

ONTOLOGIES AND THEIR APPLICATION IN ELECTRONIC HEALTH RECORDS

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Abstract

When sharing Electronic Health Records (EHRs) between different institutions, interoperability of the individual local records becomes a necessity. Ontologies represent one technology that can contribute to this goal. In a master thesis, which is currently a work in progress, the application of ontologies to achieve EHR interoperability will be examined by analyzing the different approaches of their practical use published to date. This paper gives a short overview over those plans.

1. Introduction

In modern medicine a patient's medical history is stored at many different locations, which leads to several problems. To achieve better care it is important for health care providers to be able to share patient information [12]. This goal is compromised by the lack of interoperability between the health records used by different care providers.

EHR standards such as the Health Level 7 (HL7) Clinical Document Architecture (CDA) [7] and prEN 13606 [16], and quasi-standards such as the openEHR [15] architecture have been developed to build a starting point for achieving EHR interoperability.

Two levels of interoperability can be distinguished:

Syntactic interoperability guarantees the exchange of the structure of the data, but carries no assurance that the meaning will be interpreted identically by all parties [13]. Semantic interoperability is the ability for information shared by systems to be understood at the level of formally defined domain concepts [5].

EHR reference models, such as those specified by [7], [15] and [16], define the high-level logical models for any kind of EHR and hereby enable syntactic interoperability [10]. Archetypes, a concept integrated in all three before-mentioned standards (HL7 uses the synonym "templates"), provide a fundamental means of semantic indexing of the structural organization of EHRs [9]. They build a logical interface for richer systems of concepts, i.e. ontologies.

Ontologies can contribute to achieving semantic interoperability between EHRs, e.g. by defining clinical terminologies for precise and sharable expressions during data entry, or by supporting transformations between different EHR standards [12]. The aim is not only to accomplish semantic

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interoperability but also to provide a complete new level of reasoning over medical data that is stored in multiple locations.

In the following, the ontology concept will be contrasted with the concept of archetypes, as both pursue similar goals but still differ in several points. Finally the method to be used in the analysis process will be outlined.

2. Archetypes and Ontologies

An *EHR archetype* is an *agreed, formal and interoperable* specification of the data and their inter-relationships that must or may be logically persisted within an electronic health record for documenting a particular clinical observation, evaluation, instruction or action [8]. An *openEHR / EN 13606* archetype represents this specification as a set of constraints, expressed in a standardized form, for instantiating a particular EHR Reference Model. A formal language to describe archetypes is the Archetype Definition Language (ADL) [2].

In contrast to an archetype, an “Ontology is the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality” [8]. In information systems, an ontology represents sets of concepts in a domain which:

- 1) “reflects the properties of the objects within its domain in such a way that there obtains a systematic correlation between reality and the representation itself
- 2) is intelligible to a domain expert
- 3) is formalized in a way that allows it to support automatic information processing”

Ontology description languages typically provide mechanisms for automatic derivation of new implicit information from the explicit information expressed by the ontology. A common language that is currently used for describing ontologies is the Web Ontology Language (OWL) [18] which uses the Resource Description Framework Syntax (RDF) and is the successor of DAML+OIL [4].

<pre> PERSON[at0000] matches { name matches{ PERSON_NAME[at0001] matches?{ ... } } } ontology primary_language = <"en"> term_definitions("en") = < items("at0000") = < text = <"Doctor"> description = <" Doctor of the patient "> > items("at0001") = < text = <"DoctorName"> description = <"Name of the doctor"> > > ... </pre>	<pre> <owl:Class rdf:ID="Doctor"> <rdfs:subClassOf rdf:resource= "http://www.sample.org/Domain.owl#Person"/> <rdfs:subClassOf rdf:resource= "http://www.sample.org/Archetype.owl#Archetype"/> <rdfs:subClassOf> <owl:Restriction> <owl:allValuesFrom rdf:resource="#DoctorName"/> <owl:onProperty rdf:resource= "http://www.sample.org/Domain.owl#name"/> </owl:Restriction> </rdfs:subClassOf> ... </owl:Class> <owl:Class rdf:ID="DoctorName "> <rdfs:subClassOf rdf:resource= "http://www.sample.org/Domain.owl#PersonName"/> ... </owl:Class> </pre>
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Figure 1: The „Doctor“ concept as archetype in ADL (left) and as ontology in OWL (right)

The openEHR Foundation describes the difference between archetypes and ontologies as follows [14]: “An archetype for "systemic arterial blood pressure measurement" is a model of what information should be captured for this kind of measurement - usually systolic and diastolic pressure, plus (optionally) patient state (position, exertion level) and instrument or other protocol information. In contrast, an ontology would describe in more or less detail what blood pressure is.”

In [11] Kilic and colleagues describe, how the ADL can be transformed to an equivalent OWL representation. As an example *Figure 1* shows the “Doctor” concept in both formats, as an archetype and an ontology approach.

3. Method

The goal of the thesis is to analyze the application of ontologies to achieve EHR interoperability. In [1] Ammenwerth and Haux describe a procedural model for system analysis within the tactical management of health information systems. This model is applicable in the context of our work and consists of the following four steps:

- Planning of the analysis: render more precisely the aim of the system analysis, definition of the problem area and planning of the implementation of the analysis. A list of criteria to compare the different applications will also be a part of the planning of analysis.
- Acquisition of information: in this thesis, acquisition of information will mainly be based on document and literature analyses.
- Modeling: suitable representation of the results of the acquired information based on informal, semiformal or formal methods.
- Verification: reassessment of the generated models in consideration of correctness, completeness and adequacy. The reassessment shall be done in the course of verification sessions, where experts from the domain of EHR modeling will play the role of the revisors

The before mentioned (preliminary) criteria that will be used to analyze and compare the different applications of ontologies in the EHR domain are:

- Goal and benefit
- Area of reality described by the ontology
- Relation to EHR standards
- Documented experiences with practical use
- Formalisms used

This final list of criteria will be available after the phase “planning of the analysis” is completed.

Examples of applying ontologies in the EHR domain to be analyzed within this thesis were identified in a preliminary inquiry and can be found in [3], [6], [15], [16] and [17]. The full list of material to be analyzed will be determined after completion of the “acquisition of information” phase.

4. Outlook and Conclusion

The thesis will profoundly review applications of ontologies in the field of Electronic Health Records. It will hereby provide some insight to what extent ontologies contribute to achieving semantic interoperability within current scenarios of EHR exchange.

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