

Implementation of a distributed test environment for medical datasources

David Goeth

University of Passau

Graduated seminar: Distributed Information Systems

Supervisor: Armelle Natacha Ndjafa Yakou

WS 2017/2018

February 12, 2018

Overview

- 1 Motivation
- 2 Data Integration
- 3 Dataspace
- 4 Implementation
- 5 Improvements and Outlook

Motivation

- Vast amount of data in the fields of medicine
- Data is heterogeneous (e.g. using different file formats)
- Data isn't easily accessible and needs lots of tools
- Research and health care institutions would benefit from a unique view of data [RR14]:
 - Lower Costs
 - Detecting diseases at early stages
 - Simplified collaboration
 - Health care fraud detection

- What is data integration?
- different types of data integration
- What is semantic data integration?
- What is a schema?
- Wrappers
- More highlight on semantic data integration, which leads to ontologies

- Defines the concepts, relationships, and other distinctions being relevant for modeling a domain [LL09].
- Operates on the semantic level rather than on the logical/physical one.
- Independent from lower data models
- Suitable for integrating heterogeneous data sources

- What is a dataspace?
- New abstraction of data management
- Data to be managed rarely stored using a single data model
- Supports all kind of data rather than only a few
- Provides tools allowing a tighter data integration process when required
- Difference to a Data Integration Systems (DIS): Data coexistence. DIS need a semantic integration process before providing any services.
- Pay-as-you-go integration
- Multimedia dataspace model: classes, objects and relations [NKCB11]
- Similarity relations

Implementation

Overview and project goals

- Setting up three heterogeneous data sources containing medical data about breast cancer (Relational, Images, PDF Files)
- Implementing wrappers adding keyword search functionality to the data sources
- Wrappers register themselves to the Register
- Convert data of search results to RDF
- All data sources can be queried through an unified user interface

- Resource Description Framework (RDF) [rdf14]
- Graph-based abstract data model
- Facilitates merging data expressed in different schemas
- Allows mixing of structured and semi-structured data
- Follows Linked Open Data recommendation **TODO**
- RDF4J (formerly Sesame) framework used in the thesis' project [RDF18]

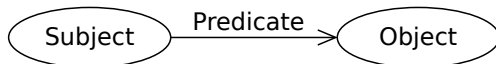


Figure: Connection between two nodes (Subject, Object) forming an RDF Triple ²

- Three kinds of nodes: IRI, literals, blank nodes
- Relations between nodes are specified by predicates
- Predicates are IRIs themselves
- Web Ontology Language (OWL) can be used to define ontologies using rdf **TODO** [owl12]

²<https://www.w3.org/TR/rdf11-concepts/rdf-graph.svg>

Wrapper (general)

- Proxy for a datasource
- Transforms an incoming dataspace query into a query the wrapped datasource understands.
- Offers its services through REST services, powered by the Play framework [Pla]
- Registers and deregisters autonomously to the dataspace
- Has to offer at least a keyword search query service
- XML configuration file using JAXB [EO03]
- Apache Lucene used to offer fulltext search functionality [Luc16]
- Keyword search currently only supports OR boolean operator
- On startup index for the keyword search service is created
 - Fetch data from the datasource
 - index them using apache lucene
 - store index

- Sample data used from Schmidbauer's PDGF [Sch12]
- sql data is translated into rdf equivalent using Bizer's D2R Map language [Biz03]
- relational to rdf mappings are defined in separate configuration file

- Digital Database for Screening Mammography(DDSM)[DDS]
- Mammography Images used to seek for breast cancer
- A case folder contains source images, overlay and case meta data
- **TODO: Example of a case folder structure or an except from the metadata?**
- DDSM-Utility used to convert (old) JPEG1 files to PNG [Sha16]
- RDF Transformation rules defined in own configuration file






- Apache PDFBox [PDF18] for extracting unstructured text content from pdf files.
- The pdf files were formerly created using Schmidbauer's medical sql data set [Sch12]
- Configuration file defining RDF transformation rules (cf. Image Wrapper)

- Responsible for managing registered datasources
- Provides user interface for executing search queries
- User Interface and REST services powered by Play framework [Pla]
- Keyword search queries are forwarded to each datasource. The result is collected by the data-Collector module
- Query results are (temporarily) stored in separate RDF repositories
- In final implementation: Search results get cached. Useful for quick access and useful for further data integration






Improvements and Outlook

- Query caching
- Incremental (Pay-as-you-go) data integration
- Query language for multimedia data (reference to Ndjafa's work)[DYT⁺09]
- Inferring knowledge using ontologies

References I

-  Christian Bizer, *D2r map a database to rdf mapping language*, 01 2003.
-  *University of south florida digital mammography home page*, <http://marathon.csee.usf.edu/Mammography/Database.html>, Last accessed on 02/10/2018.
-  M. Doller, A. N. N. Yakou, R. Tous, J. Delgado, M. Gruhne, M. Choi, and T. B. Lim, *Semantic mpeg query format validation and processing*, IEEE MultiMedia **16** (2009), no. 4, 22–33.
-  Bhakti Mehta Ed Ort, *Java architecture for xml binding (jaxb)*, <http://www.oracle.com/technetwork/articles/javase/index-140168.html>, March 2003, Last accessed on 02/10/2018.
-  M. Tamer zsu Ling Liu (ed.), *Encyclopedia of database systems*, 1 ed., Springer, 2009.

References II

-  *Apache lucene core*, <https://lucene.apache.org/core/>, 2016, Last accessed on 02/10/2018.
-  A. Ndjafa, Harald Kosch, D. Coquil, and L. Brunie, *Towards a model for multimedia dataspace*, Multimedia on the Web (MMWeb), 2011 Workshop on, Sept 2011, pp. 33–37.
-  *Owl 2 web ontology language document overview (second edition)*, <https://www.w3.org/TR/owl2-overview/>, December 2012, Last accessed on 02/10/2018.
-  *Apache pdfbox*, <https://pdfbox.apache.org/>, 2018, Last accessed on 02/10/2018.
-  *Play framework*, <https://www.playframework.com/>, Last accessed on 02/10/2018.

References III



Rdf 1.1 concepts and abstract syntax,
<https://www.w3.org/TR/rdf11-concepts/>, February 2014, Last
accessed on 02/10/2018.



The eclipse rdf4j framework, <http://rdf4j.org/>, 2018, Last
accessed on 02/10/2018.



Wullianallur Raghupathi and Viju Raghupathi, *Big data analytics in healthcare: promise and potential*, Health Information Science and Systems **2** (2014), no. 1, 3.



Maximilian Schmidbauer, *Medical data generator*, Unpublished Bachelor thesis; Accessible through the library of the university of passau, 2012.



Anmol Sharma, *University of south florida digital mammography home page*, <https://github.com/trane293/DDSMUtility>, 2016, Last accessed on 02/10/2018.