The PARADIGMA Project: an Ontology-based Approach for Cooperative Work in the Medical Domain

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Abstract. PARADIGMA (PARticipative Approach to DIsease Global Management) is a pilot project which aims to develop and demonstrate an Internet based reference framework to share scientific resources and findings in the treatment of major diseases. PARADIGMA defines and disseminates a common methodology and optimised protocols (Clinical Pathways) to support service functions directed to patients and individuals on matters like prevention, post-hospitalisation support and awareness. PARADIGMA will provide a platform of information services - user oriented and optimised against social, cultural and technological constraints - supporting the Health Care Global System of the Euro-Mediterranean Community in a continuous improvement process.

1 Introduction

PARADIGMA (PARticipative Approach to DIsease Global Management) is a pilot project of EUMEDIS, a regional project for the development of the Euro-Mediterranean Information Society. PARADIGMA aims to develop and demonstrate an Internet based reference framework to share scientific resources and findings in the treatment of major diseases.

Resolutions of the World Health Organisation suggest that population-based medicine has to become the new approach to patient care, co-ordinating medical resources for patients across the entire health care delivery system, and indicate new technologies as powerful means to support its enactment. Population-based medicine, including Disease Management, is a structured response to a set of problems of healthcare systems which results in:

- reduction of costs in the health care environment by means of the improvement of performances (dia-gnosis and therapy pathways, hospitalisation, etc.);
- redirecting of services and capabilities towards the consideration and care of the overall needs of the patient-person and not only focusing on the purely medical needs of the clinical-case;
- creating a network of care structures, aimed to compare schemes and experiences in medical practice, for continuous information exchange and improvement;

- increasing patient satisfaction by providing, in less time, the best practice and more complete assistance to take care for the whole needs related to a patient's disease;
- enhanced synergy under the organisational, cultural, informative and formative point of view, enhancing the quality of care processes and, most of all, the quality of a patient's life.

PARADIGMA choses to concentrate on expertise from the following Health Care domains, whose main aspects, from prevention to follow-up, will be addressed to define optimal practice, according to specific social, cultural, technological and organisational conditions:

1. Profilaxis of thrombo-embolism and monitoring of anticoagulant treatment .
2. Prevention focused, infant death reduction from pregnancy to the first year of life.
3. Colorectal cancer prevention and treatment.
4. Evaluation and improvement of performance in intensive care.

The reason for this choice has to be found in the relevance these themes have in the Euro-Mediterranean community.

The outline of the paper is as follows. Section 2 deals with the PARADIGMA's project strucuture. In this section the core architecture of the Care System under development is illustrated. Section 3 introduces the methodological approach adopted in PARADIGMA and illustrates the architecture of a tool, the Navigator, which supports service functions directed to the different types of system users. Lastly, section 4 contains some conclusions and suggestions for future research.

2 Project Structure

PARADIGMA's objective is to support Disease Management improvement, focusing on needs and characteristics of patients, workforce and structures. The structure of the project previews the subdivision of the activities in a sequence of phases.

The first phase is made up of two activities: Context Description (which provides a formalisation of the "as is" reality at the start of the project) and User Requirements Definition (which provides a set of possible use scenarios, from which to derive the related user requirements). Both the activities concern the organisation, processes, resources, information of a significant number of medical structures in Mediterranean countries (pilot sites).

The second phase of the project is made up of the Definition and Implementation of a structured dictionary of concepts, the Ontology for Disease Management Systems description. Ontologies are shared views of parts or domains of the world which provide conceptualisations that are agreed upon by people engaged in collaborative actions. The shared nature of these conceptualisations allows people or programs to communicate effectively and supports the development of information systems by building interoperable components that view and manipulate information in a unified, clearly defined and consistent manner.

The third phase regards the modelling of the *Clinical Pathway Schemata* (CPS) which specify the scientific, technological, organisational and human aspects of medical practice related to the different Diseases.

The next phase of the project concerns the *Functional and System Specifications Definition* which comes from comparing, in the pilot sites, the "as is" situation and the expected services and facilities, with procedures and protocols defined inside each Clinical Pathway.

Functional and System Specifications are the basis for the implementation of the PARADIGMA *Navigator* which provides a set of disease oriented and context adaptive services, developed and integrated according with functional requirements and technological constraints, based on a user friendly "navigation" of information stored on several local data bases, seen as one.

The Navigator infrastructure is provided by a software application based on the WEB technology that will communicate with the relational DBMS provided by PARADIGMA infrastructure.

The last phase of the project provides the activities of validation, test and tuning for the entire system. *System Validation* against user requirements, performed in several verification steps, is the basis for former optimisation of Navigator services.

3   Methodological Approach and Technical Solutions

The PARADIGMA framework will make provision for suitable user interfaces both to input data (electronic forms, questionnaires, guided interviews, etc.) and to navigate (user and context oriented interfaces, customised functionalities, aimed training, etc.) the framework itself. Moreover, IT and Health Care expertise are needed to benchmark, customise and use existing commercial tools, both for formalising the Ontology and for implementing Navigator functionalities.

3.1   Ontology Definition

Analysis methods and modelling methodologies will be applied to care practice and human interaction, beginning with an analysis of the relevant Disease Management System variables, in terms of organisation key characteristics: available technology, professional profiles, behavioural models of all involved humans, social and cultural aspects of the overall environment. Once the key characteristics of the overall care system have been determined, they, in turn, prescribe many of the factors that need to be customised into the individual jobs, specific work processes and human interfaces.

The project will develop an extensible and modular ontology to meet two main objectives [1]: a) resolution of the heterogeneity of the digital assets, and b) support for those involved in the Health Care System.

In medical operations, the ontology is concerned with the use or application of models and data during the whole Disease Management process. The PARADIGMA Ontology is layered at four generical levels as follows:

1. *Core Ontology*   → core level
2. *Enterprise Ontology*   → generic level
3. *Health Care Ontology*   → partial level
4. *Disease Area Ontologies* → particular level

- *Core Ontology* states Entities, Relationships and Constraints as basic Concepts, to be applied in the modelling.

- *Enterprise Ontology* states new Concepts, specialising the Core Ontology ones, which are specific to model a generic Enterprise.

- *Health Care Ontology* states new Concepts, defined at partial level, specialising Enterprise Ontology ones, which are specific to model the Health Care Domain. People involved in the PARADIGMA context can use them to build and share a common knowledge on the Health Care Domain.

- *Disease Area Ontologies* state new Concepts, defined at particular level, specialising the Health Care Ontology ones, applicable to the Disease Areas of each Competence Group. These concepts can be used to build and share common knowledge on specific Disease Management.

By using the Healt Care Ontology at partial level, it is possible to define the conceptual structure of a generic Clinical Pathway, which can be specialized to derive Clinical Pathway templates, less o more suitable for the use in the context of each Disease.

As an example of the Partial Level, Fig. 1 shows the fragment which details the concept of ClinicalCapability which is, in turn, a specialization of the concept of Capability at the Generic Level.
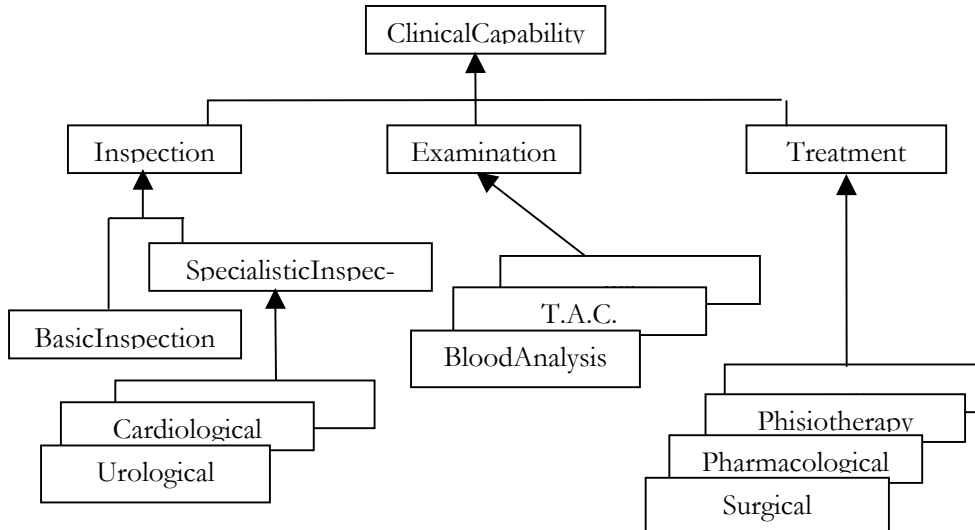

Fig. 1. Ontology fragment at partial level

Concepts relevant for the Particular Level of the ontology can be obtained by specialization of the Partial Level. Disease Area Ontologies at the Particular Level are specific for each pilot study.

3.2 Navigator Definition and Implementation

To provide integrated support to a variety of different users in a Health Care Structure, the Navigator should support selecting the most suitable solution from a given set, for specific types of actors and problems, providing for customised user interfaces. The Navigator can support this communication by providing highly visual and computable representations of Clinical Pathways that are used as a common basis for discussions and proposals. It will be concerned with acquiring the human-related expertise and focusing on developing and demonstrating a participative environment that is fit for purpose, comprehensive of methods concerned with the optimisation and integration of the human factor in Health Care System. It aims at improving the quality of work and organisation simultaneously through adaptation or fundamental redesign of contents and composition of technology and human Work Packages. The problem to be solved here is related to "Fact Gap": the gap between what *could be done* with information and what *actually gets done*.

In order to integrate the knowledge database and the execution environment the following research activities will be carried out:

- Specification of an interchange format and mechanism for transferring the rules (standards are applied if they are deemed to be suitable).
- Development of an interchange facility so that the updating of rules can be achieved and rules can be disseminated to the execution environment.
- Proof-of-concept testing of the interchange facility under test conditions
- Secondary testing of the interchange facility with real operative data.
- Performance evaluation and benchmarking of results against existing middle-tier solutions.

The NAVIGATOR infrastructure is composed by 3 systems, which interact in order to supply services and information management: 1) Presentation System Manager (PSM), 2) Services System Manager (SSM), and 3) Knowledge Storing System Manager (KSSM)

The Presentation System Manager (PSM) provides an environment to define and to consult the information. The user of Presentation System Manager can acquire or introduce informations in the system The Presentation System Manager (PSM) provides a set of predefined procedures to help the user.

The Services System Manager (SSM) provides an environment to control an to manage the information. The Services System Manager provides many services to define concepts, to exchange information between different systems and to maintain the security of the informations. The main user of the SSM services is the Presentation System Manager.

The Knowledge Storing System Manager (KSSM) provides an environment to storing the knowledge in structured way. The Knowledge Storing System Manager decompose the knowledge in elementary informations and data. In this way the user obtain information through the association of the data and rebuild knowledge approaching the information in structured way.

The NAVIGATOR infrastructure proceedes through a cyclical flow of request/response that take advantage of predefined and standard system interfaces. The communication protocol among the systems is standard XML.

4 Conclusions

The Navigator represents the most important software tool which will be developed in the PARADIGMA project, making use of the opportunities that modern ICT offers. It would be a clever interface between the Health Care structure, its processes, data and objectives, and each user (doctor, nurse,…), his job, capabilities, work environment and support tools, making data exchange between several tools possible.

Besides this, the Navigator will provide the PARADIGMA users an easy to use and attractive interface to go through the procedural steps of Clinical Pathways and use the available tools in the process of solving problems. The following impacts are to be expected from the research and development in the project:

1) the improvement of performances (diagnosis and therapy pathways, hospitalisation, etc.) and the reduction of costs in the health care environment;
2) the creation of a network of care structures, aimed to compare schemes and experiences in medical practice, for continuous information exchange and improvement;
3) the increase of patient satisfaction by providing, in less time, the best practice and more complete assistance to take care for the whole needs related to a patient's disease.

References

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Project deliverables and documents can be obtained from the PARADIGMA site:
www.paradigmamed.org