Map Generalization by Iterative Improvement

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Reducing the scale of a map can result in spatial conflict, whereby map symbols become too close or overlap. Map generalization is the process by which symbols are selected and adjusted so as to reduce such conflict. It is clear that many GIS-related applications would benefit from an automated map generalization facility and recent years have seen considerable research effort directed towards finding solutions to many of the associated problems[1, 2, 3].

This abstract describes recent work aimed at developing automated map generalization procedures based on the concept of iterative improvement. Previous related work by the authors considered the use of object displacement as a means of resolving the graphic conflict that can occur as a result of scale reduction[4, 5]. In one of their proposed solutions[4], each of n polygonal objects is assigned k candidate positions into which it can possibly move, resulting in a total of k^n map realisations. The assumption is that some of these realisations will contain a reduced level of conflict. However, generating and evaluating all realisations is not viable – the problem is NP-hard. In response to this problem, the authors made use of iterative improvement algorithms to limit the number of realisations processed. In experiments, two such algorithms (one based on gradient descent, the other on simulated annealing) were shown to be successful both in limiting the number of realisations visited and in reducing conflict. An alternative to generating multiple candidate positions at each stage of the procedure is to generate a displacement vector that minimises the conflict of the object in greatest conflict[5]. This results in generating many fewer candidate states of the map, but at the expense of increased computation for each state.

One of the failings of the previous solutions is that they make use of a single generalization operator only (i.e. displacement). This means that the techniques will work well only in relatively simple situations (i.e. where there is plenty of free map space into which objects may move); more complex situations require the use of additional operators (e.g. deletion, amalgamation, reduction and simplification) in combination. It should be noted, however, that the iterative improvement approach is generic in that it is possible to generate candidate map states using operators other than displacement. This provides a mechanism by which additional generalization operators can be introduced into the solution. As an example, consider the deletion operator; its inclusion is straightforward – the deletion of an object becomes another candidate state. In similar fashion, reduced and simplified versions of objects, and the amalgamation of two or more objects, become additional candidate states for the objects in question.

Experimental results obtained using a subset of operators (i.e. displacement, deletion and reduction) will be presented. In addition, associated problems relating to the provision of an appropriate evaluation function and the automatic generation of amalgamated and simplified versions of objects will be discussed.

References

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