Transformation of Semantic Networks into Frames

Sajid Ullah Khan

***Abstract*—Decision Support Systems (DSS) is an intellectual structure projected to help decision makers in identifying problems and the capability to solve problems accurately within the time deadlines for successful business operations. Data Warehouse (DW) is one of the solutions for decision-making process in a business organization. But it only stores data for managerial purpose and has no smart mechanism to augment decision making. Problems arise in decision support systems during access of data and information from different sources such as semantic networks, decision tables, decision trees, scripts etc and broadly integration of the data for frame based expert systems. The author has proposed a solution for transformation of one of the knowledge representation technique that of semantic network into more suitable knowledge representation format that of frames structure. The Proposed solution is further explained and proved by a case study. A simulator is developed to implement the proposed transformation solution producing the preferred output that of frames structure from the respective semantic network as input to the simulator. The proposed solution in this research is new bearing towards enhancement in decision support system and it is uncomplicated for the frame based expert systems to retrieve data and information. It leads to provide accurate and timely decisions for any business.**

***Index Terms*—Data warehousing, expert system, decision support system, semantic network, frames, knowledge representation, data extraction.**

I. Introduction

Since last few years, modern computer technologies support human in their efforts to better understand situations. These technologies are capable for dissemination of information around the organization.

Various technologies support the data management process. It includes decision support systems (DSS), information technology (IT), artificial intelligence (AI), expert systems [1]. Other technologies that support the data management are audio conferences, document management system, online databases, collaborative work support tools, corporate yellow pages and experts, data mining tool , email, help desk applications, video conference, portals, information retrieval engines [2]. Usually knowledge base sophisticated systems use smart search agents, case-based reasoning and neural networks used for data mining. The detail of some of important background study terms is discussed.

A. Business Intelligence

The technical procedure of business intelligence involves acquiring of data, from different kind of data sources which helps in decisions making.

According to C.M, Olszak "Business Intelligence is a set of concepts, methods and processes that aim at not only improving business decisions but also at sustaining realization of an enterprise's strategy", [3]. The process of business intelligence can be made more attractive with the help of such techniques and technologies of data warehouse [1].

B. Data Mining

The process of discovering desired data in the existing data is known as data mining. The process that uses various techniques such as statistical, mathematical, artificial intelligence and machine learning techniques to discover desired data from huge databases.

C. Artificial Intelligence

R. Knight, E. Rich defined AI as "It is the study of how to make computer do things which, at the moment, people do better" [4].

AI is playing vital role in the applications of new technological era. It enhances the capabilities of existing applications and databases by adding logic, knowledge and reasoning [5].

D. Expert System

It is a computer application which aims to replicate the reasoning of an expert in solving fairly complex real-world problems where lessons learnt from experience play an important part [6]. The system provides guidelines as an advisor about a specific problem [1].

Expert systems have few major components which are knowledge base, inference engine, and user interface. Knowledge base consists of fact and rules to solve the problems [7].

II. Problem Statement

Data warehouse is storage medium for a huge quantity of data in data warehouse. Data is gathered from different operational system and loaded into data warehouse using different ways. Then different reporting tools and templates are used to access this stored data [8], [18]. In large organization there is a requirement for very fast, timely and accurate decisions. Data warehouse is not enough to support an organization or any business activity to support its fast procedure of management and quick decision making because it has no intelligent mechanism for decision making. Such type of shortcomings is due to the dummy nature of a data warehouse.

Data is available in operational data stores in different representation schemes such as semantic network etc.

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Problem arises during retrieving of knowledge from different sources like semantic network, decision table, decision tree, scripts etc due to their ambiguous natures [8]. The transformation from different data representation formats in to frames structure is the need of the friendly retrieval of data from data sources in to frame based expert systems.

In this research work, the area of transformation of one of the data representation scheme such as semantic network in to frames structure is focused. It facilitates the frame based expert systems projected to enhanced decision support systems. As we know that different kind of organizations such as business organizations, colleges and universities are the main active components of society for the constant recreation of meaningful and quick decision to their daily processes. In order to improve the decision support system for an organization, a case study is conducted for an assumed university setup. It links its different processes and relationships in the form of semantic network representation scheme.

III. Literature Review

A. Introduction

Data warehousing, knowledge base system, decision support systems, expert systems, inference engine, data mining, data representation and data extraction are some of the required terms to review as a literature to understand the problem domain.

There is lot of research going on in the field of data warehousing and mining, but it seems that the area of transformation of data sources into frames for the frame based expert systems has been little focused. It can play an important role to enhance the existing decision support systems by modifying the area. Data representation and management is the sub area of artificial intelligence. Knowledge acquired from the experts or from a set of data must be represented in a format that is understandable by human beings and executable on computers. Then this knowledge is used in computer programs to derive information, make future planes and solve the problems concerning human expertise.

B. Background

There are different ways to represent data or knowledge. Some of the important data representation schemes are discussed.

1) Decision tree

Decision trees are hierarchical representation of knowledge relationships composed of nodes and links. Nodes represent goals while links are used for decisions. In [8], decision trees can simplify the knowledge acquisition process and are more natural than rule knowledge representation techniques.

2) Decision table

Decision tables are used to store data and knowledge in tabular form using rows and columns [14]. They are the best choice to represent the data and knowledge as they are quick and easy to understand and program [8].

3) Scripts

A script is useful knowledge representation structure design to represent activities rather than objects [15]. It is particularly help full in stereotypical situations and daily base event that people face every day in their lives and describes the sequences of events [8].

4) Use cases

It is used to identify and partition system functionality and separate system into two components i.e. actors and use Cases. It will supply stimuli to that part of the system, and must receive outputs from it [16].

5) Relational database

"A relational database is a collection of data items organized as a set of formally described tables from which data can be accessed or reassembled in many different ways without having to reorganize the database tables" [17].

6) Production rules

In production rules, knowledge is represented in condition- action pairs [8]. Whenever, IF condition occurs THEN some action will be performed.

7) O-A-V triplet

O-A-V is knowledge representation technique used to embody object, attributes, and values (O-A-V triplet). Object is a physical concept for which we are storing information. Every object has set of attributes. Values are the measures of attributes.

8) Knowledge map

Knowledge map is the visual representation of tacit and explicit knowledge such as experiences, methods, and process, judgments within the organization. It includes circle or images connected by lines, each labeled, to form the hierarchical view of knowledge [1].

9) Semantic networks

Semantic networks often used in artificial intelligence systems. It depicts knowledge graphically using nodes and links (arcs or arrows) connecting nodes. Nodes symbolize concepts or object, while links are correspond to the relationship between the nodes. Some of the common relationships used by arcs are "is-a" or "has-a" to show inheritance and composition respectively [8].

10) Frames

Frames were proposed by Marvin Minskey in 1970. It is a data structure used to store special hierarchical structural knowledge of a particular object. Frames structure illustrates the knowledge structure to the point and brief due to its natural capability [8]. It is widely used in applications of objects oriented programming for artificial intelligent and Expert System [9], [11]. We already have realized the limitation of the accessible data formats such as semantic networks due to its ambiguous nature the author is going to purpose solution to the problem.

IV. Focus of the Research Work

The study includes development of system architecture such as the implementation of transformation layer of the proposed system architecture with its accurate validation,

conducting a case study over the architecture and development of a simulator in order to implement the proposed solution with the help of existing tools.

V. Proposed Solution

After studying the existing complexity, author of the research work is going to eliminate the ambiguities in the existing perception of knowledge from semantic network, it is transformed in to frame structure with the help of proposed solution.

In this research, efforts are made to introduce a proposed solution. The reasons behind conversion from the semantic network into frames are that, frame is more flexible than semantic network in the sense that more slots are there in a frame to store data, and frame represents data as an integrated form as compared to a semantic network[8]. Once we obtain knowledge in a frames format, it is now easy to make rule based reasoning for decision support system to explore different decisions. The knowledge is more flexible in frame format comparatively to the semantic network knowledge representation technique. The proposed solution consists of proposed system architecture and proposed transformation algorithm.

A. System Architecture

The proposed architecture of the system consists of three main layers presentation layer, business logic layer and transformation layer. It shows the system's working flow. It leads the stages of the transformation from semantic networks into the output of frames structure. After generation of frames they are stored in frame repository. The functionality of the proposed system architecture is to produce frames structure from the semantic networks in order to facilitate frame based expert systems. Once data is available in nodes and arcs (semantic network), it has to be leveraged to positively affect the business. So decision support system can be enhanced in such a way like any other asset. Retaining and applying such type of a system architecture in the situations of data availability enables a business administration to know what to do, how to do and when and where to do it? Hence to augment frame based expert systems we need a new more flexible data representation format such as frame which stores data in more flexible and descriptive format.

B. Transformation Algorithm

The transformation layer of the proposed system architecture applies the proposed transformation algorithm. Transformation algorithm is the process of transforming data or knowledge from one form of data source into another form of data source e.g. semantic network into frames. It takes input from the user in the form of SN through presentation layer. The business logic layer receives the input and forwards it to the transformation layer. Transformation Layer will then perform the following steps:

Pseudo code

Input: Semantic Network
Output: Frame Structure
BEGIN
1- Get a node from SN and store into node1.Write node1 under heading "Frame Name" in Frame Repository.
2- Get attributes and procedures of node1
If found
Write attribute(s) under heading "attribute(s)" and procedure under "procedure"
heading in Frame repository.
End if
3- If the "node1" is linked with the other node "node2" then
A. Report relationship found
B. If label between node1 and node2 is *"is a"* then
[Generalization / is-a / a kind of]
a) Report inheritance found
b) If node1 is "to" node2
Then
i. Super class = node2
ii. Relationship = node1-node2
iii. Write node2 under heading "super class(s)" and node1
If not listed in Frame Repository.
Else [node1 is "from" node2]
i. Subclass =node2
ii. Relationship = node1-node2
iii. Write node2 under heading "sub classes(s)" and if not listed in Frame Repository.
End if
Else if label between node1 and
node 2 is "a-part-of or has-a" then
[Aggregation / a-part-of / part-whole]
a) Report aggregation found
b) If node1 is "to" node2 then
i. Relationship = node1-node2
ii. Write node 2 under heading "aggregation"
if not listed in Frame Repository.
Else [node1 is "from" node2]
i. Relationship = node1-node2
ii. Write node2 under heading "aggregation"
if not listed in Frame Repository.
End if
Else if label between node1 and node 2 is "owns/belong-to/others" then
[Association / owns]
a) Report association found
b) Relationship = node1-node2
Write node2 under heading "association"
if not listed in Frame Repository.
End if [End of main if]
4- Repeat step 3 for all the nodes connected with node1
[End of process for one knowledge node]
5- Do step 1- 4 for all the nodes in SN.
End

VI. Case Study

A case study is conducted to verify the functionality of the proposed system. Organizational knowledge is the kind of knowledge which is the overall dealing of an institution in every direction. its pros and cons, the markets it serves, and the factors significant to organizational success [13].

Author wants to improve the perception of the students due to their suitable and timely decisions in universities. It detects out adverse conditions towards success and suggests corrective activities. The input for that data is in the form of a semantic network represented in the Fig. 1.

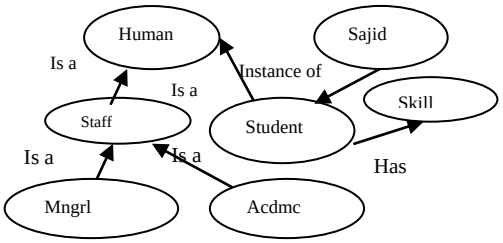

Fig. 1. Semantic network.

The knowledge is extracted from semantic network and by applying the proposed algorithm it generates list of frames along with attributes, procedures and their relationships and save all output in context of frames. It declares the status of every node in separate object frame or class. It represents a separate object frame as a class along with its attributes, sub class, super class, and specific relation type with each class (object frame), its attributes and procedure.

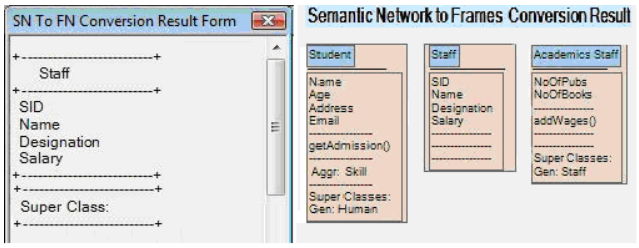

Fig. 2. Frames preview.

The recorded semantic network produces the desired resulted frames preview for the generated frames after conversion procedure. A single frame consol preview and different frames preview is shown in Fig. 2.

VII. Simulation of the Proposed Solution

An application is developed to perform the process of conversion of knowledge from semantic network into frames structure. The application provides user friendly interface to collect input values and capable to produce the desired output. The tools suggested for the simulation process are database tools and application tools. The simulator for the proposed solution consists of semantic network control panel and frames control panel which handles the input and the desired outputs respectively. Semantic network control panel enables the user to enter all the nodes inter linked, their attributes and relationships among the nodes interlinked. The procedures and relationship type for nodes can be modified. Every node is stored in repository under the heading of a specific frame name. It allows any node either existing or new node to inter link with other nodes. It also has choice to declare a specific node as a sub class or super class through selection between two choices mentioned that of "to" and "from". It is capable to identify the different kinds of a relationship among different nodes such as, aggregation, generalization and association. The simulator system for the proposed solution is perfectly feasible operationally and technically in an ordinary environment. The security and reliability of the simulator system is kept under focus during design phase as well. The best feature of the simulator is its accurate output which helps the user and expert system in quick and accurate decision making.

VIII. Conclusion

Data retrieval from data sources exists in different data representation schemes that are an important issue for knowledge retrieval to the expert systems. In this research a proposed solution is projected to converts semantic network knowledge in frames structure. This conversion is important for the frame based expert systems which can easily manipulate data through frames. A case study is adopted and according to that, the resulted frame structure can facilitate a machine perception about their problems, because the frame structures have greater expressive power than that of semantic network. It is unproblematic for the users to arrange slots for new properties and relations. It is simple to generate particular procedures, easy to take account of default information and notice missing values. Such type of frame structure can be stored in knowledge repository of expert systems, so as to have more inference power against the queries of the end users.

IX. Future Work

Several data representation schemes have been discussed in this research work. The proposed transformation algorithm is very useful in converting the representations scheme in desirable format. In this research only one of the data representation schemes which, is commonly used is transformed into suitable knowledge representation. The same function can be used with the little modification to convert the other representations schemes into frames structure to enhance the efficiency of any working expert system.

References

[1] J. D. Wren, "Engineering in genomics," in *IEEE Engineering in Medicine and Biology Magazine*, pp. 87-93, 2004.
[2] T. Holthoff, "Expert librarian applications of expert systems to library technical services," *Technical Services Quarterly*, vol. 7, no. 1, pp. 1-16, 1989.
[3] S. C. K. Shiu, J. N. K. Liu, D. S. Yeung, "Systems, Man, and Cybernetics, "Intelligent systems for the 21st century," *IEEE International Conference*, vol. 3, pp. 2257 - 2262, Oct. 1995.
[4] R. Knight and E. Rich, *Artificial Intelligence*, 2nd Ed., Wiley Intersience, 1991.
[5] D. H. Zhu and A. L. Porter, "Automated extraction and visualization of information for technological intelligence and forecasting," *Technological Forecasting and Social Change*, vol. 69, pp. 495-506, 2002.
[6] T. Connolly and P. E. L. C. Begg, *Database Systems*, 3rd Ed, Pearson Education Limited, 2008.
[7] T. Holthoff, "Expert librarian applications of expert systems to library technical Services," *Technical Services Quarterly* vol. 7, no. 1, pp. 1-16, 1989.
[8] E. Turban and J. Eronson, Edition. *Decision Support Systems and Intelligent Systems*, 6th Ed: Prentice. 2003.
[9] Frame-based expert systems. [Online]. Available: http://www.cs.siu.edu/~rahimi/cs437/slides/lec06.ppt, Accessed Date: 2008 September 19.
[10] M. Negnevitsky and A. Wesley, *Artificial Intelligence: A Guide to Intelligent Systems*, 2005.
[11] Institute of Electrical and Electronics Engineers, "Computer and control abstracts," *Institution of Electrical Engineering– Science*, vol. 21, 1986.
[12] M. L. Barrett and A. C. Beerel, *Expert systems in business: A practical approach, Lysia Limited*, London. 1988.
[13] Y. M. C. Yeh, "The implementation of knowledge management system in taiwan's higher education," *Journal of College Teaching and Learning*, vol. 2, no. 9, 2005.
[14] L. Gem. (December 15, 2009). Catalyst Development Corporation. [Online]. Available: http://www.catalyst.com/support/help/logicgem/index.html?page=html%2Ftopic6.
[15] U. Sekaram, *Research Methods for Business*, 3rd Edition, United State of America, John Wiley and Sons Inc, 2000
[16] H. Hussain, M. U. Shaikh, and S. U. R. Malik, "Exploration of research issues from text of certain field (domain), proposed text mining framework," in *Proceedings of ICCEA Bali Island Indonesia*, vol. 19, no. 21, March 2010.

[17] Qualitative Research an Introduction. (Nov 25, 2008). [Online]. Available: www.staff.ncl.ac.uk/david.harvey/AEF801/MBQualMeth.ppt.
[18] J. Firestone, "Knowledge base management systems and the knowledge warehouse: A straw man," in *Executive Information System*. 2000.

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