CONTEXTUAL DOUGLAS-PEUCKER SIMPLIFICATION

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In this paper, we develop a constrained Douglas-Peucker algorithm using a polyline to be simplified and other geometries as contextual constraints. We develop a contextual model that incrementally rewinds to the original polyline with relevant characteristic vertices to resolve contextual conflicts. Constraints covered in this paper are topology and direction. Our implementation shows a consistent representation and a technique to accelerate multi-scale simplification of polylines.

Dans cet article, nous développons un algorithme de Douglas-Peucker restreint utilisant une polyligne à simplifier et d'autres géométries comme contraintes contextuelles. Nous élaborons un modèle contextuel qui retourne par incrément à la polyligne originale à l'aide des sommets caractéristiques pertinents pour résoudre les conflits contextuels. La topologie et la direction constituent les contraintes abordées dans cet article. Notre mise en œuvre démontre une représentation uniforme et présente une technique pour accélérer la simplification multi-échelle des polylignes.

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1. Introduction

Line simplification is a fundamental process in cartographic generalization [*Cromley* 1991; *Weibel* 1997]. As an operator, simplification reduces redundancy or the level of detail required to represent a polyline at a desired scale. Line simplification is a well-covered topic with many algorithms in cartography, computational geometry and computer graphics, e.g., *Ramer* [1972], *Douglas and Peucker* [1973], *Reumann and Witkam* [1974], *Opheim* [1982], *Li and Openshaw* [1992], *Normant and Tricot* [1993], V*isvalingam and Whyatt* [1993], *Fritsch and Lagrange* [1995], *Balboa and López* [2000], *Doihara et al.* [2002], *Qingsheng et al.* [2002], *Wu and Deng* [2003], *Saux* [2003], *Gribov and Bodansky* [2004], *Kulik et al.* [2005], *Guilbert and Saux* [2008], *Abam et al.* [2010], *Daneshpajouh and Ghodsi* [2011], *Lei et al.* [2012], *Liu et al.* [2012], *Raposo* [2013] and *Abam et al.* [2014]. One of the most popular algorithms in line simplification is the Douglas-Peucker (DP) algorithm [*Douglas and Peucker* 1973]. The DP algorithm, like many other techniques of simplification, has an implicit scope to reduce the set of vertices used to represent a polyline based on some criteria (distance offset, error bound, direction/angular deflection, area and other measures). 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).

In recent times, there is a greater need to perform simplification due to multi-scale representation of online interactive maps, as well as high spatial and temporal resolution of data collected using location-enabled devices equipped with Global Positioning System (GPS). Evidence of the need for line simplification is observable in widely used Web and desktop mapping libraries or applications [*ESRI ArcGIS* 2015; *Leaflet* 2015; *Openlayers* 2015; *PostGIS* 2015, *Oracle* 2015]. As part of the Leaflet Geometry module, L.LineUtil (*http://bit.ly/1zdZ3nD*), provides utility functions for line simplification using the DP algorithm to improve vector map rendering. OpenLayers geometry library, ol.geom.-flat.simplify.douglasPeucker (*http://bit.ly/1vLJvaq*), is based on the library extracted from Leaflet. PostGIS, a spatial database extension, uses ST_SimplifyPreserveTopology (*http://bit.ly/1vhwBCg*) to perform topology preserving simplification. ESRI provides SimplifyLine_cartography as part of their cartographic toolset in ArcGIS10.2.2. The PointRemove option of Simplify-Line_cartography uses DP line simplification. Oracle Spatial

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