Investigating the perceptual aspects of tag clouds from a semantic clustering approach

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ABSTRACT
Since social tagging systems have become popular a viable visualization form for displaying annotated web resources needs to integrate unclassified content into meaningful visual representations. We argue that tag clouds can make the grade as we assume that the application of clustering techniques for arranging tags can be a challenging method to generate meaningful units within a tag cloud in order to enhance user performance. In this paper recent methods of semantic clustering for visualizing tag clouds will be reviewed followed by findings from user studies that investigated the visual perception of differently arranged depictions of tags. Finally a new approach will be proposed in order to further develop on this concept.

Keywords
Tag Clouds, Information Visualization, Semantic Cluster, Eye Tracking, Human Computer Interaction, Folksonomies;

INTRODUCTION
Since social tagging systems have become popular for annotating web resources i.e. publishing and personalizing information, extensive amounts of unordered and user-tagged information rule everyday life in the web. The need for managing this plenitude of cumulated tagging data i.e. "folksonomies" gave reason for the emergence of a simple visualization form, the tag cloud, a visual depiction of user generated tags. In our work we focus on tag clouds as a tool that provides access to large amounts of user-collected data. As contents and resources in folksonomies are subjectively nominated by users without any vocabulary control, a viable visualization form needs to integrate unclassified and hardly definable content into meaningful representations. A few variants have been proposed to enhance the interaction within a search process, i.e. varying the visual features such as font size, color and position, or alternating the arranging structure of the tags within a tag cloud. Hence improving data management i.e. reduction via clustering methods has been used either to integrate tags according to their semantic interrelations into coherent entire or to create new visualization variants of tag clouds. In our opinion semantic clustering for arranging tags can be a viable method to generate meaningful units within a tag cloud in order to enhance user performance and augment user ´s personal gain from the interaction.

Tag cloud application
The concept of a tag cloud is as popular as it is simple to adopt. Meanwhile several web tools exist (e.g. Tag Cloud Generator [1], TagCrowd [2]) that let users built their own tag cloud for their personal web space in order to provide a quick overview or a first orientation for insight seeking visitors. Beside their ease of use, tag clouds are perceived to loosen the appearance on a website as usually dominated by majorly text-based contents. However in practice the operability of tag clouds suffers from obvious limitations. Beside the weaknesses concerning quality and syntax of folksonomies [13], interaction with a tag cloud is often limited on the perception of the most frequented tags as they are displayed with larger font size, in other words tags with larger font size are longer frequented than smaller tags [7,15]. The result is the percept of a tag cloud usually dominated by one or two large tags, whereas the smaller tags earn much less attention from the users, and interaction often ends here. As an approach to solve this, Hayes and Avesani partitioned data using content clustering [9]. In this context we believe that using clustering methods can solve some of these problems in providing viable semantic entities to users.

Visualization
Generally today ´s innovations in the field of information visualization enable the implementation of more and more sophisticated techniques based on graph theory, topological algorithms, physic models, geometrical and geographical representations [17]. Similarly, work on tag clouds has been done with the motivation to embed the semantic relations between tags into a graphical frame. For example Fujimura and colleges [6] generated an algorithm displaying tag clouds within a topographic image context whereas others selected pictorial material from geo-referenced collections to generate tag maps visualizations [10]. A circular cloud layout as opposed to the common rectangular layout of tag clouds has also been proposed [4]. Furthermore Kaser and

Lemire discuss the large amount of white space in typically designed tag clouds which are problematic particularly on small-display (e.g. mobile) devices, and seek to optimize the tag cloud layout with electronic design automation (EDA) tools [11]. Having inconsistent white spaces between the lines is not as trivial as it seems as – following the proximity law of Gestalt - the white spaces can give impression of grouped lines as entities, which biases the perception in an unintended direction. Here a robust clustering algorithm could prevent such side effects. Hence we assume that semantic mapping techniques to visualize tags and their interrelations can be useful as reading and handling maps is part of most human procedural knowledge and memory abilities.

Semantic clustering

Results from our study using eye gaze analysis to investigate the visual perception of differently arranged tag clouds showed that generally the upper left quadrant of the display is the most frequented [12]. This trend can be explained by the fact that people in western cultural areas usually read texts from top left to bottom right. Effects of tag position on user perception have not been confirmed yet. These observations led to further investigations on the perceptual aspects of different tag arrangements. Several researchers have implemented tag clouds with semantically clustered tags arrangements. Semantic relatedness is defined here by the means of relative co-occurrence between tags. Whereas Hassan-Montero and Herrero-Solana could determine a better search performance of their participants for the interaction with a semantically clustered tag cloud [8], the results in our previous experiment did not show such improving effect [12]. Here the quality of the applied algorithm may have an essential role, noting that social tagging data are known to be not clearly definable in their semantic concept. Finally Begelman et al. provided a technique to measure similarity among tags in order to use a selected clustering algorithm for adequately displaying semantically-related tags [3].

Another aim of our study was to examine whether users perform characteristic search patterns within a search task. Eye gaze analysis showed that users can adopt certain patterns but no traceable strategy within a search process could be determined: some use a chaotic search patterns, others perform a serial scanning in a zigzag pattern, while again others alter their gaze behaviour during the search process between chaotic searching and serial scanning. Analogue others think that people rather scan clouds rather than read them [7]. These perceptual aspects related to processing depth have to be considered in information visualization discources, which conforms to the idea of possibly disclosing search patterns adopted by users in dependency of differently shaped stimuli.

Research on the perception of alphabetical ordered tag clouds showed that users' search processing is suddenly much more focused once the user recognizes the organisation principle [11,12]. In order to mobilize cognitive resources we claim that a better task performance can be achieved if the user is aware of the semantic organisation in a tag cloud. In this case all appropriate visual features of tag clouds are required to be well developed for ensuring an enhanced interaction within the latent information i.e. "tagging space".

Perceptual integration

Basically a tag cloud consists in a visual representation of data mined content, i.e. information resources reduced to a certain quantity of selected tags. This concept may invite users to rather search for single items than for entities, keeping the perceptual processing more pre-attentional i.e. lowering cognitive load. This gets in line with approaches from cognitive psychology underlining the fact that attention focus is limited. This could explain why people in our experiment took more time to detect the underlying hierarchical structure within the tag cloud than they needed to recognize the alphabetical order [12]. Accordingly people perceived the semantically clustered tag cloud as less helpful than the alphabetic condition, probably because they did not become aware of the clusters. Hence we suggest that once a cluster has been identified as semantically related, cognitive load should be relatively low to proceed with search. If so we can differ between first, the cognitive effort needed for comprehending an underlying semantic structure within a visualization form, and secondly the search process within a coherent context. In order to attain the latter i.e. to favour the conjunction of semantically related tags into an integrated percept, users simply could be alerted by a note when a tag cloud contains semantic clusters.

Another interesting aspect deals with the so called context dependency, referring to the phenomenon that objects with similar attributes are seen as related i.e. embedded in a common context. In line with the arguments of the Gestalt theories semantic clusters of tags could be visualized with manipulated visual features, such as differently coloured tags for each cluster within a tag cloud. If so, integrated in a certain context an item –even if not familiar – allows approaches of contextual cueing processes [5] and provides much more informational content to the user than a cumulated representation of items. For the implementation of these propositions questions of keeping system load minimal arise here to be discussed.

CONCLUSIONS

Summarizing the approaches below we see potential improvement of clustering techniques for the use on tag clouds in future research, expecting that the cognitive processes such as chunking could be engaged through visual stimulation e.g. becoming clusters signalized as entities. Based on our experience we think that semantic clustering methods are useful for classifying annotations in

social tagging systems i.e. tag clouds, as their strength lies in the procurement of meaning on a meta-level, and clustering here meets the needed standards. However they are not appropriate for all contexts [16] they still remain useful in their simplicity of visualization easy of use and to manipulate. Basically the interaction with a visualization that underlies a semantic structure demands for semantic processing by the user, i.e. the processing of the meaning, which occurs at a higher processing level than scanning a display for single lexical expressions. In our opinion we can not expect from users to autonomously search for semantic relations within such a simple visualization form, i.e. there has to be an indication for underlying structural attributes. In order to enhance the dynamic character of interaction the user could be allowed to vary the numbers of displayed clusters within a tag cloud, where he can easily switch between the different views. An option to dynamically display the evolution of tagging data over time could provide some additional insight into information content for the interested user. All together our position suggests that semantically clustered tag clouds are able to not only represent a reliable visualization form for displaying social tagging data, but to additionally enhance users´ knowledge representation and improved retentiveness of given knowledge. In this regard elaboration on the graphical appearance of tag clouds can not be seen as completed yet and provides enough legitimisation to further research.

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