Dynamic Reconstruction of Concept Maps

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INTRODUCTION

Within the e-learning context, the importance of developing concept maps—and, therefore, of developing software tools that support their design and utilization phases—clearly derives from their connection with the theme of the ontological structure of knowledge, which is founded on graph theory and which determines, according to rules defined by Joseph Novak (Novak & Gowin 1984), the node elements and the relationships with the arcs. However, concept maps cannot be described simply as a product of the evolution of the concept of content indexing, since their role encompasses not only the organizational function of knowing but also the vehiculatory function, assuming that there is a specific clarificatory task within the cognitive context that is different from, and additional to, the navigational support.

Research into concept maps takes its cue from the world of education (Novak, 1998), in which their significance is clearly recognized. On the one hand, the characteristic representation of the tissue of relationships that links the concepts together constitutes an extremely interesting expressive approach in terms of its capacity to focus attention of learners, whereas on the other hand—and mainly within the framework of constructivist didactics—the environments used for the ontological mapping of disciplines can be deployed as a locus for collaboration in exploring the cognitive and negotiative context. Both of these aspects are further promoted by e-learning (Canas, Hill, & Lott, 2003; Canas, Hill, Carff, Suri, Lott, & Eskridge, 2004), which uses concept maps not only in the representation of knowledge within a range of structural Learning Object models (Information Maps, Generative Learning, Workflow-based Learning) but also in the indexing of communication flows (Barabasi, 2004), and within interactive environments geared towards the collaborative construction of knowledge.

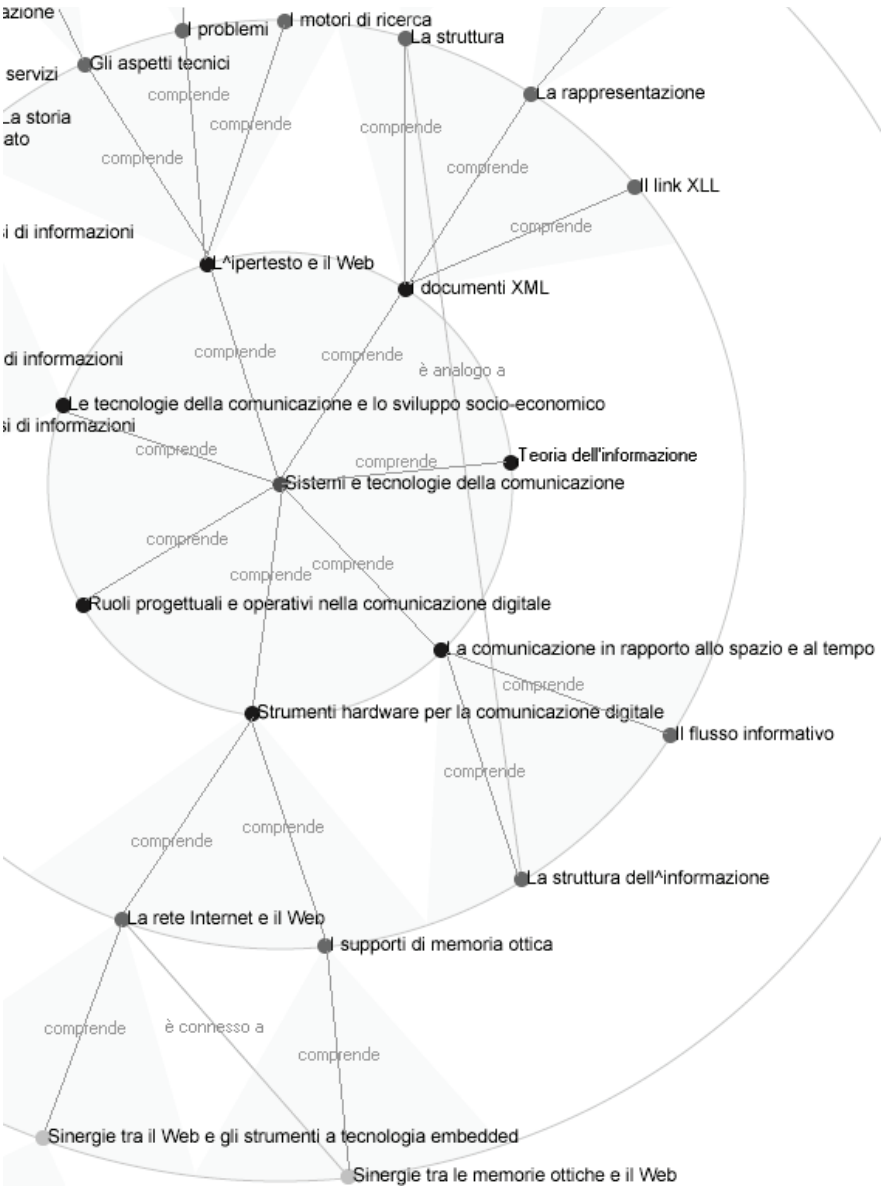
MAPS AS DYNAMIC DOCUMENTS

Concept maps, then, are used to represent cognitive structures in order to support the management of knowledge that is particularly significant in terms of the communicative and educational potential of its content (and also to explore and exploit that content collaboratively), but in order to optimize its communicative effectiveness and efficiency (Tamayo, 2004) it is necessary to use software tools that allow for its automatic reconstruction/updating and also permit visualization from multiple points of view through the application of rigorous, automatable, graphic representation algorithms (Kremer, 1994), that can take the place of the onerous task of manual design using graphic tools. Concept maps reconstructed using automated procedures are, therefore, dynamic (Tillman & Wissmann, 2004), meaning that they are part of a far larger set of "dynamic documents", which are documents produced in real-time at the user's request and which introduce information extracted from databases within formatted templates (most Websites include dynamic documents generated using various technologies—search engines being among the most common examples of dynamic content).

It is the sheer complexity and centrality of the representational aspect within the context of knowledge management that requires the use of tools which can graphically reconstruct concept maps through automated actions that based on the information contained in the Knowledge Management support databases (and, therefore, in large part, by the organization's Data Warehouse) and using online technologies are able to reproduce the schema of elements and relations in any situation in which this function is necessary, without recourse to manual operations (Pedroni, 2005).

Other tools, which go beyond the limits of manual design, allow for the dynamic structuring of online concept maps: this research has produced four models of automatic composition for concept maps, corresponding to four different reconstruction algorithms and to four different graphical forms. Some of these models

Figure 1. Proximal development in concentric circles graph



can be reconstructed on the basis of a predefined or random distribution of concepts within the documented space. Some of them feature two-dimensional graphics, whereas others have three dimensions but, in any case, as virtual objects, they are susceptible to variations in the viewing angle. These models, which have online functionality, collect data from a DBMS and compose images of maps that can be viewed in the browser and are responsive to the input of information, meaning that they are capable of supporting functions of navigation or didactic interaction, either in SVG format, or using a vector graphics mark-up language derived from XML and produced as standard by the W3C Consortium, or inside a Java applet. Within the context of training processes, their use is linked in particular with the functions of content structuring and organisational aggregation of the documents and learning objects to support the teaching activity.