Name: Soumi Chaki
Roll No: 14EE92P04
Thesis Title: Fusion of Seismic and Well-log Data for Reservoir Characterization

Abstract

Reservoir characterization is a process of finding petrophysical properties of the subsurface mainly from the seismic and well-log data. This thesis provides the interdisciplinary perspective in reservoir characterization focusing on the applications of signal processing and machine learning. The developed methods are tested using a real hydrocarbon field dataset.

Reservoir characterization has been known to be a highly data-driven problem. Huge volumes of seismic and well-log data are cleverly integrated by experts to decipher the subsurface properties. This thesis addresses the integration problems related to mismatch in frequency, sampling interval, and information content between seismic and well-log data. A variational mode decomposition based method is proposed for regularization of target lithological property i.e. porosity. Then, the proposed method is compared with existing methods in terms of normalized mutual information and entropy values.

The thesis discusses selection of machine learning algorithms and parameter setting based on training, testing, and validation performances. The results of an artificial neural network and a support vector regression model are compared using four metrics. The effect of target regularization in the pre-processing stage on the prediction performances is also investigated.

Deep learning has gained considerable interests among researchers for improved performance than traditional methods in various fields such as image/video processing, speech processing, etc. Still it is yet to be extensively employed in the realm of reservoir characterization. Therefore, a convolutional neural network based framework is designed using available well-logs and neighborhood seismic information. A class-based prediction framework using probabilistic neural network is also proposed to detect lithology class of the study area.

The artifacts and irregularities in the predicted porosity volume as a result of non-linear mapping necessitate a post-processing stage. This thesis proposes a diffusion filter based scheme to improve the prediction result. A set of diffusion and non-diffusion image-based algorithms are used, and the performances are compared using suitable metrics. The filters are initially applied on corrupted seismic data before using on predicted porosity for validation. This thesis provides an opportunity to the users to select appropriate algorithms for pre-processing, prediction, and post-processing stages to carry out reservoir characterization involving seismic and well-log data.

Keywords: Reservoir characterization, machine learning, empirical mode decomposition, variational mode decomposition, artificial neural network, support vector regression, convolutional neural network, improved complex adaptive dif-fusion filter, probabilistic neural network.