CO-155

USER GENERATED CARTOGRAPHY BY CROWD SOURCING WEB MAP STYLING

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BACKGROUND AND OBJECTIVES

For a long time the production of maps has been the domain of skilled specialists who had profound knowledge of the theoretical and practical basics of Cartography. This is changing with the advances of communication and web technologies. The user himself has more and more influence on what and how things are displayed on the maps he uses. He can adapt the maps to his own needs and on the other hand he is also able to create maps for other people to share geographical information. But how does he know about the proper design?

Cartography has gone many steps, developing from a craft with artistic features to a discipline, which tries to scientifically determine the concepts of how maps work. Within all those steps, the user has been focused more and more, as the cartographer tries to make maps, which are functional, usable and understandable through the eyes of others. So the main issue in making maps for others is to know about the users. Their context, their abilities, their experiences and expectations on what is seen on a map. Cartography and the mapmaking user have to find out about the cognitive schemata, which the map readers have in their minds, to be able to adapt the map representation to the mental representations of the readers. The assumption made here is that a better map design is reached by minimizing the distance or the differences between the physical and the mental representation.

Today many successful Examples of Web2.0-Services show that new possibilities of communication provide new ways of gathering individual knowledge together to a greater whole and use it for the benefit of all. Those new possibilities of communication implicate as well new possibilities for cartographic research and map production. Several well-known VGI-Projects (see Goodchild 2007) like Wikimapia or OpenStreetMap have demonstrated how powerful a simple data collection platform can be used to crowd-source the creation of worldwide geodatasets. Although there are many ways the Web2.0 can be used to create and publish cartographic works, it is not the Web2.0 itself, which guarantees good quality. Cartwright 2008 shows some poor examples of Mashup maps, where default symbols and basemaps from a web map API were used in mobile map contexts, ignoring map extent and resulting in poorly placed and overlapping marker icons. So to take advantage of the Web2.0 for map quality issues will depend on how the users can interact with the information provided by other users. It's the collaborative manner in which the Web2.0 has to be applied to benefit from the crowd intelligence. It even doesn't have to be a synchronous process, it can be an asynchronous collaboration like, for example in Wiki projects. The possibility of cross checking and giving feedback about the quality of data and the quality of design, as well as the merging or puzzling together of information from different users are the strengths of the collaborative crowd-sourcing approach.

Now the aim of this paper is to point out, that and how we can use principles of Web2.0-communication (see O'Reilly 2005) in a collaborative way to create 'good' map styles. A 'good' map style, in this sense, should first contain the content a user expects in a certain context and second the presentation of this content should match the viewing habits of the reader. In other words, a 'good' map style should result in a map, which matches closely to the specific map schemata (see MacEachren 1995) a user has developed before, in the given context or at least, which matches closely to a general map schema which the reader can apply, while reading the map. The aim here is to minimize the mental costs in retrieving information from the map.

Taking this into account, the map design should depend on the map purpose or function and the characteristics of the map users. Both will influence the map design, the purpose which defines the context of usage (Functionality, Actions, Media etc.) and the users with their abilities of visual perception and cognitive models (disabilities, language, culture, map reading skills etc.) , which define the expected content and its appearance.

To create maps for more than one person always means to encounter several individual and therefore different mental concepts. This implicates that the map style has to mediate between the different mental user requirements.

The following chapter discusses the possibility to organize the process of gaining insights into the user expectations, with respect to content and appearance by taking the advantages of the crowd-sourcing

principle, giving the users themselves the chance to state their individual conception of the "correct" selection and representation of geoobjects and further derive a combined community-based map-conception, which will be a prototypical map style in relation to the contributing community members.

The results chapter outlines a first attempt of realizing an online map style editor called SLDExplorer to create or modify StyledLayerDescriptor Documents, which is based on open standards of the Open Geospatial Consortium.

Finally the paper closes with some remarks about the future work towards a crowd-sourcing solution of cartographic web map styling.

APPROACH AND METHODS

For such a process of data acquisition of course there must be a certain infrastructure which enables the user to try out and develop design preferences, there must be a format or a formal language which allows to express individual conceptions of representations and there must be a platform where you can save your concept and share it with others.

There is an existing example of a Web2.0 web map style editor provided by Cloudmade, which implements a good part of the infrastructure and enables users to interactively create their individual OSM-Style by choosing colors, outline appearance and selecting which objects should appear at which zoom levels. The styles can be shared with the public to be used in web map applications over the cloudmade API and can also be chosen as a base to create new user styles. It's free of charge and it hosts the rendered map tiles, so that the user doesn't have to care about server infrastructure and tile caching technology etc. But at a closer look it's obvious, that this Web2.0 Application doesn't make use of the crowd intelligence like Wikipedia or OpenStreetMap. What is missing is the collaborative approach on working together on the same content in order to raise quality. In fact all styles are made by single users and don't get better if more users are participating creating more styles. Also the authors can't state the purpose for which the maps are made for, which makes it hard to select a style and evaluate its quality for a use in another user's context.

The following conceptual approach takes those disadvantages into account and outlines a more generic way, which is not bound to specific data.

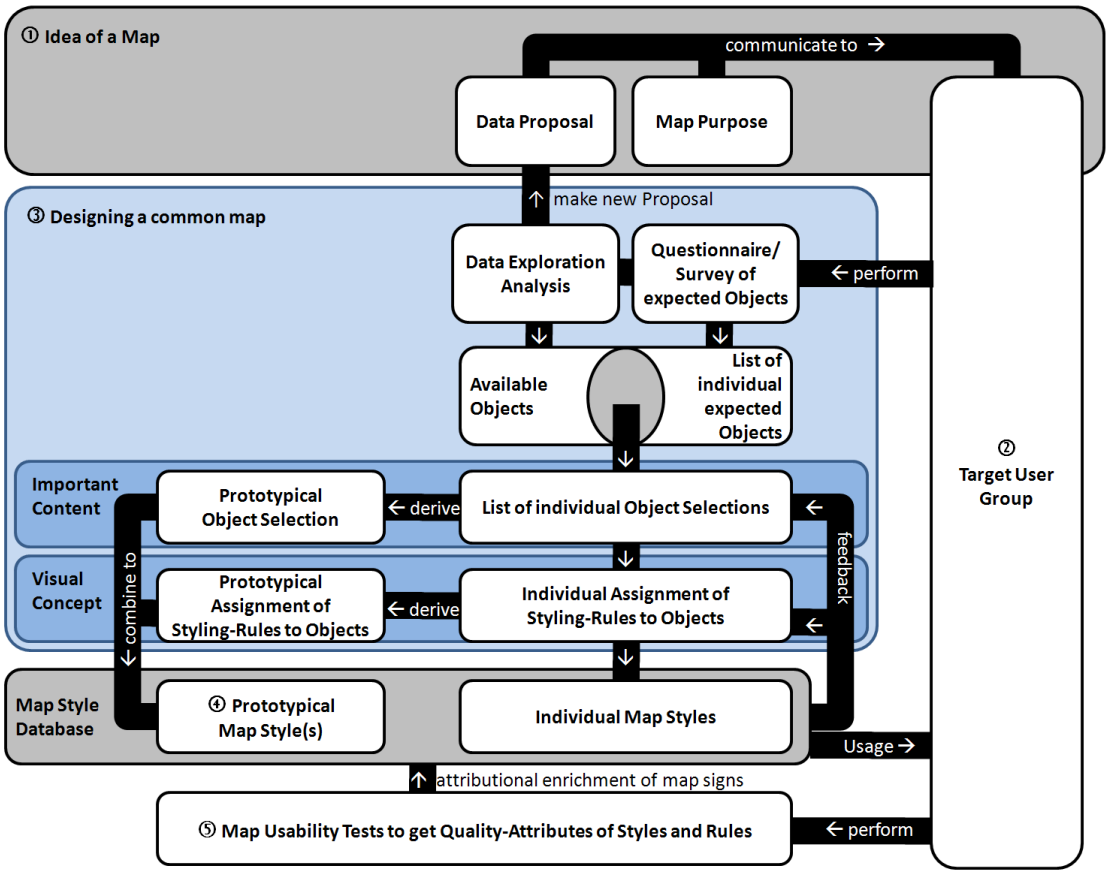
CONCEPTUAL APPROACH

Figure 1 depicts a conception of a crowd-sourcing-process for interactive web map styling. The principle which takes effect here is based upon the fact that the individual user reveals his specialized knowledge about his concept of desired or necessary content, plus his preferences in relation to the used map symbols for the visual representation. The collection of all the individual information in a database makes it possible to determine on the one hand a prototypical content and on the other hand a prototypical style (Sign-Object-Reference) of a map, which is adapted to the user-community and the map purpose. There should also be several feedback loops of already stored information from other users which allow the user to get some decision help and orientation at the creation of their individual object selection and sign-object-references. This way it is possible to learn from other users who made decisions in the same situation before. In case that the user hasn't developed a specific map schema yet, he can adopt the schemas from other community members and train his own map schema with the side effect of converging to a common map schema.

The crowd-sourcing-process starts with the formulation of the idea of the map to be produced (1). As the design of a map depends among other things of the map purpose which the map shall fulfill and of the target-group which will use and has to understand the map, at first the purpose has to be described carefully as this will be given to the users as a guiding idea during the process enabling them to imagine the usage context. Maybe there is also a proposal of an appropriate dataset to use which can be added to the idea but this could also be a point of community discussion to bring other or better available datasets into play.

Once finished with the description of the idea the crowd-sourcing-process can go on by the act of communicating the idea to the community or the target-user-group (2). Now this group can design a common map (3) in several steps by each other revealing their expectations of the required content and checking if those expectations can be fulfilled by the proposed dataset. Out of the expected and available contents a list of every user develops with each ones individual object selections from which then by means of statistical analysis a common prototypical set of expected and available objects can be derived. This step closes a kind of user analysis which gives us information about important expected contents of the map for the achievement of the given map purpose.

Fig. 1: Process of crowd-sourcing interactive web map styling



Source: compiled by the author

Another step shall reveal information about the appropriate sign-language. Again everybody can reveal his individual mental concept, this time about the object-sign-reference. This procedure indeed is a very complex one and accordingly requires software tools, which can ease the assignment decisions to the user. At this step, as well as at the object selection, the system based on web2.0-principles should facilitate the decisions using its ability to provide suggestions based on other users. With the collection of a certain number of individual object-sign-references again it will be possible to derive a prototypical assignment which represents the typical understanding of the community.

From the determined prototypical object selection and the prototypical symbolization it should be possible to combine a, for the target-group, prototypical common map style (4). This map style should bear a high degree of comprehensibility and functionality in relation to the contents and the intended map purpose.

Accompanying to the accumulation of subjective object-sign-references in the database, the system could be enhanced in a way, that proposed assignments of other users are proofed by means of different cognition tests (5) according to different properties like learnability, recognition, distinctiveness, intuitiveness etc. The results of such tests, which are also used by icon researchers (see Barker & van Schaik 2000 and Staufer 1987), could then provide further decision support at the individual object-sign-reference-procedure in form of objective qualitative cognitive sign attributes which are offered at a certain stage of the assignment process.

TECHNICAL APPROACH

Like stated above it will be necessary for a realization that there is an appropriate infrastructure on which a platform can be based to create, store and share contents and especially visualize geographical data with cartographic styling rules. Also there must be a formal language format to express those styling rules.

To build a sustainable solution, which is suitable for any arbitrary data, the software, the formats and the service interfaces should be based on open standards, which can be used by anybody. This way it is assured, that other applications can use the outcome in an interoperable way. Fortunately the Open Geospatial Consortium (OGC) provides both: open standardized formats like the StyledLayerDescriptor/SymbologyEncoding (SLD/SE) to express cartographic styling rules and open standardized web service interfaces, like the WebMapService (WMS), to visualize data with SLD and the

WebFeatureService (WFS), which provides access to the data itself. The WFS can be used to gain an overview of the attribute values of the data on which the styling can be based on.

A typical communication flow could look like the following: Via the WFS-DescribeLayer-Request it is possible to get an overview of the attribute columns of a dataset and their datatypes (Number, String etc). Further a WFS-GetFeature-Request can reveal the attribute values. Both informations are crucial to define the filters in the SLD-Document which control the application of the styling rules to the features during the rendering process of the WMS. Some WMS-types also support a GetStyle-Request which could be used to get a provided default style of the data on which the user style can be based on. During the styling process it is possible to directly get a visual feedback of the settings made in the SLD by sending frequently new WMS-GetMap-Requests which can include the actual user style as a parameter. With this functionality the user can explore the data and iteratively create and change the styling rules. Finally there must be a possibility to store the results to a common platform database from where the results can be shared and reused by others.

RESULTS

Many steps to a realization of the concept still have to be gone. Nevertheless a first prototype of web application based on the discussed technical concept has been realized to give users the possibility to create or change existing mapstyle definitions in a standardized way (see http://koenigstuhl.uni-heidelberg.de/sldexplorer). The so called "SLDExplorer" builds upon standards of the Open Geospatial Consortium (OGC) and provides support for StyledLayerDescriptor 1.0 (SLD). This component can be used for the assignment process of object- sign-referencing. Technically an SLD-Document is directly created or loaded into the Document Object Model (DOM) via AJAX-Functionality. With the help of a XSL-Transformation the SLD-Document gets translated into HTML-form Elements. After the user interaction with the form elements the content of the SLD-Document is updated via Javascript. The Application uses OGC Standards like WMS to visualize preview Images for the single Point- Line-, Polygon- and Textsymbolizers as well as for complete Rules, which can easily be set up via a graphical user interface. It is possible to create new SLD-Documents from the root or modify existing ones with the possibility of import and export as text strings.

CONCLUSIONS AND FUTURE PLANS

Up to now the SLDExplorer provides just a basic functionality to easily deal with the manipulation of SLD-Documents via a graphical user interface. But it will be necessary to enhance the application in several ways. First there must be a live preview of the data itself in form of a map, not just symbolizer previews. This map preview, using the just created styling rules, gives the user a direct feedback of the styling decisions. The map will be realized with the open source web mapping library OpenLayers which also supports several OGC interfaces. Some other User-Interface-Design questions have to be solved. Especially to reduce the complexity which a style can bear, specifically if we think of multi-scale-styles, which are needed to present zoomable web maps with up to 20 zoom levels for a world wide dataset. Different views are necessary to provide an optimal overview of the document structure, while performing the different steps of the styling process, like e.g. a semantic generalization over different scale intervals.

Beside the styling component, a lot of other issues remain to be investigated. In general, how to enhance the OGC-SLD/SE standard to provide more sophisticated styling opportunities also for thematic mapping (see Auer & Zipf 2009) and related to the above concept, e.g. the design of the database structure to store and offer the user content, the methods to derive the prototypical aggregations of object selections and style assignments or the evaluation of different cognitive test methods to determine qualitative meta-information about certain object-sign-references.

The existence of such a community-driven cartographic style database could further give researchers the chance for other kinds of studies. If we assume to have further information about the individuals who contribute their decisions, it would also be possible to extract mapping preferences related to regions, culture, age or many other characteristics. Such a database could also be a base to derive generalized user and context models for adaptive map applications such as described in Zipf 2005 for mobile maps.

ACKNOWLEDGEMENTS

This study was partly funded by the Federal Ministry of Education and Research (BMBF), Germany, in the framework of the project "3D-Sutren".

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