Measurement in generalization

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Recent research in cartographic generalization has focused on many issues, including: (1) more robust data structures for supporting the process, (2) continued work in algorithmic development, (3) semantic support for the generalization process, and (4) the modeling of geometric features. Despite the fact that most of this work requires the development and implementation of mathematical/statistical/geometric measures, little comprehensive work on generalization measurement has been reported. Specifically, as identified by McMaster and Shea, the major goals of the generalization process include: (1) the philosophical objectives of generalization, or *why we generalize*, the cartometric evaluation, *or when to generalize*, and the spatial and attribute transformations, or *how to generalize*. Although we have a reasonably clear idea of why we generalize, and an increasingly better set of spatial and attribute transformations for the process, we have a much less clear idea of the linkage between the two--when to invoke the operations, based on the major objectives and measurement techniques (when to generalize). Work on the development of basic measurements has thus lagged in this area.

Two basic types of measures may be identified: procedural measures and quality assessment measures. Additionally, some measures are used to assess individual features, or nearby features, whereas others are utilized in a more global manner. Procedural measures are those needed to invoke and control the process of generalization. Such measures might include those to: (1) select a simplification algorithm, given a certain feature class; (2) modify a tolerance value along a feature as the complexity changes; (3) assess the density of a set of polygons being considered for agglomeration, (3) determine whether a feature might undergo a type change (e.g., area to point) due to scale modification; and (5) compute the curvature of a line segment to invoke a smoothing operation. Quality assessment measures evaluate both individual operations, such as the effect of simplification, and the overall quality of the generalization (e.g., poor, average, excellent). Several studies have reported on mathematical/geometric measures, including Buttenfield, McMaster and Plazanet, yet no comprehensive framework of the existing and potential measures, and their characteristics, has been developed.

This paper: (1) provides a survey of existing measurement techniques for automated generalization and (2) designs a new conceptual framework that organizes the measures based on their intrinsic capability. This is the first step in the design and implementation of a *generalization measurement library*. Thus in the same way that researchers have built up a systematic series of generalization operations (simplification, smoothing, aggregation…), there is a need for similar research on the measurements themselves, which are needed for all aspects of

the generalization process.