

# Providing a sophisticated TM software tool to support development of a TM-based system for managing melanoma cases images

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*Abstract:* There is an ongoing research effort toward the direction of employing Semantic Web technologies, in order to improve knowledge representation and management in medical domains. Topic map (TM) standard is a semantic web enabling technology. In this framework, a TM-based system, that manages melanoma cases images and their related data, may play a vital role, in order to create a system that encompasses imaging diagnosis support utilities in the sensitive field of malignant melanoma. In order to support the development of such a system, the design and implementation of “Yellow TM” aiming to provide a sophisticated TM software tool, is presented.

*Key-words:* Topic map, Editor, Visualize, Query support, TM schema, Navigation, Retrieval

## 1 Introduction

Semantic Web is offering the mechanisms for efficient knowledge representation, in a structured and semantic way, enabling thus enhanced reasoning support that is required for integrated knowledge management systems [3,30]. Medical field and efficient management of medical data and knowledge that these data inherit, is a demanding research area. There is an ongoing research effort toward the direction of employing Semantic Web technologies and tools, in order to improve knowledge representation and management in medical domains [7, 31].

Developing systems that use ontologies and semantic web standardized languages is expected to achieve reusability, exchangeability and interoperability of knowledge [2,29]. Furthermore semantically rich systems can offer refined retrieval and navigational functionalities, as knowledge is represented in a structure and exploitable way [13, 18].

In this framework, our research effort, aiming to exploit the potentials of using Topic Map (TM) standard as a semantic ontological representation form, in order to create a TM-based system for managing dermatological images and related diagnostic data [16, 21, 26]. Topic maps is a new semantic – ontological standard to information organization, which allows to describe knowledge and to link it to existing information resources [11,12,33]. As TM are defined using well structured, internationalised and extensible

interchange syntax, they enable modelling and representing knowledge in an interchangeable form [19,22]. TM are also being described as a semantic web enabling technology for the semantic web and by design, they are able to represent any kind of ontological framework [32].

Toward the goal of developing a functional TM-based system for image indexing and retrieval, aiming to manage melanoma cases images, it has been realised that in order to create a real world application based on TM technology, there is a need for powerful tools for creating and managing TM [9]. The boundaries, on which features should be included, are defined and main design principles and important issues for the design of an efficient TM tool are outlined. In the following sub sections we present the design and implementation of “Yellow TM” aiming to provide a sophisticated TM software tool, in order to support development of TM-based knowledge managements systems and applications.

## 2 Introducing TM- based approach

As it has been outlined earlier, there is a growing concern, among medical informatics researchers, to provide distributed knowledge bases, in order to improve knowledge representation and management of medical data [27, 29]. In this framework, our research interest focuses in the sensitive area of dermatology domain and in particular on malignant melanoma

cases. As there is a steady increase in incidence of malignant melanomas worldwide, there is an intensive need for developing tools to support early diagnosis [4, 5]. It has been realised that new tools and methods are needed to manage and use the increasing amount of visual information that is produced in that field [8,21]. A TM based system that manages melanoma cases images and their related data, may play a vital role, in order to create a medical system that encompasses imaging diagnosis support utilities in the sensitive field of malignant melanoma [13,15].

The ISO Topic Maps standard (ISO) defines an abstract model for representing many different types of information structure, and an XML-based interchange syntax for that model (XTM) [11,12,33]. Although Topic Maps allow organising and representing very complex structures, the basic concepts of this model – topics, occurrences and associations - are simple [19]. Topic maps enable the structuring of unstructured information and the creation of an abstract knowledge layer which embodies the knowledge structure above any kind of information resources [6,20]. Topics and associations define the knowledge layer while topics and occurrences define information layer [20]. The representation and utilising of medical data by using topic map structures assures interoperability among various applications. Employing topic map may also support enhanced navigation and information retrieval functionalities and advanced reasoning support [1,16]. Nevertheless in order to realize and exploit the potentials of this new technology, the need for software development to manage topic maps is indispensable [1,22]. A considerable number of commercial and non-commercial implementations of software tools, that support TM technology have already been developed. These tools should assist TM developers in generating topic maps, as well as in efficient management; query and storage of TM based knowledge bases. After a short evaluation of existing TM tools, we haven't been aware of the existence of a complete free TM tool that provides all the features that could support TM developers [9]. There is still place for a powerful and easy to use application tool for TM management, and this was the motivation key for this work.

In order to set the boundaries on what features should be included in an efficient TM software application tool, a review of existing TM tool has been made, and accordingly a few basic directions were outlined, regarding the level of functionality that such a tool would be expected to provide [9]. Moreover, previous attempts, during this research effort, resulted to the design and implementation of two TM tools. TMed and ATop were created, in order to provide an integrated TM tool, aiming to meet most of the

requirements that such a tool should employ [8,10]. These tools were tested in practice and the experience that had been gained, gave useful hints and valuable inputs on how a TM tool should be refined.

Thereupon, according to all this work we have concluded to some general technical and functional requirements and have defined the design principles that are indispensable in order to implement a complete software tool for supporting TM developers to implement large-scale real world applications based on TM technology.

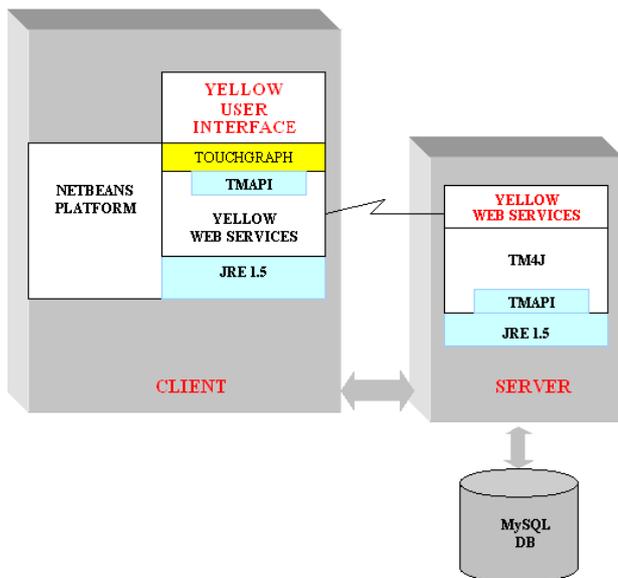
These design principles can be summarized to: Flexible extendable architecture, persistent storage of TM, more comfortable user interfaces offering enhanced editing functionalities, visualisation for interactive exploration and editing of topic maps and implementations of constraint languages, query and reasoning support via friendly user interfaces. Based on the design principles that were outlined above, "Yellow TM" was implemented aiming to provide a sophisticated TM software tool in order to support development of TM-based knowledge management systems and applications. In the following paragraphs, the proposed approaches that have been adopted for developing the TM software tool, in order to meet the predefined design requirements, are presented.

### 3 Implementation of Yellow TM tool

#### 3.1 Architecture and implied technologies

Since TM standard refers to knowledge management, it is important to enable many clients to be able to access this knowledge simultaneously, and even edit it. Thus a client-server architecture is required to support a TM software tool. The proposed tool employs a 3-tier architecture, as DB and TM-engine are placed on the server side (Fig 1). The three-tier architecture is used when an effective distributed client/server design is needed and provides increased performance, flexibility, maintainability, and scalability, while hiding the complexity of distributed processing from the user.

Yellow TM is a Java-based application [23] and has been implemented as a module under NetBeans platform [17]. NetBeans is an open-source modular, integrated development environment (IDE) that can ensure the platform independence of the developed application and enables the expandability of the developed software through future modular extension. NetBeans platform enables users to build powerful and intuitive GUIs, embodying forms and wizards.



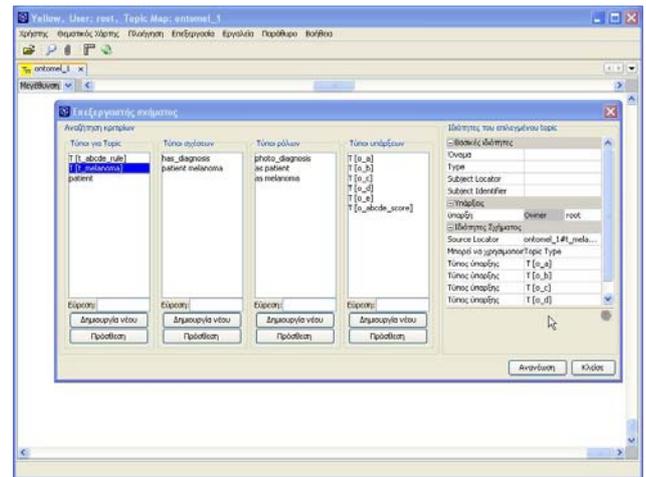
**Fig 1. Yellow TM functional Architecture**

Client/server communication is established via Web Services. NetBeans environment provide all the necessary libraries, in order to develop this communication with Web Services. Topic map server uses TM4J library for managing TM structures [24]. TM4J is an open-source framework software package supporting the XTM-standard, easy to use and provides a rich set of operations (as Java-APIs) for developing topic map applications. Finally a novel feature the support of the newly developed TMAPI, a common API for TM applications [25]. Yellow TM offers to the client a standard TMAPI interface, so any client developer that work with TMAPI, could connect and display the topic maps in its own way.

**3.2 TM Schema Visual Editor**

TM Schema is a collection of rules regarding the structure of a TM. The Schema constrains the user to follow the predefined structure of TM, validating thus that all new TM entries are concise and that TM is easily understandable and navigatable. A specification language that allows user to define the schema and constraints of a Topic Maps is a necessity and it was recently established by the ISO Working Group - the ISO JTC1 SC34 Project for a Topic Map Constraint Language (TMCL) [26].

Nevertheless, there are still not available open source tools to implement a TM schema in an easy and efficient way. The novelty of the proposal is that Yellow TM permits the definition of the topic map schema structure, providing a visual editor (Fig 2).



**Fig 2. Screenshot of Yellow-TM: TM Schema Visual Editor**

Hence, TM Visual Schema Editor has been implemented as part of Yellow TM and enables a TM creator to define and edit the desired schema for each TM, using a set of dialog boxes and wizards. This way there is no need for the creator to be aware of any particular syntax of any schema language. Schema editing is realized visually, and the schema is stored as a file with the related TM file to the server. TM schema can be edited only from TM administrator/owner. A Topic Map Schema defines all topic types, occurrence types, association types, and roles types as well as their properties. So, it is possible to infer a topic map backbone.

The main use of TM Schema is to ensure that end users follow the TM author’s guidelines laid down in a particular topic map and to enforce the prescribed topic map structure. Users while navigate and edit TM, they have to follow TM schema rules, in order to add a new TM concept. The program through wizards, which guide the user to follow TM schema while editing the TM, forces this process.

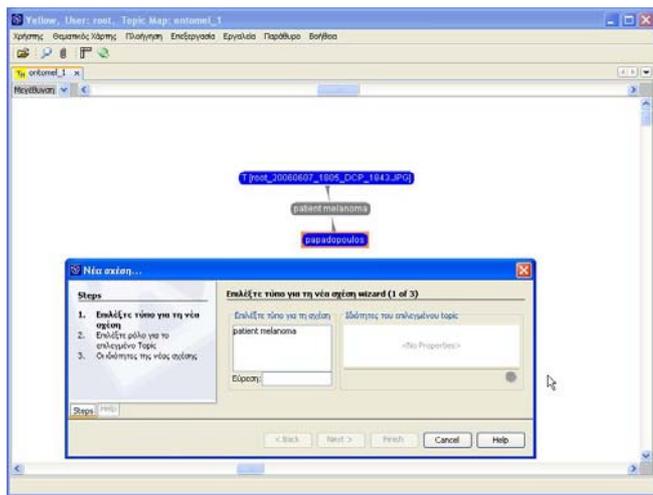
**3.3 Persistent storage of TM Data**

A topic map may contain million of topics and associations. Therefore we need to store the data persistently in a database and retrieve only relevant fragments at execution time. Yellow TM, offers persistent storage in a relational data base management system. MySQL has been selected for the persistent storage of TM. Authorized users may open a topic map or create a new one using the proper wizards that Yellow TM provides. Import and export of XTM files as well as of Schema files is also supported.



paradigm for interacting with TM data, when the user wishes to focus on the relationships between resources.

Touchgraph [28], is a general open source library that displays nodes and arcs. It is used in this approach, to display visually the TM concepts (Fig. 1). Topics and associations of the TM are represented as nodes with different colors, while roles are represented as arcs that connect topics and associations. Hence, a dynamic graphical representation of TM is provided that reflects the main properties of TM knowledge structure (Fig 5).



**Fig 5. Screenshot of Yellow-TM visual representation and editing features**

TM structure is floating on user’s screen, offering the ability to navigate in it, by expanding nodes in TM area that he wants to explore and by hiding the rest information. Thus, users should be able to focus on any part of the Topic Map and see precise information about the specific topic. It must be noticed that user is also capable to edit any of TM concept, by right clicking on the desired node and by selecting the proper wizard (Fig. 5). User can add topics, change the properties of a topic and define associations and roles. Topic properties are displayed in a separate docable panel.

**4 Concluding remarks**

Yellow TM embodies the underlying design principles stated in the paper, aiming to provide a complete suite tool for TM manipulation. It adopts a 3-tier architecture and technologies that reassure the stability, expandability and scalability of the implemented tool. Moreover, by employing Netbeans platform, Yellow TM is able to offer advanced windowing interfaces to end users, for navigate in a TM and edit it, in a simple and perceivable way. It is

designed to guide TM developers through the process of TM development, providing a form-based editing environment that embodies wizards.

Its main advantage though is the implementation of TM schema visual editor. Another novel feature is the visualisation functionalities that are provided using Touchgraph library, as well as the ability to edit and update the topic map objects while they are represented visually. One issue, which we paid considerable attention, was the provision of enhanced query and retrieval functionalities. By employing a query engine the tool supports query capabilities, using easy to use wizards and enables user to locate the information he is looking for, easily and intuitively.

Momentarily, we use Yellow TM for creating the required topic map; in order to establish a TM based system that manages melanoma cases images and their related data. Future scope of this work is to employ also reasoning support, allowing users to launch inference rule and integrated queries, for a more efficient information retrieval and knowledge management.

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