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Cartagen4py, an open source Python library for map generalisation

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Abstract:

This abstract presents *cartagen4py*, a new open source Python library for map generalisation. The creation of *cartagen4py* stems from two observations: (1) Python is the predominant scripting language for GI science and cartography, and can be used to add plugins to ArcGIS and QGIS software; (2) researchers and practitioners need open solutions for map generalisation, for better access to the state of the art techniques, and to compare different techniques in different use cases (Foerster et al. 2008, Touya et al. 2019). On the one hand, the current Python libraries such as *shapely*¹ or *PySAL*² do not contain substantive map generalisation functionalities beyond the Douglas & Peucker algorithm. On the other hand, the previous attempts to provide open and shareable map generalisation functionalities, such as *WebGen* (Neun et al. 2008) or *CartAGen* (Touya et al. 2019), are not easily usable in a Python script.

The environment to develop script in Python is already composed of open libraries that are used often by GI scientists, such as *GeoPandas*³ to load and structure spatial data, *shapely* to handle geometries, or *PySAL* to use spatial analysis methods. The *cartagen4py* library does not replace these libraries but is complementary to them to provide map generalisation tools. All geometric operations are based on *shapely*, and the input of the *cartagen4py* algorithms and processes is either a *shapely* geometry or a *GeoPandas* dataframe (when the semantic attributes are required, or when you need to keep track of the generalised features. The operations on the network features use the *networkX* library.

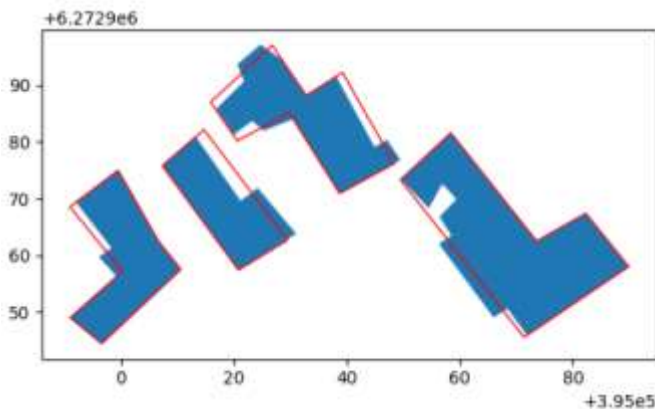


Figure 1. Results of the building simplification from Ruas (1988), previously implemented in the AGENT project. Original buildings (from OpenStreetMap) are rendered in blue, and a generalised version is printed in red.

The *cartagen4py* is mainly designed to exhibit as many algorithms from the literature, as these algorithms form the core of the library, e.g. the building simplification algorithm used during the AGENT project (Figure 1). In that sense, *cartagen4py* is closer in its ambition to *WebGen* than *CartAGen* (Table 1). Before applying generalisation algorithms, it is usually necessary to enrich the data with implicit geographic features, and *cartagen4py* also intends to provide such data enrichment tools, to help the design of automated generalisation workflows or systems. The library does not contain any implementation of generalisation workflows yet, i.e. techniques that combine or orchestrate several generalisation operations, but the library will not be limited to simple algorithms. For instance, at the time this abstract is submitted, two main features are being added to the library with the AGENT model (Barrault et al. 2001) and the

¹ <https://shapely.readthedocs.io/en/stable/>

² <https://pysal.org/>

³ <https://geopandas.org/en/stable/>

least squares (Harrie, 1999). AGENT orchestrates different algorithms to generalise buildings in cities using a multi-agent system. The least squares adjust the shape and position of multiple map features, solving proximity constraints while preserving the shape. Finally, the library also tends to contain evaluation methods, even though they are for now limited to basic monitor constraints (Touya, 2012). This evaluation part of the library is particularly important if we want to develop benchmarks of map generalisation, to compare different solutions for a similar dataset.

Generalisation operation	Algorithms implemented in cartagen4py
Line simplification	Visvalingam-Whyatt (Visvalingam & Whyatt, 1993), Raposo (Raposo, 2013), Gaussian smoothing
Building operations	Enlarge to rectangle, simplification, squaring (Lokhat & Touya, 2016), amalgamation (Damen et al., 2008)
Displacement	Random displacement (from CartAGen)

Table 1. List of algorithms currently implemented in cartagen4py.

As mentioned earlier, the code of the library is open under the CeCILL-C license which is a French equivalent of the LGPL. It is available on Github⁴. As map generalisation is usually computationally intensive when processing large datasets, the library should provide a performance that goes beyond the testing of small datasets. By heavily relying on shapely for all basic geometrical operations, there is a guarantee of performance for these basic operations, as shapely is a Python wrap of the C library GEOS.

Using cartagen4py in a Python script is an advance use, mainly dedicated to researchers or scientist developing an automated generalisation workflow. But to ease the use of the techniques exhibited in the library, we are also developing a QGIS plugin that makes a selection of algorithms available as a process in the QGIS toolbox. Then, the algorithms can be used individually by filling the GUI, or chained using the QGIS model builder. Though the development is not currently on-going, we plan to provide a similar plugin for ArcGIS users.

The documentation is currently under construction, but it will be a key factor for the adoption of the library. Besides the usual documentation of the functions available in the library using Read the docs⁵, we plan to propose Jupyter notebooks where new users can try several generalisation methods with provided sample datasets.

Although the current team of developers will continue porting new algorithms from CartAGen, and introducing new features to the library from the literature. New developers are welcome in the team, and we plan to organise a seminar by the end of 2023 to researchers and practitioners willing to help us in the development of the library.

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⁴ <https://github.com/LostInZoom/CartAGen4Py>

⁵ <https://readthedocs.org/>

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