A Displacement Method for Maps Showing Dense Sets of Points of Interest

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Extended Abstract

In the past, point data only play a minor role in map generalization, as points are either already the result of generalization (by symbolization) or are used for objects which are only shown on large scale maps (e.g. real estate maps). Now, with the growing availability of web mapping services the role of point data has changed: Besides route planning, the most common function of web maps is the visualization of user queries for points of interest (POI). Due to the limited size of commonly used displays, the map extract is often rather small, which results in a smaller scale as would be appropriate for the maps content. At this, the state of the art to resolve occurring cluttered point sets, is on the one hand interactivity (pan and zoom) and on the other hand the selection of points. Thus, often the available space is not optimally used. Therefore we propose a displacement method to improve the readability of dense sets of POIs.

Given are a set of geocoded POIs and their circular map symbols of a fixed size for a given scale. To guarantee a certain accuracy of the positioning, we require that the coordinates of each point are inside its corresponding map symbol. The quality of the placement is measured by the sum of the areas of the intersections of all map symbols. The optimal value is zero, as it means that the symbols do not overlap at all. So the strategy is to assign a distinct area to each point, which is large enough to completely contain the symbol. In order to do so, we chose an iterative method, which applies Voronoi diagrams as auxiliary structures. The initial assignment of areas to the POIs is the Voronoi diagram of their coordinates and the center of the symbols are placed on the coordinates. In each iteration, all overlapping symbols are displaced and the Voronoi diagram is adapted. The method stops, if there are no more overlapping map symbols, or if no point can be moved without

ICA European Symposium on CARTOGRAPHY VIENNA, 10–12 NOVEMBER 2015

Published in "Proceedings of the 1st ICA European Symposium on Cartography", edited by Georg Gartner and Haosheng Huang, EuroCarto 2015, 10-12 November 2015, Vienna, Austria

exceeding the given threshold (radius of the symbols), or if a given number of iterations is exceeded.

The quality of the displacement depends wholly on the calculation of the displacement vectors. So, as to improve the initial placement, small Voronoi cells should be enlarged and the sites should be closer to the center of their Voronoi cells. In order to achieve this, we apply two alternative heuristics: to move point towards the center of a largest inner circle of its Voronoi cell (a) or towards the centroid of its Voronoi cell(b).

We evaluated both methods with five datasets (European towns, airports, towers, hills and peaks) derived from Geonames. To improve the efficiency of the algorithm, we automatically remove isolated points (fix points) and divide the dataset into sets of points, which can be processed independently. For both steps, we apply once again Voronoi diagrams. In *Figure 1* on the left side the divisions for airports are shown and on the right side the result of the displacement with heuristic a).

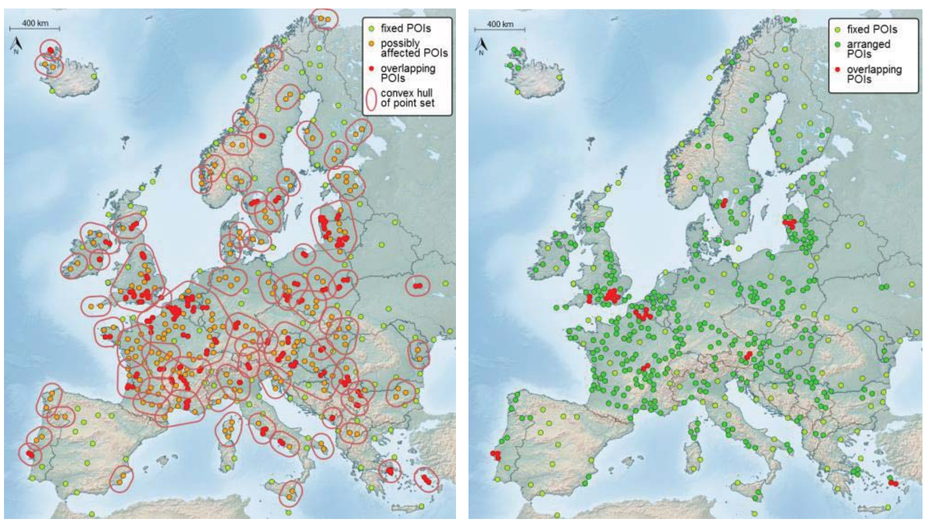

Figure 1. Airports in Europe, division of point sets and displacement result.[1]

For three datasets, the overlap of each symbol could at least be reduced to less than half of the symbol's area. In the other two datasets (peaks and towers) 33.47% and 11.89% of the symbols remain covered in large part. The percentage of solved conflicts varies between 13.2 and 79.7 depending on the density of the dataset.

[1] Parts of base map adopted from Natural Earth