An Ontology-Based Query Manager: Usability Evaluation

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Abstract. In this paper, we describe the usability evaluation experiments of an ontology-based Query manager, which is part of the SEWASIE system (SEmantic Webs and AgentS in Integrated Economies). The usability evaluation is an important step of the User-Centered Design Methodology, followed to develop the entire project that aims at enabling a uniform access to heterogeneous data sources through an integrated ontology. The Query Manager allows the user to construct the query by a diagrammatic interface generating precise and unambiguous query expressions. The main goal of our experiment is to demonstrate the ease of use of the Query Manager independently of the domain user expertise. This study confirms that the Query Manager is usable as for the end-users (domain-expert users) as for the non-domain expert users.

1 Introduction

In this paper, we describe the usability evaluation experiments of the Query Manager done in the context of the SEWASIE project. The overall project strictly follows the User-Centered Design Methodology (UCDM, see e.g. [1]) involving users from the very beginning both in the design and test steps. From an architectural point of view, the entire project aims at providing an open and distributed architecture based on intelligent agents (e.g., query agent and brokering agent) facing scalability and flexibility issues, i.e. the ability to fit in changing and growing environments and to interoperate with other systems, while offering one central point of access to the user. In the SEWASIE architecture, we highlight the major components. The **Interaction Layer** is a crucial component of the overall architecture, is composed of tools, which work together, to offer an integrated, easy to use user interaction with the system. In particular, the Query Manager allows the user to construct the query generating precise and unambiguous query expressions; moreover, the interface presentation and behaviour are entirely guided by the ontology. The **User Profile**, based on a domain-interest model, is used to offer the most appropriate set of tools depending on the user's expertise, goals, and interests. In the **Core System,** we identify, as repository of

the local ontology, the Sewasie Information Nodes (SINodes), which work to define and maintain a single administrative or logical node of information presented to the network. The brokering agent is responsible for maintaining a view of the knowledge handled by the network, as well as the information on the content of some SINodes. The query agent is the carrier of the user query from the Interaction Layer to the SINodes, and it solves a query, interacting with the brokering agent.

This paper is organized as follow, Section 2 defines the general guidelines followed in the experiment's project, Section 3 describes the Query Manager experiments, and the Section 4 collects the conclusions.

2 Usability Evaluation Methods and Guidelines

Several different definitions of usability exist (e.g. [2] and [3]). A very comprehensive definition of usability is given as "the extent to which a product can be used with efficiency, effectiveness, and satisfaction by specific users to achieve specific goals in specific environments". There are many ways to evaluate the interaction quality between the users and the system, and then there are many Usability Evaluation Methods (UEMs). A common difference among UEMs is based on skill of evaluators. In the Expert-based criteria, experts are requested to evaluate a prototype, comparing it w.r.t. existing rules and guidelines; in the User-based criteria, evaluators assess usability through real users, having them "using" a prototype. In particular, while the **Expert-based** Criteria UEMs include, among others, Heuristic Evaluation method and Expert-based method; the **User-based** Criteria UEMs includes, among others, Survey evaluation method and Observational evaluation method (we focus on Verbal and Think Aloud Protocols). For a complete UEMs description, we refer to [4].
Since our project follows the UCDM, we decide using the UEMs assessing usability through real users, in particular, we use for the Query Manager experiments the Think Aloud and Verbal Protocols, recording the tests with a video camera to valuate rigorously many pieces of information, e.g., the time a user spends to perform a task.
Several test sessions were made to evaluate the usability of the Query Manager. In particular, during the first session [5] we measured the effectiveness and the efficiency of the query-building process; in the second test [6] we performed the designed query-model complexity, the third and the fourth experiment sessions [6], we appreciated the user satisfaction after the improvements made to the Query Manager. Since the main goal of this paper is to demonstrate the ease of use of the Query Manager independently of the domain user expertise, hereinafter we refer to the last two sessions of the evaluation process, adopting the main schema described in [5]. It is composed by the following steps: user analysis, experiment design, user teaching, experiment execution, and usability analysis

3 The Ontology-Based Query Manager Usability Experiments

User Analysis. Nine people belonging to the Employees of CNA Provincial and Municipal offices class (end-users, defined in [5]) and five students of the University of Rome, are involved. In particular, while five end-users are very skilled in computer science, the other four are unskilled and they use the computer only at work. We consider the end-users, as domain expert users (DE), differently from the five students that we classified as non-domain expert (NDE).

Experiment Design. We develop different tasks (the query writing and query reading tasks); moreover, we design a model of complexity, a number of queries of increasing complexity, and a questionnaire [6] to capture relevant aspects of the interface interaction as i.e. the organization of elements on the interface.

In the model of complexity, for each query we assign the complexity tree: the nodes represent the concepts of the ontology and the weighted edges represent the relations among them. The complexity of queries is computed using this formula:

$$\sum_{l=1}^{num\_lel} l * c_{1;2} \left(\sum_{n=1}^{num\_nod\_per\_level} n * f(n,l) \right) \qquad f(n,l) = \begin{cases} av & l < l\max \\ 1 & l = l\max \end{cases}$$

where l is the number of levels, $c_{1;2}$ are the weights of edges, n is the number of nodes per level and av is the average number of nodes of the next level.

The metrics we use to describe the performance tasks are the time, the number of steps, of focus changes, of mistakes, of cancellations, of clicks on the QMP.

User Teaching. While the experiment modalities are above emphasized, here we show, in detail, the Query Manager interface [7].

Fig. 1. The Compose Panel

The query start, query composition, and query execution constitute a natural flow from the first web application tab on the left to the last one on the right hand side. The available tabs are Information Domains, Query Start, Compose, Configure, and Results (see Fig.1).

The user starts choosing the domain of interest ("Information Domains" tab) among a list of all domains available. In the tab called "Query Start" the user has to select an entry point, as the query head. After this the "Compose" tab is entered which represents the Query Manipulation Pane (QMP). The user sees the entry point and from that one she can start building the query. As soon as the query grows, the user can change the focus selecting e.g. another concept, the restriction of a property. Depending on the property selected, it can have either a concept as range or a basic data type, which can be filled with a value (restriction). When query composition is over, the user can click the "Done" button and the "Results" tab is brought to foreground. The query is shown as in the previous tab, but now the user can only select the information she is interested to know. The selections represent the columns of the query result table, configuring as desired the result table. The search can be started clicking the "Search" button and the results are displayed. The described flow can then be reversed whenever the user needs to modify the query, choose another entry point, or select a different information domain.

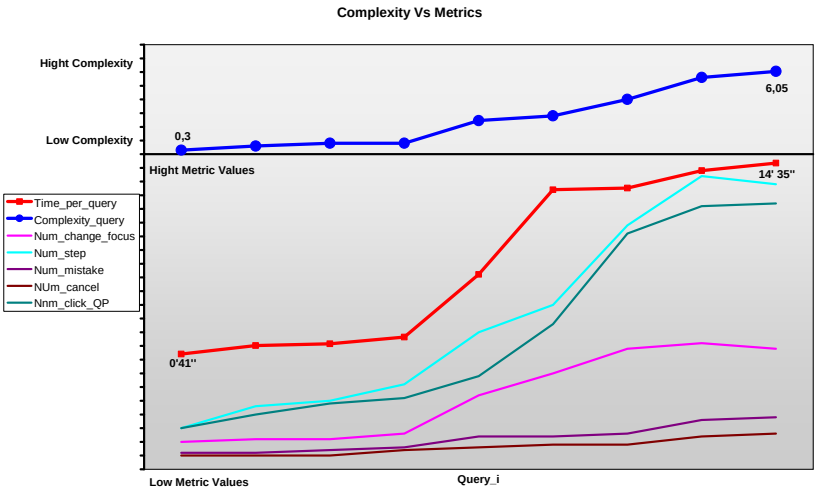

Fig. 2. Complexity vs Metrics

Experiment Execution. We meet the NDE users at the University of Rome and the DE users at the CNA of Modena. We instruct the users about modalities of the experiment and they introduce the main goal of the Query Manager without describing the functionalities of the tool; the users interact with the tool to understand how it works. During this auto-training session, we record with camera relevant performances and the users think aloud about the tool. After that, each subject is presented with tasks. While the users perform the tasks, we observe the session of test, and we record the users' utterance using a camera. Finally, we propose the designed questionnaire which is filled in by all users.

Usability Analysis. Starting from the behavior of the query complexity vs. the metrics describing the task performance (showed in the Fig.2), we highlight that the value of time spent to construct queries is independent from the domain expertise of

users. In fact, this performance measure is only function of queries complexity. In order to demonstrate that, we calculated the average values of time-spent to construct queries for the two classes of users collected in the Table 1.

Table 1. This Table contains the average values of time-spent to construct the low, the medium, and the high complexity queries for the two classes of users (NDE and DE); such results are validated with an ANOVA test.

User Class \ Complexity	**Low**	**Medium**	**High**
NDE	1' 06''	5' 22''	9' 34''
DE	0' 43''	4' 46''	9' 07''

Finally, it is worth noting that the questionnaire results highlight that the user satisfaction after achieving the specific writing tasks is independent of the user domain expertise. In fact there are non-significant gap between the values representing the average of result values of the NDE and DE users (see [6] for details).

4 Conclusions

In this paper, we have briefly described the two last sessions of usability evaluation experiments of an Ontology-Based Query Manager. The main goal of our experiment was to demonstrate the ease of use of the Query Manager independently of the domain user experience. We have observed that the amount of time spent to construct queries is independent of the domain expertise of users. The questionnaires have highlighted that the user satisfaction after achieving the specific writing tasks is independent of the user domain experience. This aspect is a very strong point, because it demonstrates that the system can be used independently of the user domain expertise, confirming that the Query Manager is usable by both end users (domain-expert users) and non-domain expert users.

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