

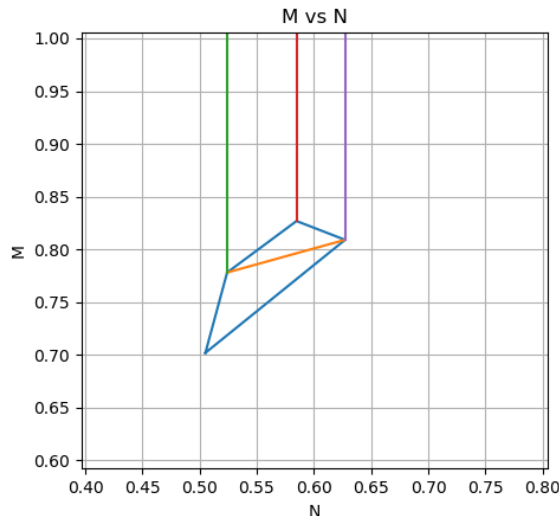


Machine Learning and Petrophysic evaluation using Litho-porosity plot.

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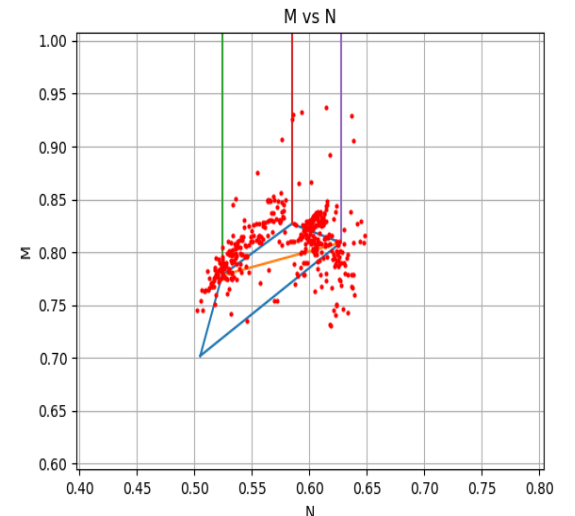
Litho-porosity plot



The porosity plot is made by Density, Neutron and Sonic logs and using the matrix coefficients for Silica, CaCO₃, Dolomite and Anhydrite.

The plot may be used to detect "Secondary" porosity in form of vugs and fractures, the reason of this is the fact that the Neutron and Density respond to the total formation porosity while the Sonic responds only to porosity which is homogeneously distributed throughout the matrix.

Analogously, taking the area that contains the matrix coefficients provide just Primary porosity.

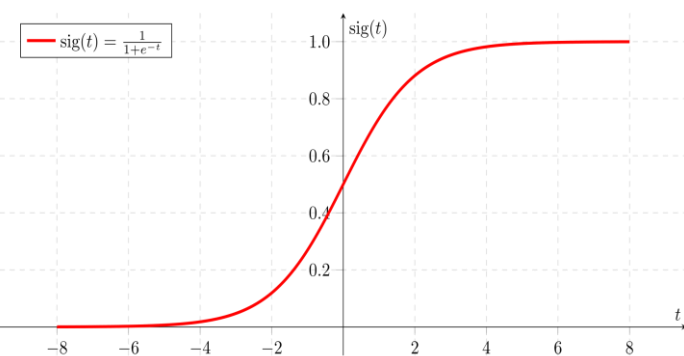


Machine learning

Machine learning is related to Artificial Intelligence. AI is an algorithm that could make decisions by itself in a certain event while Machine Learning is an algorithm that recognize patterns by itself but it does not learn that pattern alone.

The learning must be designed and controlled by the programmer in order to train the algorithm and improve its skills.

Now, we need a logistic regression in order to make our data classification. The procedure is use a sigmoid function to have output values that lies between 0 and 1 where values approaching 1 is the target and values approaching 0 are less probable to be the target.



M and N parameter, there is a L?

$$M(\Delta t, \rho) = 0.01 * \frac{\Delta t(f) - \Delta t}{\rho - \rho(f)}$$

$$N(\phi N, \rho) = \frac{\phi N(f) - \phi N}{\rho - \rho(f)}$$

$$L(\Delta t, \phi N) = 0.01 * \frac{\Delta t(f) - \Delta t}{\phi N(f) - \phi N}$$

M and N are lithological parameters that involve Density-Sonic and Density-Neutron log, but there is not a parameter described by Sonic and Neutron.

Here is the target as pattern to recognize in the machine learning algorithm. Propose an Interval on "L dimension" that contain primary porosity given a porosity found in the litho-porosity plot (M-L dimension).

Clustering

There is a new dimension and 2 relationships that involve primary porosity, this relations are graphed according to M-L and N-L parameters.

New triangle is obtained for each Surface and have a polygon distribution describing the parameter frequency on M, N and L axis.

Then, classification is fitted relating primary porosity on MN plot and possible values on L dimension containing it.

Conclusions

After both clustering graph: M-L and N-L, we can warn that all relevant values of primary porosity are contained in values of L lying between 1.3 and 1.4. Meanwhile values beneath 1.3 are less probable and values close to 1.5 are unlikely.

This machine learning algorithm was focused on relate primary porosity to a lithological parameter, but it could be applicable to relate many other parameters.

