Analyzing and Deriving Geographic Contexts for Generalization

Generalization is at the heart of national mapping strategy – building a large-scale digital landscape model (DLM), from which smaller scale DLMs are to be derived; digital cartographic models (DCMs) and products are then compiled from the corresponding DLMs.

Generalization is about representing the geographic reality as faithfully as possible under map scale restrictions. Topographic mapping is a sophisticated process – “the value and importance of topographic features must be considered in their totality” [Böhme, 1984].

The increasing demands for contextual generalization have lead to our investigation into typical geographic contexts involved in generalization. This paper discusses the various aspects and types of geographical contexts and illustrates the use of geoprocessing tools and models to derive information to facilitate contextual generalization.

Recognizing Geographic Patterns Embedded among Neighboring Features – the geographic contexts that are easy for human eyes to see, but hard to define and to identify automatically

The complexity of reality – patterns may not be in perfect configurations; they may look similar, but are different in many ways.

The nature of automation - analytical methods can be successful, but are sensitive to variations and irregularity among features.

A case study:
To analyze and derive contextual information for street blocks and buildings in urban area to guide generalization from 1:10000 to 1:50000.

Observations:
- Street blocks are kept;
- Buildings in a street block are aggregated if they form enclosing patterns and show high density;
- Relatively large buildings are kept and simplified;
- Buildings in a well-chained pattern within a block are aggregated.

Preserving Topological Relationships – the fundamental geographic contexts among features to be generalized

Topological relationships are implicitly stored in ArcGIS geodatabase; they are revealed on the fly and preserved in generalization processes.

Certain topological errors, introduced by generalization processes, can be detected and resolved.

Relative positions of features need to be maintained – this is being prototyped in Optimizer [Monnet et al, 2007a].

Buildings and streets in DLM data of 1:10,000 (left) and image of map of 1:50,000 (right) – both are enlarged (Data courtesy of Netherlands Kadaster)

Geoprocessing model to derive building density and identify street blocks with large buildings

Street blocks attributed with building density (grey-shade blocks have higher building density)

Street blocks (pink-shaded) identified for containing large buildings
Remarks:

Street blocks are formed by input street edges.
Buildings are grouped by blocks using overlay tool.
Building density per street block equals to total building area in a block divided by the block area.
Relatively large buildings are identified by size and flagged for blocks.
Enclosing patterns are analyzed by:
- creating a buffer ring inside each block
- overlaying buildings with the buffer ring
- computing the ratio of overlapping segments over total buffer length
- the higher the ratio is, the more complete the enclosing pattern is.

Buildings can be described as forming well-chained patterns when they are distributed around the perimeter of the block, with relatively small gaps between them. The gaps are obtained by erasing the buffer rings by buildings.
High building density and strong enclosing patterns may lead to all buildings in a street block to be aggregated into an urban area.
Well-chained buildings in part of a street block may be aggregated into urban area; buildings (if any) in the remaining part of a block may be treated differently.

Examining Other Geographic Contexts
– more complex and challenging

Features in context with terrain
Example specification for spot height selection:
"In mountain passes, always preserve one or more spot heights with the first consideration of the lowest ones and the second consideration of the most centered ones" [Pla, 1999]

Features interfering each other
Example guideline of generalizing tunnels and paths:
Where a man-made water channel connects to a river through a tunnel, the tunnel (entrance) wall must always be kept. If it is shorter than 25m, it will be exaggerated to 25m. If it becomes in conflict with a neighboring feature, such as a local path, the neighboring feature will be displaced, reshaped, or removed. An interactively produced result is shown below.

More on built-up area generalization
Example interactive generalization of urban features:
The cartographer performed various generalization actions while looking at the context among buildings, roads, block borders, and neighboring blocks. He balanced the spaces, alignments, representative shapes, connections, and so on, when making the changes.

Conclusions:

As more geoprocessing tools for spatial and semantic analysis become available in ArcGIS, along with the convenience of ModelBuilder, much geographic context information can be derived through logical procedures.

Topological relationships can be preserved; some feature patterns can be identified to characterize the geographic contexts. These are essential to successful generalization.

Generalization must comprehend multiple factors. We will continue deriving geographic context information, defining measures, constraints, rules, and priorities, and exercising the optimization approach for contextual generalization.