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Comparison of Permeability Prediction using Back-Propagation and Hybrid Neural Networks

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We compare the permeability prediction performance of two systems using well log data. One system consists of a single supervised-learning error-backpropagation neural network (BPNNs) and the other is composed of an unsupervised-learning adaptive resonance theory (ART) neural network and multiple fuzzy inference systems (FISs).

Usage of either supervised- or unsupervised-learning Artificial Neural Networks (ANNs) is problem-dependent. If training data sets are well-defined and well-bounded, supervised-learning ANNs are good choices; for example, BPNNs. Otherwise, unsupervised-learning ANNs are better candidates. Further, unsupervised-learning ANNs can reduce the dimensions (complexity) of problems, and can result in data reduction by grouping input data according to certain similarity measures. Reducing a heterogeneous system's complexity by "divide and conquer" is a heuristic approach. It is also a "data reduction" scheme aimed at modeling the system via several sub-systems. The heterogeneous system is first grouped into several homogeneous clusters based on certain criteria using clustering techniques. These techniques include Kohonen Self Organizing Maps with minimum Euclidean distance, and ART neural networks. The "cluster-target" pairs, namely, cluster-permeability category, are formed after these clusters are calibrated with target variables, acquired from expert opinions, core descriptions, and/or other information, such as seismography. These pairs are subsequently analyzed by analytical techniques, such as regression, BPNNs and/or FISs, to determine the underlying relationship between well logs and permeability.

Although BPNNs are model-free universal approximators, knowledge acquired by artificial neural networks is not sufficiently transparent. Users, generally, do not know what the networks store nor what the networks may recall. Nonetheless, ART may, when combined with rule systems, minimize the effort of rule construction and increase the accuracy in prediction from rule systems. The effort of constructing FIS rules may also be reduced if information about the data (e.g., similarity among data points) embedded within a system along with domain experts' knowledge is extracted beforehand. Well log data used in this research were obtained from the Smackover Formation in Appleton Field, Escambia County, Alabama.

For the permeability category employed, 68.4 % of hybrid neural network predictions matched observations whereas 62.8% of predictions made by a single BPNN matched observations (see figure).

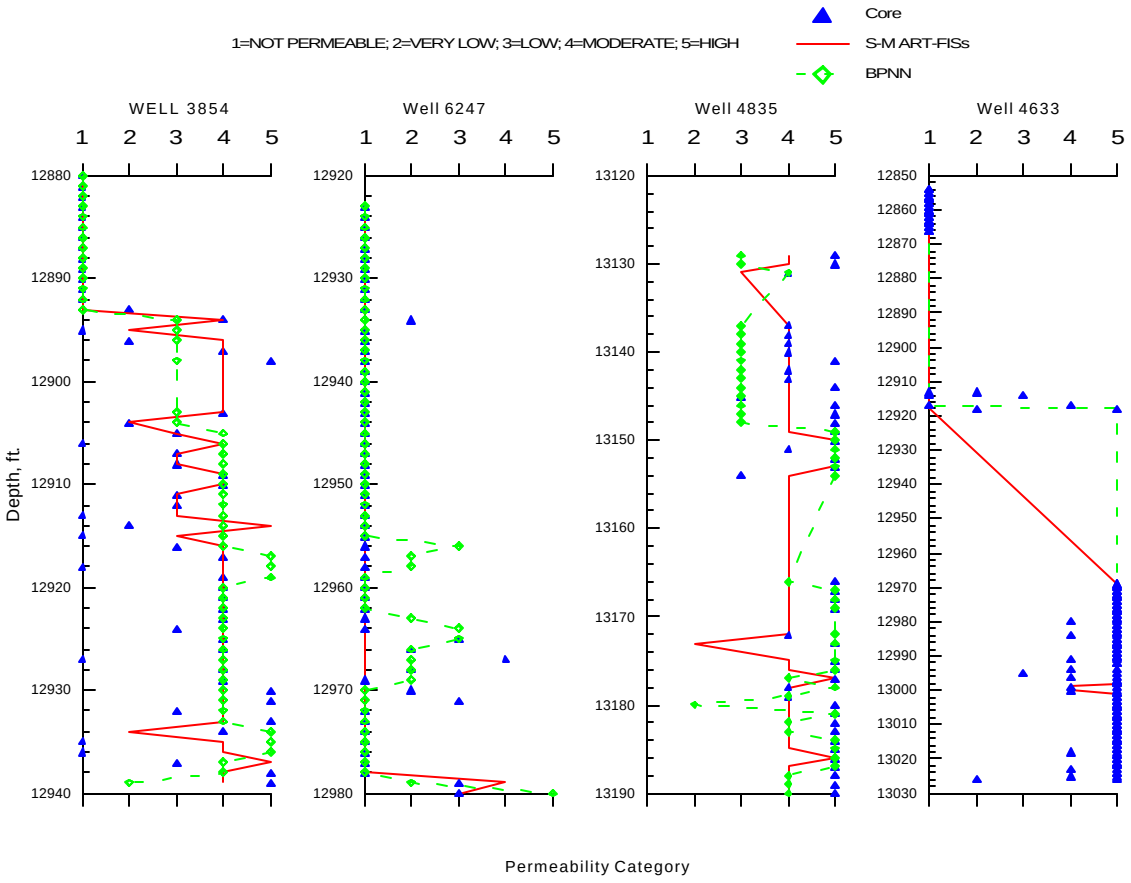

Figure. Comparison of predicted permeability category from core analysis and using proposed single-multiple ART2-FISs and BPNN.