Pushing Mature Basins into the AI revolution: Using Neural Networks to Extract Quantitative Information from Core and Thin Section Images

Geology has traditionally been a descriptive science with a significant portion of the data coming from observations of features at a range of scales. Modern practices rely in a large part on this legacy of observational data, for instance when rock facies are used to derive regional stratigraphic trends from core data, or as a building block for petrophysical classifications. However, a recent study (Lokier et al 2015) has shown that even experienced carbonate sedimentologists will often classify the same facies using different textural names. This problem is compounded when large teams collaborate on a project, resulting in a heterogeneous attribution of facies to similar rocks despite the use of a common classification scheme. This problem reduces the reliability of descriptive data.

For the first time in the history of Earth Sciences, this is about to change. Last summer, we undertook a pilot study to test the effectiveness of "Artificial Intelligence" in the form of neural networks at recognizing carbonate rock facies using the Dunham classification scheme. We used high-resolution core images from the Integrated Ocean Discovery Program (IODP) Leg 194. Core images were used to train a model written in the Python programming language using the TensorFlow machine learning library. Specifically, we used Google's Inception V3 network as a pre-trained Convolutional Neural Network (CNNs), and applied a method called 'transfer learning' to train Inception V3 to recognize carbonate core images. The results were very encouraging, with CNN achieving up to 90% accuracy at about 60 times faster than humans, and with a much greater consistency. Importantly, this work was carried out by a master student in Geology with limited coding experience, proving that these techniques have been democratized enough to be accessible to the domain experts.

This PhD project comes at an exciting time, and the PhD student will be able to investigate the ability of modern machine learning to correctly identify components in the rocks in an automated fashion. This has a tremendous potential to revolutionize the way we approach geology, and the code and tools developed in this study will be released as open access; this means that other labs will be able to use the work for their own applications.

We intend to check multiple methods (CNNs, RNNs) as well as to extract a range of features, not just facies; this could include automated fossil recognition, bedforms, etc. The goal is to build a system that can reliable extract information from digital rock, and build an objective framework for interpretation. Application to the oil and gas industry will include automatic facies stacking pattern for sequence stratigraphy, porosity permeability predictions, or facies associations. The candidate PhD will be at the forefront of modern techniques, and will be very employable at the end of this PhD.

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Group website: www.carbonateresearch.com
Minimum requirement for candidates: UG degree in geology, computer science, math or physics, 1st class degree, UK citizen

Good to have skills (but not essential): a master's degree, proven ability to publish papers by being lead or co-author on a paper, experienced with carbonates, some experience in coding is desirable but by no means essential (but need to be willing to learn).