Measurements characterisation and classification for automated line feature generalization

Corinne Plazanet

IGN - Service de la recherche - Laboratoire COGIT
2, Avenue Pasteur BP 68
94160 St Mandé Cedex FRANCE
Tel : (33-1) 43 98 84 38
Fax : (33-1) 43 98 81 71
E-MAIL : plazanet@cogit.ign.fr

Multi-scale representations in geographical databases have aroused a growing interest for the last few years. Automated generalization processes are bound to be complex, and most notably for line features, which account for so great a part of the geographical information.

A cartographer, when generalizing manually, has a global and continuous feeling of the line. This perception of the line shape guides him in his drawing of a good generalized representation. His main criterion, beside scale-consistency, is the preservation of the features in the shapes of the geographical objects. The latest works on the automation of linear objects generalization have shown the lacks and limits of classical algorithms, and clearly revealed the need to *build up a line feature recognition process prior to the generalization stage proper.*

Characterizing and classifying linear geometric shapes make it possible, on the one hand, to choose the appropriate generalizing tools together with their parameters, and on the other hand, to analyse the results and check that the æsthetics, and intrinsic topology, and global shape of the line are not damaged. The process requires first to find the relevant qualification criteria (sinuosity, homogeneity, complexity...) and the related measurements and tools. This is the subject of the present paper.

Our approach is a follow-up of works by B. Buttenfield [Buttenfield, 91] and R. McMaster [McMaster, 93], where series of measurements on each line are computed and summed up into measurement vectors, which will eventually decide the classification of the line. Shape characterization and shape matching are topics often tackled in cartography or computer vision papers. From this literature we have extracted some shape measures: some of McMaster's measures [McMaster, 89], fractal dimension, frequency, and so on... We also make use of some new measures, experimentally deduced from the distribution of characteristic points (inflection points, vertices, and "critical" points) and from tangents at inflection points (research conducted at the IGN [Affholder, 93], [Plazanet et al, 94]), see figure 1 below.

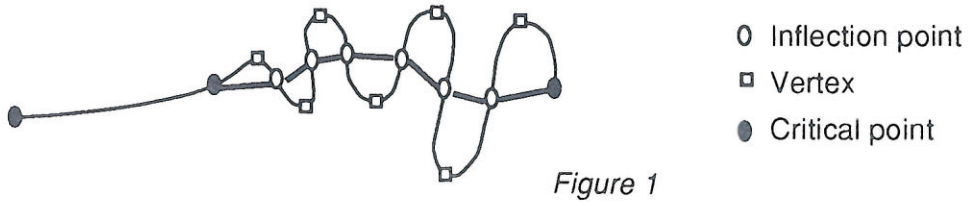

Figure 1

Based on these basic elements, two kinds of measurements are computed on the line, locally and globally :

- locally for each bend (delimited by two successive inflection points). For example the height, and the surface of the triangle defined by the inflection points and the vertex (figure 2)... can express the flatness, amplitude and symmetry of the bend.

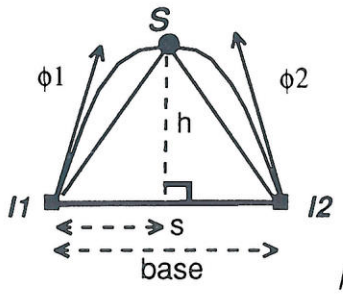

Figure 2

- globally on the line constituted by the inflection points. For example their number, their distribution, and the changes of direction of this line can account for the sinuosity of the whole line, and its general shape.

Several problems are raised and discussed. For a given measure, which are the relevant basic elements ? What is the smallest set of non-correlated measures relevant for the qualification of the line ? A crucial problem lies in the fact that the line shape may not be homogeneous: there may be windings for a while and then straight reaches. The determination of the articulation points between homogeneous segments is discussed. As to the classification problems, two approaches can be thought of: neuronal computation or cluster analysis. The first promising experimental results on a clustering classification of some arcs from the 1:50 000 road graph are exposed in the article. Next step will consist in studying the relationships between this classification and generalization algorithms.

[Affholder, 93] Road modelling for generalization. NCGIA Initiative 8. Spec. Meat. Buffalo 1993

[Buttenfield, 91] A rule for describing line feature geometry. Map Generalization Part 3 p. 150-171. Ed. Longman Scientific & Technical. London 1991

[McMaster, 89] The integration of simplification and smoothing algorithms in line generalization. Cartographica 26 p.101-121 1989

[McMaster, 93] Knowledge Acquisition for Cartographic Generalization: Experimental Methods. ESF GISDATA Work. Compiègne France Dec. 1993. To appear in "GIS and Generalization: Methodological and Practical issues" Taylor & Francis, London

[Plazanet et al 94] Représentation et analyse de formes pour l'automatisation de la généralisation cartographique. EGIS Proc. Vol 2. p 1112-1121. 1994