Geophysical Research Abstracts
Vol. 16, EGU2014-13558, 2014
EGU General Assembly 2014

Comparative Investigation of Guided Fuzzy Clustering and Mean Shift Clustering for Edge Detection in Electrical Resistivity Tomography Images of Mineral Deposits

Wil Ward (1), Paul Wilkinson (2), Jon Chambers (2), and Li Bai (1)

(1) School of Computer Science, University of Nottingham, Nottingham, United Kingdom (wcw@cs.nott.ac.uk), (2) British Geological Survey, Nottingham, United Kingdom (pbw@bgs.ac.uk)

Geophysical surveying using electrical resistivity tomography (ERT) can be used as a rapid non-intrusive method to investigate mineral deposits [1]. One of the key challenges with this approach is to find a robust automated method to assess and characterise deposits on the basis of an ERT image. Recent research applying edge detection techniques has yielded a framework that can successfully locate geological interfaces in ERT images using a minimal assumption data clustering technique, the guided fuzzy clustering method (gfcm) [2]. Non-parametric clustering techniques are statistically grounded methods of image segmentation that do not require any assumptions about the distribution of data under investigation.

This study is a comparison of two such methods to assess geological structure based on the resistivity images. In addition to gfcm, a method called mean-shift clustering [3] is investigated with comparisons directed at accuracy, computational expense, and degree of user interaction. Neither approach requires the number of clusters as input (a common parameter and often impractical), rather they are based on a similar theory that data can be clustered based on peaks in the probability density function (pdf) of the data. Each local maximum in these functions represents the modal value of a particular population corresponding to a cluster and as such the data are assigned based on their relationships to these model values.

The two methods differ in that gfcm approximates the pdf using kernel density estimation and identifies population means, assigning cluster membership probabilities to each resistivity value in the model based on its distance from the distribution averages. Whereas, in mean-shift clustering, the density function is not calculated, but a gradient ascent method creates a vector that leads each datum towards high density distributions iteratively using weighted kernels to calculate locally dense regions. The only parameter needed in both methods is an optimised choice of kernel size, for which automated procedures are available.

In general, since the gfcm does not require a convergence criterion it is notably faster than mean-shift. The mean-shift approach is sensitive to small changes of the bandwidth, whereas with gfcm the guiding pdf approximation can be intermediately reviewed and smoothed if desired. In mapping the resistivity information to 1D in pre-processing, no assumptions on the spatial shape of the clusters are needed, a common problem in centroid-based clustering.

References:

[1] River Terrace Sand and Gravel Deposit Reserve Estimation Using Three Dimensional Electrical Resistivity Tomography for Bedrock Surface Detection. Journal of Applied Geophysics, 2013. Chambers, J.E. et al.
[2] Distribution-based Fuzzy Clustering of Electrical Resistivity Tomography Images for Interface Detection. Geophysical Journal International, 2014. Ward W.O.C. et al.
[3] Mean Shift: A Robust Approach Toward Feature Space Analysis. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2002. Comaniciu, D and Meer, P.