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Abstract:
Map Generalization by Iterative Improvement: Maintaining Feature Alignment

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In previous work, the authors show the potential for iterative improvement techniques to be used as part of an automated map generalization solution ([1],[2],[3]). In particular, they present a simulated annealing algorithm that controls operations of displacement, deletion, reduction and enlargement of multiple map objects in order to resolve graphic conflict arising as a consequence of scale reduction. The algorithm adopts a trial position approach in which each of n discrete polygonal objects is assigned k candidate trial positions that represent the original, displaced, deleted, reduced and enlarged states of the object. This gives rise to a possible k^n distinct map configurations; the expectation is that some of these configurations will contain reduced levels of conflict. Each configuration has an associated overall cost, which can be computed. This overall cost combines both conflict cost (i.e. the extent to which acceptable minimum clearances between map objects are violated) and modification cost (i.e. the extent to which the map has been altered). Finding the configuration with least overall cost by means of an exhaustive search is not practical for realistic values of n and k. However, it has been shown that near optimum solutions can be found by using simulated annealing to direct a search through a subset of the configurations; thus effective resolution of graphical conflict can be achieved.

A shortcoming of the existing algorithm is that conflict cost depends only on the extent to which minimum clearance constraints are violated, and modification cost is calculated simply as a function of the degree to which each generalization operator is applied. This approach can be regarded as primitive in that more subjective elements of map quality are overlooked. The specific problem addressed here is that of maintaining building alignment. One way in which a map can suffer a

deterioration in quality during generalization is if meaningful groupings of objects loose their shape to such an extent that the group is no longer recognizable. For example, displacing a particular building object might result in a row of building objects, representing a street, becoming misaligned, thus rendering the street unrecognizable. Experiments show this type of problem to occur in practice. The solution proposed is conceptually straightforward, and involves assigning a relatively high cost to situations where misalignment occurs. The intention is that such a strategy will both discourage offending displacements from taking place in the first place, and also stimulate remedial courses of action if and when misalignments do appear (e.g. realign buildings by performing additional displacements).

The extended paper, and workshop presentation, will report on the initial stages of the implementation and evaluation of the proposed solution. We will begin by describing the process by which streets are identified in the first instance (see [4] for previous work of note). In short, this is achieved by grouping building objects on the basis of a range of variables, including: minimum separating distance between buildings, initial alignment of buildings, relative orientation of buildings, shape and size of buildings, and building attribute information. Next, we will describe a technique for measuring, and quantifying in map evaluation terms, the difference in alignment between an original grouping of buildings and any modified version that occurs during the running of the simulated annealing algorithm. This provides a mechanism for adding street misalignment costs to the overall cost associated with a particular map configuration. Finally, we will report on the extent to which the inclusion of these costs as part of the annealing process reduces the problem of misalignment due to displacement.

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[3] Ware, J.M., Jones, C.B. and Thomas, N., 2001, "A Simulated Annealing Algorithm for Cartographic Map Generalization", presented at Fourth ICA Workshop on Progress in Automated Map Generalization, Beijing.
[4] Regnauld, N., 1996, "Recognition of building clusters for generalization", Proceedings of the 7th International Symposium on Spatial Data Handling, Volume 1, Delft, pages 4B.1-4B.14.