HYBRID TECHNIQUE FOR EFFECTIVE KNOWLEDGE REPRESENTATION & A COMPARATIVE STUDY

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ABSTRACT

Knowledge representation (KR) and inference mechanism are most desirable thing to make the system intelligent. System is known to an intelligent if its intelligence is equivalent to the intelligence of human being for a particular domain or general. Because of incomplete ambiguous and uncertain information the task of making intelligent system is very difficult. The objective of this paper is to present the hybrid KR technique for making the system effective & Optimistic. The requirement for (effective & optimistic) is because the system must be able to reply the answer with a confidence of some factor. This paper also presents the comparison between various hybrid KR techniques with the proposed one.

KEYWORDS

Knowledge Representation (KR), Semantic Net, Script.

1. INTRODUCTION

Knowledge representation:

Objects - information on physical objects and concepts
Events - time-dependent actions and events that may indicate cause and effect relationships.
Performance – procedure or process of performing tasks
Meta-knowledge – knowledge about knowledge including its reliability, importance, performance evaluation of cognitive processors.
Many of the problems in AI require extensive knowledge about the world. Objects, properties, categories and relations between objects, situations, events, states and time, causes and effects are the things that AI needs to represent. Knowledge representation provides the way to represent all the above defined things [38]. KR techniques are divided into two major categories that are Declarative representation & Procedural representation. The Declarative representation techniques are used to represent objects, facts, relations. Whereas the Procedural representation are used to represent the action performed by the objects. The propositional logic, predicate logic, semantic net are the declarative knowledge representation techniques and Script, Conceptual dependency are procedural knowledge representation techniques. There is one more technique named frame that can be used as both. Each one has their own prone and cons. Now days because of market demands there are number of hybrid techniques are available. In next section we cover the few hybrid KR techniques.

1.1 KRYPTON

In 1983 Ronald J. Brachman, Richard E. Fikes, Hector J. Levesque has developed krypton a hybrid knowledge representation technique.

Technical description: Two boxes are used terminological box (T box) and assertion box (A box). TBox used the structure of KL-ONE in which terms are organized taxonomically, using frames an ABox used the first-order logic sentences for those predicates come from the TBox, and a symbol table maintaining the names of the TBox terms so that a user can refer to them. It is basically a tell ask module. All interactions between a user and a KRYPTON knowledge base are mediated by TELL and ASK operations shown in fig 3.1[14][16].

![Fig.1 Overview of KRYPTON](image)

1.2 OBLOG 2:-

In 1987, Thomas F. Gordon Presented the Oblog 2. Oblog stand for Object-oriented LOGic, is an experimental hybrid knowledge representation and reasoning system. It is a hybrid of a terminological reasoner with a Prolog inference mechanism. The description of type and attribute taxonomies are supported by terminological component whereas Entities are instances of a set of types. Horn clause rules are used as Procedures, & for determining the values of attributes are indexed by type.
1.3 MANTRA

In 1991 MANTRA was developed by J. Calmet, I.A. Tjandra, G. Bittencourt.

**Technical description:** It is the combination of four different knowledge representation techniques. First order logic, terminological language, semantic networks and Production systems. all algorithm used for inference are decidable because this representation used the four value logic. Mantra is a three layers architecture model. It consist the epistemological level, the logical level, Heuristic level.

1.4 FRORL:

(frame-and-rule oriented requirement specification Language) was developed by Jeffrey J. P. Tsai, Thomas Weigert, Hung-Chin Jang in 1992.

**Technical Description:** FRORL is based on the concepts of frames and production rules. Which is designed for software requirement and specification analysis. There are two types of frames Object frame and activity frames. Object Frames are used to represent the real world entity not limited to physical entity. These are act as a data structure. Each activity in FRORL is represented by activity frame to represent the changes in the world. Activity, Precondition and action are reserved word not to be used in specification. FRORL consist of Horn clause of predicate logic. The comparisons between various hybrid KR techniques with the proposed technique are shown in table 1.

2. KNOWLEDGE BASE SYSTEM

The KR system must be able to represent any type of knowledge, “Syntactic, Semantic, logical, Presupposition, Understanding ill formed input, Ellipsis, Case Constraints, Vagueness”. In our previous paper we have proposed the model for effective knowledge representation technique that consist five different parts the K Box, Knowledge Base, Query applier, reasoning and user interface as shown in fig 8. This time the total emphasis is on knowledge representation. This section used to describe the new hybrid knowledge representation technique which is the integration of script and semantic net KR technique. The semantic net & script KR technique are explained in next subsection.

![Knowledge Base System Model /Architecture](image_url)
2.1 SEMANTIC NET

A semantic network is a widely used knowledge representation technique. Semantic network is a KR technique in which the relationship between class and objects are represented by the connection/link between objects or class of objects.

The nodes / vertices in semantic net are used to represent the Generic class or a particular class or an instance of a class (object). Relation between them is represented by the link, which shows the activation comes from where. The links are unidirectional. These links represent the semantic relationship between the objects. Semantic network are generally used to represent the inheritable knowledge. Inheritance is most useful form of inference. Inheritance is the belongings in which element of some class inherit the attribute and values from some other class shown in Fig.1 [38].

Fig.3 represents the inheritance relation [35][38].

Because there is an association between two or more nodes the Semantic nets are also known as associative nets. These associations are proved to be useful for inferring some knowledge from the existing one. If user wants to get any knowledge from the knowledge base they need not to put any query. The activated association or relation provides the result directly or indirectly only need to follow the links in the semantic net. IS-A, and A-KIND-OF are generally used to represent the value of a link in semantic net shown in fig 2.

KR techniques are divided in to two main categories one is declarative and other is procedural. Semantic net is a declarative KR technique that can be used either to represent knowledge or to support automated systems for reasoning about knowledge. Semantic net

Fig 4 Represents of IS-A, HAS, INSTANCE [17], [38].
can be used in variety of ways, as per the requirement following are six of the most common kinds of semantic networks.

1. Definitional networks
2. Assertional networks
3. Implicational networks
4. Executable networks
5. Learning networks
6. Hybrid networks

During 1975 (See Walker ) Partitioned semantic net came in picture for speech understanding system. Then after that in 1977 Hendrix explained how we can expend the utility of semantic net using partitioned semantic net [8]. In case of a huge network semantic net can be divided in to two more net. The semantic net is to be partitioned to separate the various nodes and arcs in to units and each unit is known as spaces. Using partitioned semantic net user can define the existence of the entity. One space is assigned to every node and arc and all nodes and arcs lying in the same space are distinguishable from those of other spaces. Nodes and arcs of different spaces may be linked, but the linkage must pass through the boundaries which separate one space from another [38].

Partitioning semantic nets can be used to delimit the scopes of quantified variables. While working with quantified statements, it will be help full to represent the pieces of information consist some event. For ex "Poonam believes that earth is round " is represented by the fig 3. Nodes<POONAM>' is an agent of Event node.<EARTH>' and <ROUND> represent the objects of space1.

![Fig.5 Partitioned Semantic Net [38]](image)

Universal and existential quantifier can also be represent by the Partitioning semantic net. For ex, “Every sister knots the rakhee to her brother” in predicate logic. In predicate logic the sister S and rakhee R are represented as objects while the knot event is expressed by a predicate where as in case of semantic net the event is represented as an object of some complex object, i.e., the bite event is a situation which could be the object of some more complex event. Partitioning semantic net can also be used to represent universal quantifier. For ex “Every sister knots the rakhee to her brother” is represented in fig 4 [38]. Partitioning semantic net can also be used for complex quantifieations which involve nested scopes by using nesting space.
2.2 Scripts

A variation in the theme of structured objects called scripts was devised by Roger Schank and his associates in 1973[3]. It is an active type information which contain class of events in terms of contexts, participants and sub-events represented in the form of collection of slots or series of frames which uses inheritance and slots. Scripts predict unobserved events and can build coherent account from disjointed observations. Scripts basically describes the stereotypical knowledge i.e if the system in not given the information dynamically then it assumes the default information to be true Scripts are beneficial because real world events do follow stereotyped patterns as human beings use previous experiences to understand verbal accounts. A script is used for organizing the knowledge as it directs the attention and recalls the inference. They provide knowledge and expectations about specific events or experiences and can be applied to new situations. For example: “Rohan went to the restaurant and had some pastries”. it was good now meaning derived from the above text one gets to know he got the pastries from the restaurant and that for eating and that was good. Script defines an episode with the known behavior and describes the sequence of events. The script consist the following.

- Current plans (Entry condition, Result)
- Social link(Track)
- Played roles,
- Scene.
- Probs.
- Anything indicating the behavior of the script in a given situation.

An example of script for class room is shown in fig.7.

| Script Lecture Room |
|---------------------|
| Track: Class Room   |
| Props: Table, Chair, Chock Board, Chock Box, Duster, Lecture Stand, Projector. |
| Roles: T = Teacher S= Student |
| Entry Cond: T has prepared lecture. T has Lecture Notes. The class is open. T has attendance register. |
| Result: T has imparted knowledge. S : Acquired Knowledge. |
Advantages of using scripts:
- Details for a particular object remain open and
- Reduces the search space.

Disadvantages
- Less general than Frames
- It may not be suitable for all kind of Knowledge

3 Hybrid Knowledge Representation Technique

Every knowledge representation technique has its own merits and demerits that depend on which type of knowledge we want to represent. To navigate the problem associated with single knowledge representation technique the hybrid knowledge representation came in picture.

The script and semantic net alone is a strong representation technique but still they have some disadvantages. The previous section consist the example of script for lecture room using that we are unable to get the detailed knowledge like the teacher can teach one or more subject, Is a permanent or on contract basis, student is a regular student or part time. Student opted one or many subject. Whereas using semantic net we can’t represent the knowledge scene wise. Semantic net can’t be used to represent the knowledge event by event. So to get all the knowledge from the system, integrated knowledge representation technique is used. The hybrid structure is shown in fig 8. From script to semantic net two different directional link coming out that shows the link between the roles of script with the two different classes of semantic net. In the same way we can make the link between other roles and objects involve in scripts (scene wise) with the class and object in the semantic net. The unnamed link in semantic net shows the generalization for eg. Mode can be part time, full time and regular.
As we know the input to the system is a sentence/paragraph/story. Let us consider another example for representation.

Story 1. Ram Navami

Ram Navami is a Hindu festival that celebrates the birth of Lord Rama to king Dasharatha and queen Kaushalya of Ayodhya. Rama was an incarnation of Lord Vishnu. On this day, devotees of lord Rama keep a fast. Houses are cleaned and temples are decorated. Offering of fruits and flowers are made to the deity. It is customary to read massages from Ramayana.

The Hybrid representation for the above story is shown fig 9.

3.1 STRENGTH OF HYBRID KNOWLEDGE REPRESENTATION TECHNIQUE.

Human beings use past/previous learning & senses to understand verbal communication and in actual real world events do follow stereotyped patterns. Communication style of each one is different from other and it is quite often when relating events, do leave large amount of blanks/gaps or assumed details out of their communication. This may lead to miscommunication. In real life it is not easy to deal with a system that is not able to fill up the missing conversational features, whereas scripts can predict/assume unobserved events. Scripts can fill the gaps created from incomplete/disjoined observations and can build a sequential information. Semantic net is best knowledge representation technique for representing non event based knowledge with its technical simplicity. Even non technology savvy can also extract information/knowledge from the semantic net.
There are various knowledge representation schemes in AI. All KR techniques have their own semantics, structure as well as different control mechanism and power. Combination of two or more representation scheme may be used for making the system more efficient and improving the knowledge representation. We are trying to build the intelligent system that can learn itself by the query and have a powerful mechanism for representation and inference. The semantic net and script are very powerful techniques in some respects so the aim is to take the advantage of these techniques under one umbrella. The comparison between various hybrid KR techniques is shown in the proposed one.

4. Conclusion

Fig 9. Hybrid representation of story 1.
| No. | Knowledge Representation | Year | Author | Technical Description | Example | Diagram | Advantages | Disadvantages | Applications | Reference |
|-----|--------------------------|------|--------|-----------------------|---------|---------|-----------|-------------|-------------|-----------|
| 1   | KILPION | 1982 | H. N.  | No basis are used and knowledge is represented in the form of sentences. The system uses a simple rule-based inference engine to draw conclusions based on the given knowledge. | ![Example Diagram](image) | ![KILPION Diagram](image) | Overcomes the drawbacks of hybrid knowledge representation systems by providing a more flexible and efficient approach | Cannot reason about knowledge that is not explicitly represented | Neural language processing | [13], [14] |
| 2   | KEBOP | 1983 | T. J.  | It contains a terminological reasoner with a knowledge base that is represented as a set of rules and frames. The system uses a rule-based inference engine to draw conclusions based on the given knowledge. | ![Example Diagram](image) | ![KEBOP Diagram](image) | Provides a more flexible and efficient approach to knowledge representation | Cannot reason about knowledge that is not explicitly represented | Neural language processing | [11] |

### Table Comparison between Hybrid Knowledge Representation Techniques

| No. | Knowledge Representation | Year | Author | Technical Description | Example | Diagram | Advantages | Disadvantages | Applications | Reference |
|-----|--------------------------|------|--------|-----------------------|---------|---------|-----------|-------------|-------------|-----------|
| 3   | Beta | 1987 | Heinz W. | It is the product of Brain and Fokus, and it is a non-terminological language with a terminological component. The system uses a rule-based inference engine to draw conclusions based on the given knowledge. | ![Example Diagram](image) | ![Beta Diagram](image) | Provides a flexible and efficient approach to knowledge representation | Cannot reason about knowledge that is not explicitly represented | Processing and diagnosis on medical data | [12] |
| 4   | MANTRA | 1985 | J. H.  | It is the combination of four different knowledge representation systems: formal, informally terminological, semantic network, and procedural models. The system uses a rule-based inference engine to draw conclusions based on the given knowledge. | ![Example Diagram](image) | ![MANTRA Diagram](image) | Provides a flexible and efficient approach to knowledge representation | Cannot reason about knowledge that is not explicitly represented | Processing and diagnosis on medical data | [9] |
| Item | Knowledge Domain | Year | Author | Title/Description | Example | Diagram | Advantages | Disadvantages | Solutions/Implementation | Applications | References |
|------|-----------------|------|--------|-------------------|---------|---------|-----------|--------------|-------------------------|-------------|------------|
| 1    | Process planning | 2002 | J. F. Zhao | Overview of software using FLEX | ![Diagram](image1.png) | ![Diagram](image2.png) | 1. Modularity. 2. Incremental development. 3. Reusability. 4. Portability. | Constraints must be defined slightly. | Used for trading process model for software. | [5][6][7] |
| 2    | Relational databases | 2003 | S. Y. Lee | VERY-TEC: A knowledge-based system for enterprise-level knowledge management | ![Diagram](image3.png) | ![Diagram](image4.png) | 1. Used to run the knowledge base in concurrent manner. | ![Diagram](image5.png) | Used to run the knowledge base in concurrent manner like operating system. | [2][3] |
| 3    | Agent-based systems | 2000 | P. L. Choa | A Native model is designed for both a purpose for intelligent agents that socially adjust the environment | ![Diagram](image6.png) | ![Diagram](image7.png) | 1. Dynamic. 2. Expressive. 3. Supports multimedia. | ![Diagram](image8.png) | System can work for computer information. | [25] |
| 4    | E-commerce | 2001 | J. Y. Zhang | An extended semantic net | ![Diagram](image9.png) | ![Diagram](image10.png) | 1. Expressive. 2. Good/bad network model to devise an extended knowledge representation. | ![Diagram](image11.png) | The system is not able to make the right decision about the correct network and web server obtained from the extended model. | [3][4] |

Note: All diagrams are placeholders for actual images. The references [5][6][7][2][3][25][3][4] are placeholders for actual citations.
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