Chapter 11
Towards Patient-Centric Healthcare: Multi-Version Ontology-Based Personalization of Clinical Guidelines

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ABSTRACT

Retrieving personalized care plans from a guideline repository is an ever-increasing need in the medical world, not only for physicians but also for empowered patients. In this chapter, we continue our long-lasting research on ontology-based personalized access to very large collections of multi-version documents by addressing a novel challenge: dealing with multi-version clinical guidelines but also with a multi-version ontology used to support personalized access to them. Efficiency is ensured by a newly introduced annotation scheme for guidelines and solutions to cope with the evolution of ontology structure. The tests performed on a prototype implementation confirm the goodness of the approach. Finally, the chapter proposes an exhaustive analysis of the state of the art in this field and, in the final part, a discussion where we expand our vision to related research themes and possible further developments of our work.

INTRODUCTION

The adoption of reference ontologies and their deployment for the personalization of multi-version resources has been considered by several authors in the medical informatics domain (Grandi et al., 2012; Riaño et al., 2012; Tu et al., 2011, Wang et al., 2013) (but also in other application fields, e.g.,

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e-Government (Grandi et al., 2009)). In this work, as resources we consider clinical guidelines (Peleg, 2013), that is “best practices” encoding and standardizing health care procedures, either in textual or in executable format, and their personalization with respect to an ontology of diseases, patients or available hospital facilities they are applicable to. In practice, references to ontology classes are added to the computer encoding of resources (e.g., for which an XML (W3C, 2018a) format can conveniently be used) to introduce a sort of semantic indexing of contents representing their applicability, relevance or eligibility with respect to ontology classes. For instance, a given guideline (e.g., involving treatment of heart diseases) may contain different recommendations which are not uniformly applicable to the same classes of patients: one general therapy may be non-applicable to persons who suffer from some metabolic disorders (e.g., diabetes mellitus) or chronic diseases (e.g., kidney failure) or present some addictions (e.g., cocaine); one first-choice drug may not be administered to patients who are already under treatment with possibly interacting drugs (e.g., anticoagulants), or show genetic or acquired hypersensitivity or intolerance to some substances (e.g., patients with enzymatic defects or documented allergies), and so on. Hence, when dealing with a specific patient care case, a physician may be interested in retrieving a personalized version of a clinical guideline, that is a version tailored to his/her use needs by means of all the available personalization coordinates involving the patient’s health state, anamnesis and characteristics (e.g., genetic, demographic or preferential) and local settings (including available hospital resources, diagnostic facilities and physicians’ skills). Therefore, the personalized version will only contain recommendations which are safely and effectively applicable by the user to the patient’s specific case. Furthermore, the emergence of patient-centered healthcare (NEJM Catalyst, 2017) and the development of patient-centered decision support systems (González-Ferrer et al., Melnick et al. 2017; 2013; Sacchi et al., 2013), with the involvement of empowered patients as final users, requires the adoption of also non strictly medical characteristics and individual preferences as further personalization coordinates (e.g., level of education, meal schedule and sleep habits).

To this purpose, we introduced in (Grandi et al., 2009; Grandi et al., 2012) a personalization query engine that, starting from a user-supplied list of ontology classes representing values of the semantic personalization coordinates, can exploit semantic indexing to retrieve the relevant contents only and produce a guideline version tailored to a specific use case. Notice that, coherently with ontology-based personalization solutions also proposed in other application fields (De Bra, 2017), we use the term “personalized” as referred to the user of the computer system, that is either the medical care provider or the empowered patient who follows the guideline.

However, in a dynamic environment, the management of this kind of semantic versioning is interleaved with temporal aspects. The fast evolution of medical knowledge and the dynamics involved in clinical practice imply the coexistence of multiple temporal versions of the clinical guidelines stored in a repository, which are continually subject to amendments and modifications. Therefore, it is crucial to reconstruct the consolidated version of a guideline as produced by the application of all the modifications it underwent so far, that is the form in which it currently belongs to the state-of-the-art of clinical practice and, thus, must be applied to patients today. However, also past versions are still important, not only for historical reasons: for example, a physician might be called upon to justify his/her actions for a given patient at a past time on the basis of the clinical guideline versions applicable to the pathology of patient and which were valid at that time.

Moreover, in a dynamic environment, the definition of domain ontologies themselves is also subject to modification as the medical knowledge, clinical environments and viable technologies evolve and, thus, also ontologies come out versioned as a consequence of updates periodically effected by domain
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