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Open and Linkable Knowledge About Management of Health Information Systems

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Abstract

Given a care delivery organization, its health information system can be defined as the part of the organization that processes and stores data, information, and knowledge. There is an enormous number of frameworks, textbooks and articles that describe the scope of health information system management from the perspective of medical informatics. Transforming this knowledge to Linked Open Data results in a structured data representation that is accessible for both humans and machines, the Semantic Network of Information Management in Hospitals (SNIK). We present interfaces that are useful for researchers, practitioners and students, depending on their objectives and their Semantic Web skills.

Keywords:

Semantic Web, Information Management, Health Information Systems

Introduction

Given a care delivery organization, its health information system (HIS) can be defined as the part of the organization that processes and stores data, information, and knowledge. It usually consists of a large number of different application systems, computers, and network components (Winter et al. 2011). Managing an HIS comprises planning, monitoring and directing activities. Due to the complexity and the unique conditions in health care, HIS management is an exceptionally challenging task. There is an enormous number of frameworks, textbooks and articles describing the scope of HIS management from the perspective of medical informatics. However, the disciplines of business informatics and information systems (IS) provide an even broader view on information systems and their management. A holistic view on HIS management comprises knowledge from different scientific disciplines and requires well-defined links between these different worlds. These links help researchers and students connect their existing knowledge with further knowledge from other sources during research and learning.

In order to integrate different knowledge sources and to provide the knowledge in a structured, machine-readable data format, we extracted knowledge about HIS management from three textbooks and other sources (see Table 1) and converted it to RDF [4]. The combination of this knowledge results in SNIK, the Semantic Network of Information Management in Hospitals ("Krankenhaus" in German), which is freely and openly accessible by open tools. In order to encourage and enable other researchers, students and health informatics professionals to use available knowledge of HIS management, we interlink classes from different sources, and present and compare the interfaces of SNIK for different target audiences.

Methods and Materials

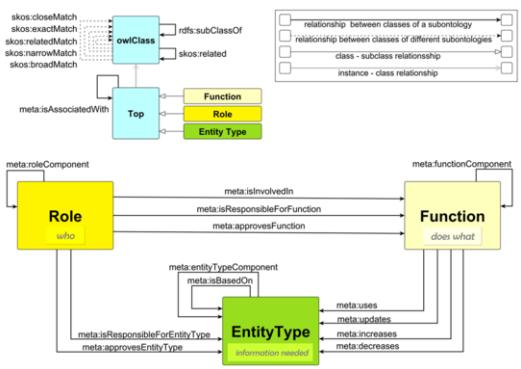

Figure 1—The SNIK Meta Model

SNIK is modelled as a modular (see Table 1) OWL 2 DL ontology. The Meta Model is the central module and provides a common vocabulary for the domain of HIS management (see Figure 1). It contains classes (rectangles in Figure 1), which represent concepts of HIS management and relations (the labelled edges in Figure 1), which represent possible interactions between them. For example, a role and a function can be connected by "is involved in", "is responsible for" or "approves". The Meta Model is extended by five subontologies (see Table 1). At the head of the class hierarchy is the "Top" class, which has exactly three disjunctive subclasses. Following the Meta Model, each class has to be a subclass of exactly one of them. The superclass of a new concept can be found by answering the question: "Who ("Role") does what ("Function") and which information ("EntityType") is needed to perform this function?"

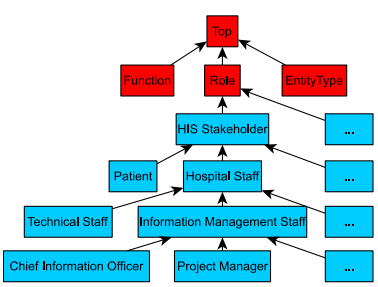

Figure 2—Excerpt from subclass hierarchy of the Meta Model and the subontology

Results

SNIK v0.8 contains 4729 classes, 329 properties, 713 interlinks and 112747 triples and is available under the CC BY-NC-SA 4.0, using open standards over interfaces with different compromises between expressivity and accessibility.

RDF Dump

In line with the *Linked Data* principles [2], we assign a unique URI to each class and follow the specifications of the Resource Description Framework (RDF), which states how facts about concepts can be modeled as *triples*. Each triple contains a subject, property and an object. There are multiple RDF serializations, such as Turtle [3], which allow abbreviating URIs using prefixes, see Table 1. SNIK is available as Turtle files at http://www.snik.eu/download/snik-0.8.zip.

RDF Browser

Users can look up a resource using the HTTP protocol to receive a description of the class, using the standards RDF and SPARQL. The LodLive RDF browser at http://www.snik.eu/ontology offers a human-readable description. Triples between URIs can be followed so that new information can be discovered.

SPARQL

The SPARQL Protocol and RDF Query Language (SPARQL) [3] allows us to manipulate and query SNIK as RDF. We offer free read access to the SPARQL endpoint (query service) at http://www.snik.eu/sparql both for manual queries and as an API. The SNIK project uses the endpoint as an API in several applications, both custom made, such as SNIK Graph (see Figure 3), and adapted software, such as the RDF browser and the OntoWiki ontology editor, see [4]. The endpoint presents the most expressive interface but requires knowledge of both the SPARQL syntax and the SNIK Meta Model.

Table 1—Modules of SNIK

Ontology	Prefix	Source
http://www.snik.eu/ontology/meta	meta	All Sources
http://www.snik.eu/ontology/bb	Bb	Textbook
http://www.snik.eu/ontology/ciox	ciox	CIO Interview
http://www.snik.eu/ontology/ob	Ob	Textbook
http://www.snik.eu/ontology/he	He	Textbook
http://www.snik.eu/ontology/it4it	It4it	Standard

SNIK Graph

SNIK Graph, available at http://www.snik.eu/graph, visualizes the structure of SNIK by modelling each class as a node and each RDF triple and OWL restriction as an edge.

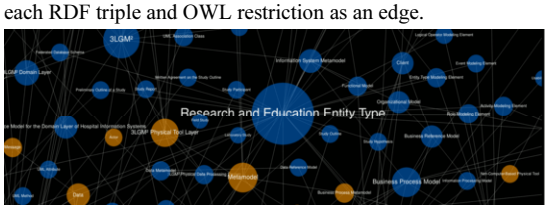

Figure 3—The SNIK Graph Visualization

Interlinks

As an open, linkable ontology, SNIK can be connected to other ontologies, especially in the field of Medical Informatics. Some concept pairs are homonyms: they have the same label but differ in meaning. For example, bb:InformationManagement has the same label as dbr:Information_management, but the definition of information management differs. There should thus be no interlink between homonyms. On the other hand, dbr:Picture_archiving_and_communication_system and bb:PictureArchivingAndCommunicationSystem have a very similar meaning, so that an interlink is generated. Label-based interlinks are generated using LIMES in previous work [4].

Discussion

SNIK is based on the Meta Model from Figure 3. It can be considered an archetype for ontologies describing a given domain (here "HIS management"), which functions in a certain role to be carried out, with information a person with this role needs and provides while carrying out those functions. This is valuable knowledge, for instance as a basis for systems analysis projects [1]. Different user groups can use the interfaces of SNIK that are most suitable to them: Semantic Web experts can use the RDF dump and the SPARQL endpoint to integrate applications with the SNIK ontology. They can also use SNIK as a vocabulary to integrate data from different formats that result from applications from different vendors. Those experts can also use the SPARQL query editor directly to answer specific questions. Students and teachers use the RDF browser and SNIK Graph, which intuitively presents knowledge without requiring knowledge of the query language and the Meta Model.

Conclusions

We publicize knowledge on the management of information systems in medicine and health care using open standards over interfaces with different compromises between expressivity and accessibility. It can be combined with other knowledge in biomedical and health informatics and in other disciplines.

Acknowledgements

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