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Enhancing usability of the similarity map for more accessible politics

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Abstract. Our project builds on an established internet service that facilitates understanding complex political agendas and helps to choose the best candidates in local or governmental elections. The service, widely adopted by the great public in Finland, is text based, and according to our claim, does not perform optimally with respect to cognitive ergonomy and visualization. The present paper describes a design iteration loop to improve the visualization of high dimensional political data. Our earlier prototype already proposed a visual similarity map interface with basic visualization and data access functionalities. According to our claim, the effective use of similarity maps improves cognitive ergonomy of the service. It takes advantage of the parallel processing of visual perception and compresses the semantic core of the multidimensional input. Yet, it has been claimed that the representation requires the user to conceptualize information in unfamiliar way. The difficulty can be alleviated by usability measures and our explorative study suggests that simplicity should be taken as a guideline for the design.

1. Introduction

Within the past few years in Finland, internet services termed *election engines* have become extremely popular and established means of the media coverage in political elections. The profiles of all candidates have been collected to a database via an on-screen questionnaire. The service lets the citizens search for the best matching candidates taking a range of issues into account, using the same questionnaire for the candidates and voters. In the basic version, the results come out as a standard list of best-matching candidates, in the manner of standard search engines.

In [Kaipainen 01] an alternative approach was proposed to improve the readability of the results by replacing extensive lists with map visualization, on which holistically similar candidates are clustered near each other. Therefore, the map represents the real complexity of the political issues better than a mere best match. To our knowledge, this is the only functioning prototype built for this purpose (see however also [Heikkinen 02]).

The earlier prototype subsumed that the map visualization would grant a better cognitive ergonomy based on parallel processing of visual perception, as contrast to more linear perception of text [Kaipainen 01]. Furthermore, it was proposed that the 2D-map would do more justice to multidimensional complexity of political agendas than the mere listing. The map was created with the most widely used Artificial Neural Network (ANN) algorithm, Self-Organizing Map (SOM, [Kohonen 82]). The function of SOM has been defined as "visualization of complex data in a two-dimensional display and creation of abstractions" and the result of the algorithm is presented in a "similarity graph of input data" [Kohonen 01].

Gärdenfors [00] has presented an approach to human concept formation, which is grounded to such spatial organization. In terms of information visualization (e.g. [Ware 00]), the map (fig.

1) expresses ordinal data with respect to two separable dimensions [Garner 78], emerging from the implicit data structure.

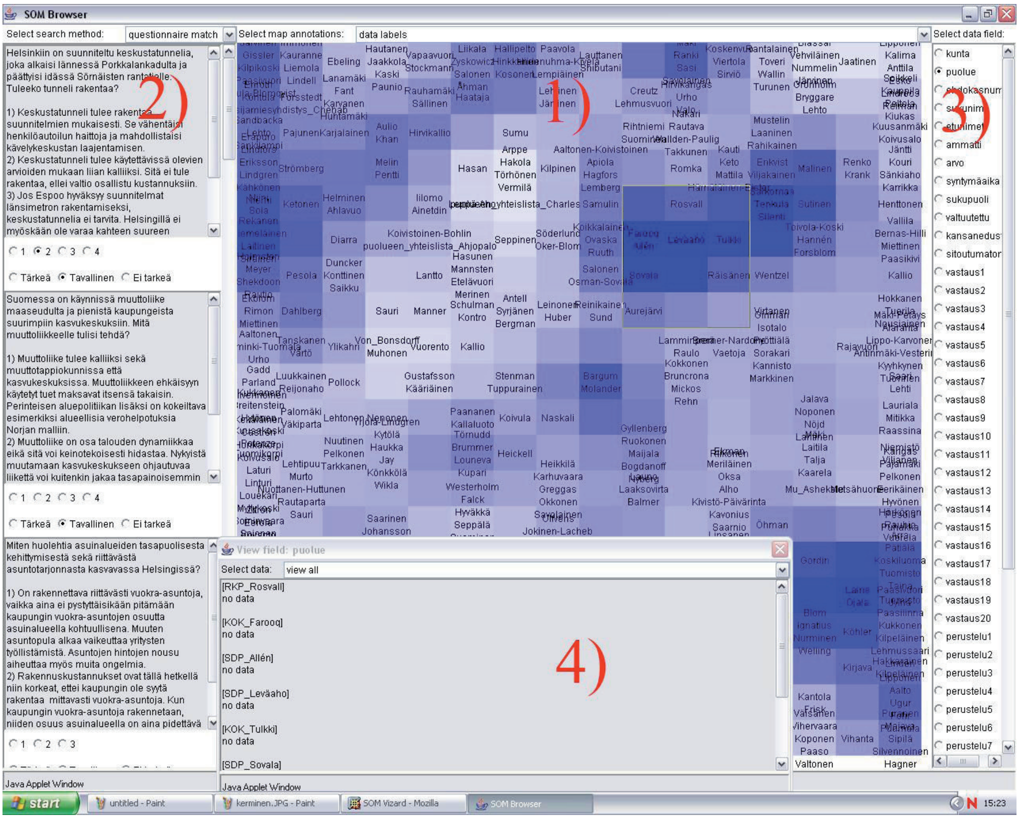

Figure 1. The prototype visualization [Kaipainen 01]. The visualization consists of the following parts implemented as a Java applet: 1) the map panel, 2) the questionnaire panel, 3) the data panel, and 4) a separate window to display the data. The prototype is currently accessible in: http://www2.uiah.fi/~mberg/kerminen/browser.html

It has been claimed that this technology (ANN) can be used to discover new groupings and to detect unnoticed diagnostically important features, but it also brings along a need to settle for less familiar interpretations [Churchland 89], such as the map here.Our goal was to improve the aspects of usability and cognitive ergonomy of the prototype by means of an iterative design process and the standard usability heuristics. Nielsen [93] has warned not to use the iterative design alone, but to use it hand-in-hand with deeper analysis. His famous 10 point list was used together with *cognitive walkthrough* design principles [Lewis 90]. Four possible users were tested using interviews to ensure the easiness of understanding. These interviews were used to guide the development of the prototype. The rest of the article describes the usability findings from the process.

2. Iterative design methodology

The development project followed the iterative design principles, which have been mentioned to work well with prototypes [Gould 85]. The prototype supported the conducted interviews by offering something tangible, and by providing a tool to externalize the developed ideas. The experiments, [Bailey 93] and [Hewett 86] brought up some relevant practical issues that iterative design brings along. As advised, two inexperienced users were challenged to find defects and two experienced users to make improvement suggestions. According to suggestions [Taylor 84] the experienced users received more open-ended questions.

The interview was planned with the guidelines of *theme-based interview*. There was a structured list of question contents from the following topics: 1.) instructions, 2.) independent test use of the version of Kaipainen et al. and encouragement for expression of new ideas, and 3.) testing development ideas on the new prototype. The common problem, misunderstandings, was avoided by active observation (prompting with questions) and the encouraging the users to "think out loud", as in [Hewett 86]. The interviews had the following objectives:

1. Detect the major problems for usability,
2. Attain new ideas to develop the program,
3. Form better idea of needed interaction and layout for the program,
4. Develop better instructions for the use of the program,
5. Test the prototypical ideas of the development, and
6. Update the structure of interview itself.

As a part of the interview, it was attempted to find suitable content for short instructions before the use. Instructions should be short, because users are assumed to be reluctant to read large manuals, [Carrol 90] and [Gould 85]. Similar to the study [Hewett 86], the teaching material was collected from the expressions of the test users. According to advices [Nielsen 00], the instructions did not contain scroll bars, used ordered lists and not full sentences, and had example pictures.

3. Design decisions

3.1. The summary of the used heuristics

The cognitive walkthrough principles [Lewis 90] were taken into account in the following way. The unmentioned principles did not require any extra effort.
1.) Make possibilities salient. This was done by placing, most of the functionalities into the menu. It was suspected that the possible problems arise with locating the functions with pressing mouse buttons on the map. These functions were chosen to be optional so that it is not necessary to locate them, but if they are located they are easy to use with mouse.
2.) Provide "undo" or "back-button". The user was given a chance to change his previous selections by navigating back and leaving the questions open. This serves the "maybe" function for choices that for example Baker [01] promoted.

Nielsen's [93] ten points (only applicable) were considered in the following way.
1. Simple and natural dialog. This was considered to be very important. Interviews were used to match concepts of the user with the interface concepts. The functions were grouped according to what seemed most natural for the interviewed test users. The application was in Finnish, the native language for most of the users.
3. Minimize user memory load. User had change to weight the importance of the questions and these had defaults to speed up the answering. The actual answers, expressing opinions, of

course could not have any leading defaults. The selection with radio buttons were placed next to questions (problem 6 in Table 1)

4. Consistency. The same information was provided in the same location every time, on the interface. This was especially so with the tested sliders (an abandoned experiment for the answering procedure, problem 7 in the Table 1) and with the displayed data.

5. Feedback. According to the wishes of the test users (problem 10 in Table 1) and an advice from [Nielsen 99b], a new function for searching candidates by name was introduced as a menu option. It was design to have simple and informative feedback about the results. The name appeared on the map, and was colored with red. This was mentioned in search dialog. Also, if the search failed, this was explained.

9. Prevent errors. The wrong mode has been mentioned as possibly the most common source of problems [Nielsen 93]. According to the interviews, the two different kinds of maps were decided to have totally different colorings, not to confuse them (problem 9 in Table 1).

10. Help and documentation. As proposed, instructions structured around diagram were presented. Instructions were placed next to the launch button, for easy access.

3.2. Interview Results

Impor -tance	**Description of the problem**	**Interview remark / Improvement (X)**				
1	large number of separate windows	T1	T2	T3		X
2	difficulties with the "data field"-selection	T1	T2	T3	T4	X
3	large number of names (only earlier version.)	T1			T4	
4	scrolling between the questions (only earlier version)	T1	T2	T3	T4	
5	the need to adjust window size and location	T1		T3		X
6	choice located far from their effects		T2		X	X
7	the use of multiple sliders		T2	T3	T4	X
8	transferring city symbol to candidate names	T1		X	X	X
9	confusing u-matrix to comparison map	T1			X	X
10	Missing search	T1	X	X	X	X
11	irritating color (red) in markings		T2	T3	X	X
12	limited length of history line	T1	T2		X	X
13	default names on the map	T1		X	X	X
14	unnoticeable winner	T1			X	X
15	unintuitive naming		T2	X	X	X
16	Missing color-code explanations	T1				

Table 1. The comments on usability problems. The summary of comments is presented in the order of importance, from the most important to the least important, based on the comments in the interview. The number on the right identifies the order of the interview (T1 to T4), X that the problems was fixed (from that on, there were no complaints), an empty space that the particular user did not mention the issue. The earlier version refers to [Kaipainen 01] and those problems were corrected before the interviews. The fifth column shows all (except the last) problems were fixed after the interviews.

As a result from the iterative design process, it is argued now that the information visualization should take simpler form, and the mentioned four parts of the prototype should be reduced to first two, still having the same functionalities. There are also other problems in the prototype that make the use virtually impossible for some users. How these problems were dealt with will be discussed next.

3.3. New design solutions

City symbol (a round marker for multiple hits):
There was an obvious problem of presenting over 900 names of candidates on the map to identify each of them to particular location (problem 1 in Table 1). As a solution, the map showed a round marker (yellow) that replaced the candidate names of that particular cell (shown in Fig. 2). This symbol was adopted from geographic map conventions and accordingly, the diameter of the marker represented the number of candidates represented. User was able to uncover the names with mouse click and reverse it. This was based on the ideas of the first test user with the agreement of the others. The click of the other mouse button revealed more information on the candidates. This functionality was previously in two separate panels. User could then choose which names were interesting and should be plot on the map.

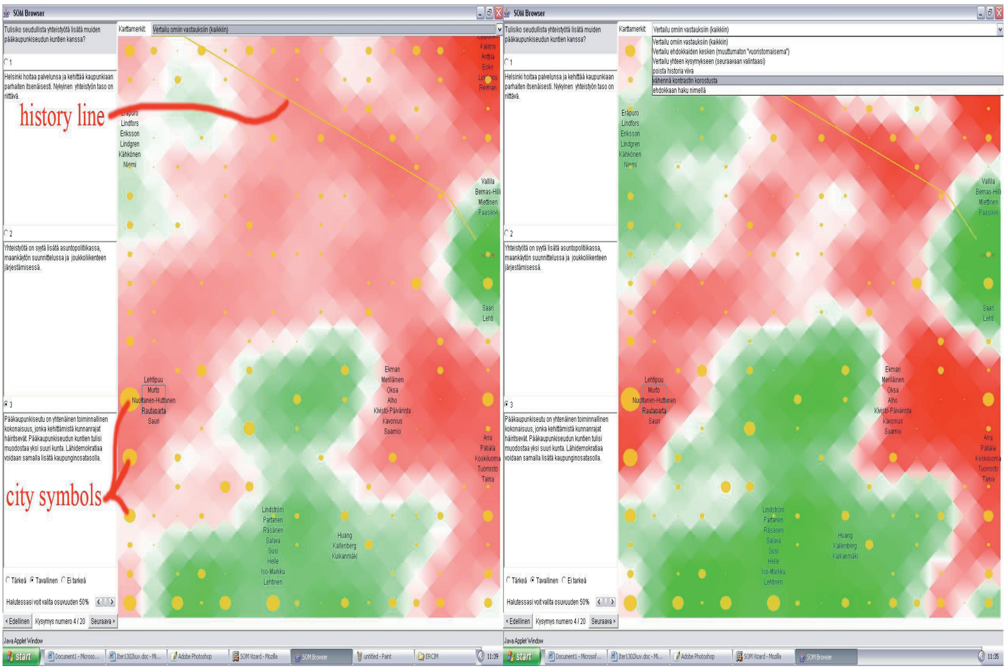

Figure 2. The normal (on the right) and histogram equalized view (added contrast)

Histogram equalization: (see e.g. [Uselton 86])
Although similarity map vectors were normalized, this does not mean that the values - to be mapped on the colors - would be equally distributed. In order to highlight the color borders, it was made possible to see uniform histogram. This was introduced to user as a menu function of adding or removing contrast. Only the one enabled was shown. It was made optional because the new distribution might distort the distances represented by shades. The psychological studies support the need for more highly [Straus 79] and equally [Regehr 93] distributed data visualization for human perception.

History line:
A “history line” was introduced as additional functionality to make the interaction between the question dialog and the coloring of the similarity map more apparent to the user. The previous locations on the map, corresponding to the previously answered questions, were

connected with straight line segments forming a trace (shown in Fig. 2). The history line was implemented as a menu option, because there were different opinions of its importance among the test users.

Background map: ("Mountain View")
The standard SOM output, u-matrix [Ultsch 90] view indicating clustering of candidates according to their statistical overall similarity. With respect to information visualization, u-matrix allows the comparison of intervals between the neighboring locations. The u-matrix view was named in instructions as "Mountain View", because it presented the coloring from white to blue (adopted from the previous prototype) and the metaphor seemed suitable to represent the static map.

Match view

In the improved version, a cloudlike visualization superimposed over the background map indicates dynamically the degree of match between candidates' profiles and the user-chosen questionnaire profiles (Fig. 2). This allows interactive exploration and navigation with different questionnaire answers. The degree of match was coded with colors ranging from red (dissimilar) to green (similar) through white (neutral).
In the original interface, each of the rectangular similarity map cells had one constant color, posing low resolution rasterized computer graphics look, which is far from natural surfaces human vision system has evolved to cope with. There were hopes for having smoother surfaces, which would promote continuity of the similarity map surfaces. The one-dimensional linear color interpolation function, provided by the programming interface, was used.

Question dialog
Most of the test users complained that too many sliders in the question dialog made the answering complicated (problems 4 and 7 in Table 1). So, all the sliders were removed, except for one particularly long question. Also according to several comments, each radio button was placed next to the corresponding choice and questions were presented one at a time.

4. Conclusions

The observation in [Hewett 86] that experts are good at pointing out plausible direction for the development and novices for spotting the usability problems seemed to hold. The latter can be best seen from table 1 (T1 and T4). T1 user pointed out most of the problems in the use and T4 least. Another reason for this is the changes made between the interviews (see X in table 1). The quantity of the information on the map required following design choices: the city-symbol, histogram equalization, and candidate search. The shading modifications attempted to make the appearance more pleasing. Also, consistency was kept in mind with the coloring choices. As an addition, history line was designed to represent temporal changes of the map.

Based on the interviews, simplicity was taken to be the most wanted interface characteristic. In past, Karvonen [00] has proposed similar ideas of the usability design. She promoted clarity as "stripped naked of all fancy features, colors, and flashy, moving objects". Also [Nielsen 99a] presented similar results. It should be emphasized that simplification is one of the general goals for this project. Lowering complexity of multidimensional information in terms of projection to 2D-surface grid, as implemented by the SOM algorithm in this case, appears to serve the function of simplification.

Discussion

The earlier election engine outcomes relied on listing the single (or few) best fitting candidate(s) as their "search" results, The alternative similarity map representation relies on the fuzzy account [Zadeh 65], and suggests graded values of similarity instead. Interpreting the map involves more than just reading the best match. Therefore, users' attention should be reserved for the content and not to be wasted on the usability problems. The next phase of the project is to provide the service, tested on prototypes, to everyone via internet.

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