Expert front ends in the environment of multiple information sources

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Among many different aspects of information retrieval from a single source one may separate three major tasks performed by a database intermediary (either person or system): conceptual analysis of the request and formal specification of the query; planning and control of the search process; and representation of the results. The addition of at least one more information source creates one new obligatory task: data (or document) base selection, and two optional tasks: data integration from multiple sources and unification of the data (document) display formats.

The multiple database environment poses challenging tasks to expert database front-ends. In many cases the database request may be decomposed into a set of isolated sub-requests and a particular independent database should be selected to satisfy each sub-request. The existence of alternative databases leads to the task of optimization of the selection procedure, where criteria like user model, cost, level of data abstraction, may be taken into account.

In a more complicated case, the request may be integrated (i.e., several dependent databases should be accessed simultaneously in order to satisfy the request). This case brings us to the task, which may be called database navigation. Database navigation implies that a sequence of related databases should be planned: the result from one database in this sequence is used for specification of the data selection condition for the next database. The database navigation task is performed by joining cross-database files. It includes two optimization tasks: selection of the path of the cross-database join fields and selection of the file join methods. Both analytical and heuristic rule-based methods may be used for solving these problems. The database navigation task is most naturally associated with relational and hierarchical databases. It is hard to justify the database navigation task for document retrieval systems, unless we know how to extract meaningful parts from the test, or read it by machines.

There is one important aspect of a general nature in data retrieval: the user's understanding of the subject area and now the initial request is described are not necessarily directly related to the actual data files and fields. Many different views and interpretations may be built on top of the stored data. We may consider these views as virtual databases. The end user communicates with the database intermediary using the terms of the virtual database; the task of the intermediary is to map these terms into the real databases, files and fields. This task, as well as the database selection and navigation tasks, is knowledge extensive and needs expertise.

Finally, there is a result representation task. The primitive solution is physical concatenation of records retrieved from different sources. However, in most applications the unification of the data display formats adopted by different databases is required. A more complicated solution evolves semantic data fusion with resolution of conflicting data, eliminating duplicates, and extrapolating gaps. The response returned to the user may be aggregated and contain general meta-statements about the data.

The solution of building front ends capable to perform the above mentioned tasks lies in the area of knowledge based expert systems. The examination of the behavior of human experts—database analysts or information retrieval specialists—gives us a picture of what kind of knowledge and decision making procedures are required to perform the data (document) retrieval tasks. The knowledge may be classified as follows: (1) subject area knowledge, (2) user profile, (3) knowledge about database structures (data dictionaries), (4) knowledge about inter-database relations, (5) knowledge about network communication protocols, and (6) knowledge about database query languages and DBMSs.

We will present general architectural principles and design solutions of a specific expert front end called Intelligent Database Assistant (IDA) developed at GTE Laboratories. IDA is designed to retrieve data from multiple heterogeneous databases. IDA performs the tasks of automatic database selection, database navigation, formal target database query generation, and connection to different remote databases. The user may communicate with IDA, either formulating a natural language query or interacting through a menu interface. The process of converting the virtual query into the set of target database queries includes the steps of selecting the database(s), finding the optimum cross-database join fields, finding the best join algorithm, mapping from the subject area
objects and relations into the database files and fields, and shaping the query according to the syntactic constraints of the target database query languages.

IDA is built in an expert fashion: it contains a generic procedural part and a compartmental knowledge base. The knowledge base has parts representing the subject area, database management, database, and communication knowledge. The experimental version of the system is implemented on XEROX 1186 Artificial Intelligence workstation, and it accesses databases residing on remote hosts. The current implementation accesses ORACLE, DB2, and FOCUS relational databases, and also ASI-STable files.

REFERENCE