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The SNIK Graph: Visualization of a Medical Informatics Ontology

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Abstract

SNIK, a medical informatics ontology, combines knowledge from different literature sources dealing with the management of hospital information systems (HIS). Concepts and relations were extracted from literature, modeled as an ontology and visualized as a graph on a website. We demonstrate the potential of the graph visualization for tuitional scenarios. SNIK complements teaching and learning with conventional literature by concentrating knowledge that is scattered over different pieces of text around one node of a graph.

Keywords:
Semantic Web, Information Management, Hospital Information Systems

Introduction

Although computer scientists have provided theory and applications for ontologies, they rarely apply ontologies to their own fields of research. There are well-known biomedical ontologies [1], but there are almost no ontologies structuring medical informatics knowledge. With SNIK, the semantic network of information management in hospitals (German: Krankenhäuser) we developed an ontology that describes HIS management from a functional point of view: Who performs which function and which information is needed or updated by this function? The role "CIO", for example, is responsible for the function "strategic information management" which updates the information artifact "strategic information management plan". Statements like these are coded as RDF (Resource Description Framework) triples in SNIK.

A typical use case of SNIK is teaching HIS management at universities [2]. Due to its use in teaching, we needed a way to visualize the ontology, so that students and lecturers can browse through the knowledge and can easily discover how different concepts are linked to each other. In previous work [3], we tested the visualization of SNIK with the help of graph visualization tools. Although offering useful functionalities, these desktop tools are not easy to handle by occasional users. Moreover, the ontology could only be used after having downloaded the latest SNIK file and having installed the tool. Now, with SNIK being available as Linked Open Data together with a web-based graph visualization based on cytoscape.js [4], users can easily analyze the linked concepts of HIS management. It is the aim of this work to demonstrate;

- the visualization capabilities of web-based SNIK ("SNIK graph") and
- their use for specific teaching and learning scenarios.

Methods

SNIK is based on knowledge from text books, frameworks, and expert interviews dealing with HIS and their management. As a first step to develop SNIK, literature was selected in accordance with the learning objectives of lectures on HIS management at Leipzig University. In these lectures, students shall learn a clear terminology for roles, functions, and information artifacts of HIS management. For its use in teaching, SNIK had to provide answers to the questions "Who performs which HIS management function and which information is needed or updated by these functions?" Thus, the SNIK metamodel was specified, which, determines the rules for extracting knowledge from texts. Relevant concepts found in texts have to be assigned to one of the metamodel classes "role", "function" or "entity type", the latter representing types of information artifacts. For linking concepts to each other, 16 different relationships were defined. Extraction from the texts was then done pairwise by reading through a chapter and extracting knowledge to spreadsheets with predefined columns. Each pair of extractors prepaired a consolidated spreadsheet for a chapter. All spreadsheets were checked again by another group in order to have one consolidated .csv-file containing the textbook's subontology. In addition, interlinks between different subontologies were specified within a further spreadsheet. The .csv-files were then converted to RDF, published on the SNIK website, [5] and the extracted knowledge became a part of the SNIK graph.

Results

The SNIK graph, which represents the current status of the SNIK SPARQL endpoint, consists of 2,845 entity types, 1,090 functions, and 234 roles (16.11.2018). It comprises knowledge from five different sources which are linked to each other by 704 interlinks (Figure 1).

The following teaching and learning scenarios can be visualized within the SNIK graph (http://www.snik.eu/graph):

(1) A teacher prepares a lecture on strategic HIS directing. He or she uses the "circle star" visualization for the function "Strategic HIS Directing" and gets a mind map to structure the lecture (Figure 2).

(2) A student has decided to be a project manager in a students' hospital project and wants to know his or her responsibilites. The "circle star" around the role "project manager" shows 24 functions and 8 entity types from three different sources a project manager is responsible for.

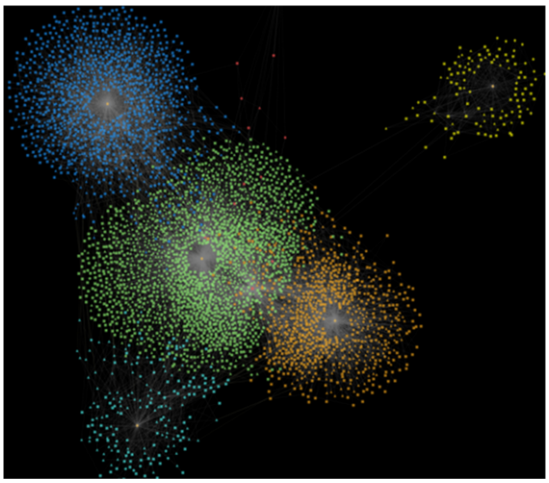

Figure 1 – Five colored clouds representing subontologies of SNIK. The clouds contain knowledge from three books (dark blue, green and orange), a CIO interview (light blue) and a framework (yellow).

Figure 2 - Circle star for the function "Strategic HIS Directing" (rectangles represent entity types, triangles represent functions and circles represent roles).

(3) Students learn new concepts about HIS quality by linking them to concepts already learned. A teacher asks a student to find out how the new concept "Quality of Data" is linked to the "Patient Identification Number". The student connects the two concepts by using the spiderworm visualization and learns that a patient identification number is associated with object identity. Object identity is a subclass of integrity of data. Besides integrity of data, there are also 13 other criteria for quality of data (Figure 3).

Conclusions

The SNIK graph enables students and teachers to browse through the knowledge of HIS management on a website. With the help of the visualization capabilities like "circle star" and "spiderworm" specific questions arising during learning, the preparation and the execution of lectures can be answered. The SNIK graph complements texts on HIS management by a highly interconnected map. Knowledge about a concept, which is often scattered over different chapters or even books, can be found around one node of the graph visualization. Other possibilities of teaching support by SNIK, like the automatic generation of multiple choice tests (e.g [6]), are subject of further research. Nevertheless, due to its size, SNIK is not free of errors. Hence, every user can participate in the continuing quality assurance process and report bugs directly within the graph visualization.

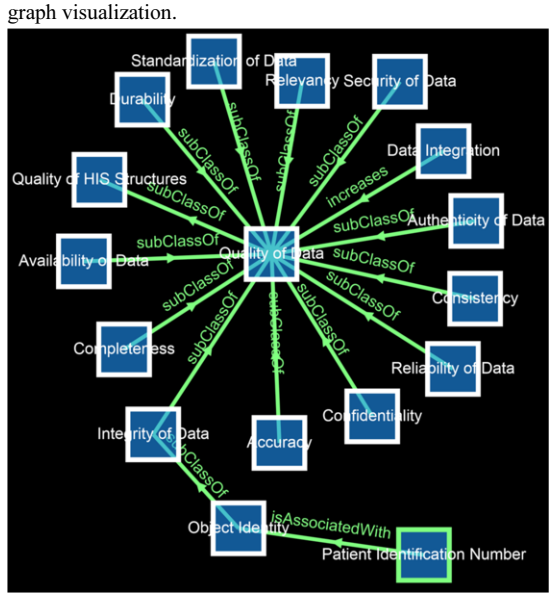

Figure 3 - A spiderworm connecting "Patient Identification Number" and "Quality of Data"(surrounded by its neighbors).

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