Open Educational Resources for Cartography: The Thematic Mapping Tutor

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ABSTRACT

At the ITC faculty of the University of Twente, we have been teaching cartography for more then 60 years. Throughout this period, the technology of mapping has undergone spectacular changes and nowadays most students do not draw their maps any more, but use software instead. However, for maps to be effective in communication, their design still has to follow the same rules as before. Ideally, one wants to teach these design rules independently from the tools, such that the students **understand how a good map works, not just which buttons to click** to create it.
For this purpose, we created the Thematic Mapping Tutor. It is an open, web-based system that provides a structured way of constructing thematic maps out of selected data. The system uses the input of the student to construct a map in the Vega-Lite grammar, which is transformed to web-graphics.
In this paper we describe the educational philosophy behind the system, as well as technical details about its functionality. We report on first tests, and reflect on the possibilities and pitfalls of the system.

OPEN EDUCATIONAL RESOURCES FOR CARTOGRAPHY

The term Open Educational Resources (OER) has been defined as "teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or repurposing by others" (Marcus-Quinn and Diggins, 2013). The concept of OER comprises the simple and powerful idea that the world's knowledge is a public good and that technology in general and the World Wide Web in particular provide an extraordinary opportunity for everyone to share, use, and reuse knowledge (Atkins et al., 2007, p.4). It is agreed among education communities, and backed by institutions, e.g. in the Paris OER Declaration (UNESCO, 2012), that to achieve the United Nations Millennium and Sustainable Development Goals (specifically those concerning education), OERs are an essential asset.

ITC, the Faculty of Geo–Information Science and Earth Observation of the University of Twente, is an institute that aims at capacity building and institutional strengthening for developing countries, specifically by providing higher education curricula. One might expect such an institute, with its mission and close links to the UN's Sustainable Development Goals, to embrace the notions of OERs. However, currently we are only just starting first tentative experiments. There are myriad reasons for this, mostly out of scope for this paper, but one in particular is the nature of much of the education at ITC: teaching people how to practically gather, model, analyse and communicate spatial data through the use of software. To freely share such exercises publicly, one has to share the software, and in many cases its license will not allow that. But over the past years, *open source* geospatial information technology has reached a significant level of maturity, flanked by open standards and the open data movement. This has resulted in using more and more open source software in our education, specifically in the domain of spatial data infrastructures, where we try nowadays to adhere to what we call an SDI^{light} philosophy.

The SDI^{light} philosophy at ITC

In teaching at ITC, and specifically in the Geoinformatics curriculum, we emphasise two principles. The first addresses the systematics of purposeful spatial data production and uptake into computerised systems;

the second addresses the methodical construction of these computerised systems, applying principles of model–driven architecture, formal specification and transformational design of SDI nodes. The term Spatial Data Infrastructure (SDI) traditionally denotes large, complex systems, using proprietary software systems. But its principles can also be applied in simpler and more cost–effective ways, and this approach we call SDI^{light} . We have the students work with, and build, a software stack consisting of free and open source components. To achieve interoperability, we emphasise the use of open standards, from the Open Geospatial Consortium and others. You can find more details on SDI^{light} and its implementation in Köbben et al. (2010).

Teaching Cartographic Communication Basics in an OER

As part of our various curricula, we have been teaching cartography now for more then 60 years. Throughout this period, the technology of mapping has undergone spectacular changes and nowadays most practitioners do not *draw* their maps any more, but use GIS or other *software*, or programming languages. However, for maps to be effective in communication, their design still has to follow the same basic cartographic communication rules as before. Ideally, one wants to teach these design rules independently from the tools, such that the students *understand how to make a good map, not just which buttons to click* to create it. We teach our students the basic rules of cartographic communication as a series of analysis and decision steps, based on the Graphic Grammar of Bertin (1967) and simplified into a workflow explained in a series of slides, and a poster (see Figure 1).

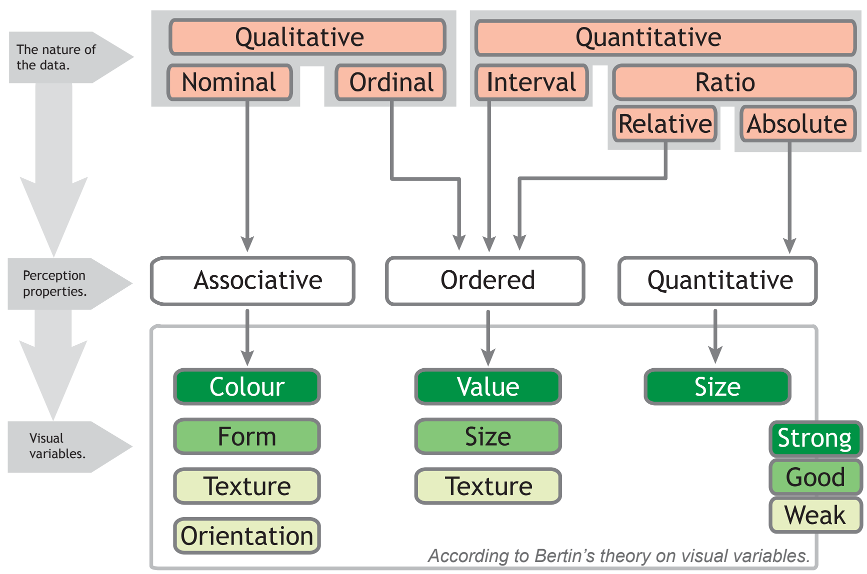

Figure 1. The basic rules of cartographic communication as a series of analysis and decision steps. This is a condensed version of the full poster found in
`https://kartoweb.itc.nl/kobben/publications/2018/posterCG.pdf`

To practice these cartographic communication principles, we have been introducing students in several programmes to cartography exercises that can be run with a wide choice of softwares, in line with the SDI^{light} philosophy explained above. Where traditionally they would be using ESRI's ArcMap, they now can also deploy the open source QGIS, on-line tools such as Carto.com, or even more formal programming–type solutions such as the Vega-Lite grammar. This is a high-level declarative grammar for interactive graphics that describes visualisations as mappings from data to the properties of graphical elements, created by the University Washington Interactive Data Lab (2018). It is expressed in a JSON format that can be transformed into the full specification of the larger Vega language. This in turn can be compiled into web content using the D3 Javascript API which ultimately results in HTML5 web pages with interactive SVG graphics.

Of course, writing Vega-Lite specifications is not a skill that can be expected of, or is needed by, every GIS scholar that needs to learn the principles of cartographic communication. But we realised that the technology does allow us to create exercises for this in a web-based, fully open and license–free system that would fit nicely with our intention to get more experience with creating and using OERs. For this purpose, we are now experimenting with an OER tool to practice the basics of cartographic communication for thematic mapping, which we dubbed the Thematic Mapping Tutor.

THE THEMATIC MAPPING TUTOR

The Thematic Mapping Tutor constitutes of a web-client and a server component. The latter stores datasets that can be set up by educators for specific exercises, through a simple web interface. This component, using the Python Flask framework, lets one upload standard GeoJSON files, and pre-processes these to make them suitable for use in the client component.

The web-client component, created using HTML5 and Javascript, provides an interface for constructing thematic maps based on the Cartographic Grammar principles described in the sections above. It offers the workflow of analysing the data, deciding on the perception needed, and choosing appropriate visual variables for the map symbols to be used. It is using the exact same terms and visuals as the teaching materials presented in Figure 1.

The system uses the choices of the student to create a Vega-Lite specification, based on a set of templates for the various thematic maps types. This Vega-Lite specification is processed in the pipeline depicted in Figure 2 to automatically produce a web visualisation. On purpose this visualisation is kept very basic, i.e., a simple legend is added, but with no further embellishments or interactivity. Nor can one change the visualisations themselves to e.g., use different colour schemes or symbol shapes. This is after all meant to be a tool to understand the consequences of the user's choices in data types and visual variables, not a full-blown thematic mapping system. . .

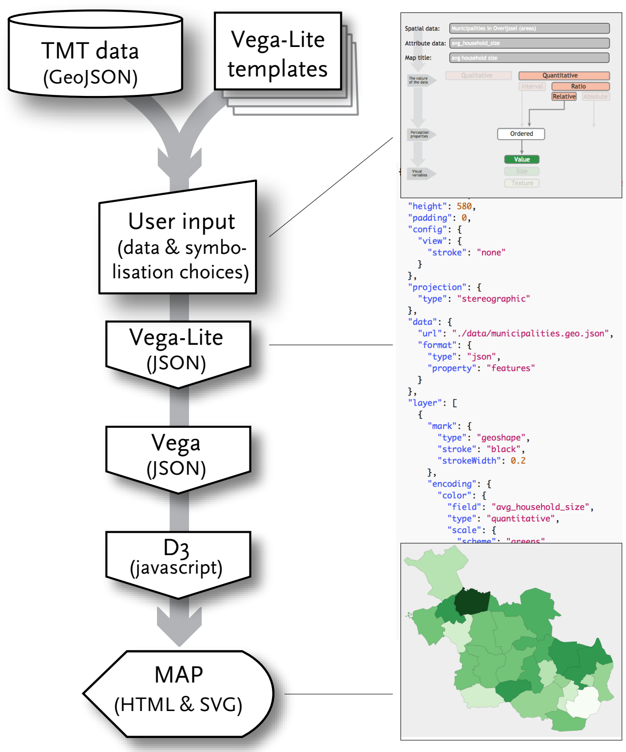

Figure 2. The implementation pipeline of the client component.

RESULTS AND DISCUSSION

The Thematic Mapping Tutor is still in development. The current stable version is available on our website `https://kartoweb.itc.nl/TMT/`, and you can follow the development on the GitHub pages at `https://github.com/GIP-ITC-UniversityTwente/TMT/`. The current version was only tested in Chrome, FireFox and Safari on MacOSX and in Edge and Chrome on Windows10.

It should be usable with no further explanation, but it of course is assuming the user is familiar with the educational materials on cartographic communication principles using the concepts and workflow as used in the poster mentioned in Figure 1.

We have tested it thusfar with very limited users: We presented it in an ITC research seminar with fellow GIS educators, and have had a first cohort of 17 students in our Spatial Engineering master use it as part of their choice topic “Introduction to Spatial Data Visualization”. Based on their feedback we are finalising the functionality and are planning to wider publish the system and invite users from around the world to test it and use it freely in their education. For that we of course will have to package it together with our teaching materials for the subject of Cartographic Communication principles, so that it will hopefully become a useful Open Education Resource.

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