The Marker Cluster:  
A Critical Analysis and a New Approach to a Common Web-based Cartographic Interface Pattern  

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ABSTRACT

The growing amount of gathered, stored and available data is creating a need for useful mass-data visualizations in many domains. The mapping of large spatial data sets is not only of interest for experts anymore, but, with regard to the latest advances in web cartography, also moves into the domain of public cartographic applications. One interactive web-based cartographic interface design pattern that helps with visualizing and interacting with large, high density data sets is the marker cluster; a functionality already in use in many web-based products and solutions. In this article, the author will present their ongoing research on the problem of “too many markers.” They will present an empirical evaluation and comparison of marker cluster techniques and similar approaches, including heatmaps and tiled heatmaps. They conclude with a first concept for overcoming some of the obstacles that they were able to identify in their study and thereby introduce a new direction for further research.

KEYWORDS

Evaluation, Geovisualization, HCI, Maps, Marker, Usability, Web

INTRODUCTION

The overall growing amount of data is a driving force behind new fields of research in mass data visualization. One of many examples for recent research conducted in this area is the field of network visualizations, like e.g. the massive data plots by Hochman and Manovich (Hochman & Manovich, 2013). One might argue that mass data visualizations are not new. What might be new are the web-based or mobile technologies and communication channels that are available for developing visualizations on the production side as well as for the audiences on the reception side. The field of visualization is moving away from being an expert-only field towards being a field that is relevant for a broad audience. Thus, data and its representations are being made accessible and usable for scholars from many different fields as well as for a broad public audience.

The same applies for data visualization in cartography. Experts in the field have been working with mass data and geovisualization techniques since the introduction of the first Geo Information Systems (GIS) in the late 1960s (Coppock & Rhind, 2001). But especially with the advances in web cartography and the growing popularity of modern web mapping applications like Google maps (Google Inc., 2014) or Bing (Microsoft Corporation, 2014), we observe that the public and academic fields are increasingly involved in the usage of modern web-based cartographic applications for private, professional and academic purposes. At the same time, we experience a growing number of services that collect or create large amounts of spatial data, for example services like Yelp (Yelp, 2014) or Foursquare (Foursquare, 2014). This combination of trends nourishes the need for new spatial mass data visualization methods for web-based cartographic applications.
In this paper, we analyze the marker cluster, a visualization method that is already being used by many web-based applications that integrate visualizations of large spatial datasets. From a scientific point of view, most of the research on marker clusters focuses on the more technical elements, like e.g. the algorithms generating the clusters (Bär & Hurni, 2011; Delort, 2010a; Kefaloukos, Vaz Salles, & Zachariasen, 2012; Stefanakis, 2005). In contrast to this related research, we investigate the functionality of the marker cluster method and take the human perception into account. Abstract representations of spatial data each require interpretation of the respective cartographic communication model. That is why also the marker cluster, just like every other layer of abstraction, will conceivably introduce errors in the user’s interpretation.

In order to better understand the user’s perception of the marker cluster, we have conducted a series of experiments. They were aimed at testing the marker cluster’s performance and precision, but also the accuracy in the users’ interpretation, in other words their level of understanding the marker cluster as an abstract representation.

With our approach, we follow a trend towards more functional cartographic representations, away from purely design and artistic map creation (MacEachren, 2004), that has emerged over the last few decades. One of the earliest and most cited publications that have informed this trend towards more objective guidelines for cartographic representations is Arthur H. Robinson’s 1952 book the Look of maps, based on his dissertation, and his book Elements of Cartography (Robinson, 1952; Robinson et al, 1984). Since then, we have seen a whole body of research evolve that has been directed towards the analysis of perception of cartographic representations. Howard’s (Howard, 1980) model for analyzing cartographic symbolization separates three distinct levels of cartographic representation: lexical, functional and cognitive. With our series of experiments, we mostly focussed on the latter: the individual perception of cartographic representation. Nonetheless, we also gained insights into the two more systemic aspects of Howard’s model through the qualitative part of our analysis.

PART 1: ANALYSIS

Challenge

In regards to small datasets, the conventional marker is still a sufficient interface solution. With an increasing number of data points, however, maps become cluttered and thereby unusable (Figure 1). This is the starting point for our research. In the field of cartography, a large research corpus already exists when it comes to two-dimensional static maps and dense data set representation. Research has been conducted with focus on e.g. label placement (Christensen, Marks, & Shieber, 1995; Marks & Shieber, 1991), dot placement (Hey, 2011) or – when it comes to clustered data – choropleth maps. All of this shows us how to work with visual features in “dense” spatial data environments.

The problem that arises when we try to translate this knowledge into the field of web cartography is the factor of zoomability. While the old methods concentrated on displaying information at one specific zoom-factor, modern web mapping applications allow the user to zoom in and out and thereby reach different levels of detail. As framed in Ben Shneidermans visualization mantra “overview first, zoom and filter, then details-on-demand” (Shneiderman, 1996), those web applications allow users to start at a low zoom-level and get an overview by seeing a large area of a big spatial data-set. In a second step, they can then zoom in and thereby filter the amount of data being displayed. In some cases, users can even zoom in until they are able to identify individual data-items and access their detailed attributes on demand.
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