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Poseacle: An Ontological Infrastructure for Managing Clinical Archetypes in Semantic Web Environments

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Abstract

There are currently different standards for representing and exchanging EHR information among different systems. In advanced EHR approaches, clinical information is represented by means of archetypes. Most of these approaches use ADL to specify archetypes. In this paper, an alternative representation in OWL is presented. The OWL representation has some advantages such as its formal condition, its suitability for sharing and reuse, and the possibility of reasoning over OWL content. This new representation allow for managing clinical information in Semantic Web settings.

Keywords:

Medical Informatics, Information Management, Electronic Healthcare Records, Semantic Web

Introduction

The lifelong clinical information of any person supported by electronic means configures his Electronic Health Record (EHR). As pointed out in [3], EHR systems must support life-long EHR, be technology and data format independent, facilitate sharing of EHRs via interoperability at data and knowledge levels, integrate with any/ multiple terminologies, support for clinical data structures and prioritize the patient / clinician interaction. Nowadays, there are different advanced standards and architectures [3] for representing and communicating electronic healthcare records, such as HL7 [8], OpenEHR [6] and the CEN ENV13606 [7]. Each standard defines its own information models and manages the information in a particular way. This implies that clinical information systems of different clinical organizations might differ in how electronic healthcare records are managed. Current advanced EHR standards make use of the dual model architecture approach [1]. This architecture is based on the meta-modelling of healthcare records, based on two basic principles. First, two conceptual levels are distinguished: (1) reference model, and (2) archetypes. This work is focused on the latter level. Archetypes are typically represented by using the Archetype Definition Language (ADL), which is a formal language for expressing archetypes, which are constraint-based models of domain content. However, ADL document are syntactic rather that semantic. In this paper, an alternative semantic representation, based on the Ontology Web Language (OWL) [5], which is the W3C recommendation for exchanging semantic content on the web, is proposed.

Methods

Tim Berners-Lee [2] defined the Semantic Web as an extension of the current Web, in which information is given well-defined meaning, better enabling computers and people to work in cooperation. Amongst the different available Semantic Web technologies, ontologies are considered a basic technology to promote semantic interoperability between independent and heterogeneous systems. An ontology represents a common, shareable and reusable view of a particular application domain, and they give meaning to information structures that are exchanged by information systems. In practical settings, ontologies have become widely used due to the advantages they have: reusability and shareability (see for instance [4]). The "de facto" standard language for representing ontologies is the Ontology Web Language(OWL), which can formally describe the semantics of classes and properties used in Web contents. In order to represent archetypes in OWL, a semantic interpretation of the archetype level has to be performed.

Apart from their different nature, the parsing and processing of information is also different in ADL and OWL. When parsing an ADL document, the result is an Archetype Object. This object contains the lists of codes, names of terms, constraints and so on. All the elements of these lists are strings so that the relations between the different elements must be explicitly searched for. In this sense, mistakes are more likely to be committed when defining an ADL document. Moreover, the processing of OWL content does both the parsing of the OWL and the capture of consistent clinical information, whereas ADL parsing does only obtain the information without guaranteeing the consistency of the clinical information. In fact, it does not perform any analysis related to clinical information contained in the archetype.

Results

The first step was to analyze the representation of clinical archetypes, so a semantic interpretation might be performed. Figure 1 shows the result of the semantic interpretation of clinical archetypes to produce an ontological representation suitable for being modeled in OWL. The top part of Figure 1 shows the ontological representation of the definition of an archetype and their links with issues such as translations, terms, audit information or terminologies. This part is common for any EHR architecture. The lower part of the figure contains some architecture specific items, such as the clinical data structures and data types. This OWL modeling brings all the information concerning a particular term together (code, name, binding, translations, constraints) so that a particular information item can be accessed and analyzed in its context.

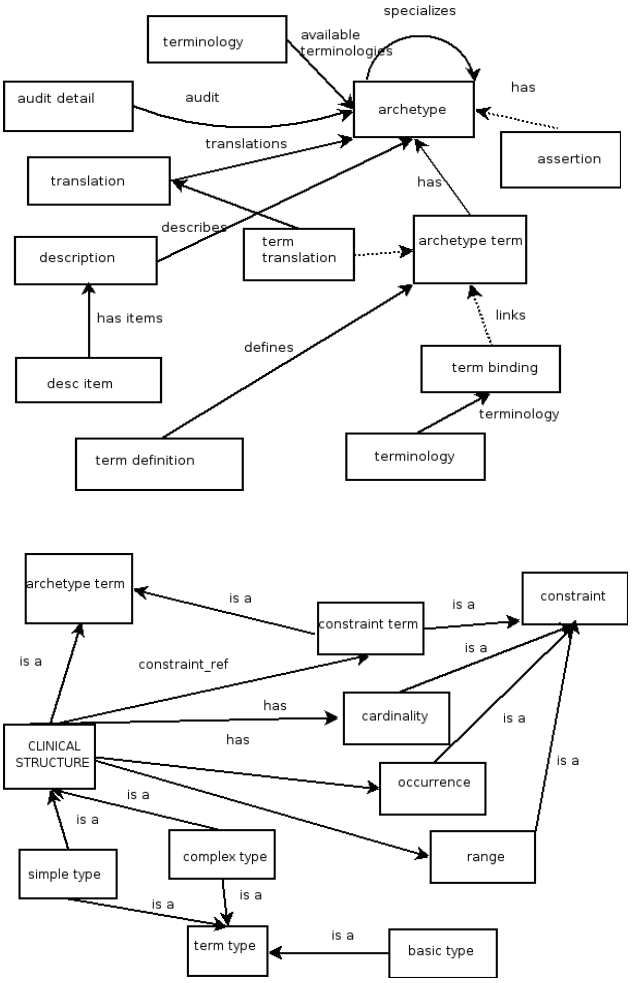

Figure 1 - Ontological representation of the semantic interpretation of clinical archetypes

Through this research work, the POSEACLE set of ontologies has been developed, providing a semantic web-oriented representation of clinical archetypes. Amongst the available EHR standards, our work has been focused on CEN ENV13606 and OpenEHR. By following the archetype approach shown in Figure 1, a set of OWL ontologies for the standards have been developed. These ontologies are available at http://klt.inf.um.es/~poseacle.

Different clinical archetypes for both CEN and OpenEHR have been manually built for clinical concepts such as measurements for Cholesterol, Creatinine, Coagulation or Blood Pressure. These archetypes can be found at the referred web portal. To simplify the use of the ontologies, an OWL archetype template is also available; then, the user only needs to instantiate the ontology to define the archetype.

Discussion and conclusions

In this work, a Semantic Web-oriented ontological modeling of clinical archetypes has been presented. This approach is based on semantic technologies rather than syntactic ones such as ADL, so that more efficient knowledge management mechanisms can be developed. As a result of this work, different ontologies have been obtained to represent archetype models for CEN and OpenEHR. Hence, the ontologies developed can also be used by Semantic Web applications in the health domain. These ontologies can be used as a starting point for defining a framework for the consecution of semantic interoperability across clinical information systems.

Acknowledgments

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