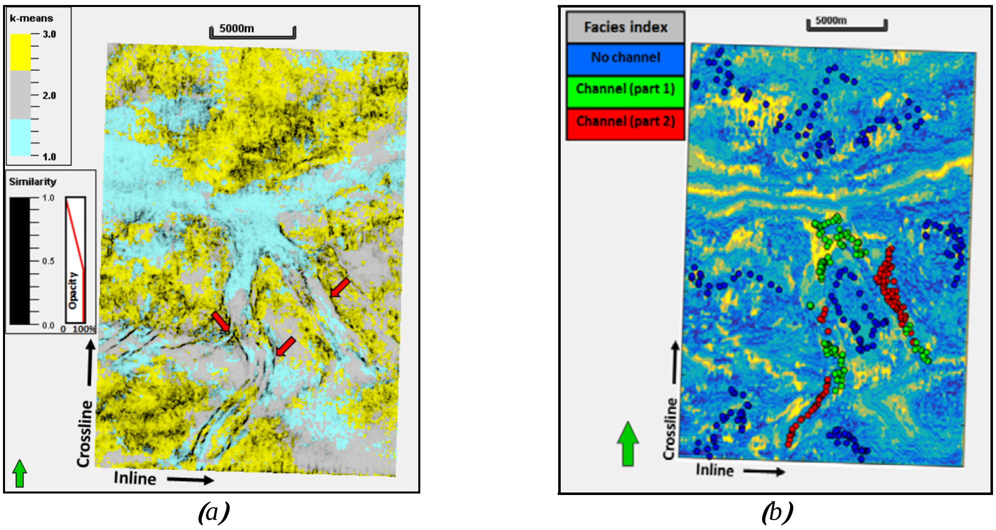

Figure 2 *(a) Studied time slice by executing k-means for k = 3 which separate facies into two group, (cyan and gray). Red arrows show two original channel branches. (b) Data seeded according to the output information of k-means algorithm which were used as the input of SVM.*

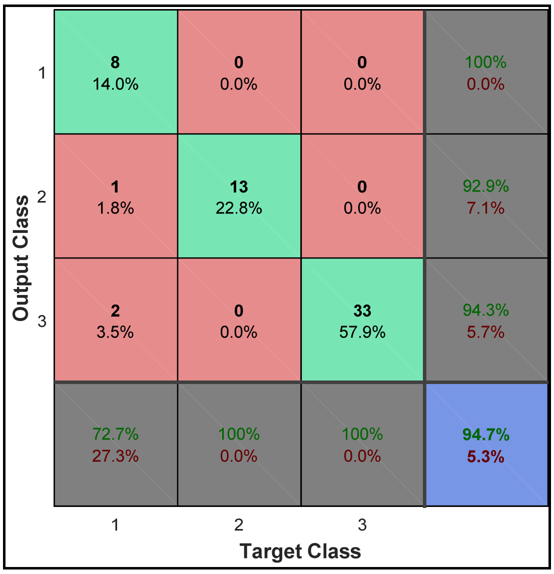

Figure 3 *The training accuracy of SVM with training data shows 94.7 percent accuracy.*

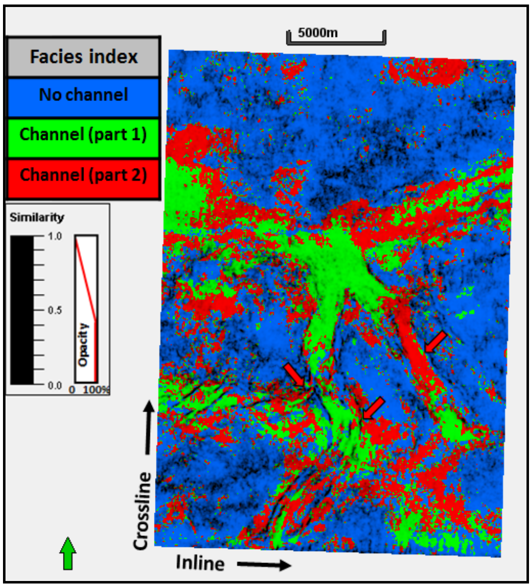

Figure 4 *Facies classification by using SVM, green and red colors show channel facies with different properties and blue relates to the other facies.*

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