

Extended Concept Mapping Tools for building sharable content objects for Digital Repository Applications

K. Jayakumar
Director IT

Dept. of Administrative Reforms and PG
Govt. of India

Ruchika Barua
System Specialist

World Bank Project for
Capacity Building for Good Governance

ABSTRACT

Concept mapping tools empower experts to play an active role in the knowledge capture process and enable build *knowledge* models with interconnected sets of linked concept maps and resources of the domain.

Knowledge models and digital repositories are intended to be used as a means for sharing knowledge among domain experts and users. They may also provide functionalities that facilitate and interface ingenuous capabilities that enable machines perform autonomic functions such as metatagging, building of concept maps, intelligent search and retrieval, knowledge inference and so on.

This paper describes an approach employing extended concept maps in the context of urban municipality reforms and details its capabilities to provide support to users for building the knowledge repository application. The approach facilitates encapsulating of knowledge elements of the domain, meta-tagging concepts to enable repurposing content, linking concept maps, adding propositions, annotations and handle multidimensional data including images, spatio-temporal data, generation and presentation of on the fly graphics and such other visualizations to enhance human cognition. The targeted purpose is to present explicit and tacit knowledge captured earlier in the repository, adapted to user profiles and facilitate collaboration and knowledge sharing. The features also enable content authors to contribute effectively to fill knowledge gaps that may be evident during interactive sessions using the knowledge repository.

The proposed approach provides a scaffolding for experts, as they build concept maps collaboratively on the network, link their maps to others, and decide how to extend their knowledge models with a view to encapsulate knowledge as sharable content objects and their presentation adapted to various user profiles.

The approach also enables mining of related information and propose information to aid the user capture knowledge and enhance the quality of contents of the digital repository.

The paper begins with a brief summary of the concept mapping process and elaborates on the mechanisms that can be associated with the digital repository. It describes the approach, interactive features and performance of the extended concept mapping tool for providing intelligent, adaptive features for dynamic views of the contents of the knowledge repository. It closes with a discussion of next steps for refining the proposed approach.

Keywords

Concept mapping, knowledge acquisition tools, knowledge engineering and modeling methodologies, knowledge management environments, strategic problem solving

1. Concept Maps

Successfully capturing and sharing expert knowledge depends on the ability to elucidate expert knowledge and to represent it in a form supporting examination by others. In light of the difficulties in capturing knowledge through traditional knowledge engineering processes, there is considerable interest in facilitating the knowledge capture process, in particular through methods that allow more direct and natural interactions between system and expert .

Concept maps represent concepts and relationships in a two-dimensional graphical form, with nodes representing concepts, connected by links representing propositions. Concepts are represented with the most inclusive, most general concepts at the top or as the central focus and the more specific, less general concepts and details arranged hierarchically below or in a collapsible network form spreading around the central focus.

An important characteristic of concept maps are the "cross-links." which represent relationships (propositions) between concepts in different domains of the concept map. Cross-links help to see how some domains of knowledge represented on the map are related to each other.

As a knowledge capture method, concept mapping is appealing for its elegant cognitive pattern enabling better comprehension. Experts can construct knowledge models of their domains directly and iteratively in a collaborative manner or actively participate in assisted knowledge elicitation processes for facilitating knowledge capture and sharing, by producing representations that are easily understood by others. Construction of concept maps are often useful in the context of specific questions for which answers are sought or some situation or event that is attempted to be understood through the organization of knowledge in the form of a concept map.

In the context of enhancing value of the services that are associated with a knowledge repository, it would be useful to facilitate users in progressively re-creating cognitive mental models on the fly, in an order and manner that they perceive as useful using the concept maps which had been constructed earlier through collaborative efforts of knowledge workers and domain experts on the internet.

2. Extended Concept Maps (X-CMap)

As a value proposition for users of the knowledge repository, it is important that the concept maps must be associated with metadata, graphics, GIS, text descriptions and web references. Each node in the concept map also represents a concept object which encodes such information and appropriate user tools for viewing them.

The concept object itself is a self contained knowledge element with information about data, processes and systematic functions contained within. The concept objects are used within the overall meta-model solution framework which enables use of such concept objects for knowledge building, exploration and problem solving adapted to user requirements.

Concept nodes have the knowledge element contained in XML format and can be associated with URL's, geo-spatial data, images and text windows which activates when a selected node is clicked or with a 'mouse over'.

APIs (Application Program Interfaces) built around the concept objects allow applications to access the data of other systems, while at the same time accommodating inhouse models. These APIs define the information available in one knowledge domain/system and how another domain/ system should access and interpret this data.

Fig 2.1 to 2.3 show the extended concept maps with the windows displaying associated graphics when invoked by a 'mouse over' on the concept node.

3. Knowledge Exploration and Representation

Knowledge representation is often characterized as an optimized depiction of a number of possible ways in which to present the concepts and their interrelationships. The domain exploration may be enacted in the users mental model by following several strategic shortcuts and viewing from multiple perspectives, often by expanding on concept nodes or collapsing them to vary the patterns of associations. Insights, experiences and past associations are frequently used during the knowledge build process as also in the use of the knowledge model for problem solving. Knowledge building is increasingly seen as a distributed and collaborative activity.

Design and development of a strategic intervention for problem solving within a knowledge domain is a complex activity. The process for design of solution is often characterized as a top-down breadth-first search of the space of possible solutions. Problem solvers need to be adept at generating and evaluating a range of candidate solutions to a problem.

The manner in which the knowledge exploration and problem solving process proceeds determines the optimality of the solution that is constructed to the initial problem specification.

Fig 3.1 gives the conceptual block diagram of the digital repository and how extended concept maps could be used with a knowledge repository.

Collaborative building of a knowledge repository and its refinement involves early commitment to, and refining of, a suboptimal representation of the domain. Strategic knowledge is usually developed through trial and error iterative mode. Much of what the knowledge builder knows is gained through feedback on experience.

4. Processes and Mechanisms for Problem solving in the Knowledge space

Mechanisms for reuse and repurposing of knowledge when used in a knowledge repository is seen as offering a method for ensuring that innovation is captured and disseminated quickly, helping the organisation to remain at the leading edge. Knowledge workers need to be skilled in reusing the concept objects and preparing their own knowledge extensions, solutions to facilitate reuse by others.

The affordances of new technology and geographic distribution of resource persons, experts and knowledge workers provide greater opportunity and motivation for knowledge building and its use in problem solving to be conducted, at least in part, as a collaborative, distributed activity. A large amount of current research is concerned with developing tools and methodologies to support problem solving teams separated by space and time

XC-Map enable such collaborative and networking process to facilitate professionals involved in constructing, elaborating and evaluating a range of candidate representations and solutions. Roles, responsibilities, aspects, features, associations etc between and among concept objects gets defined iteratively with the use of XC-Map. Collapse and expansion on the concept nodes, reorganisation of concept nodes with a specific node in focus is possible.

Preparing users for using knowledge repositories is much more than enabling them to access the necessary domain knowledge. Users may also need to facilitate the processes of tacit knowledge capture using mechanisms and tools such as XC-Map that are provided as part of the knowledge repository. The proposed approach will promote the development of skills required in professional practice, in particular for

- ? Learning by gaining feedback on experience.
- ? Evaluating alternative approaches to the same problem.
- ? Reusing knowledge contained in past cases, and facilitating the reuse of solutions.
- ? Working in a collaborative and distributed setting.

Much of the knowledge used in professional domains is tacit, knowledge-in-action. This represents the "know how" of how to put knowledge into practice. In order to accumulate knowledge from experience, there is a need to gain feedback on the professional work undertaken by others or by the user in the past and to effectively reflect on such insights.

The nature of the problems solved by the users, and the range of ideas contained in the cases, promotes the view that there is no single right answer to a problem, and the design process involves interpreting claims made in solution cases, assessing different approaches to the same problem and making trade-offs between them.

5. Capabilities and Performance of the XC-Map

The performance capabilities of the XC-Map can be briefly summarized as under :

GUI with Dynamic Content presentation

It enables packaging information in the form of interrelated concept objects for presentation to multiple user profiles. Profiling users based on who uses the web pages, in what manner and customizing presentation of contents in the web for better appeal and usage value to users can be based on information collected as part of the interactive browsing behavior or through intelligent interfaces using neural networks.

Creation of Ontology and Metadata for various Domains :

The XC-Map facilitates the creation of an ontology within a specific domain - as an explicit representation of important concepts and relations within such domain.

Construction of Knowledge Models –

The models constructed with XC-Map during collaboration are not only shared mental models of the problem, but also robust dynamic models that act as "holding environments" for a range of ideas that could otherwise be difficult to fully articulate and share.

Interpreting Information - Information when found, can be often misinterpreted in the absence of associated context, supporting data, framework, assumptions, etc. Information and contents to be interpreted with their true meaning will require the understanding of these associated facts and details and their pattern. Such reliable interpretation would be possible within the solution framework offered by XC-MAP.

Integrating and Re-Organizing Information - Putting data together for new analysis requires the integration of multiple perspectives. Comparing perspectives and identifying their similarities and differences is a time-consuming task if accurate enabling mechanism such as concept objects, metadata schema etc are not as accessible as the source data itself. XC-Map overcomes this limitation.

Evolving concepts with rediscovery of facts and their analysis - Links between different domains of knowledge on the map help to illustrate how these domains are related to one another. The XC-Map facilitates revision of the maps, positioning of concepts in ways that lend to clarity.

Analysing concepts from multiple perspectives "learning style" differences in cognitive abilities are, to a large extent, user dependent and the mechanisms that aid

knowledge management and their use for problem solving would need to factor such differences in the patterns of learning. With its XML based architecture and object oriented emphasis with enabling features for adaptive dynamic presentations, the XC-Map offers considerable opportunities for knowledge builders and problem solvers. The tool can be used in isolation or interfaced ingeniously with the overall digital repository design

6. Future Extensions

Dynamic character to knowledge repositories are made possible with the use of languages like asp, jsp, CGI, perl etc; tools and mechanisms such as XC-Map; neural network implementations for intelligent interfaces and implementation of standards such as SCORM for repurposing content. The present work will be extended for exploring enhancements for use metadata and implementations with neural network and use of SCORM standards.

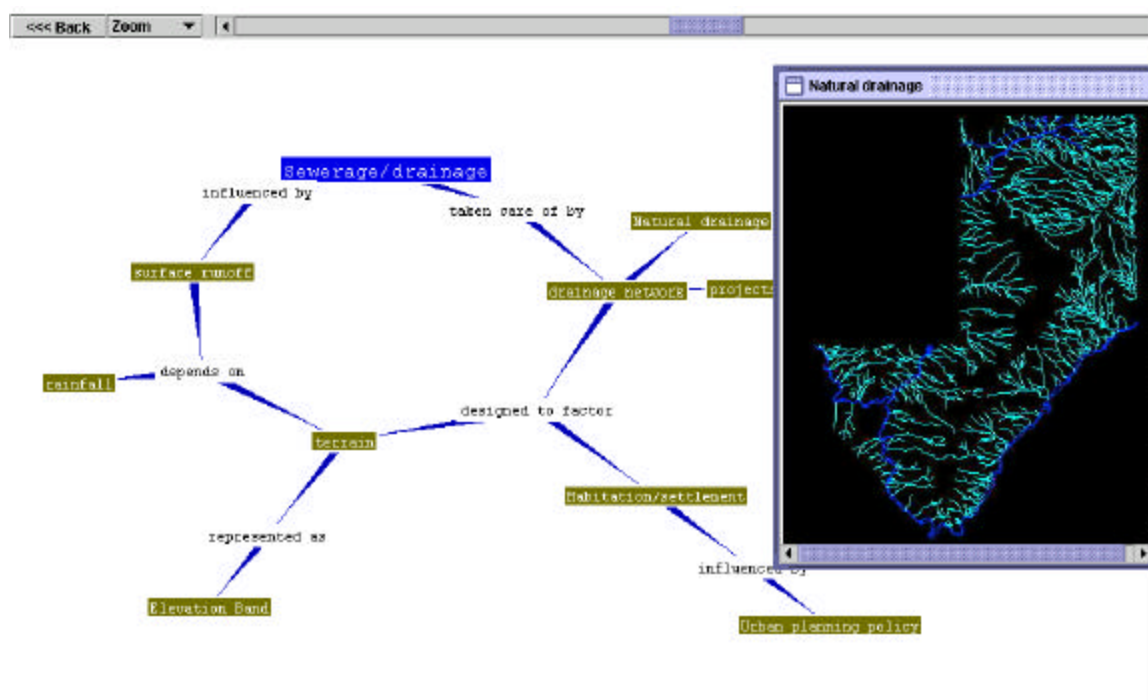


Fig 2.1 Natural Drainage information associated with the concept map on sewerage/ drainage

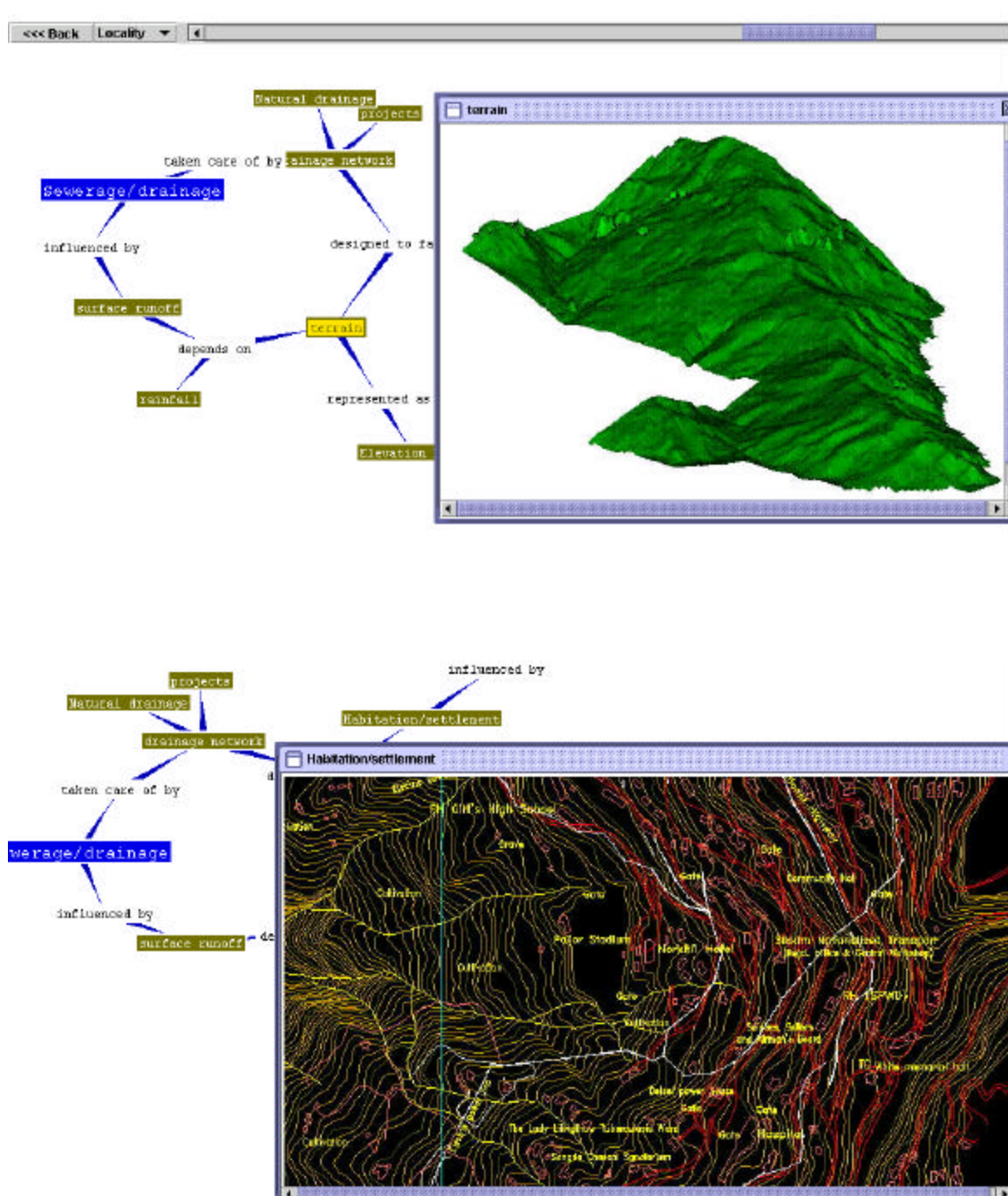


Fig 2.2 Information on digital terrain and habitation/ settlement associated with the concept map

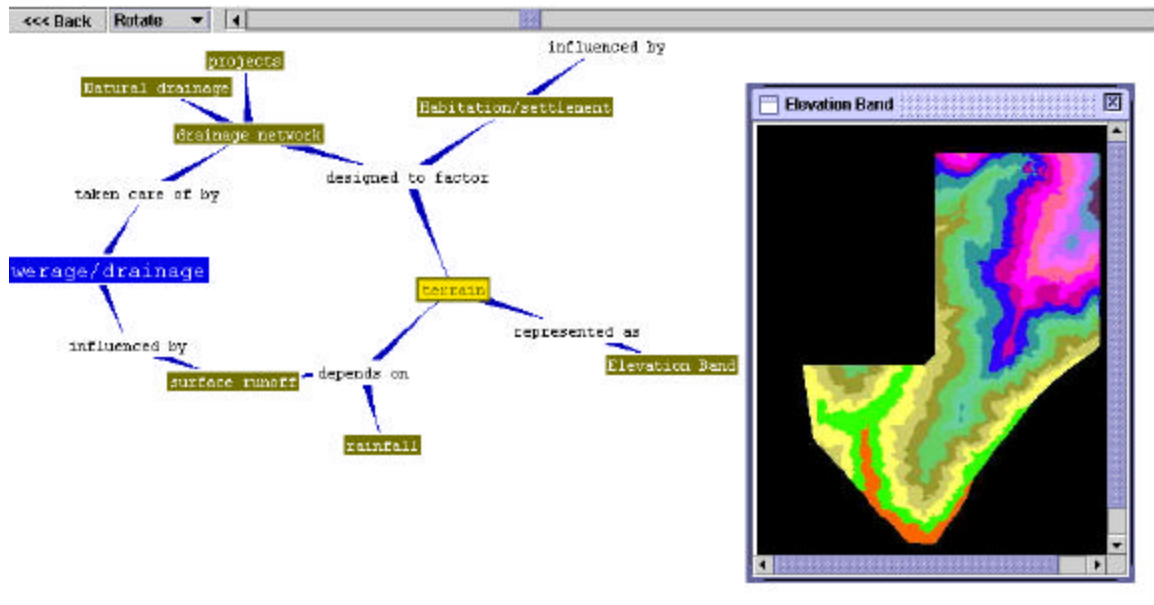


Fig 2.3 Thematic maps used with concept map tools in Knowledge repository

GUI			Digital Repository
Search Engine	X-CMap		
Content Objects			
APIs	Metadata	Document Management System	
XML knowledge elements	Contents		

Fig 3.1 Conceptual block diagram of the knowledge repository