
MAPDRAW - AN ONLINE TOOL TO DRAW ANYTHING YOU WANT ON TOP OF A MAP

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ABSTRACT

Paper and pencil is a classical approach for user surveys, and it also applies to maps as a printed paper map can be the support for many kinds of annotations. But the annotations drawn on a paper map cannot easily be analysed in a GIS. This paper presents an online and open tool, called MapDraw, which was designed to annotate online maps, and directly reuse the annotations or drawings as a GIS input. The paper presents the functionalities of the tool. Then it describes possible uses within research in geographical information science, but also in mapping agencies or for professional users of topographic maps. Finally, the paper presents how the raw annotations of maps can be astutely analysed for different purposes.

Keywords cartography and user survey and annotation and open source software and sketch map

1 Introduction

During a training session to the early crisis response to an earthquake, firemen had to analyse the location of the disaster and they used their topographic paper map to draw annotations that they later used to make decisions about their intervention (Figure 1). When we asked about the potential use of multi-scale interactive web maps instead of their paper copies of topographic maps, to easily switch from broad to detailed views, they simply answered that they would not consider this solution if they were not able to annotate the map and share the annotations with colleagues.



Figure 1: Photograph of a topographic paper map annotated by firemen during a training session to the early crisis response to an earthquake.

From this anecdote, we can see that there is a need for an online interactive tool that enables drawings and annotations on interactive multi-scale maps. Such a tool should be able to (1) start a drawing at any scale of the map, (2) provide free-form drawing interactions, (3) provide a GIS export of the drawing, and (4) include textual annotations of the drawings and of the map. This paper describes MapDraw, an open online tool, which tries to address these four requirements.

The paper is structured as follows: Section 2 describes the MapDraw tool. Section 3 describes several current and future uses of the MapDraw tool, in research and in a national mapping agency. Section 4 briefly presents how to analyse the drawings exported from MapDraw, and the final section concludes and discusses future research.

2 Description of MapDraw

As we were analysing the existing tools to draw on maps and annotate them, there were two main kinds of possible tools. First, it is possible to use any GIS tool to visualise web maps, and then use the editing tools of the GIS to draw and annotate the map. But we are targeting users unfamiliar with a GIS, and thus much easier interactions than the complex editing tools you can find in a GIS. The other possibility was the Gribrouillon platform developed by French OpenStreetMap contributors [1]. This great tool meets the requirements (1) and (2) of our desired map annotation tool, with user-friendly interactions that even kids can quickly master. However, the export capabilities are limited, and there is no possibility for textual annotations, or even providing a legend of the drawing.

Similarly to Gribrouillon, there are two modes in the MapDraw tool. The first one is an *exploration mode* where you can pan and zoom on a web map, and change the map background between different Web Map Tile Services. The second mode is the *drawing mode* which fixes the map view and enables the drawing interactions. We explain below the functionalities of the drawing mode.

As shown in Figure 2, a drawing is composed of as many layers as necessary, each layer being given a colour and a textual annotation. A layer does not necessarily contain a unique feature, as shown by the "Hotels" layer in Figure 2.

The mouse wheel can be used to adjust the width of the stroke so that the user can draw details with a small width, and cover large areas with a larger stroke width. It is also possible to draw a straight line by pressing a keyboard key while moving the mouse. Because it is not easy to draw with the mouse or by touching the screen with a finger, buttons are provided to delete the last feature added to the layer, or to clear the whole layer. When the drawing is finished, a button enables exporting it as a GeoJSON file. We want to export the final drawing not the details of the mouse stroke to obtain the drawing, so mouse strokes in the same layer are aggregated during export, and the export file only contains one polygon or multi-polygon for each layer. Figure 3 shows how we simply convert the mouse path into a (multi-)polygon.

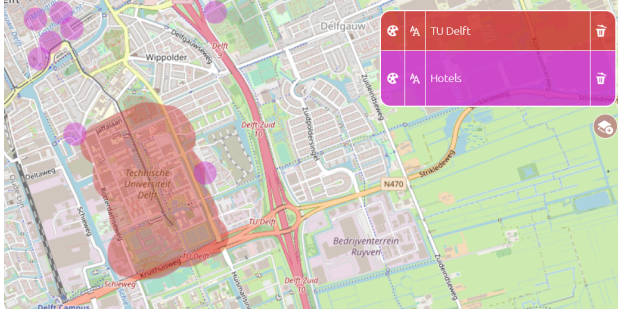


Figure 2: Example drawing illustrating the layers model used in MapDraw.

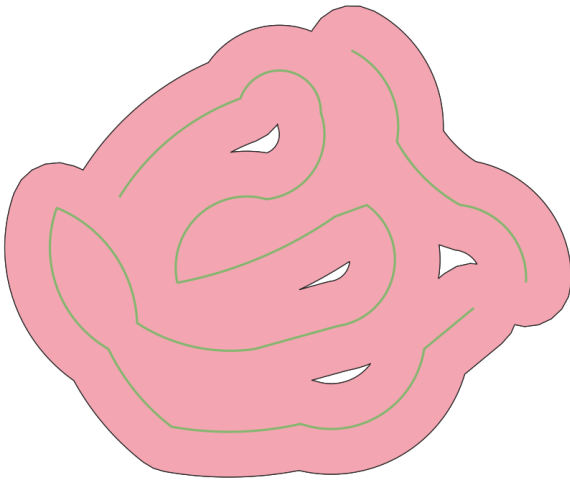


Figure 3: Transformation from the stroke of the drawing to the polygon exported by MapDraw: the stroke width is used to buffer the lines, and then a dissolve operation is performed to merge the polygons.

2.1 Data and Software Availability

A default version of MapDraw can be accessed freely online¹.

The code of the default MapDraw platform is available on Github², as well as the variant for deep learning annotation³ (see Section 3.3), and the code to generate tiles⁴ (see Section 4).

The documentation to install and use MapDraw is also provided online⁵.

3 Different uses of MapDraw

3.1 Supporting user studies

User studies are essential in cartography to better understand the user's experience with interactive maps [2]. But, as the freedom of interaction is important, it becomes complex to control the user's experience in the context of a user study, and software tools are necessary to design these studies [3]. Annotating a map is a usual task in user studies about spatial cognition [4], and MapDraw can be used to transpose such studies with interactive multi-scale maps. Figure 4 shows how we used MapDraw to reproduce the famous experiment by Daniel Montello, asking students from the University of California at Santa Barbara to trace the limit between southern and northern California, which are

¹<https://lostinzoom.huma-num.fr/mapdraw/>

²<https://github.com/LostInZoom/lostinzoom-experiments/tree/master/mapdraw>

³<https://github.com/LostInZoom/lostinzoom-experiments/tree/master/deepmapdraw>

⁴https://github.com/LostInZoom/deepmapdraw_tile_maker

⁵<https://lostinzoom-experiments.readthedocs.io/en/latest/mapdraw.html>

vague regions [5, 6]. In his study, the limit is drawn on a paper map, and the limits are then digitised manually in a GIS, which is a tedious task. With MapDraw, the drawn limits are directly exportable into a GIS, and we can even introduce some vagueness of the limit by using the width of the line.



Figure 4: Boundary between South and North California drawn with MapDraw, following the protocol from Daniel Montello [5].

3.2 Annotating maps for crisis management

A rapid response to natural disasters usually requires maps as tools to analyse the location of the disaster and make decisions about the rapid response [7]. In particular, as mentioned in the introduction, we attended an exercise of rapid earthquake response [8] where topographic maps were printed on large paper sheets and then annotated.

During the observed exercise, the following annotations were on the maps (Figure 1):

- partitions of the field to assign different rescue teams to different locations of the disaster.
- a regular grid with coordinates for each cell (e.g. C3) to facilitate the discussions about locations.
- high-risk areas (e.g. schools, hospitals), and points of interest (e.g. the epicentre of the earthquake).
- updates to the map due to the earthquake (or any other disaster), e.g. collapsed roads or buildings, as the information is passed by field officers.

These annotations could be done with MapDraw instead of paper prints, to facilitate the reuse and sharing of the annotations. However, the current features of MapDraw do not allow such an application yet. For instance, the feature, existing in Gribouillon, which shares the URL of the annotations and has them still rendered in the navigation mode, needs to be developed in a further version of MapDraw.

3.3 Annotating maps for machine learning

When we want to develop models to recognise patterns in maps, such as text elements [9], complex road patterns [10], or multi-scale landmarks [11], deep learning is the most obvious technique, but it requires large annotated datasets. Figure 5 shows how we used MapDraw to annotate salient portions of maps. In this case, one layer corresponds to one class that should be recognised by the deep learning model (e.g. 'river' or 'building' in Figure 5).

To facilitate the use of MapDraw to annotate a map for deep learning purposes, we developed a variant of the tool that we called DeepMapDraw. The main difference between both tools is that the data is directly exported in a PostgreSQL database. Then, the data can be used to generate image tiles to train a deep learning model that recognises patterns in a map (see Section 4).

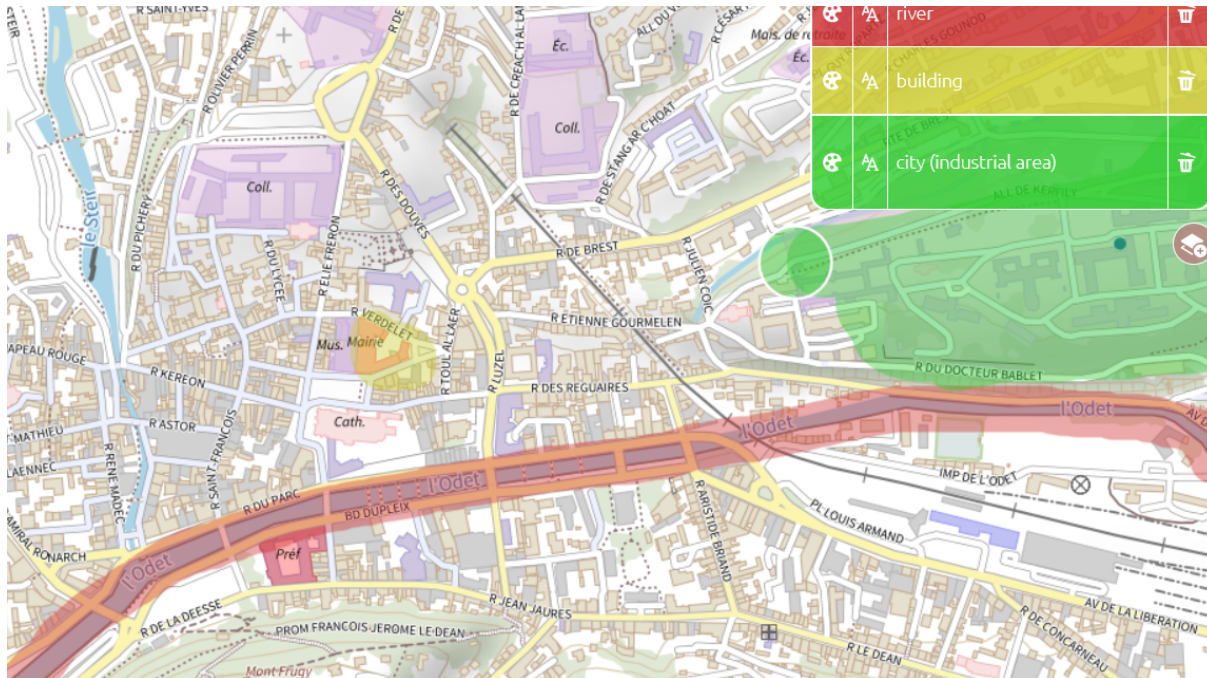


Figure 5: MapDraw used to annotate salient features in a map, in order to generate a training set for deep learning models able to recognise these salient features.

3.4 Assessing maps with experts

Now, topographic maps are produced at different scales with automated processes, in particular for map generalisation. But these automated processes are far from perfect, and the cases where the map is not legible due to a poor automated generalisation have to be identified, to be later corrected. Whether it is about assessing the legibility of a map [12], or just assessing the quality of a map generalisation process [13, 14, 15], it is complex to define and compute quantitative metrics, and the use of human cartographers is common to complement the quantitative evaluation [16]. We propose to use MapDraw to make this expert evaluation easier.

Figure 6 shows a French topographic map at the 1:25000 scale with clear generalisation problems that is annotated by an expert of map generalisation with MapDraw. The advantage compared to past experiences of expert evaluation [16], is the ease of the tool, its flexibility in the annotation process, and the fact that the annotation are directly geolocated.



Figure 6: A French topographic map with map generalisation problems annotated with MapDraw.

3.5 Georeferenced sketch maps

Sketch-maps are “compact spatial representations that express the key spatial features of a situation for the task at hand, abstracting away the mass of details that would otherwise obscure the relevant aspects” [17, p. 61]. Sketch-maps are great tools to study spatial cognition [18], and have been used in recent studies to understand how much a user recalls a map [19, 20]. Usually, the sketch maps are drawn on paper, but their analysis is then hardly automated. In a recent study, sketch maps were drawn with MS Paint [21], which gives similar free-form drawing tools, but also more advanced options. But MapDraw allows a much quicker analysis of the sketch map as it is exported in a vector format.

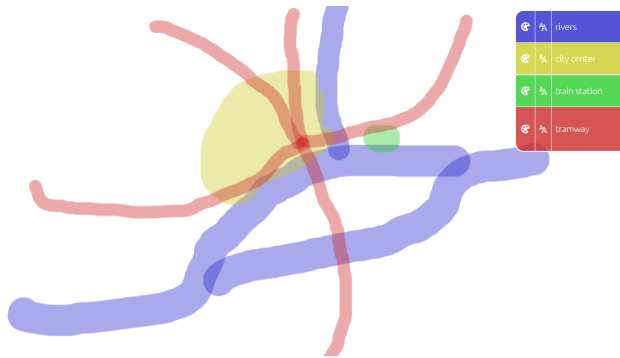


Figure 7: A sketch map of the city of Nantes, France, achieved with MapDraw guided by the actual administrative limits of the city.

Figure 7 shows a georeferenced sketch-map drawn with the MapDraw tool. Aligning a sketch map with topographic data is a very complex process [22], and using MapDraw to have a reference bounding box or blank administrative limits for the sketch map can facilitate this alignment.

4 How to analyse the drawings?

The simplest way to analyse the drawings is to import the GeoJSON files in a GIS. As they are already georeferenced, they can be aligned and mixed with any kind of vector or raster spatial data for analysis. But we also developed two types of specific analyses of the drawings. First, when someone is conducting a user survey with MapDraw, the result is that we have multiple drawings of the same area, and we may want to compare these drawings. To analyse those overlapping drawings, we create a raster representation of the drawings where the value of each pixel is the number of coloured areas that cover the pixel (Figure 8). We create this raster by combining several of the basic raster functions of QGIS, but a similar process can be achieved with any GIS.

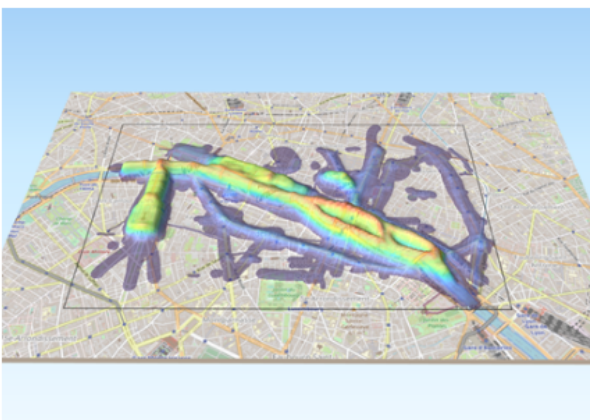


Figure 8: A 3D visualisation of the raster combination of multiple drawings of a map of Paris (people were supposed to draw the memorable elements of the map).

The second type of specific analysis tool we developed is a tile generator in order to train deep learning models. The tile generator establishes a connection with the database that stores the drawings, retrieves the extent of the drawings and creates a mesh of tiles for each extent. For each tile, a couple of images are generated (Figure 9), one showing the background map, and the other showing the drawings as masks of different classes with a grayscale.



Figure 9: Two tiles generated from MapDraw data, and their corresponding masks.

5 Conclusions and future work

To conclude, we think that MapDraw will be a useful tool for researchers to create different applications where drawing on a multi-scale interactive map is necessary. The applications of MapDraw described in this paper are only the ones we have started to develop, and many more are possible.

To foster even more applications, we plan develop new features for the tool. First, to be used more easily during field surveys, we need to develop a version of MapDraw that is really compatible with a smartphone or a tablet. Right now, sizing the stroke width is only possible with the mouse wheel, and it is critical in most uses of MapDraw to change the stroke width. Furthermore, as MapDraw is a drawing application, we decided to export what we see, i.e. the coloured areas, rather than the linestrings that form the skeletons of these coloured areas. We would like to add an option to export the skeleton of the drawing instead of the coloured areas. Finally, as mentioned in Section 3.2, we want to add an alternative to the export which would be to store the drawing as WFS on a server, making it possible to share the drawing with a URL, and have displayed also in the navigation mode, at different scales.

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References

- [1] Adrien Pavie. Gribrouillon, 2020.
- [2] Robert E. Roth, Arzu Çöltekin, Luciene Delazari, Homero F. Filho, Amy Griffin, Andreas Hall, Jari Korpi, Ismini Lokka, André Mendonça, Kristien Ooms, and Corné P. J. M. van Elzakker. User studies in cartography: opportunities for empirical research on interactive maps and visualizations. *International Journal of Cartography*, 3(sup1):61–89, October 2017.

- [3] René Unrau and Christian Kray. Enhancing Usability Evaluation of Web-Based Geographic Information Systems (WebGIS) with Visual Analytics. In Krzysztof Janowicz and Judith A. Verstegen, editors, *11th International Conference on Geographic Information Science (GIScience 2021) - Part I*, volume 177 of *Leibniz International Proceedings in Informatics (LIPIcs)*, pages 15:1–15:16, Dagstuhl, Germany, 2020. Schloss Dagstuhl–Leibniz-Zentrum für Informatik. ISSN: 1868-8969.
- [4] Lynn S. Liben, Lauren J. Myers, and Kim A. Kastens. Locating Oneself on a Map in Relation to Person Qualities and Map Characteristics. In Christian Freksa, Nora S. Newcombe, Peter Gärdenfors, and Stefan Wöfl, editors, *Spatial Cognition VI. Learning, Reasoning, and Talking about Space*, pages 171–187, Berlin, Heidelberg, 2008. Springer Berlin Heidelberg.
- [5] Daniel R. Montello, Alinda Friedman, and Daniel W. Phillips. Vague cognitive regions in geography and geographic information science. *International Journal of Geographical Information Science*, 28(9):1802–1820, September 2014.
- [6] Song Gao, Krzysztof Janowicz, Daniel R. Montello, Yingjie Hu, Jiue-An Yang, Grant McKenzie, Yiting Ju, Li Gong, Benjamin Adams, and Bo Yan. A data-synthesis-driven method for detecting and extracting vague cognitive regions. *International Journal of Geographical Information Science*, 31(6):1245–1271, June 2017.
- [7] Valérie November and Laurence Créton-Cazanave. Inquiry In Control Rooms – An Analysis Through The Lenses of Space, Time and Practice. In A. Tapia; P. Antunes; V. A. Bañuls; K. Moore; J. Porto, editor, *ISCRAM 2016 Conference Proceedings – 13th International Conference on Information Systems for Crisis Response and Management*. 2016.
- [8] Simon Guérin-Marthe, Pierre Gehl, Caterina Negulescu, Samuel Auclair, and Rosemary Fayjaloun. Rapid earthquake response: The state-of-the art and recommendations with a focus on European systems. *International Journal of Disaster Risk Reduction*, 52:101958, January 2021.
- [9] Jerod Weinman, Ziwen Chen, Ben Gafford, Nathan Gifford, Abyaya Lamsal, and Liam Niehus-Staab. Deep Neural Networks for Text Detection and Recognition in Historical Maps. In *2019 International Conference on Document Analysis and Recognition (ICDAR)*, pages 902–909, September 2019. ISSN: 2379-2140.
- [10] Chengming Li, Honggang Zhang, Pengda Wu, Yong Yin, and Sichao Liu. A complex junction recognition method based on GoogLeNet model. *Transactions in GIS*, 24(6):1756–1778, 2020.
- [11] Quentin Potié, Guillaume Touya, Chaimaa Beladroui, Amina El-Moutaouakkil, and William Mackaness. Deep learning for anchor detection in multi-scale maps. In *Abstracts of the ICA*, volume 5, pages 1–2, Vienna, Austria, September 2022. Copernicus GmbH.
- [12] Lars Harrie, Hanna Stigmar, and Milan Djordjevic. Analytical Estimation of Map Readability. *ISPRS International Journal of Geo-Information*, 4(2):418–446, March 2015.
- [13] Elsa M. João. *Causes and Consequences of Map Generalisation*. Taylor & Francis, London, 1998.
- [14] William A. Mackaness and A. Ruas. Evaluation in the Map Generalisation Process. In William A. Mackaness, Anne Ruas, and L. Tiina Sarjakoski, editors, *Generalisation of Geographic Information*, pages 89–111. Elsevier, London, 2007.
- [15] Jantien Stoter, Xiang Zhang, Hanna Stigmar, and Lars Harrie. Evaluation in Generalisation. In Dirk Burghardt, Cécile Duchêne, and William Mackaness, editors, *Abstracting Geographic Information in a Data Rich World*, Lecture Notes in Geoinformation and Cartography, pages 259–297. Springer International Publishing, 2014.
- [16] Jantien Stoter, Dirk Burghardt, Cécile Duchêne, Blanca Baella, Nico Bakker, Connie Blok, Maria Pla, Nicolas Regnauld, Guillaume Touya, and Stefan Schmid. Methodology for evaluating automated map generalization in commercial software. *Computers, Environment and Urban Systems*, 33(5):311–324, September 2009.
- [17] Kenneth D. Forbus, Jeffrey Usher, and Vernell Chapman. Qualitative Spatial Reasoning about Sketch Maps. *AI Magazine*, 25(3):61–72, September 2004. Number: 3.
- [18] Niem Tu Huynh and Sean T. Doherty. Digital Sketch-Map Drawing as an Instrument to Collect Data about Spatial Cognition. *Cartographica: The International Journal for Geographic Information and Geovisualization*, 42(4):285–296, December 2007.
- [19] Kristien Ooms, Philippe De Maeyer, and Veerle Fack. Listen to the Map User: Cognition, Memory, and Expertise. *The Cartographic Journal*, 52(1):3–19, February 2015.
- [20] Pyry Kettunen, Katja Putto, Valérie Gyselinck, Christina M. Krause, and L. Tiina Sarjakoski. Perception and Recall of Landmarks for Personal Navigation in Nature at Night Versus Day. *Modern Trends in Cartography*, pages 281–301, 2015. Publisher: Springer, Cham.

- [21] Merve Keskin, Kristien Ooms, Ahmet Ozgur Dogru, and Philippe De Maeyer. Digital sketch maps and eye tracking statistics as instruments to obtain insights into spatial cognition. *Journal of Eye Movement Research*, 11(3), June 2018.
- [22] Malumbo Chaka Chipofya, Carl Schultz, and Angela Schwering. A metaheuristic approach for efficient and effective sketch-to-metric map alignment. *International Journal of Geographical Information Science*, October 2015. Publisher: Taylor & Francis.