Submission code: YMYJ5DN48W

See this and other abstracts on our website: https://home.sbgf.org.br/Pages/resumos.php

Using a CNN Network to Automate Seismic Fault Detection

Alysson Alves (Federal University of the São Francisco Valley - UNIVASF), Igor Guimarães Barros (Oxaala Tecnologias), Vitor Pereira Fontes (Federal University of the São Francisco Valley (UNIVASF)), João Pedro Silva Gomes (Federal University of Bahia - GAIA), Paulo Barros (Oxaala Tecnologias), José Luiz Silva (Oxaala Tecnologias), ALEXSANDRO CERQUEIRA (Federal University of Bahia - GAIA)

Using a CNN Network to Automate Seismic Fault Detection

Introduction

Identifying structural faults is a fundamental step in seismic data analysis, particularly in gas and petroleum exploration, as these features are crucial for understanding reservoir compartmentalization and potential migration pathways. Traditionally, geophysicists perform this interpretation manually, which a time-consuming, labor-intensive, and subject to interpreter bias. To overcome these limitations, Artificial Intelligence (AI) offers a promising solution. This study proposes the application of a Convolutional Neural Network (CNN) to automate the detection of seismic faults, aiming for a more accurate and efficient interpretation workflow.

Method and/or Theory

The process begins by loading a pre-trained CNN model and a 3D seismic data cube. We use synthetic data with a range of fault parameters, including dip, throw, and size. The methodology consists of applying the network trained slice by slice (inline, crossline, and depth slice) in the seismic cube. Each patch is independently normalized to ensure scale consistency before being input into the model. The CNN processes each patch and outputs a corresponding prediction map, where each pixel value represents the probability of it belonging to a fault. These individual prediction maps are then stitched back together to reconstruct a full fault probability mask for the entire 2D section. To ensure a coherent and smooth result, a blending algorithm is applied in the overlapping areas of the patches, averaging the predictions to achieve a seamless outcome. This post-processing step generates a continuous and geologically plausible fault map from the aggregated patch-based predictions.

Results and Conclusions

The fault detection generates a comprehensive 3D fault probability cube by analyzing seismic data through a neural network model, where each voxel contains a value between 0 and 1 indicating the likelihood of a fault presence. The results are influenced by several key parameters: the window size (default 128x128) and step size (default 20) used for processing seismic sections, which affect the resolution and computational efficiency of the detection. The quality of the results is measured through binary IoU (Intersection over Union) metrics and accuracy scores, while the processing speed is optimized through configurable batch sizes and parallel processing capabilities. This methodology was applied in the F3-Block and the Mexilhão Field to extract the entire fault probabilities with good results. The future perspective of research includes improving the network approach and advancing to generate a fully 3D framework.