Applications of machine learning and deep learning on facies classification and salt identification

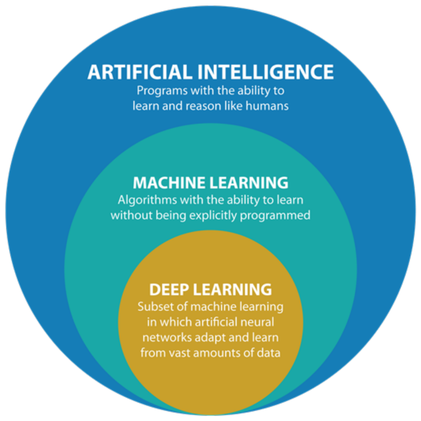
Marcelo Guarido*, Junxiao Li, Raul Cova

*mguarido@ucalgary.ca

Abstract

Machine learning is a field from computer science that aims to create algorithms to automatically recognize patterns on datasets to perform predictions. Its application in geoscience is relatively recent, but the applications possibilities are promising. Here, we are presenting two different research projects with machine learning applications: gradient boosting for facies classification and deep learning for salt identification on seismic images. In both projects, the machine learning algorithms showed to be powerful tools to assist interpreters on their work. For the facies classification project, data augmentation and the gradient boosting classifier led the rock predictions to an elevated accuracy of 60%. Image segmentation was implemented to identify salt bodies on seismic batch images, and the *IoU* score reached was 0.8.

Introduction



Machine learning is a field of computer science that gives computer systems the ability to ”learn” (i.e. progressively improve performance on a specific task) with data, without being explicitly programmed. This field is composed by a long list of algorithms with many purposes, and its applicability is widely known in different fields, such as medical research, digital marketing, product recommendation, etc. However, its application in the Oil&Gas industry is relatively new, but with a growing interest. In this work, we are presenting the application of two different methods on geophysical data. The first is using *Gradient Boosting for Facies Classification* from well logs, while the second is the application of *Deep Learning for Salt identification* in seismic images.

The application of gradient boosting on facies classification uses patterns on well logs values to predict the correspondent rock types. As a supervised learning problem, the model is trained on wells where the true answer is known.

The salt identification project uses the data form the *TGS Salt Identification Challenge* from the *Kaggle* website. The proposal is to use seismic images and a set of known answers to train a deep learning model to predict salt bodies on new seismic images. As this is a problem of image segmentation (pixel classification), a modified *Convolutional Neural Networks* algorithm was applied.

Conclusions

Facies classification was successfully done using a gradient boosting algorithm. The well logs provided were cleaned, completed for missing data, and augmented to improve the facies predictions. This work-flow increased the accuracy from 47% to 60%, on nine different rock types.

Salt identification showed to be very difficult and costly to achieve, as it is an image segmentation problem. To predict the salt it was required a deep learning model with a high number of parameters. Also the number of training images was not enough. Data augmentation was applied multiplying the number of training data by 4, improving significantly the *IoU* score to 0.8.

Acknowledgement

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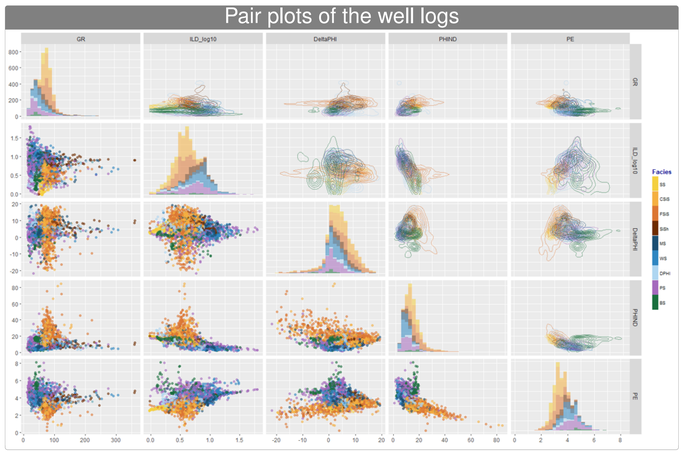
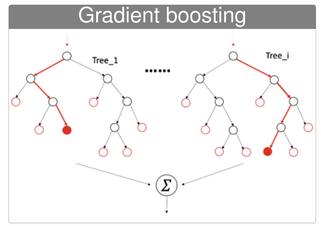
Facies Classification with Gradient Boosting

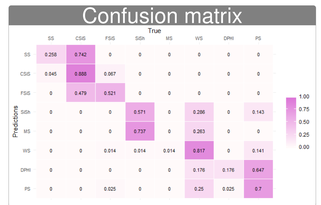
Pair plots of the well logs



Gradient boosting



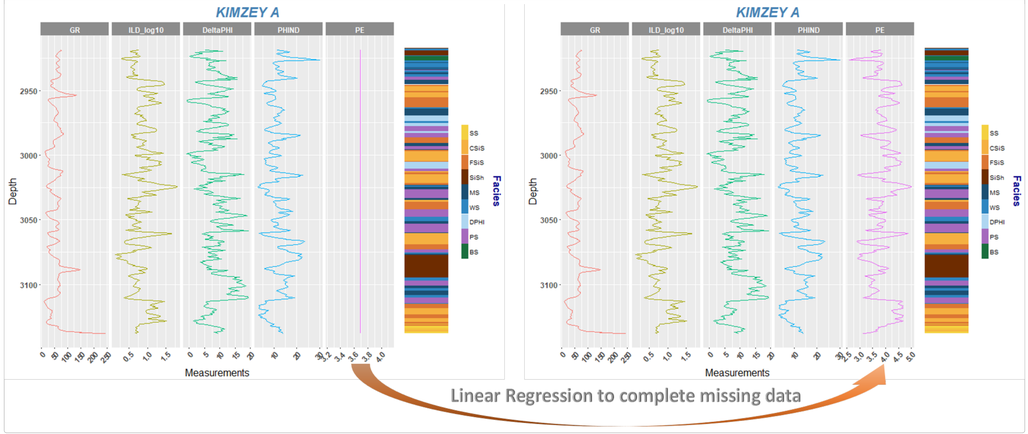
Confusion matrix



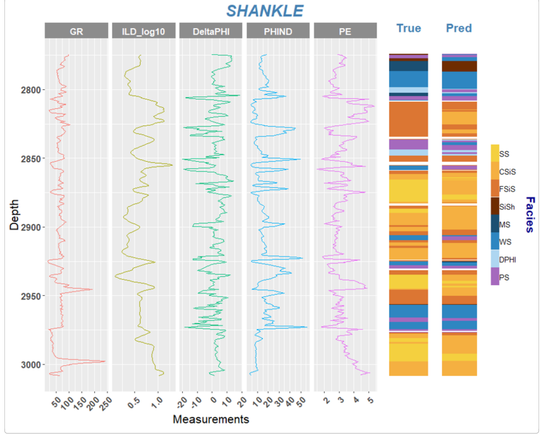
Description

Well logs and indicators were provided from ten wells locations. Data cleaning was initially required, as one of the well was ”broken”. Two wells had the *photoelectric effect* (PE) log missing, and were filled with a linear regression of the others logs. Using only the Five well logs and two indicators as the gradient boosting input to generate the predictive model was not enough (47% accuracy), and new features were created from the logs, as their gradient and polar coordinates. New predicted facies were smoothed by a median filter and the accuracy on the validation well increased to 60%.

Linear regression to fill the missing PE



Final predictions

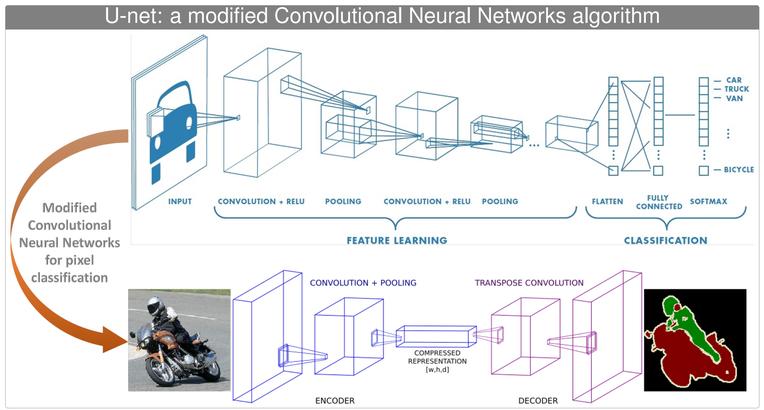


Salt Identification with Deep Learning

Description

For the *TGS Salt Identification Challenge*, the goal is to use a set of 4000 seismic images with their respective masks (pixel classification) to train a machine learning model that predicts salt bodies on 18000 test images with the higher accuracy. A modified *Convolutional Neural Network* model, a *U-net* shaped series of encoders and decoders, and data augmentation to multiply were used. This deep learning model has a high number of parameters and requires high performance computers (such as GPUs) to be trained. The predicted salt over the validation set had a 0.8 average score on the *IoU* (intersection over union) metric.

U-net: a modified Convolutional Neural Networks algorithm



Original (green) and predicted (red) salt over seismic images