Semantic Annotation of Patient Data in a Commercial Health Information System

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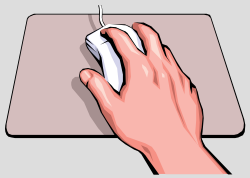
The ORBIS Hospital Information System

- ORBIS technologies allow both Agfa and the customer to
  - Define forms for medical documentation and to build applications
  - Implicitly define arbitrary data structures (as part of applications or customer specific)

Define forms



IT staff of the hospital

clinical users

Use of forms for documentation

ORBIS EPR
Form definition and instances

- Common applications: medical history (anamnesis), letter of discharge, nursing, etc.

Rationale

Orbis forms are stored

- as Enitity-Attribute-Value structures
  - Attributes are defined at design time, values are added by the clinical user during runtime
- in a generic data model

- The approach is extremely flexible (no restrictions through a rigid central data model) and renders the system extensible
- There are multiple ways to model the same clincial fact
- Utilizing the knowledge inherent in these forms requires semantic annotation

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Semantic Annotation

- Semantic annotation of form elements is achieved through codes from controlled vocabularies
- These semantic annotations are stored in a set of tables located in the same database as the forms

- Turns raw data into accessible knowledge
- Enables CDSS and other applications to exploit and structure this knowledge according to their own needs

The Annotation Process

- What is annotated?
  - Semantic annotation of form elements during design time (attributes)
  - Semantic annotation of form instances during runtime (values)

  How is the data annotated?
  - Manually (at design time)
  - Semi-automatically (at runtime)
  - User support through specific tools is essential for (Terminology Browser, NLP algorithms for semi-automatic text analysis)
  - Assignment of multiple semantic concepts is possible

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Semantic annotation applied to a form

ORBIS 5/30/2007 23:01:33 OMED@ZENT -05.03.29.6189

File Edit Extra Administration ? KG INT FINT/SINT2 ARZT INT

New Bannister, Andrea 05002166 act/h

Favorites

Patient Data Manageme
Outpatient Clinic
Ward
Functional area
Intensive Medicine

Job List Information
Ward Graphic
Appointment List
Data Interpretation Care

Health Record Overview
Wunden Übersicht
TPROC_Demo
InfoService
[Patient History]

Additional Information

Patient History*

Anamnese Sekretariat Reference to Central EPR

Status **erstellt**

Case History

Entered by Dr. Waltraud Facharzt für Innere Medizin
Entered on 5/30/2007 22:49
Data Entry Mode ○ History from patient
◉ History from third party
○ Mother
○ Father
◉ Other
○ Other mode

Current Case History

Previous illnesses ○ no ◉ yes Diabetes
Previous Operations ○ no ○ yes
Current Medication ○ no ○ yes

Allergies ○ no ◉ yes Nickel, Penicillin

Risk factors
Alcohol ○ no ○ yes
Smoker ○ no ○ yes
Other ○ no ○ yes

Childhood Illnesses ☐ Scarlet fever ☐ Chickenpox
☐ Measles ☐ Mumps
☐ Diphtheria ☐ Pertussis
☐ Rubella ☐ Other

84100007: History taking (procedure)

102478008: Pre-existing condition (finding)

106190000: Allergy (disorder)

44054006: Diabetes mellitus (disorder)

33396006 : Nickel (substance)

373270004 : Penicillin (substance)

Pre-classified Properties

Runtime-classified formal values

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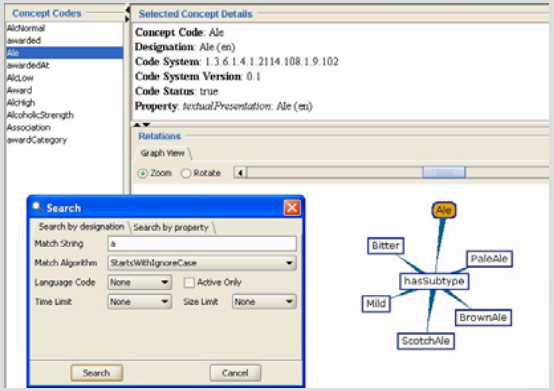
The Coding Interface
During form definition and during runtime

Form Composer

- Manually used by form author
- Result: Code, Terminology-System, Version



CTS Terminology Explorer [1]

Form

- Automatic evocation during runtime
- Information sent to coder: pre-classified information (Code, System, Version) plus raw data
- Result: Code, State

- LexGrid as a terminology server
- HL7 CTS to access terminological contents

Architecture of the Semantic Components

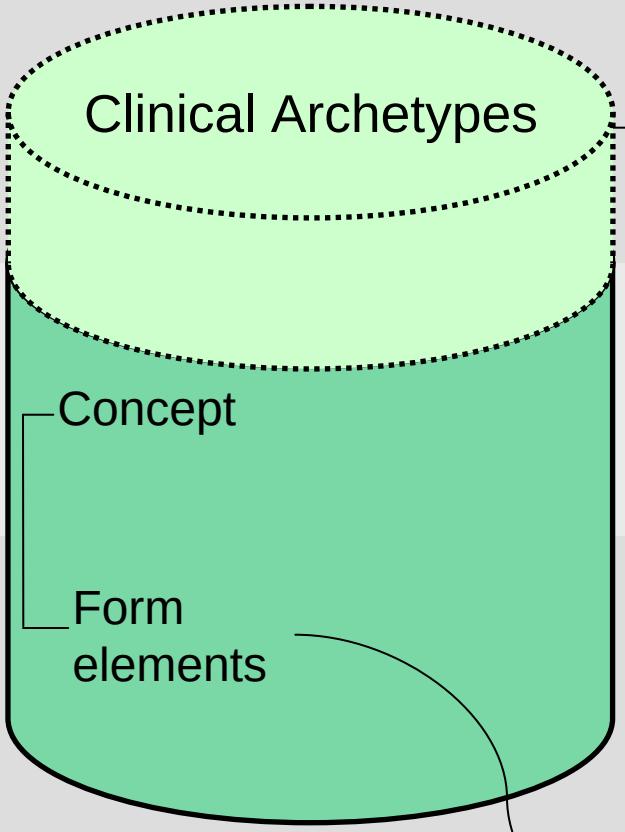
- The terminologies reside in a central terminology server
- HL7 CTS is used as a communication protocol to exchange data between the data repository and the terminology server
- Maintainability and interchangeability through usage of evolving standards and OpenSource Software
- Openness for all kinds of ontologies, terminologies and nomenclatures

Semantic Layers in the Generic Data Model

Possible further semantic layer

“Medical Dictionary” Layer

Form Data (Database Representation)



Blood Pressure
- Systolic
- Diastolic
- Patient ID

SNOMED Code:
271649006
Systolic blood Pressure

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Information Retrieval

- Queries are SQL reports that are stored or user-defined
- The query terms search the database for matching form annotations
- Queries retrieve
  - the semantic code and label of the associated input fields (attributes)
  - the raw form data stored in the form instances (values) and their semantic codes
- Sample query

  "Get all information related to patient x which refers to allergies, except for allergies having occurred in his family history"

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Results and Conclusion

- Through semantic annotation at a very granular level, the annotation process is separated from the abstraction
- A flexible architecture preserves openness for all kinds of terminologies
- Open for knowledge interpretation from different views (realized by additional semantic layers)

Thank you

References

[1] http://informatics.mayo.edu/LexGrid/index.php?page=ctsdemo. Accessed May 30, 2007.

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