Automatic Evaluation of User Adaptive Interfaces for Information Organization and Exploration

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ABSTRACT

Visualization by projection or automatic structuring is one means to ease access to document collections, be it for exploration or organization. Of even greater help would be a presentation that adapts to the user's individual way of structuring, which would be intuitively understandable. Meanwhile, several approaches have been proposed that try to support a user in this interactive organization and retrieval task. However, the evaluation of such approaches is still cumbersome and is usually done by expensive user studies. Therefore, we propose a framework for evaluation that simulates different kinds of structuring behavior of users, in order to evaluate the quality of the underlying adaptation algorithms.

Categories and Subject Descriptors

H.3.3 [**Information Systems**]: Information Search and Retrieval

General Terms

Algorithms, Measurement, Performance, Design, Reliability, Experimentation, Human Factors

Keywords

User Adaptivity, Evaluation, Information Organization, Information Retrieval, Information Exploration

1. INTRODUCTION

In many domains users are interested in information that they cannot clearly specify, e.g. by some keywords, and therefore they would prefer to use methods that support interactive organization or exploration of the information collections of interest. For example, a journalist might be researching the background of his current article or someone might look for new music that fits his taste. In such everyday exploratory search scenarios, usually large data collections are accessed. Visualization by projection, e.g. using dimensionality reduction methods, or – flat or hierarchical – structuring are means to ease these tasks. These methods are especially beneficial, if the visualization reflects the user's personal interests and thus is more intuitively understandable.

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However, except for the user's own collections, personalized structuring is not generally available. Meanwhile, several approaches have been proposed to tackle this problem, see for example [1, 3, 4, 5]. Unfortunately, the evaluation of the performance of the different methods is still a quite challenging task, which is usually done by time consuming and expensive user studies. Besides the problems of designing and evaluating a user study appropriately, it is difficult to compare the outcome of different studies for different interfaces, since very often the goals of the study, the study design and the selected user groups differ quite significantly.

In the following, we propose a framework to tackle these evaluation tasks at least for a subset of interfaces: We focus on approaches that combine the visualization of the aggregated or pre-structured content of a collection with a method to interactively change the class/tag assignment and/or the location of the object in the visual interface.

2. SCENARIO

Assume we have a user-adaptive retrieval system that is able to automatically structure a document collection, e.g., using a self-organizing map or a (hierarchical) clustering algorithm. The task of the user is to organize the collection such that it reflects his personal organization criteria. Therefore, first an initially unpersonalized structure is created which provides an overview of the collection. The user can then interact with this representation, e.g., search and access objects and move objects in the visualization that he feels should be located elsewhere. From this user interaction, an individual representation should be learned – e.g., by metric learning or learning of a simple feature weighting scheme for similarity computation [2, 3] – that represents the user's organization preferences. The process is assumed to be continuous, i.e. the collection visualization is iteratively adapted until it meets the user's structuring preferences.

2.1 Evaluation Approach

In order to evaluate such a setting, we have to simulate the way a user is selecting and moving objects. Furthermore, we have to define a target structure or projection – the "ground truth" – that we would like to obtain. One way to do so is to use a structure or projection that would be automatically derived by a (hierarchical or flat) clustering or projection process and to add "noise" features to the objects that disturb the structuring algorithm[1]. As a result of the added

[1] We have to ensure that the "noise" features induce a random structure in the collection that is not ignored as noise by the adaptation algorithm. See [6] for detailed discussion.

noise, the structuring of the objects differs from the ground truth which represents the simulated user's point of view. Changing the amount of noise (e.g. the number of noise features) controls the difference between the initial and the desired structuring and thus the difficulty of the adaptation task. The adaptation process can be described as follows:

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modify objects by adding random features
compute visualization on modified objects
repeat
  select an object o to be moved
  select new position c (place or cluster)
  move o to c
until o needs or could not be moved
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Iteratively, the user selects an object and moves it to the best position according to his ground truth similarity measure (i.e. ignoring the artificial noise features). The adaptation algorithm then updates the feature weights. This process is repeated until the selected object could not be moved because it is already at the desired position or due to possible limitations of the adaptation algorithm. Ideally, this should force the adaption process to finally ignore the artificially added noise features. This could later be analyzed, together with the quality of the finally obtained visualization, for which the one obtained without the noise features is the "gold standard". What remains to be done is to make sure that the simulated user behaves like a real user. Since we usually have to consider different kinds of user behavior, we have to simulate different prototypical users by changing selection and moving strategies.

2.2 Example

In the following, we assume a classification scenario, e.g., objects are assigned to categories (cells) obtained by a self-organizing map, which is interactively visualized. Different selection strategies can be applied for user specific selection of changing the assignment of objects to clusters or tags:

1. Greedy selection of cell and object: First, the cell with the lowest average pairwise (ground truth) similarity of the contained objects is chosen for further investigation. Within this cell, the object with the lowest average pairwise (ground truth) similarity with all other objects in the same cell is selected to be moved.

2. Greedy selection of cell and random selection of object: The cell is chosen as in the previous scenario. However, an arbitrary object is selected from this cell.

3. Random selection of cell and greedy selection of object: Here, the cell is chosen randomly whereas the object to be moved is selected from this cell by the greedy selection approach used in scenario 1.

4. Random selection of cell and random selection of object: In this scenario, both, the cell and the object to be moved from the cell, are selected randomly.

Note that scenario 3 appears to be the one that comes closest to the real use case where a user does not look into all cells before picking an object to be moved but within a specific cell tends to select the object that fits least into the cell according to his preferences. An overview of the different selection strategies is given in Table 1. We successfully performed a first experimental evaluation of such a strategy for the evaluation of an interactive retrieval system that makes use of a growing self-organizing map for structuring a text document collection [6]. A second evaluation was done for a prototypical music retrieval system [7]. Both studies could prove the usefulness of the proposed approach.

Table 1: Overview of cell selection strategies.

		cell selection	
		greedy	random
object selection	greedy	scenario 1	scenario 3
	random	scenario 2	scenario 4

3. DISCUSSION

We proposed a framework for evaluation of user adaptive systems for information organization that simulates different kind of structuring behavior of users, in order to evaluate the quality of the adaption algorithm. Even though the proposed framework is quite general, it leaves a lot room for improvement. For example, the so far proposed user strategies for object selection are only object for crisp object classification and do not yet explicitly consider visualizations where the distances between objects in the projection are relevant.

4. REFERENCES

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