



Automated Transformation of openEHR Data Instances to OWL

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openEHR is an open standard specification in health informatics that describes the management and storage, retrieval and exchange of health data in electronic health records (EHRs)

- Recently, openEHR systems have seen wider adoption in countries such as Norway, Sweden, Slovenia and Russia.
 - EMRs, EHRs, Registries...
- Besides of its value to establish semantic interoperability, openEHR might also help to integrate and facilitate **secondary use** on EHR data:
 - Cohort Identification / patient recruitments
 - Clinical Decision Support
 - Data Mining
 - ...

Background

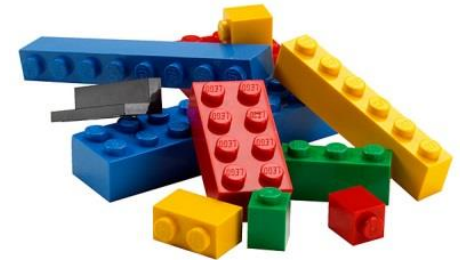
- For **secondary use**, combining clinical data with knowledge is sometimes necessary
- Knowledge is often represented based on the formalism of the **Web Ontology Language (OWL)**.
- While openEHR provides a formalism to bind elements of the information models to terminologies, it does not support a direct access to **formal ontologies** for querying, reasoning etc.
- Hence, Lezcano et al. developed a method to transform openEHR concept definitions (**Archetypes**) to a formal representation using the OWL [1]

However, transformation of **actual clinical data** to OWL still requires the laborious, manual creation of mapping scripts for different data types and database.

Research Question:

„Is it possible to automate the transformation of openEHR-based **clinical data** into **individuals** of the Web Ontology Language? (OWL)“

- A Comprehensive Semantic eHealth Framework
- Enables a standard-based, detailed, canonical representation of health data
 - Computable
 - Exchangeable
- Multi level modelling:
 - Separation of clinical and technical aspects of software development
 - Constraints on a Reference Model (RM) are defined using the Archetype Definition Language (ADL).
- Benefit:
 - Changes in the domain layer (archetypes) do not cause changes in the reference model and the underlying database!



Sources

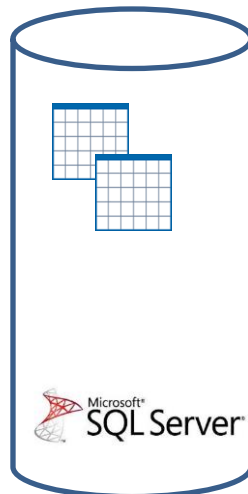
 Copra System GmbH

 medisite
ON YOUR SITE

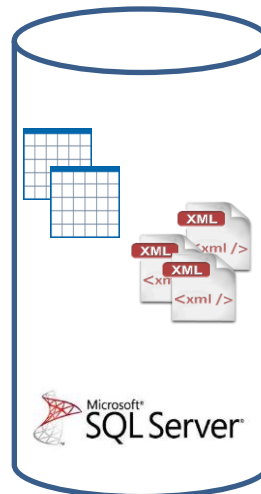
 SAP

 OSM

Core Data Warehouse



Copy of Source Data
(Staging Area)



Clinical Data
Repository

 openEHR



Archetype Store

Provision

 Microsoft®
SQL Server®
Analysis Services

 Think!EHR
PLATFORM

 i2b2

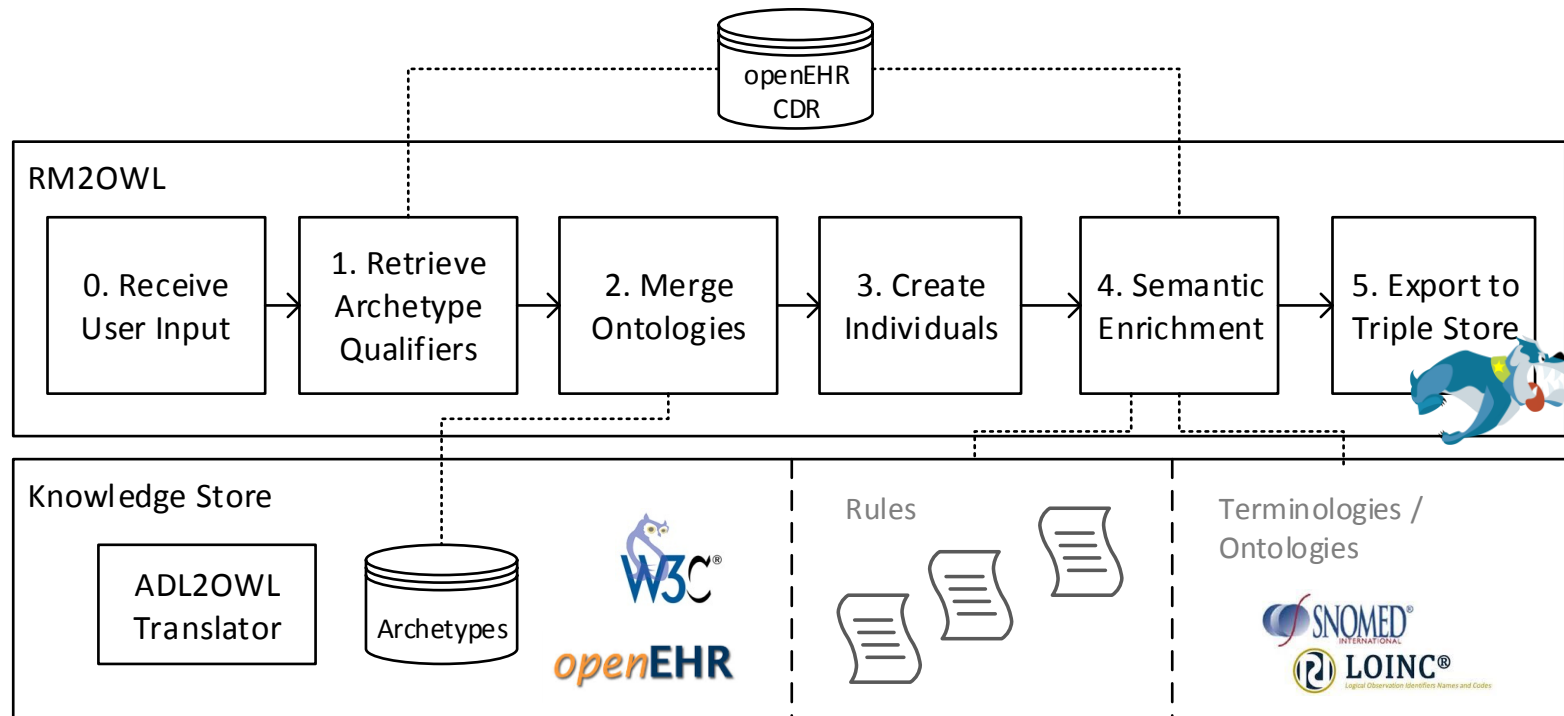
 Stardog

1. Extract, Transform, Load

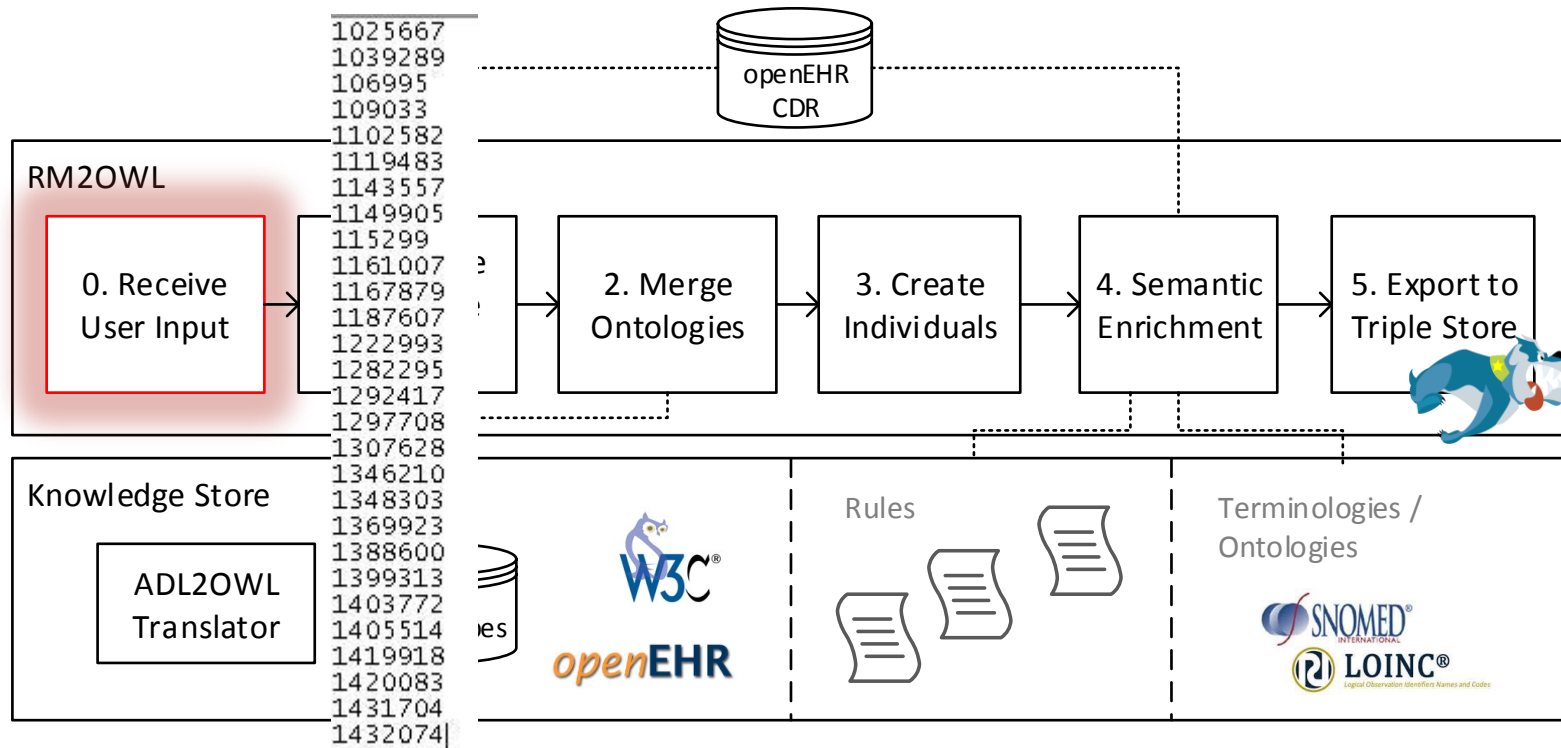
2. Normalization

3. Data Analysis

Results: RM2OWL Architecture



Results: RM2OWL Transformation

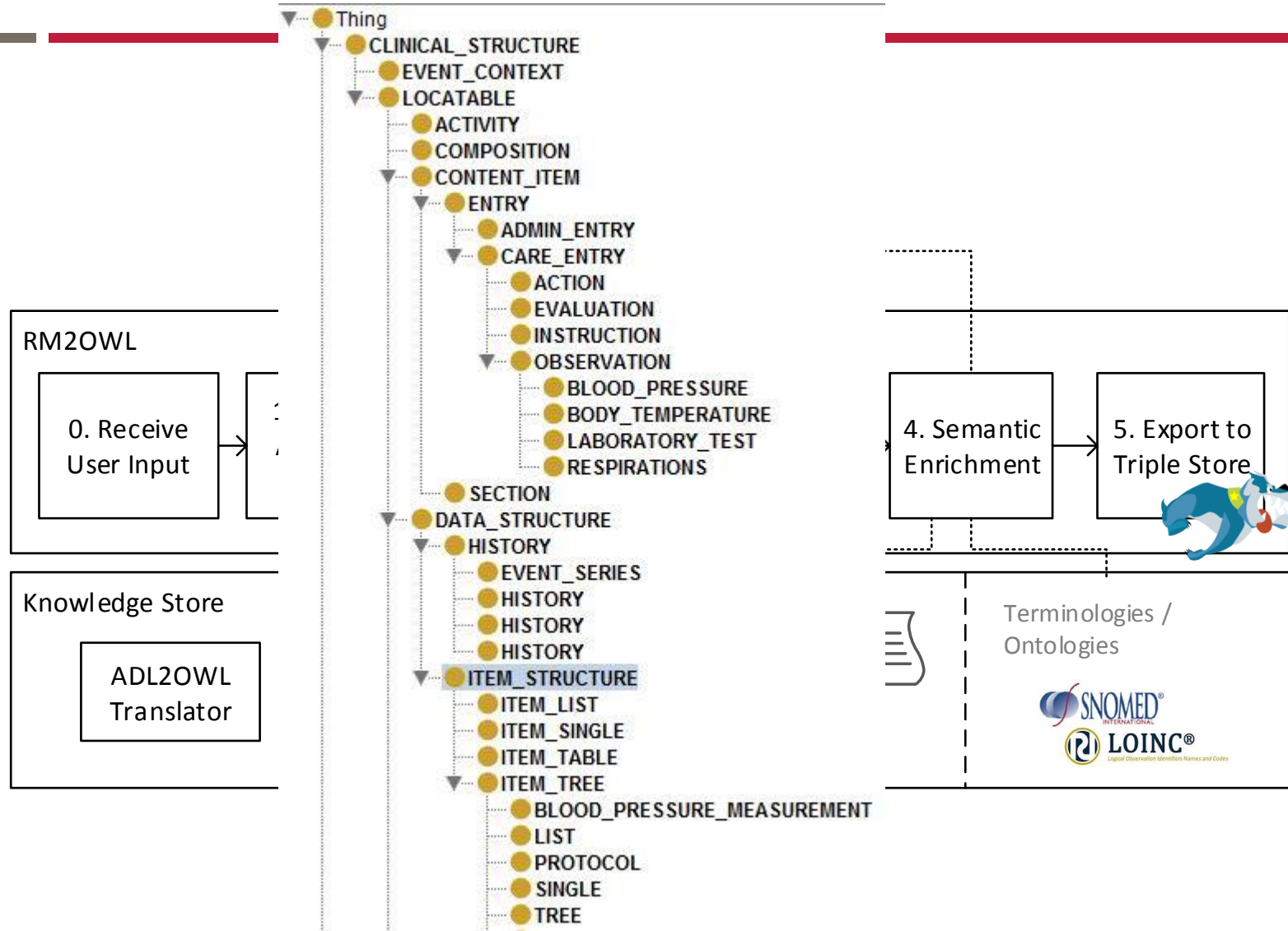


Results: RM2OWL Transformation

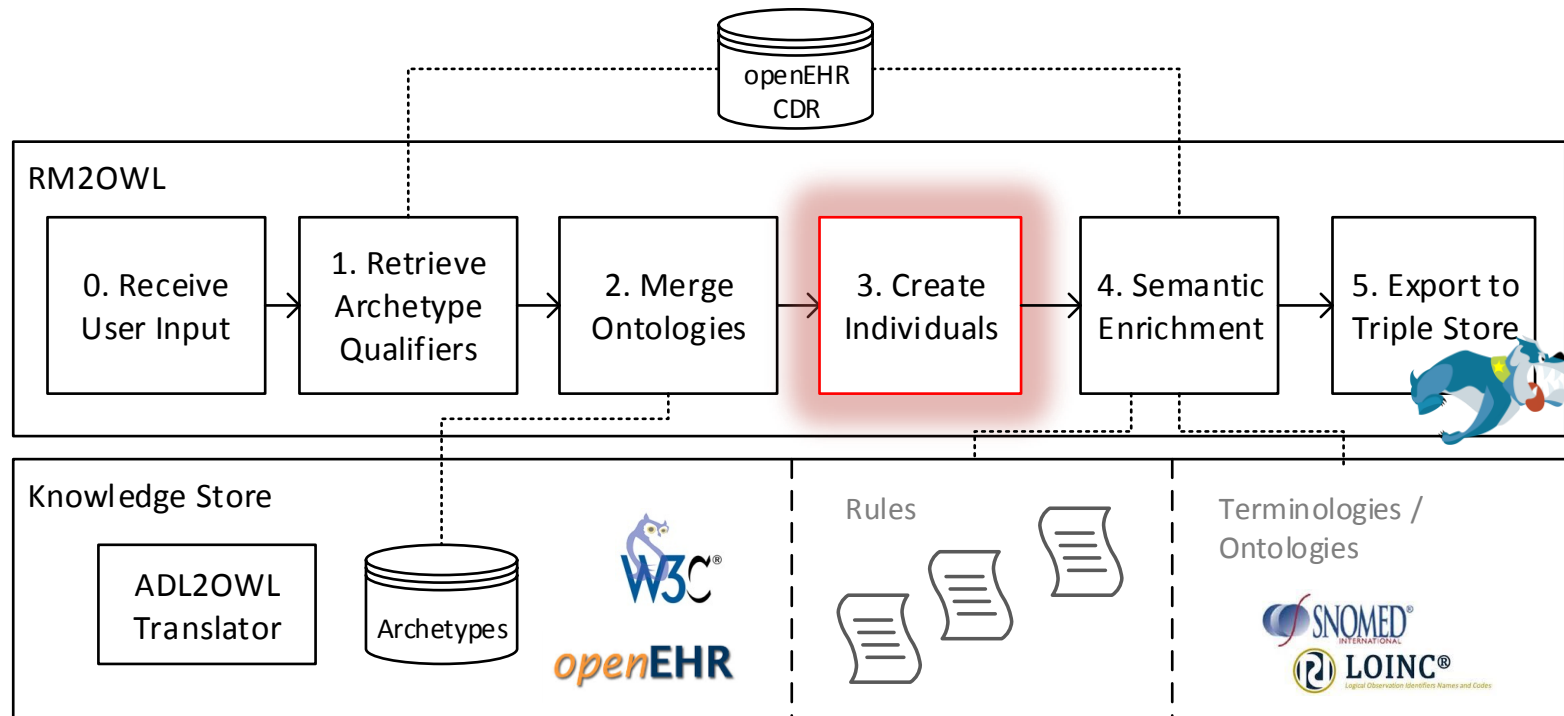
Tabelle: ☐ Archetype			Neue Zeile Zeile löschen		
ID	composition	parent	ID	ADL	OWL
2320581	655940	0	1	openEHR-EHR-CLUSTER.device.v1	archetype (adl_version=1.4)...
2320582	655939	0	2	openEHR-EHR-COMPOSITION.report.v1	archetype (adl_version=1.4)...
2320584	655941	0	3	openEHR-EHR-COMPOSITION.report.v2	archetype (adl_version=1.4)...
2320586	655942	0	4	openEHR-EHR-EVALUATION.alert.v1	archetype (adl_version=1.4)...
2320589	655943	0	5	openEHR-EHR-CLUSTER.device_details.v1	archetype (adl_version=1.4)...
2320590	655944	0	6	openEHR-EHR-OBSERVATION.nine_hole_pe...	archetype (adl_version=1.4)...
2320591	655945	0	7	openEHR-EHR-OBSERVATION.glasgow_co...	archetype (adl_version=1.4)...
2320594	655946	0	8	openEHR-EHR-OBSERVATION.braden_q_sca...	archetype (adl_version=1.4)...
2320597	655947	0	9	openEHR-EHR-OBSERVATION.glasgow_co...	archetype (adl_version=1.4)...
2320598	655948	0	10	openEHR-EHR-OBSERVATION.body_temper...	archetype (adl_version=1.4)...
2320599	655949	0	11	openEHR-EHR-EVALUATION.problem_diag...	archetype (adl_version=1.4; uid=cc3a20b3...
2320600	655950	0	12	openEHR-EHR-EVALUATION.health_risk.v1	archetype (adl_version=1.4; uid=70e1c139...
2320605	655952	0	13	openEHR-EHR-OBSERVATION.height.v1	archetype (adl_version=1.4)...
2320606	655953	0	14	openEHR-EHR-OBSERVATION.body_weight...	archetype (adl_version=1.4)...
2320607	655951	0	15	openEHR-EHR-CLUSTER.specimen.v1	archetype (adl_version=1.4; uid=48803d0f...
2320610	655954	0	16	openEHR-EHR-OBSERVATION.respiration.v1	archetype (adl_version=1.4)...
2320613	655956	0			

ADL2
Tran:

Results: RM2OWL Transformation



Results: RM2OWL Transformation



```
<data xsi:type="ITEM_TREE" archetype_node_id="at0001">
```

```
<items x
```

```
<
```

```
</items:
```

```
</data>
```

```
<data archetype_node_id="at0002">
```

```
<name>
```

```
<value>data</value>
```

```
</name>
```

```
<origin xsi:nil="true" />
```

```
<events xsi:type="POINT_EVENT" archetype_node_id="at0003">
```

```
<name>
```

```
<value>Messung</value>
```

```
</name>
```

```
<time>
```

```
<value>2010-04-30T15:02:00</value>
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```
</time>
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```
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```

```
<items xsi:type="ELEMENT" archetype_node_id="at0004">
```

```
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```

```
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```

```
<defining_code>
```

```
<terminology_id>
```

```
<value>local</value>
```

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</terminology_id>
```

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<code_string>at1026</code_string>
```

```
</defining_code>
```

```
</name>
```

```
<value xsi:type="DV_QUANTITY">
```

```
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```

```
<units>/min</units>
```

```
<precision>0</precision>
```

```
</value>
```

```
</items>
```

```
</data>
```

```
</events>
```

patient_1

type

PATIENT

links

CASE

COMPOSITION

pulse.:PULSE

pulse:ANY_EVENT

pulse:PULSE_MEA

pulse:R

pulse:RATE_DV_C

pulse:HISTORY

TE_DV_QUANTITY

QUANTITY_UNITS

NTITY_PRECISION

RATE_DV_QUAN

TY_PRECISION_1

rec_value

98

unit_value

/min

precision_value

0

Results: RM2OWL Transformation

Diagram illustrating the RM2OWL Transformation results, showing a database connection and a table of clinical terms.

Database Connection: openEHR CDR

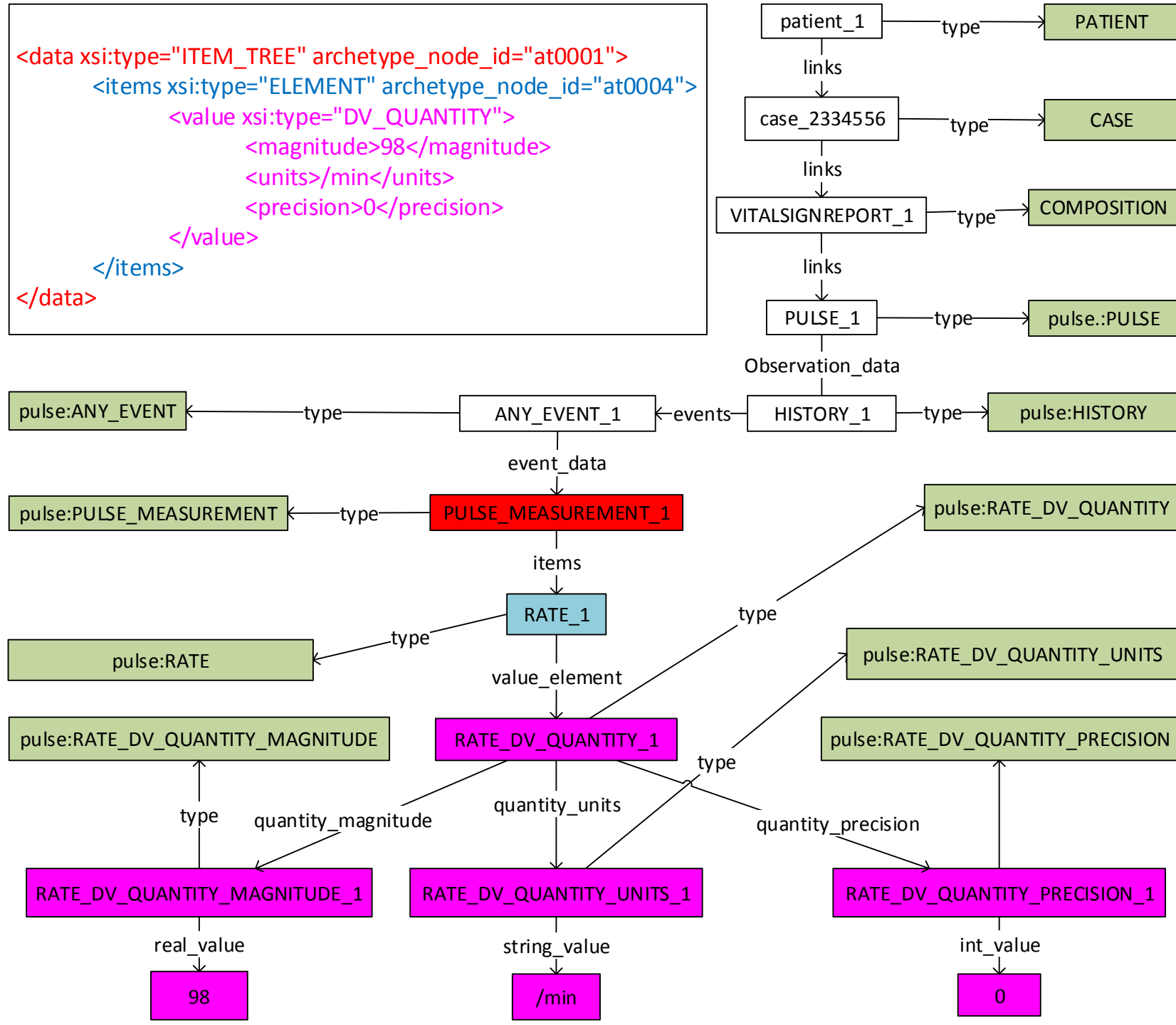
Terminologie: SNOMED International Clinical Terms, 2002

Knoten	Code	Veröffentlichung
Manschettengröße	246153002	2003
Systolisch	163030003	2003
Diastolisch	163031004	2003
Blutdruck	163020007	2003
*		

```

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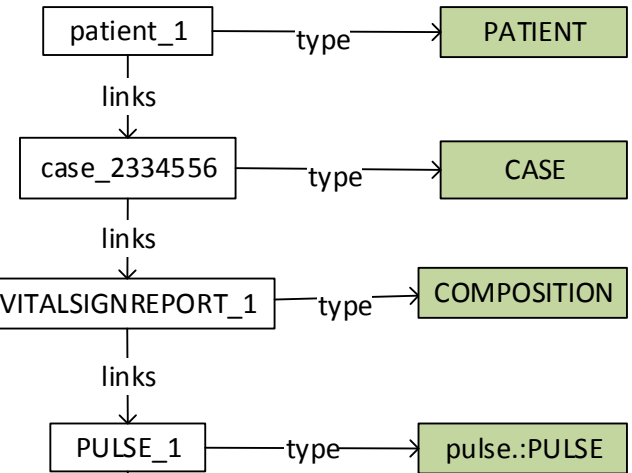
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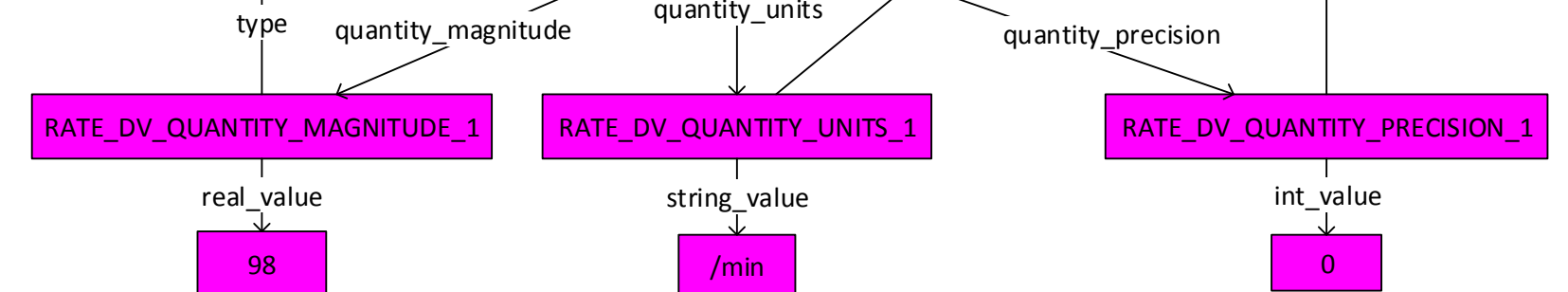
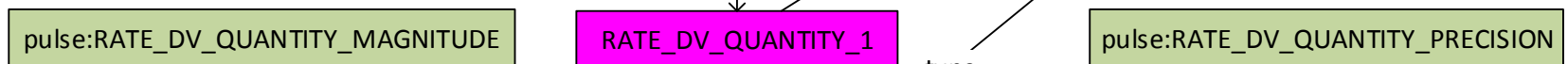
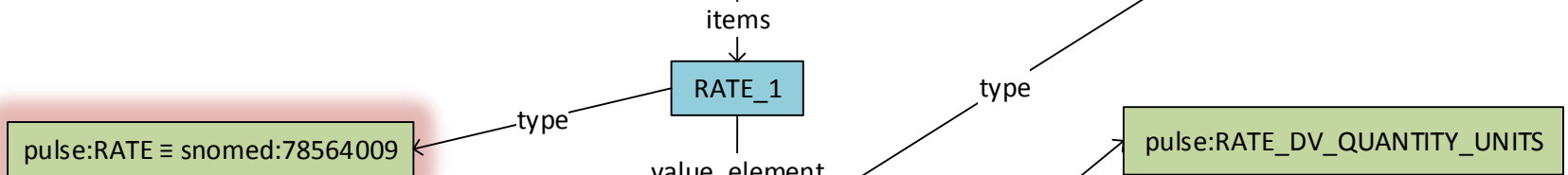
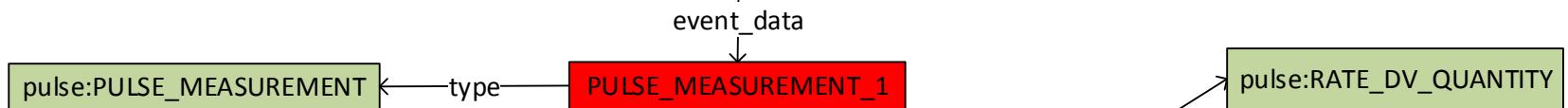
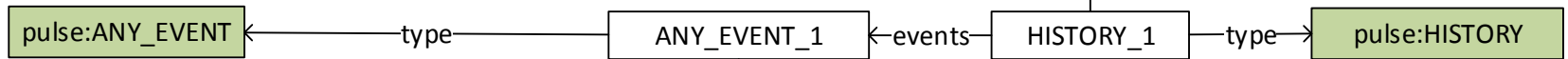
```

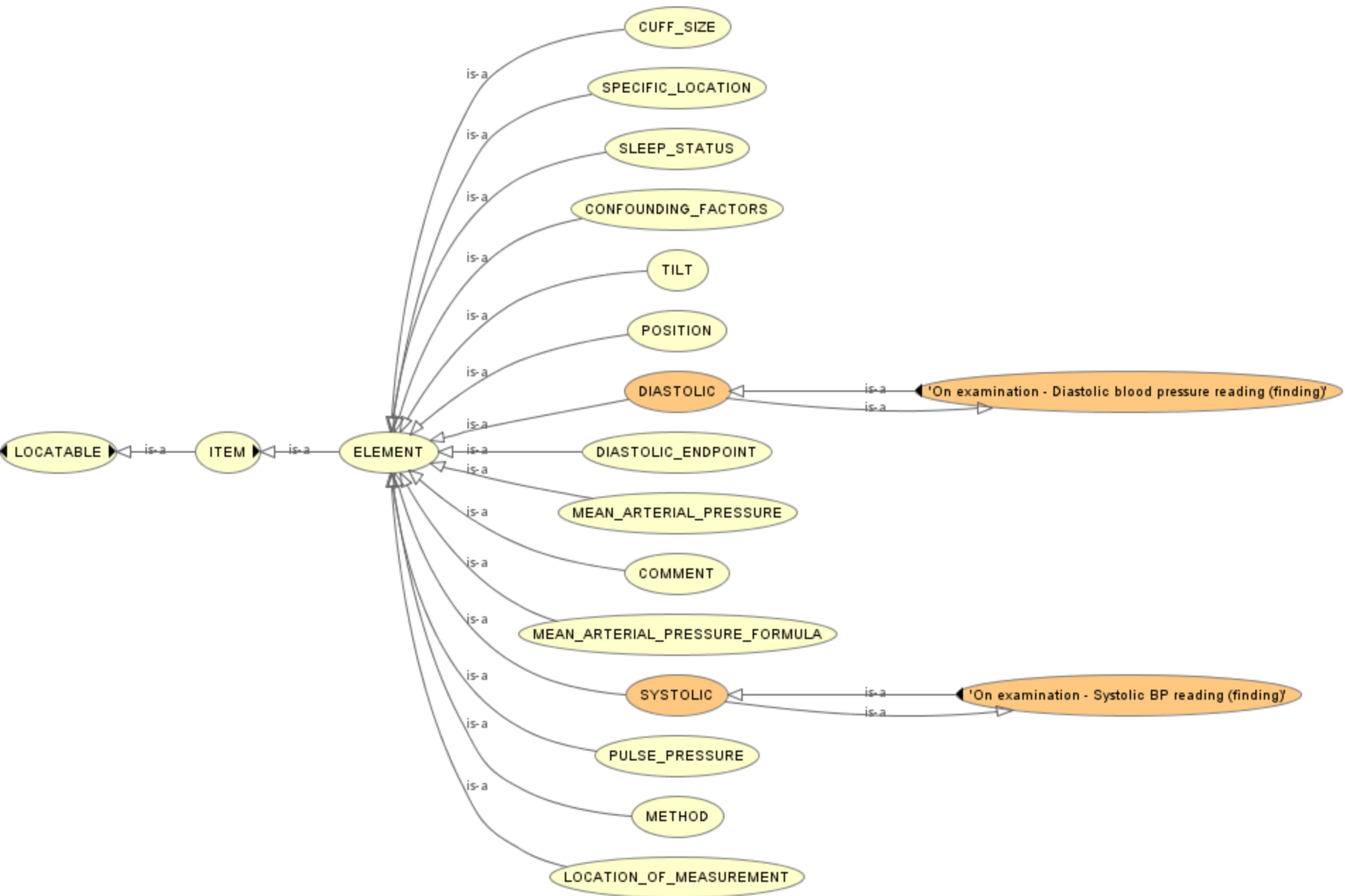
<data xsi:type="ITEM_TREE" archetype_node_id="at0001">
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    </value>
  </items>
</data>

```

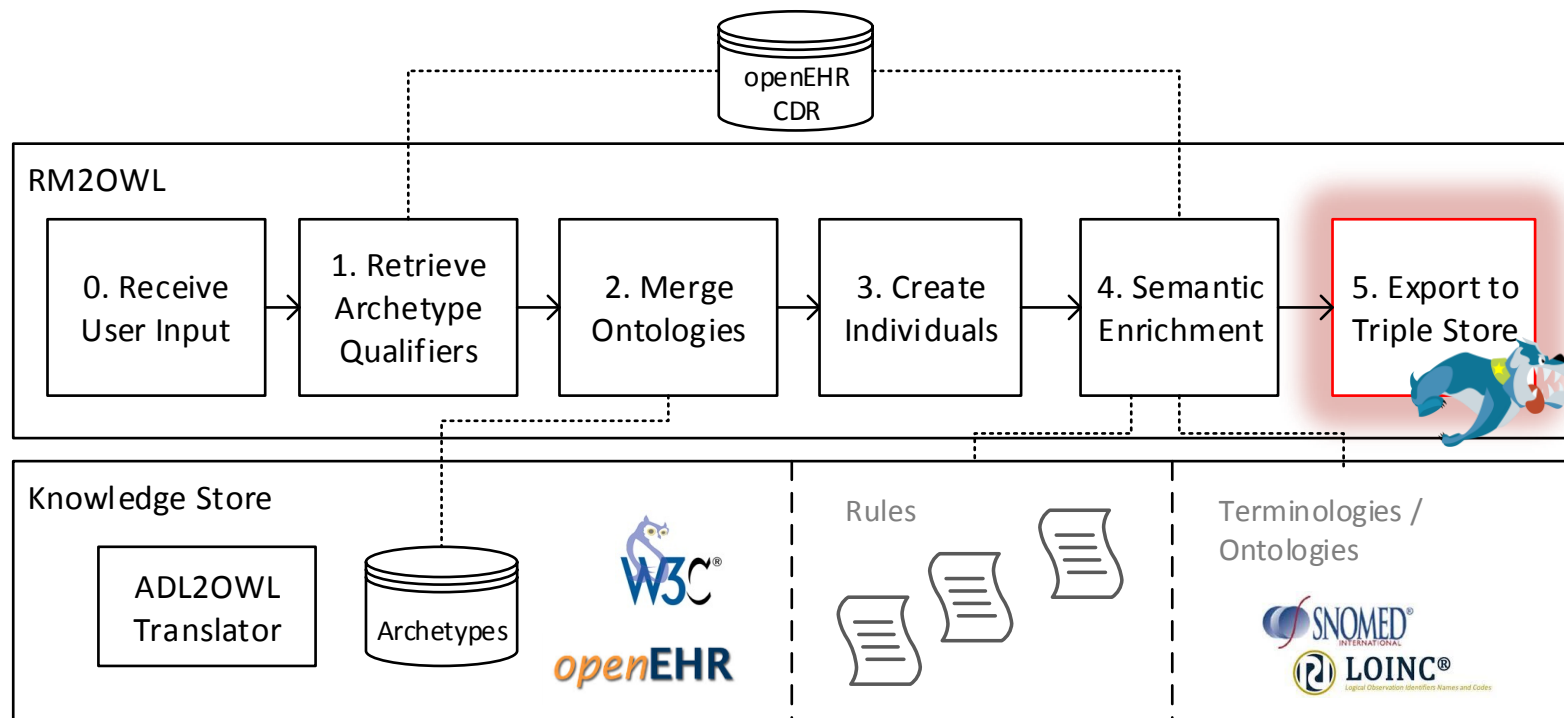


Observation_data





Results: RM2OWL Transformation



Discussion

- It is possible to implement a tool to automatically transform arbitrary structured clinical data to OWL (no more need to adjust to new requirements!)
 - The terminology binding functions of openEHR enable automated merging of its OWL representation with terminologies and ontologies
 - However, the tool needs to be enhanced to support all entry classes
- Safe time and resources to provide medical data to researchers
- New opportunities:
 - SPARQL
 - SWRL (Decision Support?)
 - Semantic Similarity
 - Linked Open Data...

Future Work

- Add functions to support all entry classes
- A function to preselect items would help to avoid unwanted transformations
- A graphical user interface would make it more easy to use.
- Do some interesting research based on the system 😊



Thank you for your attention

Questions, Remarks, Complaints?

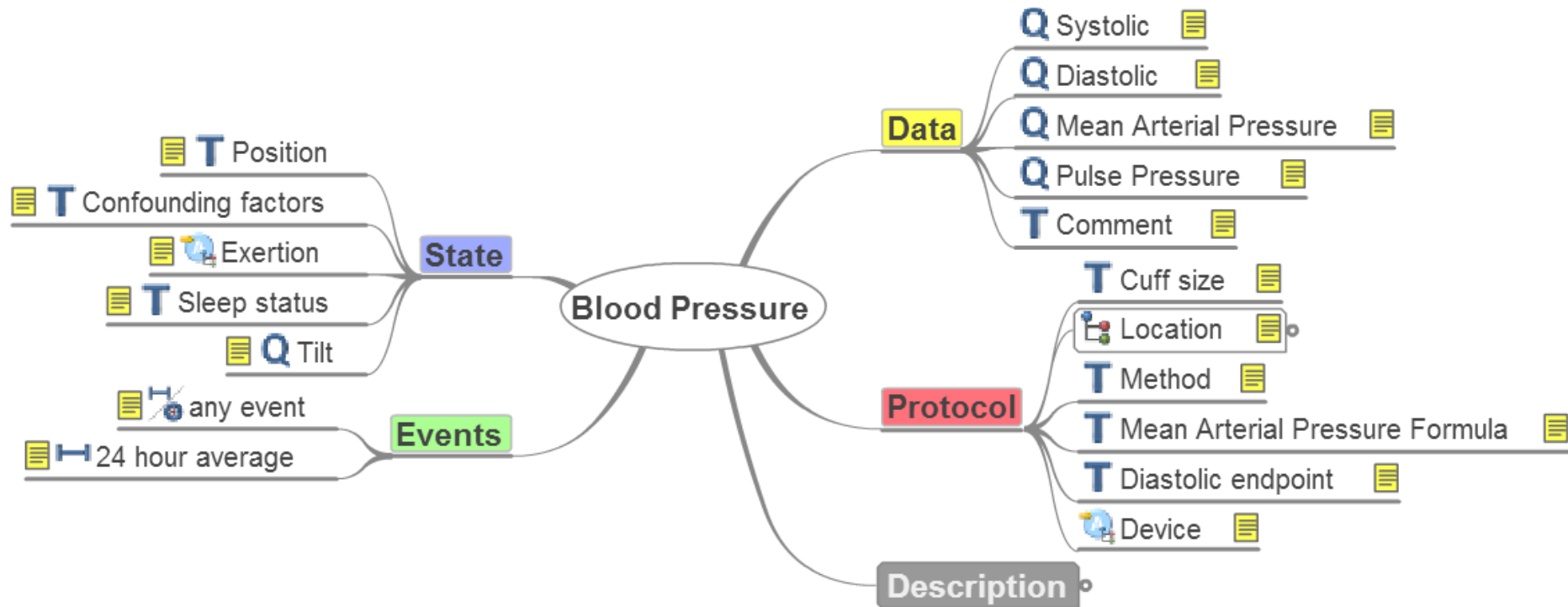


References

- [1] Lezcano, L., Sicilia, M. A., & Rodríguez-Solano, C. (2011). Integrating reasoning and clinical archetypes using OWL ontologies and SWRL rules. *Journal of biomedical informatics*, 44(2), 343-353.

[Query Body Temperature](#)

openEHR Archetypen III



Methods: openEHR Multi-Level Modelling

