International Cartographic Association
Association Cartographique Internationale

L’Alpe d’Huez: A Benchmark for Topographic Map Generalisation

Guillaume Touya

LASTIG, Univ Gustave Eiffel, ENSG, IGN, F-77420 Champs-sur-Marne, France, firstname.lastname@ign.fr

Keywords: Map generalisation, Benchmark, Topographic map, Constraint, National Mapping Agency

Abstract:

L’Alpe d’Huez is a ski resort in the French Alps, and it is also famous among cyclists for the number of bends in the road to the ski resort. It is a good location to evaluate the capabilities of map generalisation tools, as the surroundings contain urban, rural and mountainous areas, and it was chosen 15 years ago as one of the four datasets to benchmark map generalisation software (Stoter et al., 2009). The EuroSDR benchmark used data from IGN France, the French National Mapping Agency (NMA). At that time, open science policies were not popular in NMAs, but now they release their dataset with open licenses, so it is a good opportunity to create an open benchmark for topographic map generalisation.

Although NMA have been using automated generalisation for some years now to produce their topographic maps (Duchêne et al., 2014), there are still many issues of map generalisation that automated solutions cannot handle. And usually, NMAs decide to lower the cartographic quality of the map, until better generalisation techniques are proposed. This is why we think it is still useful to propose a benchmark for NMA-oriented topographic map generalisation, to foster the development of new techniques.

The dataset proposed for the benchmark is not the exact same one used in the EuroSDR project (Stoter et al., 2009), as a few layers have been trimmed (Figure 1). It contains the usual important layers for map generalisation (buildings, roads, rivers), basic topographic layers (contour lines, forests, lakes), and layers that might require specific procedures (ski lifts, tower points, embankment lines). The goal of this benchmark is to generalise the dataset for a 1:50k scale map. The symbols for the target 1:50k scale map are described in a table file, using the same template as the EuroSDR project. The projection used is “NTF Lambert II Etendu”, EPSG 9801.

Figure 1. Extract of the proposed dataset.

The target scale and the style description are not enough to describe what the dataset should look like at the 1:50k scale, and we propose to use generalisation constraints (Beard, 1991) to describe what the target map should look like. The constraints are described in a table file that follows the structure of the constraints proposed during the EuroSDR benchmark (Stoter et al., 2009). Table 1 shows a small extract of these constraints, with two constraints on the area of buildings: these two constraints make sure buildings are large enough at the target scale (IGN-1-4), and that buildings that are already large do not change too much (IGN-1-5). There are 33 constraints on one object, 17 constraints on a relation between two objects, and 14 constraints on groups of objects. Although some constraints are given with instructions on the algorithms to use to satisfy the constraint (e.g. constraint IGN-1-4 in Table 1 that recommends elimination for very small buildings), these constraints do not explain how the data should be generalised, but only

describe the properties of the generalised data, so many different generalisation approaches can be used for this benchmark.

IGN-1-4	EuroSDR-1-1	Minimal dimensions	polygon	Building		Area	no	target area > 0.2 map mm^2	IF initial area < 0.012 map mm2 THEN delete the building	5
IGN-1-5	EuroSDR-1-3	Minimal dimensions	polygon	Building	initial area >= 0.4 map mm^2	Area	yes	target area = initial area ± 20 %		2

Table 1. Extract of the proposed table of constraints to define the target map, with two constraints on building area.

In order to use this dataset as a benchmark for topographic map generalisation, there should be a way to evaluate how much the generalised map satisfies all the constraints provided in the benchmark. For each constraint, we have to compute the satisfaction for all the constrained objects in the map. According to the literature on constraints-based evaluation (Bard, 2004), we need (1) a function that measures the current value of the constrained property (e.g. the *area* in the constraint IGN-1-4 from Table 1), and (2) a function that derives a satisfaction value from the current value and a goal for the constraint (*area > 0.2 map mm²* is the goal for constraint IGN-1-4 in Table 1). Satisfaction values are modelled with a qualitative scale of 8 values from "Unacceptable" to "Perfect" (Touya, 2012). A code to compute these constraint monitors, i.e. the entities that measure the current value and the satisfaction of a constraint on one map object (Touya, 2012), is available in the open CartAGen platform (Touya et al., 2019). However, to make the evaluation easier, we plan to release a QGIS plugin that computes the constraint satisfactions automatically, given the shapefiles of the generalised data. Knowing that a given constraint on a given road object is better satisfied with a generalisation process A compared to another process B, does not guarantee that process A is globally better than process B, as we have to summarize all the constraints satisfactions. Even if the satisfaction mean can be a good proxy of the global generalisation quality, we propose to use aggregation techniques inspired from social welfare (Touya, 2012) as they capture with more subtlety the differences between two distributions of constraint satisfactions. Importance values are provided in the constraints table, as some constraints are more important to fully satisfy than others, and these importance values are used to weight the aggregation of the constraints.

There are lots of constraints and layers in this dataset, some very common, and some more anecdotal (e.g. the preservation of patterns of groups of lakes). Generalisation processes/software able to deal with all of these constraints should be quite rare, but it should not prevent researchers and developers to use this dataset to benchmark their generalisation process/software, on a subset of the constraints. For instance, a generalisation process that only generalises buildings could use this dataset and only consider the constraints on buildings to evaluate the results. Maybe different sub-benchmarks could be derived from this dataset, to foster the use of the dataset to benchmark these generalisation processes limited to a few layers of the map.

Acknowledgement

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 101003012).

Dataset

https://doi.org/10.5281/zenodo.5749324

References

Bard, Sylvain. « Quality Assessment of Cartographic Generalisation ». *Transactions in GIS* 8, nº 1 (2004): 63-81. https://doi.org/10.1111/j.1467-9671.2004.00168.x.

Beard, Kate M. « Constraints on rule formation ». In *Map Generalization*, (eds) Barbara Buttenfield & Robert McMaster, 121-35. Longman Pages, 1991.

Duchêne, Cécile, Blanca Baella, Cynthia A. Brewer, Dirk Burghardt, Barbara P. Buttenfield, Julien Gaffuri, Dominik Käuferle, et al. « Generalisation in Practice Within National Mapping Agencies ». In *Abstracting Geographic Information in a Data Rich World*, (eds) Dirk Burghardt, Cécile Duchêne, & William Mackaness, 329-391. Lecture Notes in Geoinformation and Cartography. Springer International Publishing, 2014. https://doi.org/10.1007/978-3-319-00203-3_11.

Stoter, Jantien, Dirk Burghardt, Cécile Duchêne, Blanca Baella, Nico Bakker, Connie Blok, Maria Pla, Nicolas Regnauld, Guillaume Touya, et Stefan Schmid. « Methodology for evaluating automated map generalization in commercial software ». *Computers, Environment and Urban Systems* 33, nº 5 (2009): 311-24. https://doi.org/10.1016/j.compenvurbsys.2009.06.002.

Touya, Guillaume. « Social Welfare to Assess the Global Legibility of a Generalized Map ». In *Geographic Information Science 7th International Conference, GIScience 2012*, (eds) Ningchuan Xiao, Mei-Po Kwan, Michael F. Goodchild, & Shashi Shekhar, 7478:198-211. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer Berlin / Heidelberg, 2012. https://doi.org/10.1007/978-3-642-33024-7_15.

Touya, Guillaume, Imran Lokhat, & Cécile Duchêne. « CartAGen: An Open Source Research Platform for Map Generalization ». *Proceedings of the ICA* 2 (2019): 1-9. https://doi.org/10.5194/ica-proc-2-134-2019.