Semi-Automatic Knowledge Transformation of Semantic Network Ontologies into Frames Structures

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ABSTRACT: *Knowledge is modeled in various knowledge representation formats like semantic network, decision table, decision tree, etc. Such representations are used to express knowledge in natural languages. There is a major difference between programming languages and Natural languages. They both are used for communication purpose. The former is used for communication between human and machine and the latter is used for human communication. Semantic network is one of the knowledge representation technique used for communication between knowledge engineer and user. It lacks logical completeness and exactness. Due to the uncertainty of information about nodes and links in semantic networks problems arise in inferring and queering of knowledge. There is an object oriented layout of knowledge representation known as Frames structures that can be modified with slot filling capability and procedural attachments. In this research paper, a solution is proposed to extract knowledge from semantic networks ontologies in a semi-automatic way of knowledge transformation into an inferring suitable knowledge source so-called frame structure. Our proposed technique readout a standard Owl XML file expressing semantic network ontology designed in Protégé, and transforms into an equivalent frame based knowledge source. The resulted knowledge source is stored in Frames repository providing better inferring capability. Various case examples have been adopted in order to validate the proposed technique by verifying the number and names of the nodes/frames, the number and type of attributes and methods for each node/frame and the type of relationship between any of the two nodes/frames were identical in the input and the corresponding output.*

Keywords: Semantic network, Knowledge transformation, Frames structure.

Received:

1. Introduction

Knowledge is an asset of an organization that arises from the accumulated transactions and other data. Knowledge changes as the new ideas about the same fact arise and stored in a suitable knowledge source for further processing. Knowledge is either represented as conventional programming or knowledge base system. Various knowledge representations techniques exists currently that maybe appropriate to the circumstances. Regarding the characteristics and taxonomy of knowledge there are few major knowledge representations families are logic programming, rules based or production systems, semantic networks and frames based representation languages. Knowledge is usually defined by its relationships to other concepts as a graph of labeled nodes and directed arcs to encode knowledge. A graph data structure is used, with nodes used to hold concepts, and links with natural language labels used to show the relationships. It is capable to handle the case of inheriting multiple different values. The natural languages are usually depicted through semantic network representations to communicate between knowledge engineer and user.

In most cases, the morphology of semantic net-works is more likely to frames based knowledge representation but it have no slot filling capability and lack meta data information. There exists uncertainty in semantic network so it leaves out a great deal of information due to which it causes difficulties in knowledge extraction process.

A frame is a much likely the conception of object oriented programming and have meta data information, which defines the state of an object and its relationship to other frames (objects) known as slot composed of facets. Frames are also called slot-filler knowledge representations. Each slot of a frame has associated with it a set of entities called slot values and the fillers are the attached procedures capable to handle the changing slot's values. Formal semantic hierarchy of frames denotes "has-part" and "is-a" relationships. A Frame sounds very much like an object, whose data members are the slots, and whose methods are the attached procedures or daemons. It makes use of inheritance for "is-a" relationships, and containment or references for "has-part" relationships. Unlike other knowledge sources it has greater communicative power to deliver easy knowledge extraction process comparatively [2], [3].

The composition of the research paper is as; literature review is discussed in section 2. It consists of background knowledge, existing relevant research approaches and comparative analysis of knowledge representation techniques. In Section 3 Proposed solution is elaborated including problem statement and proposed system architecture, which represents a layered approach and a transformation function. Section 4 and 5 explains the implementation process and results of this research effort respectively.

2. Literature review

Various research approaches have been expected to enable knowledge workers to make decisions based on consented fact and information [4]. Knowledge extraction is the integration of knowledge from heterogeneous knowledge sources and to store it further in a suitable knowledge repository for useful machine interpretation. The broad integration of knowledge through knowledge extraction process from dissimilar sources is a challenging task.

2.1 Background Knowledge

It is essential to have a background study about various existing knowledge representation techniques to enhance knowledge sources for maximum utilization. Mostly used knowledge representation methods are; Decision trees that are hierarchical representation of knowledge relationships composed of nodes and links. Nodes represent goals while links are used for decisions. It is easy to extract knowledge from trees using computer programs and its further conversion into production rules [1]. A kind of knowledge source used to store data and knowledge in tabular form using rows and columns is known as decision table [5]. Decision tables are the complete set of conditional expressions composed of four components is; condition entries, condition stubs action entries and action stubs. The relational database is collective set of multiple data items ordered by described tables, records and columns. Knowledge can be accessed or reassembled without reorganizing the database tables. It is capable to respond to queries about complex information from a relational database [5].

Production rules are the rules sets as a collection of rules for a particular class of platform. It consists of condition-action pairs. Actions follows conditions e.g. IF <Condition> Then <Action 1> Else <Action 2>. It means when conditions is proved to be true then Action 1 should be initiated otherwise Action 2 would be applicable. One of the knowledge representation techniques O-A-V Triplet is the association of Object, Attributes, and Values (O-A-V triplet). Objects are instances of class. Object are defined by its attributes which stores the characteristics or properties of that object and values measures of attributes maybe used to classify objects [3]. In Knowledge map the knowledge either external or internal to the organization is stored in knowledge repositories e.g. experiences, methods, and process, judgments within the organization. Circle or images are interlinked and labeled, to create the hierarchical view of knowledge [3]. There are two components of a knowledge map usually; diagram and specification [6].

Semantic networks were first defined by Ross Quillian in 1968. It depicts knowledge using nodes and links (arcs or arrows) connecting further nodes in a graphical way. Nodes are declared as concepts or object, and links indicates these relationships between nodes. Some of the common kind of relationships used as arcs are "is-a" or "has-a" to show inheritance and composition respectively [1]. It is a special case of directed graph to show knowledge structure; often used in artificial intelligence systems.

Frame was proposed by Marvin Minskey in 1970. It is a data structure used to store knowledge of a particular object. It is a hierarchical structure mostly used in object oriented programming applications for Artificial Intelligence and Expert System purposes [3], [6]. A frame includes two major structures known as slots and facets. A slot is set of attributes that describes the characteristics of object in frame. Each slot contains one or more facets. Facets may be used as sub slots some times, describe some knowledge or procedural information about the attribute in the slot [1]. It usually exists in different forms such as values, default, range, if added, if needed and any other type of information [1].

2.2 Existing Research Approaches

In this section existing research approaches are critically discussed and their limitations are highlighted.

2.2.1 Knowledge Extraction from Semantic network

Mohamed Nazih et.al [7] presented a Knowledge Extraction System (KES) for Semantic Network to extract object and goals. In this research work a survey based approach model the aspects of the inherent vague-ness and uncertainty characterizing the Knowledge Extraction (KE) process. The application of computing to KE is particularly tempting to model mechanisms which learn the user's view of Objects' applicability.

Limitations:

In this research effective mechanism is less focused to describe the procedure of the integration of fuzzy approaches for knowledge extraction from semantic network so as to avoid the factor of uncertainty for the effectiveness of KESs.

Hameed et.al made research efforts about a Text mining framework. According to this research effort; in text acquisition one will select relevant textual data instead of only to collect, gather or retrieved textual data. Text exists in heterogeneous formats obtained from internal and external sources. It may have a different format like portable document format (PDF), text (txt) and document (doc) etc. There should be a single format defined for all the diverse text formats. The mechanism of information extraction from different textual format varies; it may leads towards complexity without transforming obtained text into a single format [8]. Single formatted text documents are received or selected by Text processor from the pool of documents. There is unique assigned index to each document in the pool of documents and selection is done through that index. A Knowledge repository is a framework of knowledge base. The contained knowledge is related to some specific domain. Semantic network generator is specified to generate semantic networks dynamically from the concepts and relationships [8]. There is Frames generator to generate frames from the input semantic network. The need for frames generation is actually achieved for knowledgeintegration and due to the more expressive power of frames. Frame is flexible knowledge representation to increase the number of slots. Frame is consolidated form of knowledge for a specific object. In Artificial Intelligence the object oriented programming tasks are implemented through frames. A single frame may describe a single object. [2].

Limitations:

The proposed framework has defined frame as a more flexible and preferable knowledge representation but has defined no any process or rules about the transformation of knowledge from semantic network into frames.

Simon Beckstein et.al has made research efforts about intelligent stream based systems integration of stream data with semantical background knowledge. Two different architectural approaches are proposed about event stream processing and background knowledge integration. First approach is to add an ontology access mechanism to a common Continuous Query Language (CQL) and further comparison with an adapter class that achieves SPARQL queries on a knowledge base. The second architecture is based on an extension of SPARQL to process RDF data streams [9].

Limitations:
The proposed approach still needs promising research efforts to support completely the integration of semantic reasoning into stream processing.

2.2.2 Knowledge Base System Enhancement Models
Nemati et al [4] proposed knowledge warehouse architecture to support decision making process for corporate managers. An intelligent analysis mechanism was introduced to enhance decision support system by refining all phases of knowledge. An addition to the Data Warehouse (DW) model is innovated so-called knowledge warehouse (KW) architecture. It assists leverage to the efficiency of retrieval and sharing of knowledge across the organization by capturing and coding of knowledge. Particularly, there are three main features of related research. The first is analysis tasks that enhance perception and understanding. Developing a table showing the correlation across the tasks and technology evaluates various inductive analysis technologies with the appropriate analysis task. Evaluation of the results of these technologies smeared to model analysis. Second research feature is the observation about capability of Knowledge Ware-house Architecture and its analysis in a controlled and practical environment. A third research feature is the computer-assisted generation of influences, especially deep descriptive influence, and empirically testing their capability to augment user appreciative [4]. There is an object-oriented knowledge base management system module introduced, knowledge analysis work shallow, and a communication manager. The proposed module integrates a varied knowledge objects and analysis tasks [4]. The objective of Knowledge Ware-house Architecture can be applied through giving extension to the data warehouse architecture. There are six major components of the proposed extension: Knowledge acquisition module, feedback loops, ETL module, knowledge storage module, analysis workbench and user interface module [4]. The knowledge acquisition module is chiefly responsible for the conversion of implicit to explicit knowledge, feedback loop middleware between knowledge acquisition and storage module. The ETL module is responsible for preprocessing of data and data loading from external databanks into the Knowledge Warehouse storage area similar to the data warehouse. An object-oriented knowledge base management is one of the main components of the Knowledge Warehouse architecture is system (KBMS) that carryout the integration process of knowledge base, model base, and analysis tasks [4].

Limitations:
The KW architecture support and improves phases of knowledge but to define knowledge modification, rules and processes for transformation of knowledge into suitable form is little focused.

Qureshi et al made research efforts to store organizational knowledge in a way to achieve full utilization of that knowledge for an organization. Their suggested architecture for optimal transformation qualifies the inferring and queering process speedy and accurate. It will facilitate expert systems of decision tables and decision trees into knowledge base [10]. According to this proposal, a transformation method is introduced to carryout optimal transformation of knowledge present in decision trees and decision tables into knowledge base. Both of the knowledge representation schemes first to be converted into corresponding human interpretable rules by using transformation functions. Decision Tree into rules transformation can easily be achieved by using top-down, left-to-right approach but their maybe two possibilities to transform Decision Table. To convert Decision Table into a Decision Tree is the first possible way and then Decision Tree into set of rules transformation. Secondly, direct transformation of the Decision Table into a set of human interpretable rules. The refinement of fresh created rules to adjust the knowledge representation is the next step after rules formation. By applying optimization function over each rule, unnecessary and unwanted conditions are removed in the refinement stage. Efficiency is achieved by optimizing rules in the refinement stage. The resulted rules are then compared with the already existing rules in the Knowledge Base after rules refinement and optimization stage. The Knowledge Base will be updated only when the refined rules does not exist already. If there is deficiency of the refined rules in Knowledge Base then the rules should be updated and those rules should be eliminated which already exist in the Knowledge Base during comparison [10].

Limitations:
The proposed research framework strongly depends on the transformation functions that need to be defined in each case along with its defined validated outcomes.

2.2.3 Comparative Study of Knowledge Representation Techniques
It is quite essential to adapt a comparative revision for different knowledge representation techniques. So as to learn about suitable features for knowledge extraction and inferring, to determine the factors that influences the expressiveness and power in structuring knowledge bases. To structure knowledge bases usually some knowledge representation techniques (rules, semantic networks, frames, logic) considered operative and critically evaluated to regulate suitable application area [11]. There

are various data representations schemes discussed below;

1. Decision tables are used in various applications for knowledge representation and storage. But it is considered as unsuitable in the framework of expert systems, because it is not measured as structural representation technique for data. It has scalability issues and may require domain knowledge. Due to proportion of rows and columns complexities exists in huge tables. There is another issue of its extensibility may be very costly [11].

2. Decision trees are widely used in training and classification of data but its structure, which causes some key problems in inferring and knowledge extraction. The outcome of decision trees needs to be firm and should be limited to one attribute only. Secondly the functions of decision trees are unstable and causes problem. Decision trees are proven to be highly complex when formed from numeric data sets [12].

3. Many large applications use scripts and have varied applicability in many types of computation. Scripts have deficiency that may not be suitable to represent all kinds of knowledge [12].

4. Object attribute value triplets are used in knowledge management applications. It offers a principally suitable way to signify assured facts within a knowledge base. It is commonly used to represent knowledge. It consists of objects and attributes. Objects can be either conceptual or physical and are further defined but their attributes. Attributes are measured by values in a specific way may be stretched to deliver the foundation to picture heuristic rules [3].

5. One of the most common methods to represent knowledge is the use of production rules. It is very easy to debug, adapt and preserve IF-THEN rules. Inferring from production rules could be simply to fire rules when its evidences are satisfied. Inference engine would need to have a mechanism for conflict resolution. However, may have some complexities in knowledge extraction process whenever there is no any predefined order of rules execution. It causes inefficiency due to rule dependency as modularity and prioritization of rules alone cannot resolve the problem. For example; “Rule A” has high priority over “Rule B” and “Rule B” has high priority level over “Rule C”, but “Rule C” is more preferable over “Rule A”. There is also a big issue of inexpressiveness for production rules that causes complexity [13].

6. Using semantic network for representing knowledge is of particular significance because it allow us to clearly structure the knowledge to be reflected in the same way is being represented in the real world. Events and natural language verdicts can be represented through semantic networks. Due to their hierarchical nature the notion of semantic network is very broad. It is used to show complex casual relationships in the form of complex and large diagram. Logic and heuristic improvements providing little increase in system performance specifically if the natural expressiveness of semantic network be kept maintained however, it is difficult to be clear about the syntax and semantics in semantic nets [13].

It may consist of ambiguous links among different nodes. It can be very difficult to reason from. It is essential to clarify in inferring process what types of links exist between nodes within the semantic networks and there are no limitations on permissible links [14]. Using semantic network it may be difficult to show all the different inference situations. It causes reliability issues while searching across the diagram because inferring becomes a complex process. Kinds of links in large range and the ways they conduct indirect linkages and the huge quantity of concepts normally included in a semantic network makes it prone to a combinatorial outburst. Due to ambiguous nature of semantic network it is used only as a communication tool between the knowledge engineer and the domain expert. It may be modified later on the knowledge has been obtained and its further transformation into suitable knowledge source that is easier to process [14].

7. Frames are a knowledge representation technique which is also categorized as an extension to semantic network. It is comparatively easy to extract knowledge from frames. Unlike other knowledge representations schemes it has some distinct features in enhanced provision of inferring process [15].

1. The capability of frame to perform default reasoning is one of the distinct characteristics of frames based knowledge representation.

2. Frame based knowledge representation scheme facilitate procedural attachment to frame field. Whenever a given frame field value is read or changed, the procedures can be invoked. Frame based systems can help in applying heuristic explorations over the knowledge base.

3. It can also support reasoning in few ways e.g. default reasoning through inheritance and heuristic explorations over the procedural attachment, by testing the properties of frames it normally have some quantity of built in predicates that may provision reasoning.

4. It lets the system designer to structure logical packages of knowledge base. Such a beneficial feature of frame based

knowledge is specifically most useful in those problem domains where knowledge components are highly structured.

5. Frame based systems have a significant overlap with object-oriented methods except that all objects communicate with each other without achieving any action.

6. An expert system confined uncertainty and inconsistency in its knowledge base often established on the expert's rules and facts. Causes of the uncertainty are inadequate knowledge, unreliable knowledge, random knowledge, and contradictory information. There are several ways to account this uncertainty.

7. Frames representation of knowledge capable of more natural provision of values than semantic nets comparatively e.g. each of the slots has restrictions to describe permissible values in a slot range. There may be instances or classes defined in frame. Inheritance is easily tackled and implemented using object-oriented programming practices.

8. Non-technical can easily understand because it makes programming more easily readable by grouping linked knowledge to improve expressive power. It is easy to modify slots for new properties and links. Default information modification and detection of missing values can be easily managed.

9. Frames including nodes of a frame-based network signify typical examples or stereotypes of de-fined objects so-called concepts, and can be announced as data structures where data in turn contain data.

10. Frame theory has one of the fundamental assumption is that when new situation encounters e.g. a considerable change in one's opinion of the situation occurs, frame represents a concept the one chooses from his/her memory and modify it to return the new reality.

Frame structure is a knowledge representation technique to account for our capability to deal with fresh situations that are encountered continuously, through our current knowledge of preceding events. To overcome the problem it may prove to be a suitable knowledge source for maximum utilization of knowledge.

3. Proposed Solution

This section provides problem statement and discusses the proposed architecture for extraction of knowledge from semantic network ontologies in a semi-automatic way of knowledge transformation into an inferring suitable knowledge source.

3.1 Problem Statement

The gap between human depiction of knowledge and machine reasonable logic is the main problem faced when extracting knowledge from semantic network. After studying the existing complexity [7] [8], a solution is proposed to cover the complexities in the existing system. Thus a solution is proposed to achieve semi-automatic knowledge transformation from semantic networks into frames, enabling the inferring and queering process fast and accurate to facilitate expert systems. The Proposed solution comprises system architecture and the transformation function.

3.2 System Architecture

The architecture of the working flow of the system has been discussed in this section. It illustrates the layered approach of the knowledge transformation process. There are a couple of layers defined in the proposed system architecture as shown in figure 1.

3.2.1 Presentation Layer

It provides transparent, user friendly and adaptable middleware for presentation knowledge and information to the user. To fulfill this purpose presentation layer describes the user model in semantic network ontology.

3.2.2 Business Process Layer

The user introduces knowledge designed as semantic network ontology into Business Process Layer via Presentation Layer. The Business Process Layer covers process representation and embeds a Business Function layer aligned with transformation function to carryout business goals. Transformation Function consists of three steps shown in the figure 1. In the first step each node is stored under the frame name. In the second step the attributes of each node are stored under the frame name and in the third steps the relationships among nodes of the semantic network ontology are indicated and shown in frame structure distinguished in three broad categories such as generalization, aggregation and association respectively. The resulted frame structures are stored in a frames repository. The overall functionality of the proposed system architecture is to get input as semantic network ontology and produce the frames structure as output.

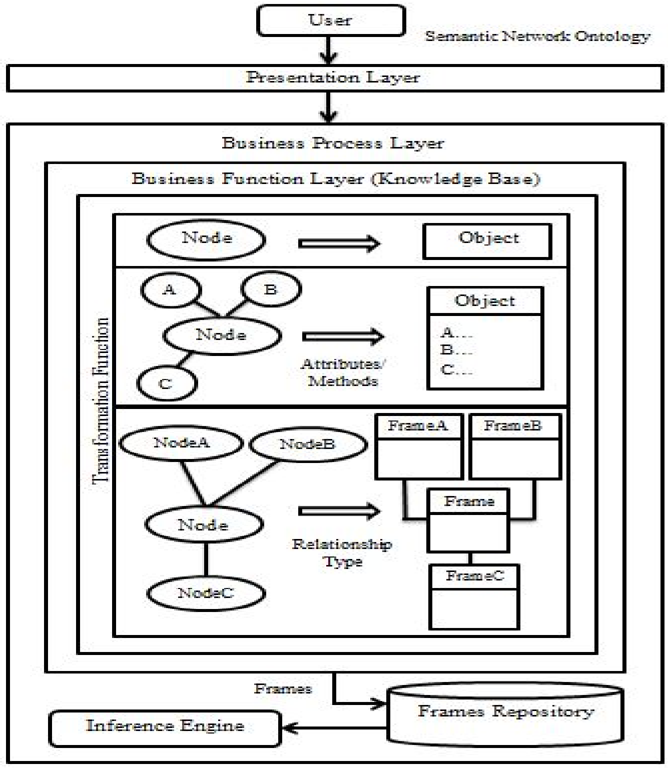

Figure1. Proposed System Architecture

3.2.3 Transformation Function

The semantic network is converted into frames through semi-automatic procedure by applying transformation function. The generated frames are stored in frames repository.

Input: Semantic Network
Output: Frame Structure
BEGIN

1. SN Node's to Frame Repository (FR)

Get each Node of SN
Check Frame Repository
If not listed in Frame Repository
Store node under heading "Frame Name" in Frame Repository
Return
Else
Do nothing

2. Adding Node's Properties in FR

For each Node of SN get Properties/Attribute(s)
If found Properties/Attribute(s) = Not Null Check Frame Repository
If not listed in Frame Repository.
Write property/attribute(s) under heading "Property/Attribute(s)" in Frame repository.

Return
Else
Do nothing

3. Adding Node's Methods in FR

Get Methods for each Node
If Procedure/Method(s) = Not Null,
If not listed in Frame Repository.
Write procedure/method(s) under heading "procedure/methods" in Frame repository.
Return
Else
Do nothing

4. Adding Link's Label in FR

For each Node of SN
If a Node interlinked with another Node
For each link get label of Relationship
If label between Nodes is "is a" then
[Generalization / is-a / a kind of]
Return Link Type= Generalization
Store in Frame Repository under corresponding Frame Name
End if
Else if label between Nodes is "a-part-of
or has-a" then
[Aggregation / a-part-of / part-whole]
Return Link Type= Aggregation
Store in Frame Repository under corresponding Frame Name
End if
Else if label between Nodes is "owns/belong-to/others" then
[Association / owns]
Return Link Type= Association
Store in Frame Repository under corresponding Frame Name
End if
Return (Next Link)
Next Node
End.

The knowledge designed in semantic network ontology is processed in Business Process Layer. It covenants with certain organization, institute, industry or the area where the proposed solution is to be implemented. Input is accepted in the form of semantic network ontology and output is generated as frames structure. The transformation Function consists of three steps shown in the figure 1. In the first step each node is stored under the frame name, the attributes are search out for each node and stored under frame name in second and in the third step methods/procedure existing for each node are searched out to store in the frame structure and relationships are retrieved among nodes of semantic network varies in kinds e.g. generalization, aggregation and association respectively.

4. Implementation

The applicability of the new proposed system architecture needs relevant effort to introduce it in the victim case. A model case example is shown in figure 2 and 3 showing a semantic network and frames preview respectively. It is adopted to exemplify the working procedure of the system architecture. Semantic network ontology representing a university campus is taken as input and converted into its respective frames structure. It retrieves all the nodes from the semantic network and stores them as frame structure in frame repository after accomplishing the knowledge transformation process.

An application is developed to implement the transformation function. The tools suggested for the simulation of the proposed function are semantic network ontology designing tools, transformation function application tools and database tools. Protégé 4.1 is used to design ontologies one of the well-known software used to handle semantic networks visualization. It provides visualization of nodes and links. The application to achieve transformation function is developed to upload and read the file stored in OWL XML format and convert into corresponding frame structure. Database tool are used for keeping the repository of resulting frames. The designed system provides a user friendly interface to acquire desired output from the processed input that may also be termed as the functionality of system design.

The quantity of nodes or frames a system supports depends on factors such as how many slots with values it has and thus no exact numbers can be defined. The System can be deployed in ordinary hardware requirements.

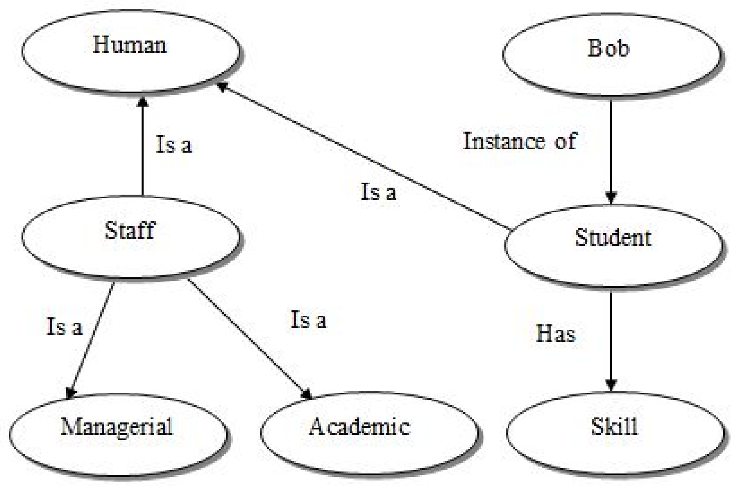

Figure 2. Semantic Network

The above figure is designed in protégé so as to get semantic network ontology. It delivers a readable file source in XML/OWL format and is further uploaded in transformation function application to generate list of corresponding frames. The output may explore as frame preview.

Frames Representation

1. Frame Name: Staff No Attribute(s)/ No Methods Generalization:Human

2. Frame Name: Managerial Staff No Attribute(s)/ No Methods Generalization:Staff

3. Frame Name: Academics Staff No Attribute(s)/ No Methods Generalization:Staff Association: Courses

4. Frame Name: Student No Attribute(s)/ No Methods Association: Degree Program Aggregation: Skills

5. Frame Name: Skills No Attribute(s)/ No Methods Aggregation: Student

6. Frame Name: Courses No Attribute(s)/ No Methods Aggregation: Degree Program Association: Academics Staff

7. Frame Name: Degree Program No Attribute(s)/ No Methods Generalization:Bachelor Degree Program Master Degree Program Association: Student Aggregation: Courses

8. Frame Name: Bachelor Degree Program No Attribute(s)/ No Methods Generalization:Degree Program

9. Frame Name: Master Degree Program No Attribute(s)/ No Methods Generalization:Degree Program

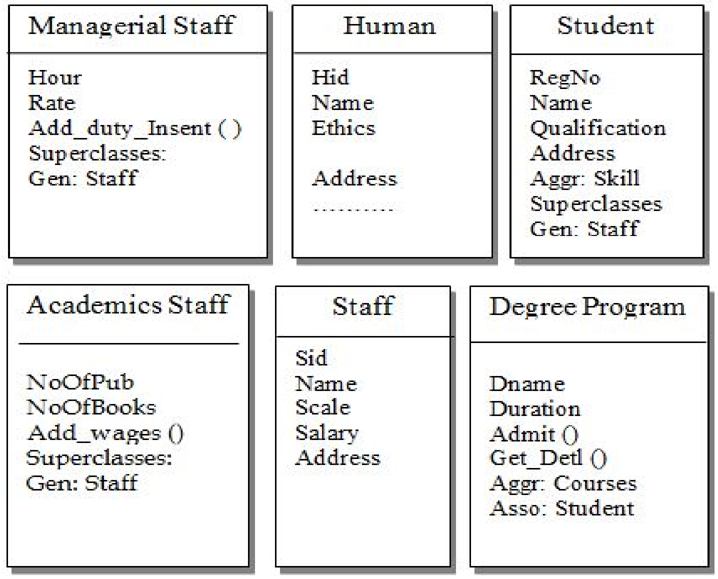

Figure 3. Frames Preview

5. Result

The output of the proposed system architecture is verified and validated by the three experts from well-known software companies. There are nine case examples adopted to exemplify and validate the system architecture with the help of developed system simulator. In table 1 all the nine case examples are shown. All the case examples are classified into three groups based on the complexities of their semantic network ontologies. The amount of nodes (N), relationships (R) to other nodes, methods (M) or procedures (P) and attributes (A) collectively are termed as complexity of the SN ontology. Unified Medical Language System (UMLS) is the semantic network ontology designed considered as a large and complex case example. It includes forty nine nodes interlinked to other nodes with different relationship types, procedures and its attributes to form semantic network ontology. The second example classified as large group of case example is the semantic network ontology for animals and birds. It consists of twenty five nodes only.

Large	Medium	Small
N > 20 +R + P + A	N > 10 < 20 + R + P + A	N < 10 + R + P + A
1- Org. Ontology 2-Animal/ Birds 3-Hos. Hierarchy	1-SAM's Family 2-Uni. Campus 3-Human Stages	1-Mal. Infection 2-Class Room 3-Mammals

Table 1. Three Categories of SN Examples

In table 2 the small case examples are ordered as a first category. It has less than or equal to ten nodes. In order to exemplify each class three case examples are adopted respectively. The medium case examples are ordered as second category of case examples. They have greater than ten nodes and less than equal to twenty nodes. The large case examples are ordered as a third category of case examples. They have greater than twenty nodes. The analysis for all the case examples is shown in table 2. All the components of SN complexity e.g. number of nodes or frames, number of attributes, number of methods and the number of each kind of relationships are examined for each case example.

Case	Class	No of Nodes	Methods/Attributes	Relation Type		
				Gen	Aggr	Asso
1	Small	07	Nil	03	03	01
2	Small	03	02 M/ 0 A	Nil	02	01
3	Small	09	02 M/ 0 A	02	03	04
4	Med	18	02 M/ 0 A	07	02	09
5	Med	11	02 M/ 0 A	07	01	04
6	Med	13	01 M/ 2 A	04	06	03
7	Large	49	02 M/ 0 A	39	09	10
8	Large	24	02 M/ 1 A	11	17	04
9	Large	31	Nil	09	12	11

Table 2. Analysis of Case Examples

Conclusions

Knowledge is available in diverse representation techniques in operational data stores. Semantic network is one of the knowledge representation scheme used to communicate between knowledge engineer and user. It is the depiction of knowledge that causes a lot of complexities in inferring and querying to the inference engine. Frames have more expressive power and have faster and accurate inferring as they exist in object oriented form. In this research effort new system architecture has been proposed for processing of knowledge transformation from semantic network ontologies into frames structure. This transformation is important for the maximum knowledge utilization without any ambiguity and complexity. The newly proposed system architecture, transformations function and system simulator design is the novel contributions of the research to perform the required transformation. The system performance has been tested on nine case examples; three each from the small, medium and large classes. The results were verified for each case example qualitatively by matching;

a. The number and names of the nodes/frames is identical;

b. The number and type of attributes and, methods for each node were identical;

c. The type of relationship between any of the two nodes was also identical in the input and the corresponding output.

Hence the achieved transformation is accurate and the objectives of the research have been achieved. There are few concerns and tasks that should be taken in further interpretation in future to carry enhancement in knowledge transformation process such as; to make sure the possibility to transform all the knowledge sources to their suitable and desired format. The re-usability and modification of the same system will be helpful as stepping stone for any kind of business logic. The proposed system architecture can be revised after modifying its features. Upcoming advanced automation tools can be used to modify the functionality of the simulator. The system maintenance issues can be handled in a better way and the storage structure can be upgraded.

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