PRE-STACK SEISMIC INVERSION FROM DEEP LEARNING WITH CROSS-SHAPE DEEP BOLTZMANN MACHINE

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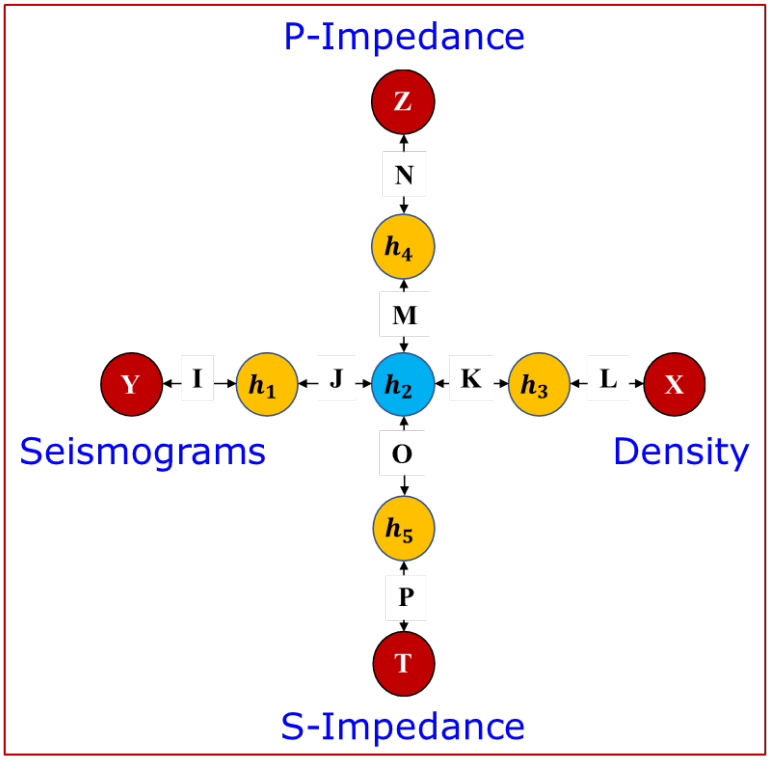
ABSTRACT

A cross-shape deep Boltzmann machine is created for deep learning purposes by connecting four different restricted Boltzmann machines located at the vertices via a hidden neuron layer at the center of the cross. The training process is performed by minimizing an energy function that is similar to the least square solution of an inverse problem. The cross-shape design allows the system to immediately populate subtle changes in any input layers toward the remain ones, which allows better capturing the non-linear relationship between the rock properties and recorded seismic amplitude in a pre-stack seismic inversion problem. The algorithm requires low frequency starting models to normalize the input properties before training the network, and to convert the results into absolute values after network applications. The resulting models demonstrates the network's excellent capability of capturing all features in the training dataset when accurately reconstructs the input logs at well locations and produce geologically reasonable impedance sections. Furthermore, the network has the potential to become an efficient solution to any non-linear inverse problem, provided sufficient training data is made available.



Cross-shape deep Boltzmann machine with four red visible neuron layers {*X, Y, Z, T*} where training data is fed into the network; and 5 hidden layers {h_1, h_2, h_3, h_4, h_5} to extract information from inputs. The neuron layers are connected with bidirectional weighting matrices *I, J, K, L, M, N, O* and *P*. Hidden neuron h_2 (in blue) reflects with simultaneous interactions between visible input neurons.