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Evaluating the Quality of Predictive Geological Maps Produced using Self-Organizing Maps

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With increased data collection, extraction of useful information from large, often multi-dimensional (where each dimension is a unique data-type), datasets becomes a challenge. Associated with the problem of extracting usable information is the need to evaluate the information extracted to determine its validity. Traditionally, geophysical data has been interpreted in map or profile form one data-type at a time using primarily visual inspection by the interpreter. This approach become increasingly difficult as the dimensionality (e.g. number of data-types) of the dataset is increased. As such, new methods for discovering patterns in multi-dimensional geophysical datasets need to be investigated. Self-organizing maps (SOMs) are a class of unsupervised artificial neural network algorithm which are used to cluster multi-dimensional data while preserving the overall topology of the original dataset. As geophysical responses measured in the field are closely linked to the local geology it is postulated that SOMs can be employed to cluster multi-dimensional geophysical data in order to produce predictive geological maps. In the development of an effective work flow for creating predictive geological maps using SOMs, synthetic and real world test cases are used so that the predictive maps can be compared to a known geology. This comparison can be done through visual inspection. However, quantitative measures of clustering quality are also desired. In this project three different types of cluster quality measures are investigated: cluster morphology measures (e.g. the Quantization Error and the Dunn Index); class/cluster concatenation measures (e.g. Cluster Purity and Normalized Mutual Information); and decision-based measures (e.g. the Rand Index and F-Measure). SOM predictive mapping was applied to mapping the Baie Verte Peninsula on the north coast of the island of Newfoundland, Canada. The Baie Verte Peninsula is a region of complex geology with good regional geophysical data coverage (magnetics, gravity, radiometric, and VLF) and good regional geological mapping. This allows the predictive maps produced through the SOM process to be evaluated both through visual inspection and quantitatively using all three types of clustering quality measures.