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A COMPARATIVE STUDY OF CONCEPTUAL GRAPH AND CONCEPT MAP

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ABSTRACT

The purpose of this paper is to compare two types of graphical models that are widely being used nowadays. The models are called conceptual graph and concept map. Although the names of these models are similar, however, the characteristics of each model are different. A number of 18 papers are compared and important elements for these models are discussed in these papers. This paper is divided into eight sub-topics. The output of this paper is the comparison of characteristics and usage of these two graphical models. In the last part of this paper, a conclusion of the models is made to give better view of it.

Keywords: conceptual graph, concept map, usage, comparison, advantages and disadvantages.

INTRODUCTION

Graphical knowledge representation is similar to traditional knowledge representation, but the results or outcomes are displayed graphically. There are a lot of traditional knowledge representation techniques that are famous for the past few decades, however, lately, graphical knowledge representation techniques had been accepted widely. This is because all the possible outcomes from the model are known and easily being declared in graphical model. Not only that, this model which is represented by a type of map, graph or network is easily understood by human, flexible and also dynamic.

In graphical knowledge representation model, every documents or query is transformed into a graph or a map (Jin and Srihari, 2007). Graphical knowledge representation not only being used in various domains but it is also useful in computer vision with its major goal to classify objects. In this approach, concepts are extracted first in order generate graph based knowledge representation techniques. There are many famous graphical knowledge representation techniques that are widely being used. Such techniques are cognitive map, concept map, conceptual graph, decision tree, ontology, self-organizing map, and semantic network.

The main major issues in graphical knowledge representation techniques are the process to extract concepts from large volumes of data and what is the suitable method to represent such data. The ways the outcome is being displayed can vary based on the methods. This research will create suitable graphical techniques that can be used to represent huge amount of data and complex data rhetorical structures. In this paper, two graphical knowledge representation techniques will be compared based on its characteristics, functions, usage, advantages and disadvantages. The graphical models that will be compared in this paper are concept map and conceptual graph.

CONCEPT MAP

Concept map was proposed by Professor Novak from Cornell University, United States in 1972. Concept map is a graphical way of representing and organizing knowledge in a theoretical concept (Rueda *et al.*, 2008; Kamble and Tembe, 2012). The main goal of concept map is to develop logical thinking and study skills in a hierarchical structure of knowledge (Hung and Hung, 2009; Yang and Liu, 2009). According to (Novak and Govin, 1984), concept map can be used as an assessment method and a research tool which offers more advantages than traditional method. It can also make the learning process become easy. Figure-2 shows an example of concept map in the topic of computer memory.

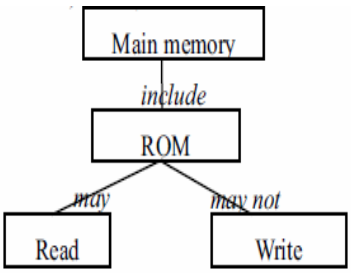

Figure-1. Example of Concept Map (Lin *et al.*, 2002).

From this Figure, it is shown that the map uses is-a relationship which stated ROM as a main memory. Under the concept ROM, there is a characteristics of ROM which is ROM can be read but cannot be written. When creating a concept map, the one who create it will reflect what they know and what they do not know of the map. The map presents the relationship among a set of connected concepts and ideas.

Conceptual graph

Conceptual Graph is a knowledge representation tools which defines the structure of a complex object structure on the basis of semantic networks and Pierce's

Existential Graph. It is a representation of a symbolic representation of knowledge, developed by Sowa in 1984 using the notions of concepts and concept relations (or relations) with the purpose to express meaning. Conceptual graph defines a single ides which cover objects, attribute and action. Conceptual graph is widely used in linguistic processing and was introduced of the combination of Pierce's existential graph and Philmore's semantic network. Conceptual graph can be viewed as a diagrammatic system of logic with the purposes to express meaning.

Conceptual graph (CG) is an example of graph based knowledge representation model that is widely used in text mining along with other domains such as natural language processing, information retrieval, expert systems and knowledge representation (Gonzalez *et al.*, 2001). It is a technique used in knowledge representation developed by Sowa in 1984. CG is a logic based knowledge representation which uses a direct translation of natural language based on Semantic Network and Pierce's Existential Graph (Kamaruddin *et al.*, 2008; Polovina *et al.*, 2005; Gerald *et al.*, 1995; and Sowa, 1984). The main advantage of CG is that it is finite, connected and bipartite between two elements which are concepts and relations (concepts connect only with relation and relation only with concepts) (Kamaruddin *et al.*, 2008 and Gerald *et al.*, 1995) which makes its representation accurate and highly structural. Besides, CG can represent information semantically and extend the knowledge representation method from data oriented low level processing stage to the knowledge oriented high level processing stage Kamaruddin *et al.*, 2008; Zhong *et al*., 2011).

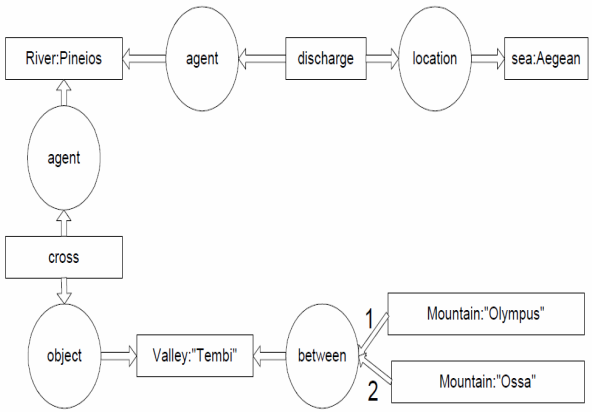

Figure-2. Example of Conceptual Graph (Source: Karapuolos *et al.*, 2008).

CHARACTERISTICS OF CONCEPTUAL GRAPHS

CG is represented in both text (linear form) and graphical format (display form) which consists of two elements; concepts and relations. In CG, square vertices represent concepts and oval vertices represent relation as in example (Figure-1) below expressing "A cat is on a mat":

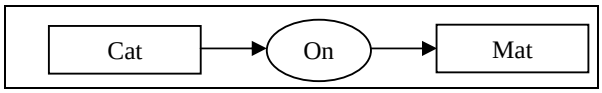

Figure-3. Example of Conceptual Graph.

Concept is defined as entities, attributes, states and events whilst relation is the relationship between concepts. Basically, each concept in a conceptual graph represents only one single idea. Relation is indicated by a bidirectional arrow.

CHARACTERISTICS OF CONCEPT MAPS

Concept maps is defined as a model of current knowledge about the world in a given domain and given context (Albert and Steiner, 2005). Compared to other graphical model, concept map provides a more natural way of expressing and presenting domain ontologies.

In a concept map, the ideas and information (concepts) are represented as boxes or circles which is connects with labeled arrows to connect the concept. Concept map is represented by a set of concepts and a set of relationship (or relations) between the concepts. The concepts are labelled as a directed graph with the vertices (nodes) representing the concepts and the directed and labelled edges (arcs) between it representing the relationship between concepts. Normally, concept map is represented in an is-a, and part-of relationship.

When two concepts are combined, the link relating the concepts are called proposition. The process of visualizing these relationships among different concepts is called concept mapping.

ADVANTAGES OF CONCEPTUAL GRAPH

The main advantage of CG is that it is finite, connected and bipartite between two elements which are concepts and relations (concepts connect only with relation and relation only with concepts) (Kamaruddin *et al.*, 2008; Gerald *et al.*, 1995) which makes its representation accurate and highly structural. Zhong *et al*, (2011) indicates that CG is better than any other knowledge representation such as Semantic Framework, Semantic Web, Formal Logic and others. Moreover, based on Kamaruddin *et al.*, 2008, there are four advantages of CG listed as follows:

a) Simplify the representation and relations of information using labelled arc.
b) Expressions from CG are similar to natural language.
c) Provides accurate and highly structural information then keyword approach.
d) Semantic and episodic association between words can be represented using CGs.

Not only that, CG also is a type of graphical format that is easy for human user to understand. By using CG, it is possible to have the knowledge base's data and its rules represented in the same format, allowing the rules to be checked without the need of any translator tools and

it is easy to construct user interfaces (Kassos, 2011; Amati and Ounis, 2001).

ADVANTAGES OF CONCEPT MAP

According to Plotnik (2014), the main advantages of concept map is divided into five purposes with three advantages. Listed below are the purposes followed by the advantages. Concept map can be used for several purposes such as to generate ideas or brainstorming, to develop complex structures, to communicate complex ideas, to aid learning by adding new and old knowledge easily to the map and lastly to assess understanding and discuss misunderstanding. The major advantages of concept maps are the map are easy and to quickly recognized. Not only has that, the minimum uses of text made if easy for user to find the concept words or ideas. Lastly, the map allows holistic understanding of the concept words.

Disadvantages of Conceptual Graph

The main problem in CG as stated from Zhong *et al.* (2011) is to automatically construct a CG for a given text or sentence. In addition, CG tends to become polynomial and involves with large number of parameters. The disadvantages of conceptual graph also are that computational requirements increase with the size of knowledge base which causes complexity to the process's performance.

DISADVANTAGES OF CONCEPT MAP

The main problem of concept map is the relationships on concept map are sometimes difficult to interpret by novice users. If the concept map are generated wrongly, it may distort the important relationship and the map can be difficult to read. Since concept map is being represent in a simple way, concept map may be lack of detailed semantic meaning. User may only know the basic information of the map without knowing deeper understanding on the topic in the map.

Comparison of conceptual graph and concept map

The differences of conceptual graph and concept map are best described using Table-1 below.

Table-1. Comparison on conceptual graph can concept map.

Characteristics	Conceptual Graph	Concept Map
Definition	Conceptual Graph is a knowledge representation tools which defines the structure of a complex object structure on the basis of semantic networks and Pierce's Existential Graph.	Concept map was proposed by Professor Novak from Cornell University, United States in 1972 as a graphical way of representing and organizing knowledge in a theoretical concept
Purposes	Use as a reasoning, knowledge representation and natural language semantics.	Use to stimulate the process of ideas generation (brain storming).
Elements	Uses first order logic in the graph.	Uses concept mapping to represent relationship between ideas.
Difficulty Level	More difficult than concept map since it involves specific elements in the graph.	Less difficult than conceptual graph since it involves concept and detailed relationship between the concepts only.
Usage	Conceptual graph is used in language tool, reasoning tool, learning tool and intelligent agent tools.	Concept map is used as creativity tool, hypertext design tool, learning tool, and assessment tool
Advantages	Although the graph is simple, the representation is accurate, and highly structural. It is similar to natural language where it can represent semantic and episodic association between words.	Can be used to illustrate any type of situation or system. The links between the concepts can be one-way, two-way or non- directional. The concepts and the links may be categorized and the concept may show temporal or causal relationship between concepts.
Disadvantages	Difficult to automatically construct a CG .It tends to become polynomial and involves with large number of parameters. Computational requirements also increase with the size of knowledge base which causes complexity to the process's performance.	The representation is really simple. For user to get detailed information, causal relation will need to be implemented in this model.

According to Table-1, these two models that are described here in this paper provide different usages and also difficulty. From the Table, concept map is less complex than conceptual graph. Although the name of these two models is similar, there is a slight difference in its advantages and disadvantages. The advantages of conceptual graph are that is can represent data in a more accurate way. The representation of the model is also highly structures. Conceptual graph can represent detailed information since the representation includes the objects, and also actions of the data. In concept map, any situation can be represented using this model. The representation can happen in one way, two ways or non-directional. The disadvantages of these two models can be explained in that conceptual graph is difficult to generate. The pre-processing phase involves a lot more steps than concept map. The computational requirements in conceptual graph will increase with the size of knowledge base which causes complexity to the process's performance. In concept map, the representation is really simple which lack of causal relation between the data. Therefore, in order to represent complex structure of data and huge amount of data, upgraded version of graphical models need to be implemented which includes together causal relation and can caters higher order language (semantic, and pragmatic information).

CONCLUSIONS

Although these two graphical models are similar in its name, however, the usage and characteristics are different. Conceptual graph is more detail than concept map since it involves concept, the relationship and also the agent (person/object) that is doing the process. Concept map on the contrary will just categorized the concepts into is-a relationship. From Table-1 above, we can see that conceptual graph is more accurate, and highly structural which can be useful to represent complex process, system or situation. In the future, a hybrid version of this graphical models is needed which can represent complex structure of data and can cater higher order language. Causal relation, semantic and pragmatic analysis will be used in the future to cater the problem of most graphical knowledge representation methods which lack of detailed information.

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