A Knowledge Representation Technique for Intelligent Storage and Efficient Retrieval using Knowledge based Markup Language

A. Meenakshi, R. Aghila, P. Suganthi and S. Kavya

1 Department of Information Technology, K.L.N. College of Information Technology, Sivagangai, Madurai – 630612, Tamil Nadu, India; rajeshmeenakshi1@gmail.com
2 Department of Computer Science and Engineering, K.L.N. College of Information Technology, Sivagangai, Madurai – 630612, Tamil Nadu, India; suga.pathma@gmail.com, aghila25481@rediffmail.com
3 Department of Computer Science and Engineering, K.L.N. College of Information Technology, Sivagangai, Madurai – 630612, Tamil Nadu, India; kavyasme@gmail.com

Abstract

**Background:** Knowledge Engineering is an engineering discipline that involves integrating knowledge into computer systems in order to solve complex problems normally requiring a high level of human expertise. Knowledge Engineering is the technique applied by knowledge engineers to build intelligent systems: Expert Systems, Knowledge Based Systems, Knowledge based Decision Support Systems, Expert Database Systems etc.

**Methods:** This work builds a Knowledge Base using Knowledge Base Markup Language (KBML) which is derived from XML architecture. All the Meta information is stored in a KBML file whereas the actual data may be available in any data source.

**Findings:** This system also provides facilities to search/add the contents to and from the Knowledge Base dynamically. The experimental results show that the system provides a high precision, recall and f-measure values which proves the high relevance of the retrieved values.

**Applications:** Builds an intelligent system for Edaphology domain which concerns with plants and its related soil features. It provides the edaphologists and agriculturists by retrieving relevant and useful information about the plants. This is of huge importance as plant growth and yield are directly dependent on the soil features.

**Keywords:** Data Source, Edaphology, Knowledge Base Markup Language, Meta Information

1. Introduction

Living in a fast moving world, it is natural to expect things faster. Similarly, in our quest for data search we need fast and efficient retrieving methodologies. With the evolution of new technology and new products in various domains, researchers are focusing more on exploring new techniques of storage, managing and retrieval of data and knowledge from a repository which has been acquired from various sources. Only having a repository of data or efficiently organizing the data cannot guide decision makers or management to make accurate decisions as humans do. The best approach is to integrate and manage the data in the form of knowledge. Retrieving of exact knowledge through online is increasing and it requires more amount of time to retrieve from different data sources and creating knowledge from information available. Knowledge searching through mobile phones does not exist through SMS. To defeat these anomalies, we have built a Knowledge Base using Knowledge Base Markup Language (KBML) which is derived from XML architecture. This system also provides facilities to
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search/add the contents to and from the Knowledge Base though mobile phones and Windows Mobile phones without using GPRS.

The aim of this work is to build a secured intelligent storage mechanism, which can store the information in the form of knowledge using the knowledge based representation technique with the help of KBML tags, also the retrieval process is also simplified as it can just refer the KBML file which contains the Meta information about the Knowledge which is going to be stored in distributed data sources.

1.1 Knowledge System to Soil Database
Edaphology is a domain that is bothered with the influence of soils on living things, notably plants. The term is additionally applied to the study of soil influences. An agricultural soil science explores soil's physical and chemical properties to search out the plants acceptable for cultivation. The most common pitfall information is the lack of standardization of the nomenclature and of the data acquisition procedures. The user is not required to know fully the model to interact with the system. The retrieval of a large amount of the same type of data is very efficient, even though the user need not know completely the database schema to formulate the queries. Here the decision support systems are used in arriving at decisions on what kind of plants can be that grown in soil, based on the domain information given by the user.

The dataset comprises of various plant names and soil attributes obtained from various Edaphologists and agriculturists and these are made used in evaluating the processed system. The database considered for the consists of 49 different types of plant species and for each plant species the geological taxonomy properties were represented in this database. The 49 different types of plant species represented in this database were Prosophis juliflora, Cyprus sp, Hariyali, Indigo plant, Palmyra, Eucalyptus, Neem, Tamarind, Acacia, Ipomoea, Thespesia populanea, Vagai, Eucalyptus, Vetiver, Banyan, Calotropis, Lantana camera, Ammania baccadera, Astracantha longifolia, Cyanodon, Thespesia, Cassia, Acacia Arabica, Grasses, Wetland weeds, Croton sparciflorus, Gomphrena spp, Pongamia glabra, Tricalli, Jatropha, Bonassus, Agave, Ferns, Rich evergreen shrubs and bushes, Cactus, Tephrosia purpurea, Pungai, Manjanathi, Cassia auriculata, Cyprus rotantus, Dates, Prosophis, Delonix regia, Karuvalam, Argimone, Calotropis, Lantana, Pungam, Sandal. The geological properties suitable for 49 different plant species were represented in the database. They were clay, Granite, Laternite, sand, Western Ghats, Eastern Ghats. Typically, the taxonomy properties of each plant species were represented here such as Fine, montmorillonitic, isohyperthermic, noncalcareous, Chromic Haplusterts, Typic Rhodustalfs, Mixed, Typic Haplustepts, Clayey-skeletal, Loamy, Lithic Ustorthents, Typic Ustipsamments, Vertic Haplustepts and montmorillonitic. The various colors of the soils were represented here in this database such as grayish brown, Red, very dark grayish brown, Yellowish brown, Brownish yellow, Dark yellowish brown, Dark...
Brown, Reddish brown, Dark Reddish brown, Brown, Pale Brown, Light Brownish Grey, Light gray to gray, Grayish brown, Very pale brown, White, Light brownish gray, Dark red, Yellowish red, Light red, Dark grayish brown, Brown to dark brown, reddish yellow, Brown, very dark brown, strong brown. In this database, the size of the particles that make up the soil such as clay, silt and sand are listed for each color of soil separately. For each color, the depth and the mineral content of soil such as PH, EC, Ca, Mg, Na, K, P2O5, and K2O are represented in this database which will provide nutrients to plants. The database is structured into parent plant database and child description database as mentioned in Figure 1 and Figure 2.

1.2 Existing System and Its Limitations

In any knowledge based system, the first step is to model the domain knowledge collected from experts, so as to enable effective retrieval of knowledge\textsuperscript{13,14}. Some of the existing knowledge based systems have employed the data structure termed as $K$-graphs, tree data structure for representing the expert knowledge in their domain of interest\textsuperscript{15,16}. The $K$-graphs was able to represent the expert knowledge about domains in problem-solving, minimizing the semantic loss that would occur if production rules were used instead\textsuperscript{17,18}. A tree data structure very much resembles a graph, and it can also be defined as an acyclic connected graph where each node has a set of zero or more children nodes, and at most one parent node\textsuperscript{19,20}.

Existing Data Structure suffers from the following limitations:

- Ambiguous design in storage of data.
- Slower performance.
- Insecure data storage.
- Complexity in retrieving the appropriate data.
- Increased Space and Time Complexity.

The aim of our proposed system is to design a new knowledge representation technique for Edaphology which eliminates the drawbacks of existing storage techniques and to build an efficient system with high relevant retrieval and with minimum space and time complexity.

2. Proposed System

2.1 Conversion of Meta Information in KBML

This work performs the searching of knowledge across several data sources. The searching facilitates the user to select particular data sources from a list and to get the search result.

During the search process, the existence of the search string is first looked up into a KBML file. This KBML file has the Meta information about all the knowledge in a
particular data source, the KBML file which is a feature, enabled with derived XML architecture so that our goal of efficient retrieval of exact data is achieved. Information is stored in form of knowledge (KBML Tags).

Security is a factor of major concern in any mode of data storage, so we take immense care of this stored information. Here, each knowledgebase is provided with a unique ID, which is stored in an encrypted format. When a search is made, the title is first picked and the corresponding IDs are used to navigate for retrieving the description. If the search keyword is not found in the KBML file, the control is passed to search the knowledge in the database for retrieval.

End-users may wish to create knowledge when the particular search is not present. In such cases, users should create an account and enter the knowledge along with the title and description. At this stage, a KBML file is created for this newly created knowledge with all its constraints.

2.2 Enhanced Knowledge Base Representation

Our vision of efficient retrieval comes true by the fast fetching of information stored in the form of knowledge. This system builds a Knowledge Base using Knowledge Base Markup Language (KBML) which is derived from XML architecture. All the Meta information is stored in a KBML file whereas the actual data may be available in any data source. Knowledge sharing is achieved, as this system can retrieve information from heterogeneous data source through this KBML file. This system also provides facilities to search/add the contents to and from the Knowledge Base though mobile phones and Windows Mobile phones without using GPRS.

2.3 Derivation of KBML using XML

Extensible Markup Language (XML) is a fast emerging technical tool. It has several advantages to its name. The limelight feature of “user defined tags” makes this technology worth its salt.

The sample structure of KBML is represented in Figure 3. We use the structure of XML and derive our KBML file which is purely knowledge based. XML has a predefined structure whereas KBML has exclusively user defined structure; this is the major reason why we prefer KBML to XML. Apart from this KBML has a hierarchical structure which superimposes the characteristics of its predecessor XML. The exciting feature that KBML possesses is user can add his own information and by giving it with a unique id, which serves as a Meta information. This forms a part of the knowledge store that can be modified accordingly. Search of information which is our ultimate aim is also made easy.

2.4 KBML in Edaphology

The KBML file is used to store the Meta information about the soil corresponding to each plant. The edaphology deals with the plant and its classification, here edaphology is a best suited case where we can impart the Knowledge base to represent the details of plants and its description as knowledge and this process is enhanced by the use of KBML file which contains the Meta information of the respective data stored in it. In order to avoid the complexities in using the tree structure we go for KBML. The sample KBML file created by our system is as shown in Figure 3.

2.5 Dynamic storage: Adding the Knowledge

It is a key feature of the project that makes our database a dynamic one. Knowledge can be represented in any form such as text, documents etc. When a particular
search is out of reach of the data sources, users may create their own knowledge to the data source. To facilitate the users, a wizard (as shown in Figure 4) is designed which contains the simple steps to add the knowledge to the specified Knowledge base and the corresponding data source, provided the users are already registered. The system is also extended to add the user's knowledge to the knowledge base through Mobile phones. Through the use of this feature our project seems to be “user-friendly”.

Figure 4. Adding a parent plant record.

2.5.1 Updating the Knowledge

Day in and day out we have new information. Any knowledge created is not constant, changes are mandatory so as to maintain the efficiency. Changes or updating are done when new techniques are introduced. To carry out these updates, users are allowed to update the existing knowledge that helps other searchers to gain knowledge. Also we can comment/ question on the particular knowledge of the user.

2.5.2 Retrieval: Searching The Knowledge

It is the main part of the project, by which the data that a user needs is retrieved unto him. It is easier for us to search the relevant information which is available from the selected knowledge base through windows/mobile applications. When the user searches a particular knowledge, they are allowed to select knowledge base and data sources from which they need to search the knowledge from a varied variety of options. All the relevant results are displayed as a list (as shown in Figure 5) and the knowledge is obtained by navigating to the specified data source.

Figure 5. Plant output based on the input values.

3. Experimental Results

Users have the option of adding data in the already existing data base. While adding data about a plant the fields like name of the plant, taxonomy, geology should be filled in the appropriate text boxes is as given in the form of Figure 6.

Figure 6. Add data source.
3.1 Result Analysis

For analyzing the performance of the implemented systems, six input queries (shown in Table 1) are used. The results obtained in each system for the six input queries are listed. The results are then analyzed using evaluation metrics.21

The number of plants retrieved for query 1 to query 6 is mentioned in the Table 2.

| Table 2. Number of plants retrieved |
|---|---|---|---|---|---|---|
| Query 1 | Query 2 | Query 3 | Query 4 | Query 5 | Query 6 |
| No. of Plants Retrieved | 11 | 15 | 10 | 13 | 12 | 10 |
The evaluation metrics used are precision, recall, F-measure, ranking efficiency, number of plants retrieved, memory usage and response time.

- Table 3 shows the evaluation metric values of precision, recall and F-measure.
- The system yields good performance values with respect to precision, recall and F-measure.
- The maximum values of precision, recall and F-measure reaches one which shows the effectiveness of the proposed system.
- Good precision, recall and F-measure values validate the effectiveness of the system.
- Table 4 shows the ranking efficiency obtained for the system.
- The ranking is found out for two conditions. One is when top 5 results are taken and second, when top 10 results are taken.
- In both conditions, system yields good results by achieving good efficiency values.
- The maximum values in both cases come about one.
- Average value in case 1 is about 0.46 and in case 2, it is about 0.41. Total average is about 0.435.
- The values indicate the validity of the system.
- Table 5 gives memory usage and response time achieved by the system.
- The system consumed an average of 261 Kb per query with a minimum of 111 Kb for the 2nd query.
- Average response time came about 1060 ms with a minimum response time of 1015 ms for the 1st query.
- High number of plants retrieved, low memory usage and low response time further demonstrates the effectiveness of the system.

### Table 3. Precision, Recall and F-measure values of the tree based system

|   | Precision | Recall | F-Measure |
|---|-----------|--------|-----------|
| Q₁ | 0.4       | 0.4    | 0.40      |
| Q₂ | 1.0       | 0.2    | 0.33      |
| Q₃ | 1.0       | 0.2    | 0.33      |
| Q₄ | 1.0       | 0.2    | 0.33      |
| Q₅ | 1.0       | 1.0    | 1.00      |
| Q₆ | 0.83      | 1.0    | 0.907     |

### Table 4. Ranking efficiency values of the tree based system

|   | Ranking (top 5) | Ranking (top 10) |
|---|----------------|------------------|
| Q₁ | 0.4            | 0.5              |
| Q₂ | 0.2            | 0.1              |
| Q₃ | 0.2            | 0.1              |
| Q₄ | 0.2            | 0.2              |
| Q₅ | 1              | 1                |
| Q₆ | 1              | 0.9              |

### Table 5. Memory utilized and response time values

|   | Memory utilized (kb) | Response time (ms) |
|---|----------------------|--------------------|
| Q₁ | 480                  | 1015               |
| Q₂ | 111                  | 1041               |
| Q₃ | 233                  | 1072               |
| Q₄ | 287                  | 1065               |
| Q₅ | 215                  | 1063               |
| Q₆ | 210                  | 1075               |

4. Conclusion and Future work

Development of the Knowledge Base Markup Language (KBML) is used to improve the performance of the search process for Edaphology domain by selecting data sources. Each data source contains a set of knowledge descriptions to serve the requests. Using this, the search was made efficient. With world moving too fast all that a user expects is an efficient time constraint and we have strived to impose the same and have achieved a reasonable success. The precision, recall and f-measure values shows the high relevancy of retrieved values.

Also, in future the computation complexity can be further reduced with the help of effective searching and retrieval methods, leading to decrease in the time delay and improving search accuracy. Decreasing the time delay and improving search accuracy also would improve the system. Better knowledge management can be brought in by incorporating latest smart concepts into data structures. Also, better information retrieval employing latest techniques can also improve the system performance.
5. References

1. Qwaider W Q. Integrated of knowledge management and E-learning system. International Journal of Hybrid Information Technology. 2011; 4(4):55–70.
2. Ramya ST, Rangarajan P. Knowledge based methods for video data retrieval. International Journal of Computer Science & Information Technology. 2011; 3(5):167–75.
3. Ralph LL, Ellis TJ. An investigation of a knowledge management solution for the improvement of reference services. Journal of Information Technology and Organizations. 2009; 4:17–38.
4. Moayer S, Gardner S. Integration of data mining within a strategic knowledge management framework. International Journal of Advanced Computer Science and Applications. 2012; 3(8):67–72.
5. Ben-Zvi T. The efficacy of business simulation games in creating decision support systems. International Journal of Decision Support System. 2010; 49(1):61–69.
6. Eldin SS, Ahmed ASE, Elsayed A. Using of conceptual representation approach for query expansion in information retrieval. International Journal of Engineering & Computer Science. 2012; 12(4):55–65.
7. Anyanwu MN, Shiva SG. Comparative analysis of serial decision tree classification algorithms. International Journal of Computer Science and Security. 2009; 3(3):230–40.
8. Kebede G. Knowledge management: An information science perspective. International Journal of Information Management. 2010; 30(5):416–24.
9. Mollahosseini A, Barkhordar M. Supplier knowledge management for supplier development. International Journal of Business Information System. 2010;14(4):17–26.
10. Kohail SN, El-Halees AM. Implementation of data mining techniques for meteorological data analysis. International Journal of Information and Communication Technology Research. 2011; 1(3):96–102.
11. Khattak AM, Khan AM, Lee S, Lee YK. Analyzing association rule mining and clustering on sales day knowledge with XL miner and weka. International Journal of Knowledgebase Theory and Application. 2010; 3(1):13–22.
12. Kumar V, Rathee N. Knowledge discovery from database using an integration of clustering and classification. International Journal of Advanced Computer Science and Applications. 2011; 2(3):29–33.
13. Kulkarni MSV. Mining knowledge using decision tree algorithm. International Journal of Scientific & Engineering Research. 2011; 2(5):1–6.
14. Kavitha V, Punithavalli M. Clustering time series data stream – a literature survey. International Journal of Computer Science and Information Security. 2010; 8(1):29–37.
15. Nie G, Rowec W, Zhanga L, Tiana Y, Shi Y. Credit cards churn forecasting by logistic regression and decision tree. International Journal of Expert Systems with Applications. 2011; 38(1):15273–85.
16. Vohra R, Das NN. Intelligent decision support systems for admission management in higher education institutes. International Journal of Artificial Intelligence & Applications. 2011; 2(4):63–70.
17. Patil RA, Ahire P G, Patil PD, Golande AL. Decision tree post processing for extraction of actionable knowledge. International Journal of Engineering and Innovative Technology. 2012; 2(1):152–55.
18. Tanwar P, Prasad TV, Datta K. Comparative study of three declarative knowledge representation techniques. International Journal on Computer Science and Engineering. 2010; 2(7):2274–81.
19. Rao VS. Multi agent-based distributed knowledge mining: an over view. International Journal of Reviews in Computing. 2010; 3:83–92.
20. Silwattananusarn T, Tuamsuk K. Data mining and its applications for knowledge management. International Journal of Data Mining & Knowledge Management Process. 2012; 2(5):13–24.
21. Venkatesan E, Velmurugan T. Performance analysis of decision tree algorithms for breast cancer classification. Indian Journal of Science and Technology. 2005; 8(29):1–8. doi: 10.17485/ijst/2015/v8i1/84646.