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Schematic maps in MobileGIS environments: an automated simulated annealing based case study

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Background

MobileGIS refers to the use of geographic data in the field on mobile devices like networked personal digital assistant (PDA). The main components for MobileGIS are global positioning system (GPS), mobile device i.e. mobile phone, and communication network with GIS acting as the backbone. Map generalization is the process by which small scale maps are to be derived from large scale maps. This requires the appropriate use of map generalization operations to be performed subsequent to scale reduction to reduce the graphic conflict.

Method

This paper looks at how human factors requirements can be considered in the context of graphic conflict reduction for MobileGIS applications. Currently, this reduction is achieved by using schematic mapping techniques. The application of schematic mapping can be thought of as a data reduction technique for large scale datasets to make it suitable for rendering in mobile applications. This work makes use of simulated annealing (SA) based technique. At the start of the optimization process SA is presented with an initial approximate solution (or state). In the case of the schematic map problem, this will be the initial network (line features with travel time, each made up of constituent vertices). The initial state is then evaluated using a cost function C; this function assigns to the input state a score that reflects how well it measures up against a set of given constraints (topological, angle, minimum edge length, clearance). If the initial cost is greater than some user defined threshold (i.e. the constraints are not met adequately) then the algorithm steps into its optimization phase. This part of the process is iterative.
At each iteration, the current state (i.e. the current network) is modified to make a new, alternative, approximate solution. The current and new states are said to be neighbours. The neighbours of any given state are generated usually in an application-specific way. The iterative process continues until stopping criteria are met (e.g. a suitably good solution is found or a certain amount of time has passed).

Results

Prototype software for producing schematic maps tailored for MobileGIS has been developed. The software makes use of the simulated annealing optimization technique. The software is currently implemented as a VBA script within ArcGIS. This technique has been used previously to control operations of displacement, deletion, reduction and enlargement of multiple map objects to help resolve spatial conflict arising due to scale reduction. These maps are subsequently displayed within the ArcPad application on a HP iPAQ PDA and tests have been carried out using different datasets. The results of applying simulated annealing based approach for automated schematic map generation is promising and further work will be done in enhancing the software with more functionality.

Conclusions

Development of automated schematic map generation techniques and cartographic specification for large scale

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digital geographic datasets suitable for MobileGIS applications was done and various tests carried out. Spatial conflict between feature classes at the specified scale ranges are to be dealt with by applying simulated annealing metaheuristic optimization technique.

Keywords MobileGIS · Large scale spatial data representation · Visualization · Map generalization