Tatyana Yakhno
Erich J. Neuhold (Eds.)

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Volume Editors

Tatyana Yakhno
Dokuz Eylul University
Computer Engineering Department
Kaynaklar Campus, Buca
Izmir, Turkey
E-mail: yakhno@cs.deu.edu.tr

Erich J. Neuhold
Darmstadt University of Technology
Fraunhofer IPSI
Dolivostr. 15
64293 Darmstadt, Germany
E-mail: neuhold@ipsi.fhg.de

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Preface

This volume contains the proceedings of the Fourth International Conference on Advances in Information Systems (ADVIS) held in Izmir, Turkey, October, 18-20, 2006. This is the fourth conference dedicated to the memory of Professor Esen Ozkarahan, who was one of the pioneers of database machine research and a founder of database systems in Turkey.

The main goal of the conference is to bring together researchers from all around the world working in different areas of information systems to share new ideas and represent their latest results. This time we received 120 submissions from 27 countries.The Program Committee selected 38 papers for presentation at the conference.

The invited and accepted contributions covered the main research topics related to information systems such as information representation and exchange, databases and datawarehouses, Semantic Web and ontologies, data mining and knowledge discovery, information retrieval and knowledge engineering, architecture of information systems, and distributed and wireless information systems. All these topics were discussed in detail during the conference.

The success of the conference was dependent on the hard work of a large number of people. We gratefully acknowledge the members of the Program Committee, who helped to coordinate the process of refereeing all submitted papers. We also thank all the other specialists and our additional referees, who reviewed the papers.

August 2006

Tatyana Yakhno
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Processing Preference Queries in Standard Database Systems*

Paolo Ciaccia

DEIS, University of Bologna, Italy
pciaccia@deis.unibo.it

Abstract. Locating the "right" piece of information among a wide range of available alternatives is not an easy task, as everyone has experienced at least once during his/her lifetime. In this paper we look at some recent issues arising when a database query is extended so as to include *user preferences*, which ultimately determine whether one alternative is reputed by the user better than another one. In particular, we focus on the case of *qualitative preference* queries, that strictly include well-known skyline queries, and describe how one can take advantage of the sorting machinery of standard database engines to speed-up evaluation both in centralized and distributed scenarios.

1 Introduction

But society has now fairly got the better of individuality;
and the danger which threatens human nature is not the excess,
but the deficiency, of personal impulses and preferences.
John Stuart Mill

Consider the problem of finding a good hotel where to stay while spending one week in Bologna, and that the available alternatives are:

Name	Price	Stars	Rooms
Jolly	30	2	40
Continental	35	2	30
Excelsior	60	3	50
Rome	60	5	100
Holiday	40	4	20
Capri	50	2	60

Obviously, many other hotel's properties, such as phone number, number of floors, etc., are present in the Hotels relation, but you are only interested in the three ones above, namely Price, Stars, and number of Rooms, to make your choice. Which is the "best" hotel? Is it *Jolly*, which is the cheapest one? Or, perhaps, is the *Rome* hotel, which attains the maximum number of stars? Or, as your wife suggests, is *Holiday*, that is a

* Part of this work has been supported by the MIUR PRIN Project WISDOM (Web Intelligent Search based on DOMain ontologies).

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4-stars hotel, costs 20 Euros less than *Rome*, and promises to be a very quiet place with only 20 rooms?

The above is a simple, yet realistic, example of how *preferences* can easily enter into the task of extracting from a database the "best" alternative(s) to take and how they can largely influence the result of a query. In this paper we will go through some basic issues concerning how queries with preferences can be formulated and how they can be efficiently evaluated, even on standard SQL databases. We start by considering the specific case of *numerical preferences*, and then we move to the more general scenarios in which preferences are *qualitatively* represented through a preference relation. The paper concludes by addressing the problem of evaluating preference queries over peer-to-peer networks.

2 Numerical Preferences

For everything you have missed, you have gained something else, and for everything you gain, you lose something else.
Ralph Waldo Emerson

Traditionally, database queries in which the user wants to discriminate between "good" and "bad" solutions have been dealt with by resorting to *numerical scoring functions*. In its essence, the basic idea is simple: if you have a relation r with schema $R(A_1, \ldots, A_n, \ldots)$, and you want to find the best alternatives according to the values of attributes $\mathcal{A} = \{A_1, \ldots, A_n\}$, then define a function $f(\mathcal{A})$ that assigns to each tuple $t \in r$ a numerical value, $f(t.\mathcal{A})$, called the *score*, or the *utility*, of t. For instance, consider the function:

$$f_1(\text{Price}, \text{Rating}, \text{Rooms}) = 40 \times \text{Stars} - 1 \times \text{Price} - 0.5 \times \text{Rooms}$$

where the negative weights for Price and Rooms mean that lower values for such attributes are preferred. Using f_1 one obtains, say, $f_1(\textit{Rome}) = 40 \times 5 - 1 \times 60 - 0.5 \times 100 = 90$, and $f_1(\textit{Holiday}) = 40 \times 4 - 1 \times 40 - 0.5 \times 20 = 110$.[1] By the way, no other hotel in our sample relation can do better than *Holiday* (thus, your wife is fine with f_1!). Clearly, changing the weights can lead to different top-ranked results. For instance, lowering the weight of Rooms, thus the relative importance of this attribute, from 0.5 to 0.1, would make *Rome* better than *Holiday*.

A database system can naïvely evaluate a numerical preference query by first sorting data according to descending values of f and then returning only the first, top-k, tuples, where k is either specified by the user or set to a default value by the application. It is now well understood that this strategy can incur a large overhead, since it does not take advantage of the fact that only k tuples need to be produced. How the knowledge of k can be exploited for minimizing sorting costs, exploiting available indexes, and, more in general, determining an effective top-k query evaluation strategy is described in [1].

[1] For the sake of conciseness we slightly abuse the notation and write $f(\textit{Rome})$ to mean that we are applying f to the tuple whose identifier is *Rome*. Similarly, $f(t)$ is sometimes used as shorthand of $f(t.A_1, \ldots, t.A_n)$.

Specific solutions that require f to be a linear function or to be derivable from a metric distance are presented in [2] and [3], respectively.

The A_0 algorithm by Ronald Fagin [4] was the first one to provide an efficient solution for evaluating numerical preference queries in a *distributed* scenario. A_0 assumes that one has n independent "sub-systems", each managing the tuple identifier and one of the attributes in $\mathcal{A}$. Each sub-system can return its (sub-)tuples ordered according to the preference on that attribute (*sorted access*) and also supports a *random access* interface, by means of which one can obtain the needed attribute value, given the tuple identifier. The key result in [4] is that, if f is *monotone*, then one can stop performing sorted accesses as soon as k complete tuples are obtained through sorted access. This is to say that all sub-systems have returned at least k common tuple identifiers. The final result is obtained by performing random accesses for all the tuples that have been returned by at least one sub-system, and then computing their scores. Using f_1 as defined above, A_0 would determine the top-1 result of the (now vertically partitioned) Hotels relation by fetching 3 tuples from each sub-system, since at that point one hotel (*Holiday*) has been returned by all the three sub-systems.

Name	Price
Jolly	30
Continental	35
Holiday	40
Capri	50
Excelsior	60
Rome	60

Name	Stars
Rome	5
Holiday	4
Excelsior	3
Capri	2
Jolly	2
Continental	2

Name	Rooms
Holiday	20
Continental	30
Jolly	40
Excelsior	50
Capri	60
Rome	100

We note that *Capri* will not be evaluated at all, and that on this instance A_0 will *always* stop after 3 sorted accesses, since its stop condition does not consider the specific form of f_1 at all.

Although numerical preferences have been largely adopted for modelling user preferences, they have an intrinsic limit, in that *not all reasonable preferences can be expressed using a scoring function*. For instance, assume that your preferences on hotels are (P_1): "*I definitely prefer hotels with less than 50 rooms. Then, I want the minimum price and the highest quality*". Any scoring function f respecting these preferences should assign the same score to, say, *Holiday* and *Jolly*, since both have less than 50 rooms, and the first costs more but has also more stars than the second. On the other hand, it should be $f(\textit{Jolly}) > f(\textit{Continental})$, since both hotels have less than 50 rooms and 2 stars, but the first is cheaper. From this one derives that $f(\textit{Holiday}) > f(\textit{Continental})$, which is definitely not a consequence of your preferences (since *Continental* costs less than *Holiday*)!

A further caveat of scoring functions is that they force the user to compromise between different attributes, that is, to choose specific weights for each of them. However, for every possible choice of weights, it is likely that some good alternative remains hidden in the database. Moreover, weights are difficult to set up, and predicting the effects of changing one of them is a hard task, especially when the number of attributes is moderately large.