

A PROPOSED SYSTEM FOR CONCEPTUAL REPRESENTATION

Shaimaa Salah Abbas¹, Ahmed Sharaf Eldin² & Adel Elsayed³

¹Helwan University, Egypt

²Helwan University and Sinai University, Egypt

³Learning Systems, Inc., UK

Email: Shimaat_it@yahoo.com, profase2000@yahoo.com, a.elsayed@learningsi.net

Abstract. Concept mapping is an evolving approach for knowledge representation. Most of the existing concept mapping tools doesn't allow users to query the generated graph for retrieving concepts, relations or even patterns. In this paper, a system is proposed to create concept maps from normal text. The proposed system consists of a number of stand-alone modules which can operate independent of one another, but the output of some feeds is an input to others. The proposed system produces a dynamic graph that can be expanded and modified. It also allows user to query the graph by searching for specific concept(s) as well as specific relationship type or a given pattern same way like the traditional DBMS. The proposed system uses a graph DBMS (Neo4j) where all concepts, relationships and properties are stored in the graph database. It uses Cypher query language to create, alter, drop and search the graph elements. The generated graph is node-Arc graph. Although cypher language is used by developers because it needs some experience or training, it is much similar to the traditional SQL. For normal users, the interface of the system is very simple and the cypher language can be ready extracted by utilizing the Arrow tool website where the user drag and drop nodes and relationships and also identifies the properties of each node same way like other concept map tools but the difference is that after finalizing the graph, there is an option in the tool where the user can export the Cypher code. then the user can run the exported code into the Neo4j GDBMS.

Keywords concept mapping, knowledge representation, Cypher, query language, database

1 Introduction

Stewart (1979) defined concept maps as a structural way of representing relationships among concepts of a discipline, or a part of a discipline (Stewart, 1979). Stewart highlighted that concept maps, due to its flexibility, are utilized as curricular tools, instructional tools, or as evaluation tools. Novak, Bob Gowin & Johansen (1983) defined concept maps as a research tool and instructional technique that can be utilized for an effective meaningful learning. According to Ausubel's learning theory, the researchers stated that meaningful learning is achieved when learners are able to relate new knowledge to relevant concepts they own (Novak, Bob Gowin, & Johansen, 1983). Construction of concept maps includes the use of labeled concepts framed in circles or rectangles, linking words, that could be prepositions, placed on connecting directed/simple arrows to connect one concept to another, and may include the use of some graphical visualization of concepts (Åhlberg & Ahoranta, 2004). The map is usually organized in a clear simple hierarchy. Most of the concept map researches focus on the construction and development of concept maps (Cañas, Valerio, Lalinde-Pulido, Carvalho, & Arguedas, 2003; S.-M. Chen & Bai, 2010; S.-M. Chen & Sue, 2013; Coffey, Reichherzer, Owsnick-Klewe, & Wilde, 2012; Ke, 2013; Qasim, Jeong, Heu, & Lee, 2013; Valerio Arbizu, 2014) as well as evaluation of concept maps as an effective learning tools (Ben Salem, Cheniti Belcadhi, & Braham, 2013; Jetter & Kok, 2014; Kibar, Yaman, & Ayas, 2013; Kumaran & Sankar, 2013; Watson, Pelkey, Noyes, & Rodgers, 2016). Sharaf Eldin, Elsayed, Nasr, & Thabet (2013) proposed a new tool named ADS (Conceptual, Delivery, Student) for representing concepts and relationships of data models within a given framework. The implemented tool was tested in lectures delivery. Results indicated that the proposed tool was found to be more efficient than the utilization of normal lectures delivery method. Also, the utilization of the proposed tool decreased the gap in exam grades between students with different levels (Sharaf Eldin, Elsayed, Nasr, & Thabet, 2013).

In this study, Graph Databases and Cypher Graph Database Query Language are utilized for the construction of concept maps. In graph database, relations are the main focus of the graph data model. Data is represented in nodes and relationships. Each node represents an entity / attribute. Each node physically contains a list of relationship records to other nodes. Those relationship records in the graph model are organized by type and direction and may contain additional attributes. Neo4j software is one of the leaders of the existing graph databases. Cypher Graph Database Query Language is a declarative pattern matching query language. It has a SQL-like syntax. It was designed for graph traversals. All about patterns in graph.

2 General Research Approach

2.1 The System

The system consists of a number of stand-alone modules. These modules should be able to operate independent of one another, but the output of some feeds is an input to others. In the current study, we started the development of the system by customizing the system to be developed using GDBMS (Neo4j) as shown in Figure 1. A brief description of these modules will be explained in the next sections.

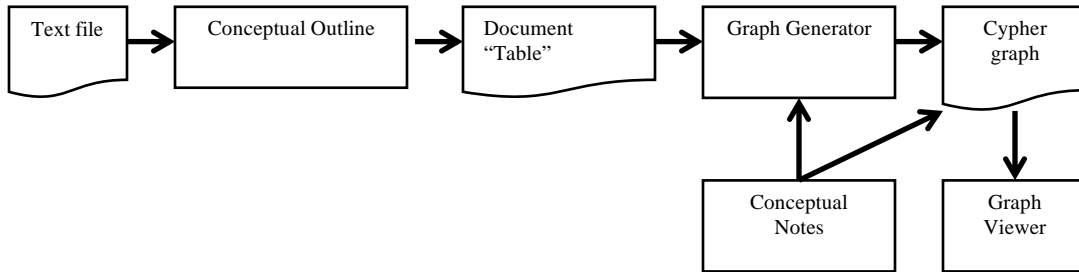


Figure 1: The proposed system modules using GDBMS

2.2 Conceptual Outline

This stage enables a user to read text from a file in order to extract the main concepts and incorporate them in appropriate propositional forms. While the concepts are directly extracted from the text, the relationships used in constructing the propositional forms (the predicates) will have to be provided by the user and are not usually extracted from the text. After generating a number of propositions, the user may want to combine some of them in conceptual statements e.g. causal statements or reasoning statements. In this case, after deciding on the appropriate conceptual statement to use, the user will have to allocate the propositions to the corresponding conceptual construct of the statement. For example, a statement like: ‘after the burner was ignited, hot air started to inflate the envelope of the hot air balloon’ is a causal statement that has two constructs: cause and effect. The first proposition in this statement, therefore, will be allocated to the ‘cause’ construct of the causal statement and the second proposition will be allocated to the ‘effect’ construct. In addition to the construction of conceptual statements, users may like to ‘cluster’ parts of a large conceptual representation in order to make the map more readable. In this study, this module is manually operated. The output of this stage of text analysis, the conceptual outline stage, will be saved in an appropriate MS. Word document.

2.3 Graph Generator and Editor

This module will read in the output of the ‘conceptual outline’ stage, coded into a cypher format, in order to generate the corresponding graphical representation. There are two ways to generate cypher coding of the output of the conceptual outline stage, First, we can use the Arrow Tool website to enter concepts, relationships and other supplementary or complementary information then extracting the cypher code. In the second method, we can use the cypher language to create the concepts, relationships and other supplementary or complementary information. Then we can export the generated code and run it in the Neo4j graph database. The main representation will take the form of a ‘node-arc’ graph. However, the tool will also display the constructs of conceptual statements and any additional clustering information in an appropriate format. This stage of graph generation is computer activated. After the initial display is generated, the user will be given the option of editing the map to manually adjust and refine the graph as required. This stage is referred to as ‘graph consolidation’.

2.4 Conceptual Graph Viewer

Once generated, the user may need to manipulate large conceptual representations in various ways to support the graph navigation process. A set of requirements for this stage is summarized in Table 1. Cypher language enables

the user to manipulate/search/modify/delete the concepts and relationships stored in The Neo4j graph database. Figure 2 and Figure 3 show a sample of the cypher text and the generated graph of an online banking text example.

Table 1: Initial Requirements for the Graph Viewer

Visualization Tool	
Function	Description
Read in graphical data	This tool shall allow the user to import files in cypher format
Select concepts of interest	Users will be able to choose to view the relationships between certain concepts, rather than viewing all concepts at the same time.
Messages of caution	Note that the system should display a message when there are no relationships between the selected concepts.
Select relationships of interest	Users also shall be able to indicate the type of relationship he wants to view at a time. For ex: he can type “Part of” relationship to be viewed this time. The system in this case will show only all the relationships with type “Part of” that exist between any of the concepts.
Select concept of interest	A user can select a focus concept; this means that all the connected relationships to that concept are the ones to be viewed.
Combined selection	A user can have a focus concept while specifying the type of relationships to be viewed along with this concept.

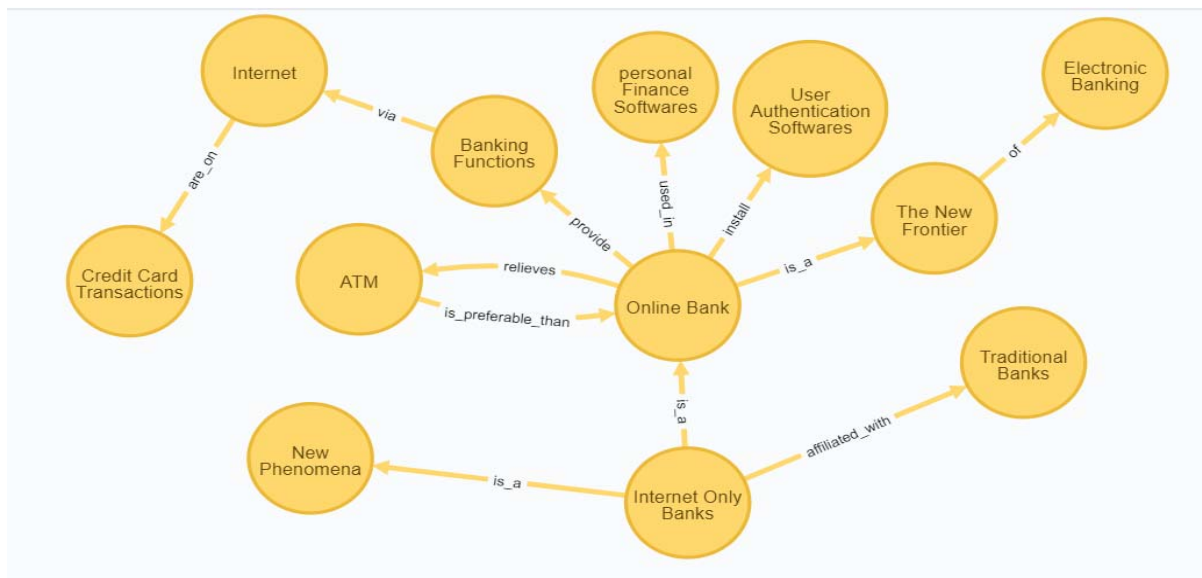


Figure 2: The generated Concept Map for online banking example using Neo4j

<pre> CREATE (C1: OnlineBank {title:'Online Bank' }) CREATE (C2:thenewfrontier {name:'The New Frontier'}) CREATE (C3: electronicbanking {name:'Electronic Banking'}) CREATE (C4: Authentication_SW {name:'User Authentication Softwares'}) CREATE (C5:personal_finance_SW {name:'personal Finance Softwares'}) CREATE (C6:banking_functions {name:'Banking Functions'}) CREATE (C7:internet {name:'Internet'}) CREATE (C8:credit_card_transactions{name:'Credit Card Transactions'}) CREATE (C9:ATM{name:'ATM'}) CREATE (C10:internet_only_banks{name:'Internet Only Banks'}) CREATE (C11:new_phenomena{name:' New Phenomena '}) CREATE (C12:traditional_banks{name:' Traditional Banks '}) </pre>	<pre> CREATE (C1)-[:is_a {roles:['meaning']}]>(C2) CREATE (C1)-[:install {roles:['meaning']}]>(C4) CREATE (C1)-[:used_in {roles:['meaning']}]>(C5) CREATE (C1)-[:provide {roles:['meaning']}]>(C6) CREATE (C1)-[:relieves {roles:['meaning']}]>(C9) CREATE (C10)-[:is_a {roles:['meaning']}]>(C1) CREATE (C2)-[:of {roles:['meaning']}]>(C3) CREATE (C6)-[:via {roles:['meaning']}]>(C7) CREATE (C7)-[:are_on {roles:['meaning']}]>(C8) CREATE (C9)-[:is_preferable_than {roles:['meaning']}]>(C1) CREATE (C10)-[:is_a {roles:['meaning']}]>(C11) CREATE (C10)-[:affiliated_with {roles:['meaning']}]>(C12) /* to query the graph to retrieve all nodes and relations*/ MATCH p=()->() RETURN p </pre>
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Figure 3: Cypher text of the generated Concept Map for online banking example using Neo4j

3 Summary

In this paper, a system is proposed for conceptual representation. The system utilizes a graphical database software called Neo4j and Cypher query language for creating concept maps. The created concept map is dynamic. At any stage, the user can keep adding, updating or deleting graph elements and extend the graph. The proposed system allows the user to query the graph to search for specific concept(s) as well as specific relationship type or a given pattern. There are two ways to query the graph. In the first way, the user can use the interface of the software to select specific concept or relationship type or the entire graph. This is beneficial in large graphs where there is a wide range of concepts and relationships stored in the graph database. It gives the user the ability to concentrate on a specific part of the graph instead of looking at the entire graph. In the second way, the user can use the Cypher Query Language to conduct some complicated operations such as searching for specific pattern or use a combination of query operations to retrieve specific results.

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