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# A PORTAL OF KNOWLEDGE BASED ON CONCEPT MAPS

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**Abstract**. In this research we intend to create an integrated environment consisting of a set of tools able to support different activities using concept maps. These activities range from education to knowledge engineering applied to the knowledge management. In the first case, maps will be used to assess processes of knowledge of students. In the second, maps will be used to generate concept models to be the basis for developing domain ontologies that, associated with architectures of software agents, will carry out intelligent tasks for knowledge management. We emphasize the use of technological resources to support educational practices focused on meaningful learning and, more specifically, we delimit the problem of the use of technological resources in order to promote the redefinition of textual contents using graphic representations in the form of concept maps.

## 1 Introduction

In recent years, the emergence of a number of basic functions for concept maps has made their construction quite easy. Among these functions, publishing and sharing of maps with the help of the computer have become quite popular. More recently, we found a considerable increase in production of computational tools for the automatic construction of maps, directly from data sources, for example, from unstructured texts. In fact, 10 of 15 approaches to automatically build concept maps were published in the last three years, the majority (93.34%) concerned with education (46.67%) and analytical purposes (46.67%) (Kowata, Cury & Boeres, 2009).

In their learning processes, students in more advanced stage usually make connections between different fields of knowledge. To perceive them in a text is often a tedious task for a teacher. In maps, these bonds are easily perceived through what we call "cross links", which are links between concepts of different domains of knowledge. When students work in small groups and cooperate to learn a given subject, favorable cognitive and affective results emerge. Among a huge range of applications, concept maps help students to learn more meaningfully. The concept maps also help teachers to visually indicate and summarize key concepts and their relationships. Maps also assist groups in collaborative tasks. In this latter case, concept maps assist in the communication between members and in the management of project development, and they facilitate the capture and use of the meaning of the issue for each student.

In primary education, the maps also bring some advantages over the texts. Being ludic, they help the child build, pleasantly, knowledge in an interdisciplinary way. For not relying on grammar rules, they have the potential to help children with difficulty of constructing sentences.

And finally, we can say that the maps help students to learn how to learn, i.e., the best way of learning build, correct and expand the knowledge of the maps previously constructed.

## 2 Project Goals

We think in creating an integrated environment consisting of a set of tools able to support different activities using concept maps for educational and knowledge engineering purposes. In short, this environment will allow, from a technological point of view: 1) the comparing of maps of the same domain of knowledge; 2) the merging of maps from the same domain; 3) the automatic generation of maps from unstructured text; 4) the semi-automatic generation of concept models that will give support to the development of domain ontologies to be used for knowledge management applications.

It is worth noting that the proposed environment will also be useful in the context of knowledge construction by students. Thus, we can easily interfere with such constructions and cause major imbalances in the students´ processes of conceptualization.

### *On the nature and use of concept maps*

A concept map is a set of logical propositions that define a context. We can also say that a concept map is a set of facts that also depicts the structures of these facts. To illustrate the idea, let's take some examples. One child writes the text "Claudia is beautiful." It can be represented by a simple concept map containing the triple

<Claudia> <is> <beautiful>. As far as we know, neither “Claudia” nor "beautiful" are concepts. However, the sentence represents a knowledge built by a child and that may be important when we want to follow the cognitive development of that child. This is also the case with " a bee can fly," "John loves Mary" and countless other sentences. On the other hand, for the text "Teachers are enabled to give certain subjects," a concept map containing the triple <Teachers> <are enabled to give> <certain subjects> can easily be constructed. In this case, the map closely follows its nature, creating a relationship between concepts. But in either case, we have maps as a set of logical propositions. There are, however, instances where a word may suggest the two situations. For example, “Alan Poe is a writer” can give an agent the understanding that there is a profession called “witer” and that “people” can have this profession.

Depending on the approach we use the same text can generate two different maps: a map containing any logical propositions or a map containing strictly logical propositions that define relationships between concepts. So, these two types of maps serve the following purposes:

- Concept maps to represent processes of individual and collective learning, or maps for educational purposes;
- Concept maps for conceptual modeling. Here, maps will serve as intermediate representations in semi-automated processes for the construction of domain ontologies to be used in knowledge management activities.

### *2.1 The use of maps beyond education*

Recently, the knowledge engineering has used ontologies (Section 3.4) for knowledge management. Knowledge management is functionally engaged in the generation, storage and dissemination of knowledge within a corporation. It encompasses different activities, ranging from techniques to human resource techniques related to information systems (Bock, Schlömmer, 2004).

Ontologies, in turn, to be handled by computers, have been represented by description logics. They have played an important role in knowledge management with regard to building intuitive human-machine interfaces, intelligent information retrieval, among others. Ontologies are used to capture knowledge about some domain of interest.

Why use concept maps in the context of knowledge management? Concept maps are considered a successful tool to share knowledge of a given domain. They are also good to communicate consensus and to help the communication between domain experts and knowledge engineers (Starr, 2009).

## 3 Activities and tools

For the full use of concept maps it is necessary to develop adequate technological support. Educational needs link paths related to the technologies described as follows:

### *3.1 Comparison of maps*

Comparing maps is very costly to the teacher. He/she must read the entire map of the student, check each connection between the concept as well as concepts themselves, understand their meaning and, after all this, check whether the student has represented the contents of the map according to what he expected. When thinking about maps with more than ten concepts, the possibility of overloading of connections and relationships between the concepts might disturb the teacher´s analysis.

An advantage of the comparison of maps is that it makes possible to group the students according to their ways of constructing the maps. By comparing a set of N maps made by N students it might be possible to group them in such a way that the students, whose maps are similar to one another would stay together. Another possibility could be assembling groups with greater discrepancy between them to achieve greater diversity (cooperative groups).

By comparison we can also classify documents. If we have a program that turns texts into maps, we can group those, who deal with the same subject or have approximately the same focus.

For example, a teacher gives an exercise during a lesson. Students respond individually to the exercise in textual form. For each answer, a concept map is constructed automatically by a tool. From the collection of maps built, another tool compares them in regard to their similarities and their differences. Groups, therefore, can be made. By comparing maps it is possible to identify similarities and differences of the activities of several

students. Thus, it is possible to form discussion groups of two kinds: 1) one composed of apprentices which gave similar response to a given problem (convergent), 2) one composed of apprentices who have different responses (divergent). Groups of convergent nature can improve their answers while divergent groups can change their opinion about their initial belief or strengthen it.

### *3.2 Automatic Generation of maps*

Even with the popularization of many techniques of construction and the existence of diagramming tools, the construction of concept maps from scratch still proves difficult (Chang *et al*. 2008). The time and effort spent in acquiring knowledge for the development of a concept map are still challenges (Lee, *et al.*, 2009), especially in areas of higher education and research (Valerio & Leake, 2006) and dependent on specialists (Chang *et al*., 2008).

Our research proposes an approach for the automatic construction of concept maps from texts. The approach we propose emphasizes the fidelity to the original text, ensuring the comprehensibility of the concept maps constructed. Thus it needs to face the challenges involved in the handling of natural language, in addition to the particularities of the Portuguese language. So, the adoption of methods and techniques that restrict the semantic loss when mapping text-to-concept map, without compromising the essence of content and without limiting the human reading, is crucial to the success of this approach (Kowata, Cury, Boeres, 2010).

### *3.3 Merging of maps*

The scenery here may be that of a classroom, where many students draw concept maps to a given problem. Next, we may want to know, what knowledge the group has, as a whole, about the problem domain. If we gather all the maps constructed into a single map, we get the desired response.

Joining maps, we can not only identify the prior knowledge of students, but also relate it to the new level of their understanding. Similarly, it is easier for the student to create the "cross links" or create relationships between different domains. Merging maps inevitably passes by comparing maps, as mentioned in the previous section. Once the similarities are identified, we can combine the maps mainly considering their differences.

In the context of knowledge management, by merging maps, we can match the knowledge of several experts to build a map with the important elements of a given domain, during an activity of domain analysis.

### *3.4 Ontologies from maps*

Concept maps and ontologies are very similar to each other, especially structurally. Therefore, importantly, we believe it is possible to create ontologies from the maps. The representations on maps, however, do not require the same rigid formalism as those in ontologies. Given their graph topology, both can be easily processed by computers. In addition, their propositional structure is very similar to the structure used to represent properties in description logic. Starr (2009), Zouaq (2008), Gomez-Gauchia *et al* (2004), among others, suggested creating a procedure to support the transformation of concept maps in a knowledge base on description logic.

Here we are interested in ontologies as representations of knowledge particularly in support of learning and in knowledge management. Using agent-based architecture, ontologies can also guide the construction of virtual environments to support learning and cognitive modeling of students, considering their independent productions and those resulting from their cooperation and collaboration. Ontologies may also be useful in supporting the construction of grammatically correct texts.

### *3.5 System general architecture*

Figure 1 gives a general architecture of the proposed system. All databases elements, except for users, are arranged by specific areas. The maps will be generated in a format compatible with the CmapTools editor. The software agents will help as much in resolving ambiguities in the text as in extending of ontologies.

## 4 Conclusions

Much of the project has been developed as tools resulting from dissertations or undergraduate work. So far we have prototypes of the following tools:

- Map comparator (Lamas *et al*, 2008). In this work, concept maps are described as graphs and the comparison is performed using graph matching, more specifically, graph isomorphism.
- Automatic generator of maps from unstructured text in Portuguese (Kowata *et al*, 2009,2010; Kowata, 2011). In our case study, we note that the methods and techniques combined with the linguistic search algorithms allowed the definition of a viable solution for the construction of concept maps from text in Brazilian Portuguese.

In addition to the prototypes mentioned above, the Map merger is in an advanced stage of construction. Regarding the automatic generation of maps for ontologies, we are still in preparation of a specification for the requirements.

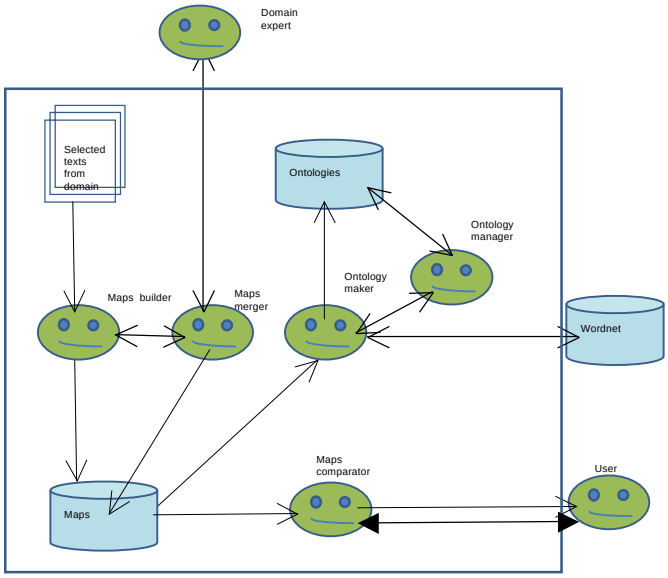


**Figure 1**: The architecture of the proposed system.

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