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Said GACI and Olga HACHAY

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Application of Radial Basis Function Artificial Neural Networks in Seismic Data Processing

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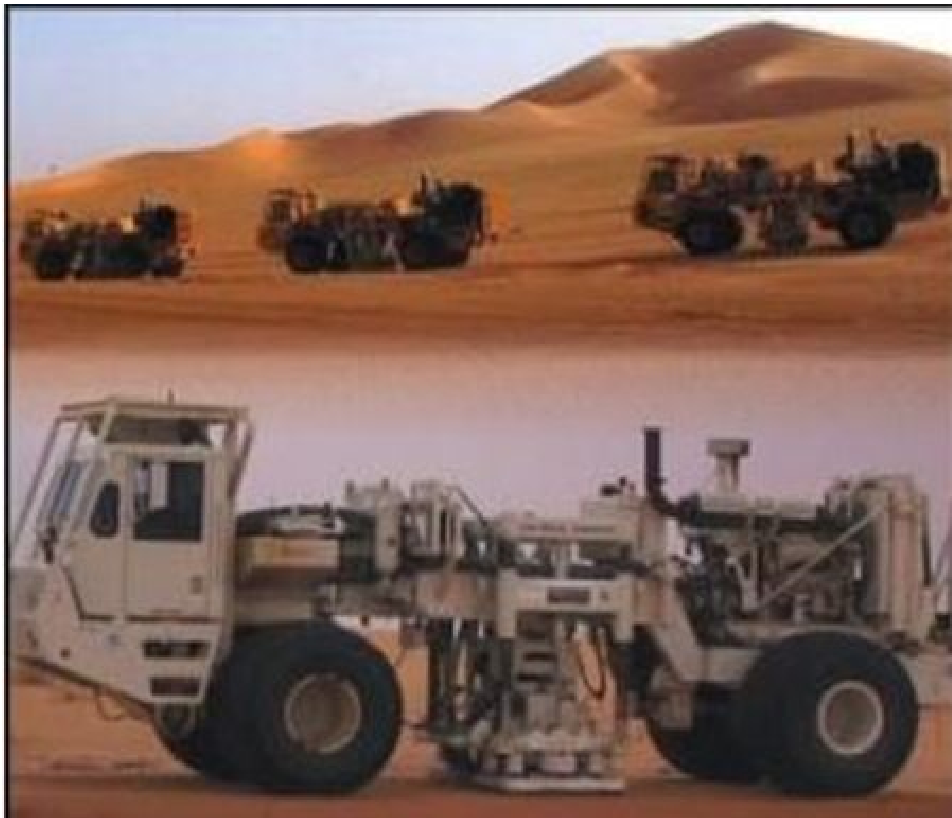
Summary

During the last decade, the application of artificial neural networks has gained in popularity, thanks to its ability to discover input-output relationships. The aim of this work is to attempt to use the radial basis function artificial neural network (RBF-ANN) to address tow problems in seismic data processing, to recognize and remove the seismic random noise and to inverse seismic data. The proposed structure has the advantage of being easily trained by means of a back-propagation algorithm without getting stuck in local minima.

We use numerical examples, along with synthetic and field data, to demonstrate the validity of the proposed method in practice. The effects of network architectures, i.e. the number of neurons in the hidden layer, the centre and the width, on the rate of convergence and prediction accuracy of ANN models are examined. The optimum network parameters and performance were considered as a function of the testing error convergence with respect to the network training mean square error. An adequate cross-validation test is run to ensure the performance of the network on new data sets.



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CONTENTS

CHAPTER ONE

SEISMIC SPECTRAL DECOMPOSITION APPLICATIONS IN SEISMIC: A REVIEW AND APPLICATION

MOHAMMED FARFOUR[1], JALAL FERAHITA[2], NOUREDDINE DJARFOUR[3] AND AITOUCH MOHAND AMOKRANE[2]

Abstract Time-Frequency analysis or spectral decomposition is a technique that allows geophysicist to visualize frequency content of seismic data along time axis. The technology started as a simple band filtering technique that shows amplitude spectrum at user-defined bandwidth and became a routine technique in modern workflows of seismic interpretation and reservoir characterization. One advantage of this innovative approach over other processing and analysis algorithms is its simplicity and easy-to-use. In fact, spectral decomposition does not require advanced processing workflows; it can be programmed and run in common open software programs. Over the last decades numerous techniques of time-frequency analysis and case studies have been published in literature. In this work after introducing the fundamentals behind the most common decomposition methods we show some real examples using Matlab software. We then use commercial software to address a challenging seismic data from South Texas to reveal some features of the reservoir that are hidden in the seismic broadband.
Key words: Seismic sections, Ural region, tectonic information, 3-D density model, oil and gas prediction.

1. Introduction

Seismic signal can be considered as non-stationary signal which composed of different components, all localized at different time and frequency. The amplitude spectrum of Fourier Transform indicates the presence of different frequencies but does not show their temporal distribution. Therefore, Short Time window Fourier Transform (STFT) was suggested. In STFT analysis, signal through a short window is considered a stationary. By shifting the time window along the whole signal, one can obtain the frequency content in frequency-time (2-D) image (Chakraborty, and Okaya, 1995). Over the past decades, several analysis approaches have been developed and showed successful applications in both seismic data processing and interpretation. The majority of these algorithms belong to either linear or quadratic methods.

In the linear methods, the signal is subject to inner product with pre-assigned mathematical functions derived from a mother function by simple operations; examples include STFT (Allen, 1977), Wavelet Transform (Chakraborty, and Okaya, 1995, Sinha et al. 2005), S-Transform (Stockwell et al., 1996). In all these methods, the time-frequency representation can be influenced by the choice of the mathematical function with which the signal is decomposed. In addition, the Heisenberg uncertainty limits the resolution of the T-F resulting images. In quadratic methods, the problem introduced by the use of the mathematical functions is overcome. However, the interference term renders the Time-Frequency representation ambiguous and its interpretation more complicated. Furthermore, the reconstruction of the signal is more complicated than in the linear methods (Daubechies et al., 2008). Recently, other techniques have been proposed to solve the problems above. This includes the Matching Pursuit Method (Liu and Marfurt, 2007), Local Time-Frequency decomposition (Liu and Fomel, 2013), the Empirical Mode De-

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