mR-V: Line simplification through mnemonic rasterization

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Linear features (e.g., roads, rivers), outlines of areas (e.g., municipal boundaries, lake banks) or moving objects' trajectories (e.g., humans, vehicles) are represented on paper or digital maps with polyline geometries. Sampling, discretization and generalization processes result in polylines represented by a subset of vertices of the original line. The simplified version of a linear feature may violate some spatial relations (topological, direction or distance) that apply between the original line and some other objects in space, unless a model that considers the context of the neighbouring space is applied. The latter turns the line simplification into a rather complicated and challenging-to-automate process. This paper introduces a method that supports a consistent line simplification without considering the context of the neighbouring space. The method applies well-known geo-processing tasks, such as polyline-to-raster and raster-to-polyline conversions, and is compliant with the raster tiled maps as well as the discrete global grid systems.

Les entités linéaires (p. ex., les routes, les rivières), les pourtours de surfaces (p. ex., les limites municipales, les rives des lacs) ou les trajectoires d'objets en mouvement (p. ex., les humains, les véhicules) sont représentés sur des cartes papier ou numériques avec des géométries de type polyligne. Les processus d'échantillonnage, de discrétisation et de généralisation donnent lieu à des polylignes représentées par un sous-ensemble de sommets de la ligne originale. La version simplifiée d'une entité linéaire peut enfreindre certaines relations spatiales (topologie, direction ou distance) qui s'appliquent entre la ligne originale et certains autres objets dans l'espace, à moins qu'un modèle qui tient compte du contexte de l'espace avoisinant ne soit appliqué. Ce dernier transforme la simplification de la ligne en un processus plutôt complexe et difficile à automatiser. Cet article présente une méthode qui appuie une simplification uniforme de la ligne sans tenir compte du contexte de son espace avoisinant. La méthode applique des tâches bien connues de géotraitement, par exemple la conversion de polylignes en données matricielles et de données matricielles en polylignes, et elle est conforme aux cartes des tuiles matricielles de même qu'aux systèmes mondiaux de quadrillage discrets.

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1. Introduction

A map or visualization of the earth's surface represents geographic features at a smaller scale. Hence, the information it contains must be restricted to what can be presented graphically at map scale and fit in the map medium. This adjustment process is called *generalization* [*Keates* 1989]. One fundamental generalization process in cartography is *simplification*, which applies to linear features (e.g., roads, rivers), outlines of areas (e.g., municipal boundaries, lake banks), or moving objects' trajectories (e.g., humans, vehicles). Simplification of a line involves removal of high density vertices, based on a given criterion (e.g., minimize line distortion by controlling the offset of the generalized line from the original [*Douglas-Peucker* 1973]), to reduce complexity or redundancy in a dataset.

The reduction technique is simple, but obtaining a consistent or meaningful output is a complicated problem. The issues of consistent simplification arise from the fact that real world geometric properties are often constrained by neighbouring objects within a given space. Simplification of geometric properties without context may change the meaning of such properties (semantic representation). The problem has been investigated in the past and various methods that consider the contextual information of the neighbouring space have been proposed, implemented and tested [*Tienaah et al.* 2015].

On the other hand, with the wide-spread use of earth browsers (e.g., Google Maps, Bing Maps, and OpenStreeMap), background maps are mainly delivered through raster tiles at various zoom levels (resolutions) [*Stefanakis* 2015b]. Linear features

dx.doi.org/10.5623/cig2016-401