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Redraw the map: a web application for polygon schematization

Jakob Listabarth [a,*], Dirk Burghardt [a]

[a] *Institut für Kartographie, TU Dresden, Jakob Listabarth – jakob.listabarth@tu-dresden.de , Dirk Burghardt – dirk.burghardt@tu-dresden.de*

* Corresponding author

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Abstract:

In contrast to schematized line maps (mostly transit maps), schematized polygon maps are rarely used. One reason may be that creating them is tedious: even though computer scientists have been developing algorithms over the last two decades, none are currently ready for application by cartographers and map makers. These implementations are the result of algorithmic research and hence not necessarily intended to be easily accessible and ready to use. As a consequence, they require complex setups or are not robust enough for practical use. We thus lack a ready-to-use schematization tool.

With this prototype for polygon schematization in the browser, we aim to fill the gap of accessible workflows. It is grounded in a defined set of functional requirements derived from cartographic best practices, including:

- Support for importing and exporting geospatial data in common formats (e.g., GeoJSON, Shapefile, KML),
- Automated validation of geometry type, topological consistency, coordinate reference system (CRS), and level of detail,
- Interactive parameter adjustment to fine-tune the resulting schematization, and
- Real-time feedback during the schematization process.

The visual design of the interface builds upon these requirements, e.g. by adopting a layout with a central map canvas, a sidebar for parameter management, and contextual toolbars that appear based on user actions. The design emphasizes intuitive navigation (e.g. by using shortcuts) and *progressive disclosure*, i.e., revealing advanced options only when needed, which supports both novice and experienced users.

Currently, creating schematized polygon maps is a time-consuming process requiring special knowledge, for both manual and automated creation:

- Manual creation of schematized polygon maps in vector-editing software is time-consuming: e.g., it requires a complete redrawing when changing the projection or scale midway through the manual process. It also requires special knowledge: e.g., specific snapping tools depending on the used vector-editing software.
- Automated generation is time-consuming, current implementations are hard to find (if they are publicly available). They also require special knowledge: e.g. setting up dedicated software environments.

A web-based prototype, in turn, would be accessible to everyone, and is familiar to map-makers: tools like Mapshaper – mapshaper.org by Matthew Bloch, see Harrower and Bloch (2006) – or geojson.io (by mapbox) are widely adopted.

The implemented schematization algorithm is an area-preserving approach published by (Buchin et al., 2016). All edges of the resulting geometry are aligned to a set of orientations. This set is usually defined by cardinal (rectilinear) or intercardinal (octilinear) directions, but also allows arbitrary orientations (regularly and irregularly spaced). The algorithm consists of two steps: edge alignment and simplification.

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The first step turns edges into staircases: each step of these staircases itself is composed of two edges, both of which adhere to one of the allowed orientations. During this process, special care needs to be taken to preserve the topology, e.g. in cases of acute angles where steps of different staircases may intersect and consequently would change the topology.

The second step simplifies the geometry, which is, due to the staircases introduced in step 1, a more detailed geometry than the input. The simplification step needs to preserve the directions and the area, in addition to the topology. This is achieved by complementary edge moves. Each edge move is a combination of a negative and a positive area change, across a boundary line between two neighbouring polygons to balance out the total area change. This simplification step is repeated until no more edge moves are possible, or a user-defined minimum number of edges is reached.

With this the algorithm guarantees two important properties for cartographic schematization: the topology as well as the area are preserved. This, and its flexible design allowing for arbitrary orientations, makes this algorithm a good fit.

This prototype is a proof-of-concept for creating schematized polygon maps in the browser. The resulting prototype will be published as a public Github repository, including the algorithm implementation as well as the user interface. It can then serve as a starting point for a variety of research projects. Possible directions include improving the performance or flexibility of the algorithm, an iterative user-centered design-process to improve its usability, eye-tracking studies using generated geometries or qualitative studies on schematization styles (algorithm parameters). This starts to close the gap on accessible polygon schematization tools for cartographers.

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