Web Page Extension of Data Warehouses

Anthony Scime
State University of New York College Brockport, USA

INTRODUCTION

Data warehouses are constructed to provide valuable and current information for decision-making. Typically this information is derived from the organization's functional databases. The data warehouse is then providing a consolidated, convenient source of data for the decision-maker. However, the available organizational information may not be sufficient to come to a decision. Information external to the organization is also often necessary for management to arrive at strategic decisions. Such external information may be available on the World Wide Web; and when added to the data warehouse extends decision-making power.

The Web can be considered as a large repository of data. This data is on the whole unstructured and must be gathered and extracted to be made into something valuable for the organizational decision maker. To gather this data and place it into the organization's data warehouse requires an understanding of the data warehouse metadata and the use of Web mining techniques (Laware, 2005).

Typically when conducting a search on the Web, a user initiates the search by using a search engine to find documents that refer to the desired subject. This requires the user to define the domain of interest as a keyword or a collection of keywords that can be processed by the search engine. The searcher may not know how to break the domain down, thus limiting the search to the domain name. However, even given the ability to break down the domain and conduct a search, the search results have two significant problems. One, Web searches return information about a very large number of documents. Two, much of the returned information may be marginally relevant or completely irrelevant to the domain. The decision maker may not have time to sift through results to find the meaningful information.

A data warehouse that has already found domain relevant Web pages can relieve the decision maker from having to decide on search keywords and having to determine the relevant documents from those found in a search. Such a data warehouse requires previously conducted searches to add Web information.

BACKGROUND

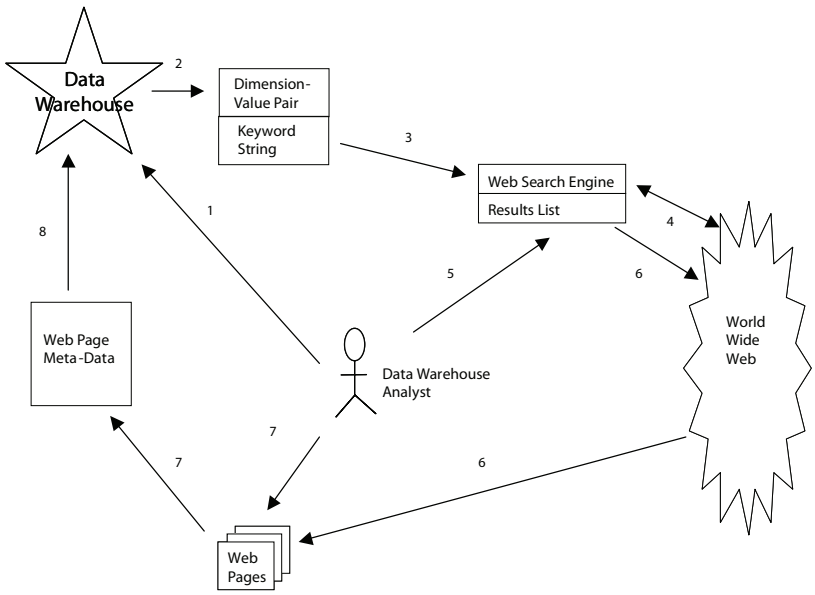
To provide an information source within an organization's knowledge management system, database structure has been overlaid on documents (Liongosari, Dempski, & Swaminathan, 1999). This knowledge base provides a source for obtaining organizational knowledge. Data warehouses also can be populated in Web-based interoperational environments created between companies (Triantafillakis, Kanellis & Martakos, 2004). This extends knowledge between cooperating businesses. However, these systems do not explore the public documents available on the Web.

Systems have been designed to extract relevant information from unstructured sources such as the Web. The Topicshop system allows users to gather, evaluate, and organize collections of Web sites (Amento, Terveen, Hill, Hix, & Schulman, 2003). Using topic discovery techniques Usenet news searching can be personalized to categorize contents and optimise delivery contents for review (Manco, Ortale & Tagarelli, 2005). Specialized search engines and indexes have been developed for many domains (Leake & Scherle, 2001). Search engines have been developed to combine the efforts of other engines and select the best search engine for a domain (Meng, Wu, Yu, & Li, 2001). However, these approaches do not organize the search results into accessible, meaningful, searchable data.

Web search queries can be related to each other by the results returned (Wu & Crestani, 2004; Glance, 2000). This knowledge of common results to different queries can assist a new searcher in finding desired information. However, it assumes domain knowledge sufficient to develop a query with keywords, and does not provide corresponding organizational knowledge.

Some Web search engines find information by categorizing the pages in their indexes. One of the first to create a structure as part of their Web index was

Figure 1. Data warehouse Web extension architecture



Yahoo! (http://www.yahoo.com). Yahoo! has developed a hierarchy of documents, which is designed to help users find information faster. This hierarchy acts as a taxonomy of the domain. Yahoo! helps by directing the searcher through the domain. Again, there is no organizational knowledge to put the Web pages into a local context, so the documents must be accessed and assimilated by the searcher.

DynaCat provides knowledge-based, dynamic categorization of search results in the medical domain (Pratt, 1999). The domain of medical topics is established and matched to predefined query types. Retrieved documents from a medical database are then categorized according to the topics. Such systems use the domain as a starting point, but do not catalog the information and add it to an existing organized body of domain knowledge such as a data warehouse.

Web pages that contain multiple semi-structured records can be parsed and used to populate a relational database. Multiple semi-structured records are data about a subject that is typically composed of separate information instances organized individually, but generally in the same format. For example, a Web page of want ads or obituaries. The first step is to create an ontology of the general structure of the semi-structured data. The ontology is expressed as an Object-Relationship Model. This ontology is then used to define the parsing of the Web page. Parsing into records uses the HTML tags to determine the structure of the Web page, determining when a record starts and ends. The relational database structure is derived from the ontology. The system requires multiple records in the domain, with the Web page having a defined structure to delimit records. However, the Web pages must be given to the system, it cannot find Web pages, or determine if they belong to the domain (Embley et al., 1999).

The Web Ontology Extraction (WebOntEx) project semi-automatically determines ontologies that exist on the Web. These ontologies are domain specific and placed in a relational database schema. Using the belief that HTML tags typically highlight a Web page's concepts, concepts are extracted, by selecting some number of words after the tag as concepts. They are reviewed and may be selected to become entity sets, attributes or relationships in a domain relational database. The determination is based on the idea that nouns are possible entity and attribute types and verbs are possible relationship types. By analyzing a number of pages in a domain an ontology is developed within the relational database structure (Han & Elmasri, 2004). This system creates the database from Web page input, whereas an existing data warehouse needs only to be extended with Web available knowledge.