



## **A rapid local singularity analysis algorithm with applications**

Zhijun Chen (1), Qiuming Cheng (2), and Frits Agterberg (3)

(1) Faculty of Resources, China University of Geosciences, Wuhan, China (Zhijun-chen@cug.edu.cn), (2) State Key Lab of Geological Processes and Mineral Resources, China University of Geosciences, Beijing&Wuhan, China, (3) Geological Survey of Canada, Ottawa

The local singularity model developed by Cheng is fast gaining popularity in characterizing mineralization and detecting anomalies of geochemical, geophysical and remote sensing data. However in one of the conventional algorithms involving the moving average values with different scales is time-consuming especially while analyzing a large dataset. Summed area table (SAT), also called as integral image, is a fast algorithm used within the Viola-Jones object detection framework in computer vision area. Historically, the principle of SAT is well-known in the study of multi-dimensional probability distribution functions, namely in computing 2D (or ND) probabilities (area under the probability distribution) from the respective cumulative distribution functions. We introduce SAT and its variation Rotated Summed Area Table in the isotropic, anisotropic or directional local singularity mapping in this study. Once computed using SAT, any one of the rectangular sum can be computed at any scale or location in constant time. The area for any rectangular region in the image can be computed by using only 4 array accesses in constant time independently of the size of the region; effectively reducing the time complexity from  $O(n)$  to  $O(1)$ . New programs using Python, Julia, matlab and C++ are implemented respectively to satisfy different applications, especially to the big data analysis. Several large geochemical and remote sensing datasets are tested. A wide variety of scale changes (linear spacing or log spacing) for non-iterative or iterative approach are adopted to calculate the singularity index values and compare the results. The results indicate that the local singularity analysis with SAT is more robust and superior to traditional approach in identifying anomalies.