Design and generation of Linked Clinical Data Cube

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CSIRO COMPUTATIONAL INFORMATICS
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Australian Imaging Biomarkers and Lifestyle data

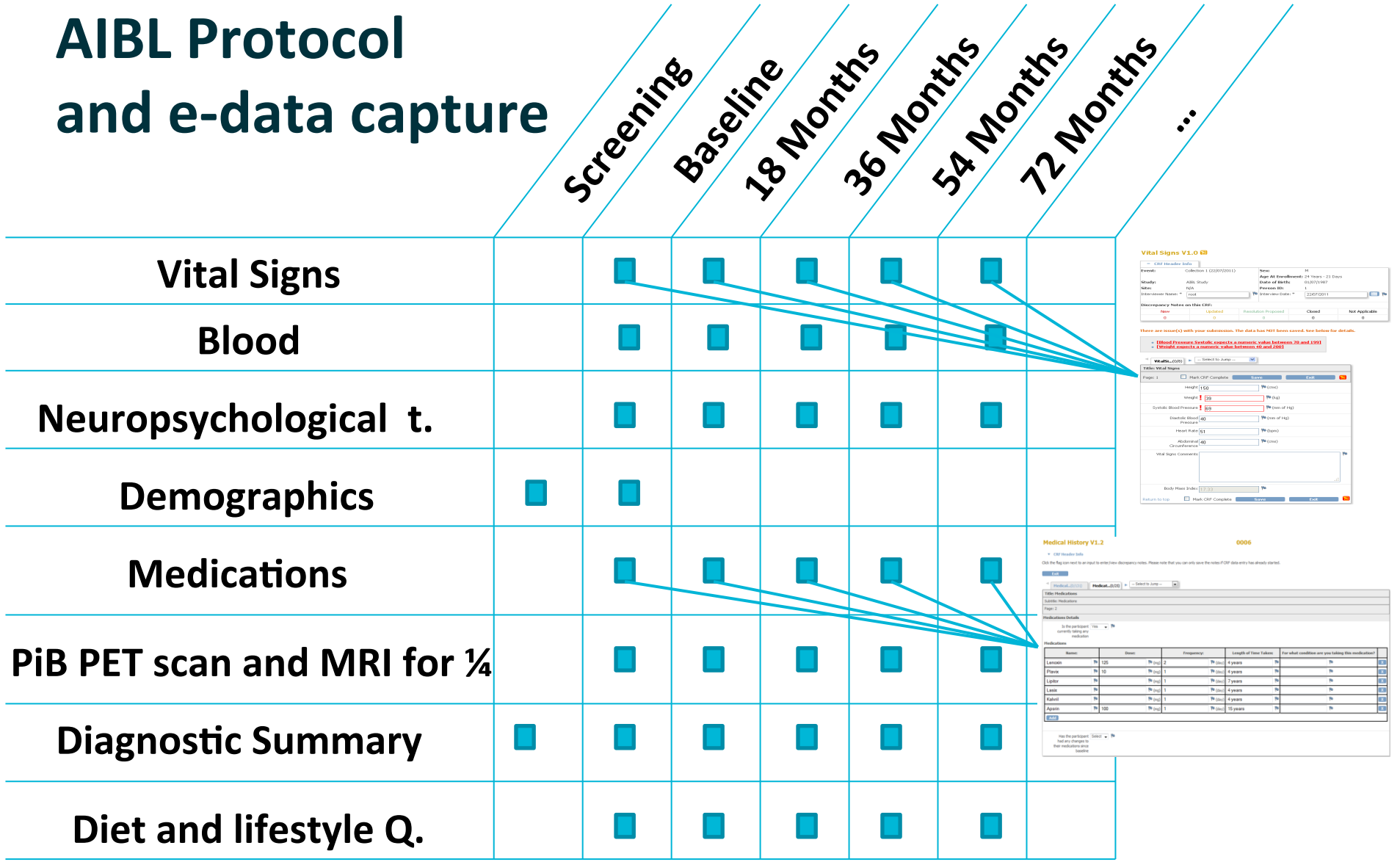
Problem – Solution – Remaining challenges

- Data collected for the AIBL study
  - (aibl.csiro.au)

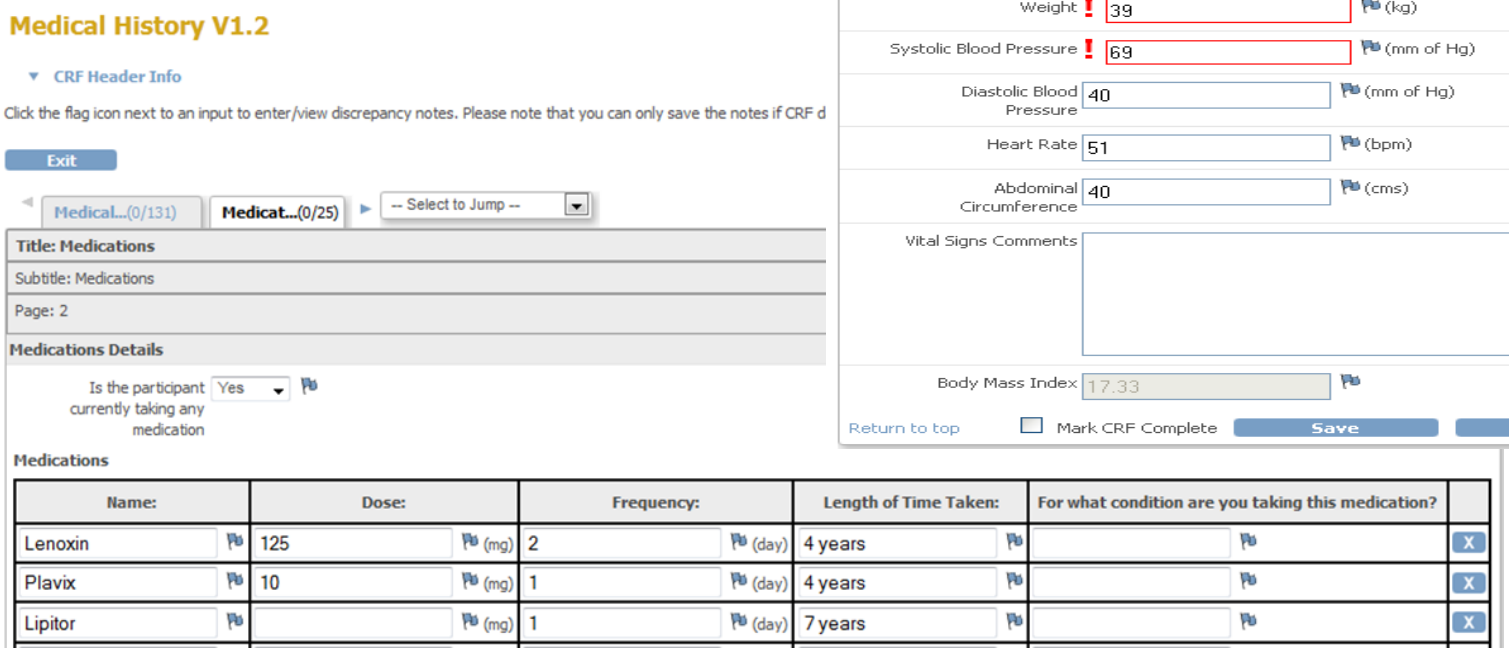
- For the early detection of Alzheimer's Disease
- Protocol aligned with Alzheimer's Disease Neuroimaging Initiative (ADNI)
  - Plus nutrition, lifestyle
- Microdata collected via electronic data capture tool (OpenClinica)
- To be consumed by researchers
  - 1) discovery + data quality assessment (fix)
  - 2) production of publishable results

- Original format (export format): CDISC ODM
  - Clinical Data Interchange Standards Consortium
  - Operational Data Model

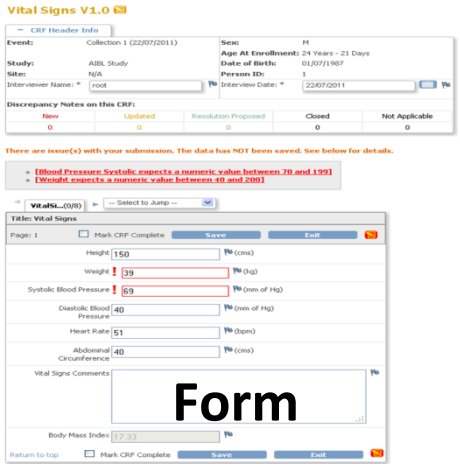
AIBL Protocol and e-data capture



Examples of forms (OpenClinica)



CDISC ODM XML Schema



ODM

METADATA

*Study

* MetadataVersion

* Study Event Def

*Form Def

* ItemGroup Def

* Item Def

DATA

*Clinical Data

*Subject Data

* Study Event Data

*Form Data

* ItemGroup Data

* Item Data

Data types

Same OID

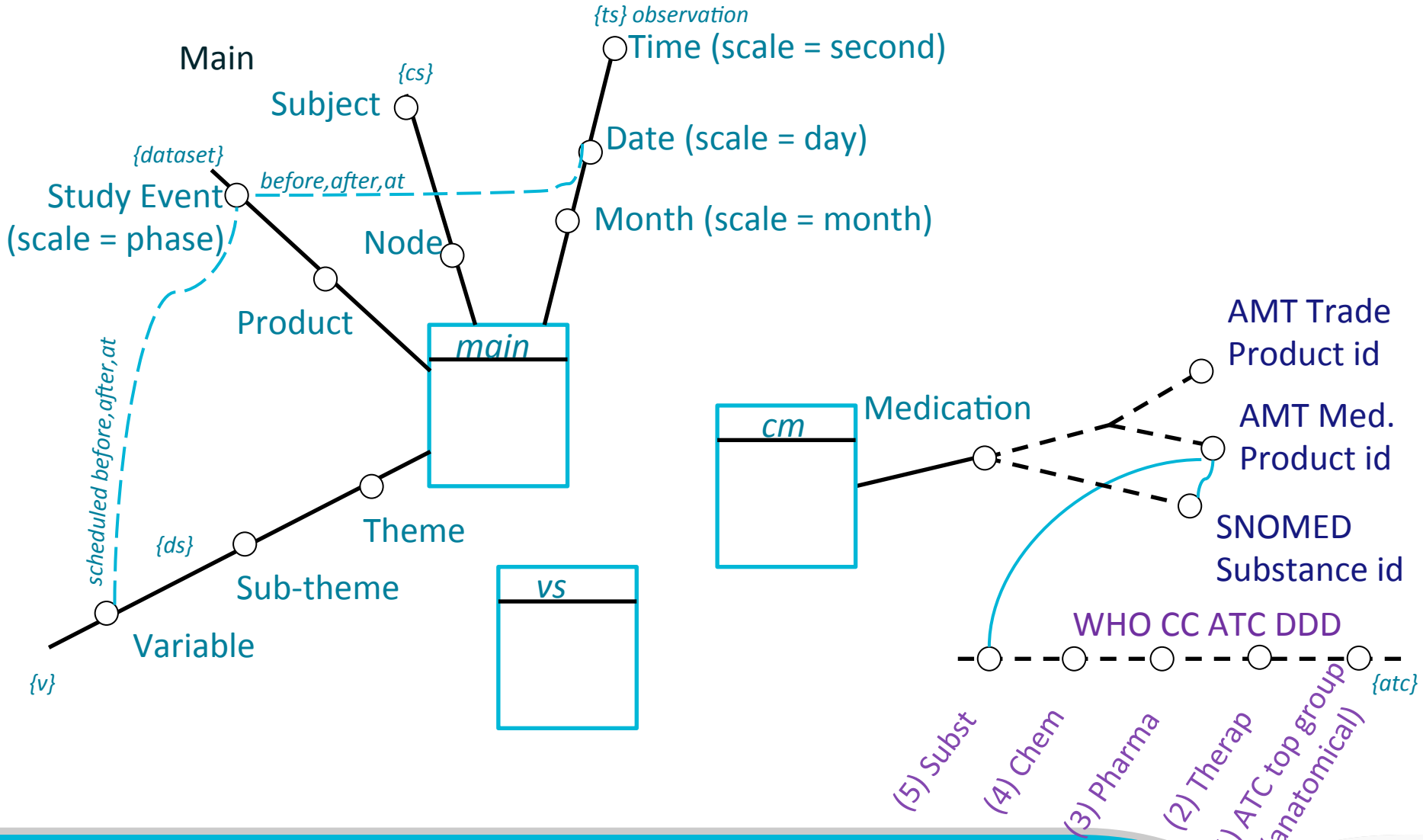
Data values

Current use of AIBL data

Problem – Solution – Remaining challenges

- Conversion in tabular format (Excel or CSV)
- Browser-based exploration tool
- Additional processing via Excel or R or …
- (different toolset for AIBL and ADNI)

Primary motivation: add new dimensions



Is this a Semantic Stats problem?

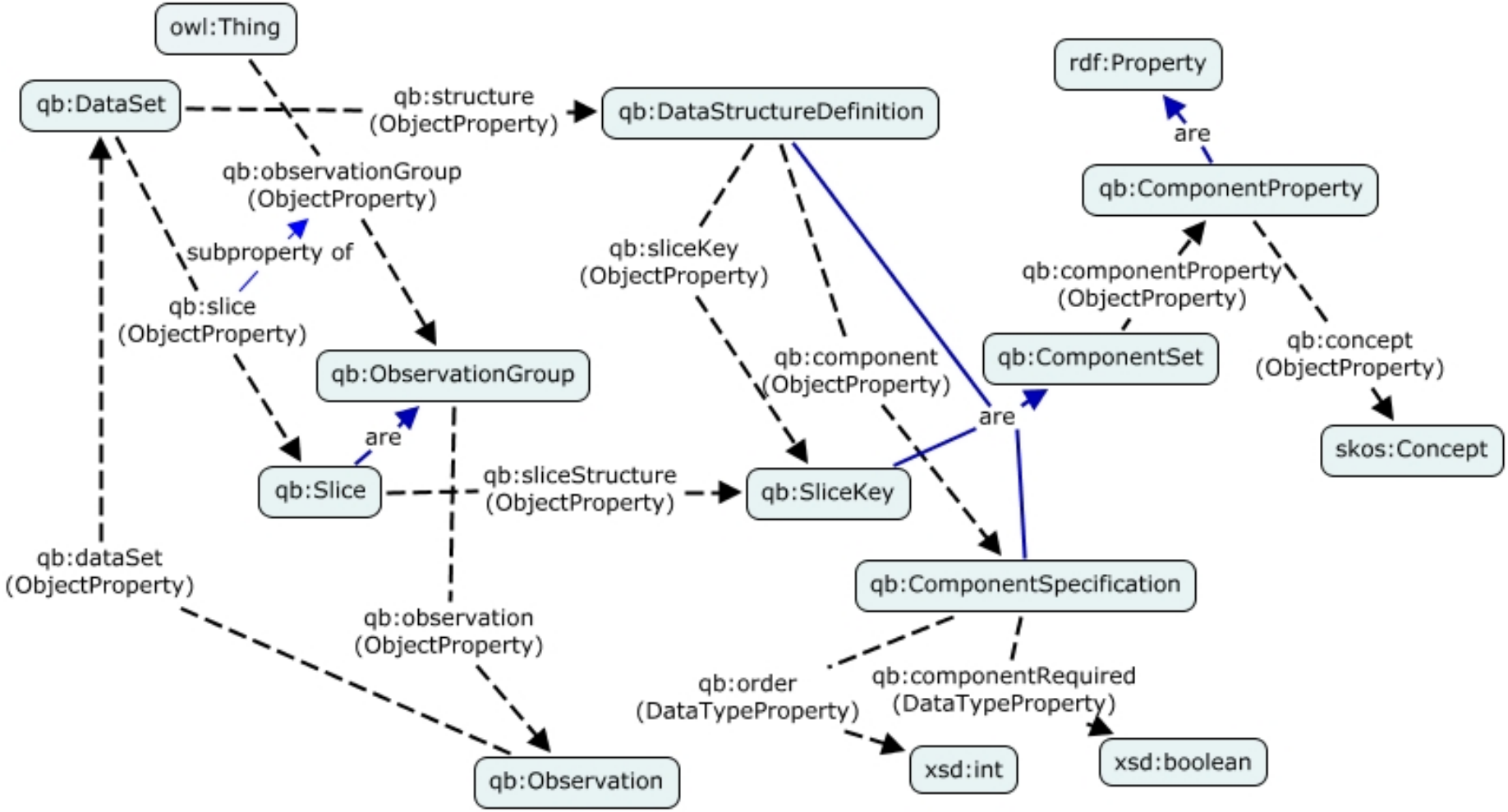
Problem – **Solution** – Remaining challenges

- Yes!
  - Transition from monolithic tree structure to multi-dimensional data cube → RDF Data Cube Vocabulary (and associated SDMX best practices for slicing it)
  - Complex study structure plus user-defined data types → DDI-RDF Discovery (and associated DDI Best practices)

RDF Data cube http://purl.org/linked-data/cube

- RDF Data Cube (qb): a method to organise linked data in slices
  - A vocabulary published by the W3C Government Linked Data (GLD) Working Group (Working Draft)
  - Also the method used to publish statistics data and environmental data in Europe e.g. for Bathing Water Quality in UK http://www.epimorphics.com/web/projects/bathing-water-quality
- Advantages
  - Allows multiple views on the same data (similar to OLAP)
  - Generic approach which supports the links to domain-specific definitions
- Useable:
  - In any browser via Linked Data API (HTML output)
  - In JavaScript via Linked Data API (JSON output)
  - In R via SPARQL

QB (Candidate Rec. version)

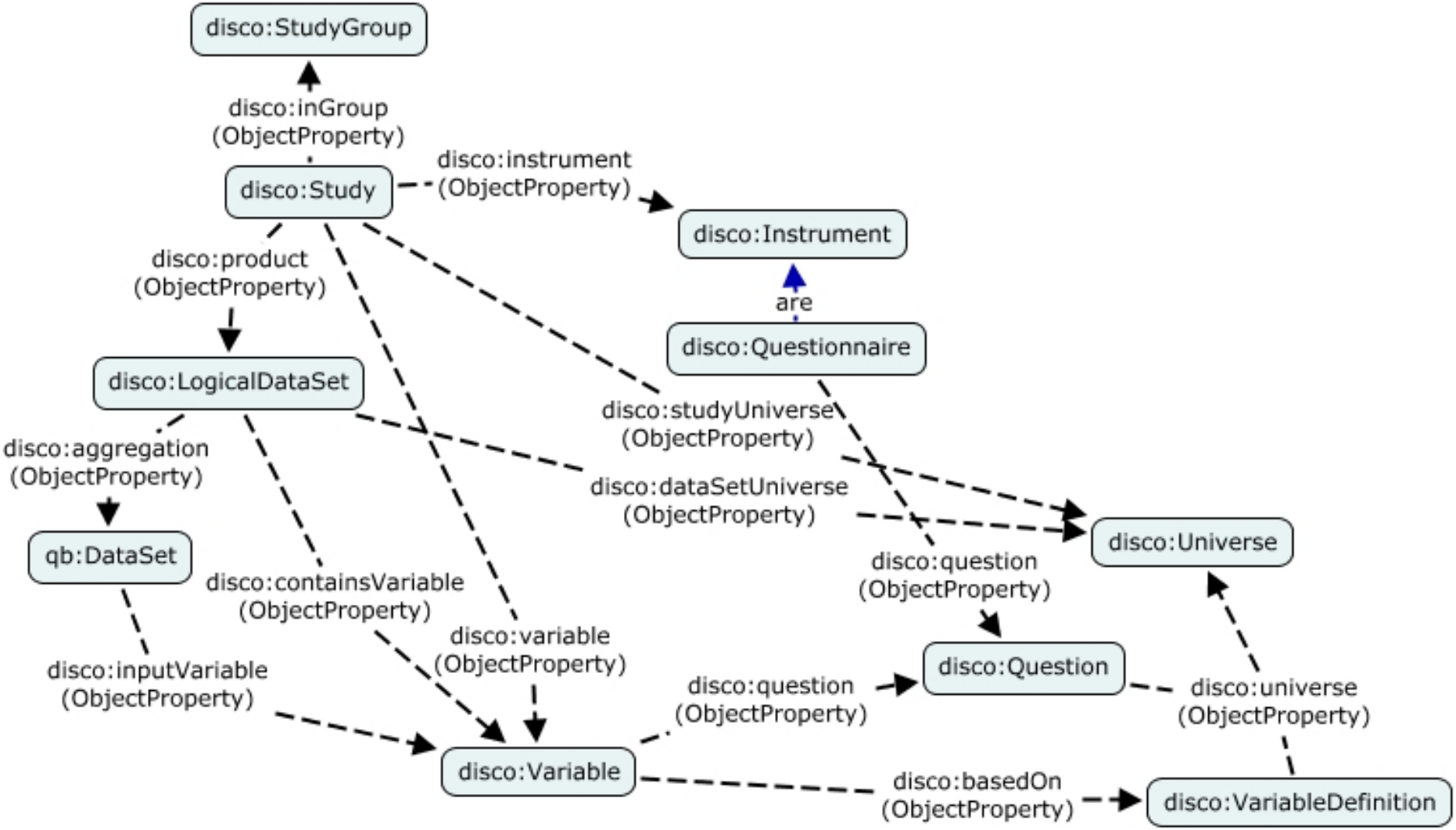


DDI-RDF Discovery

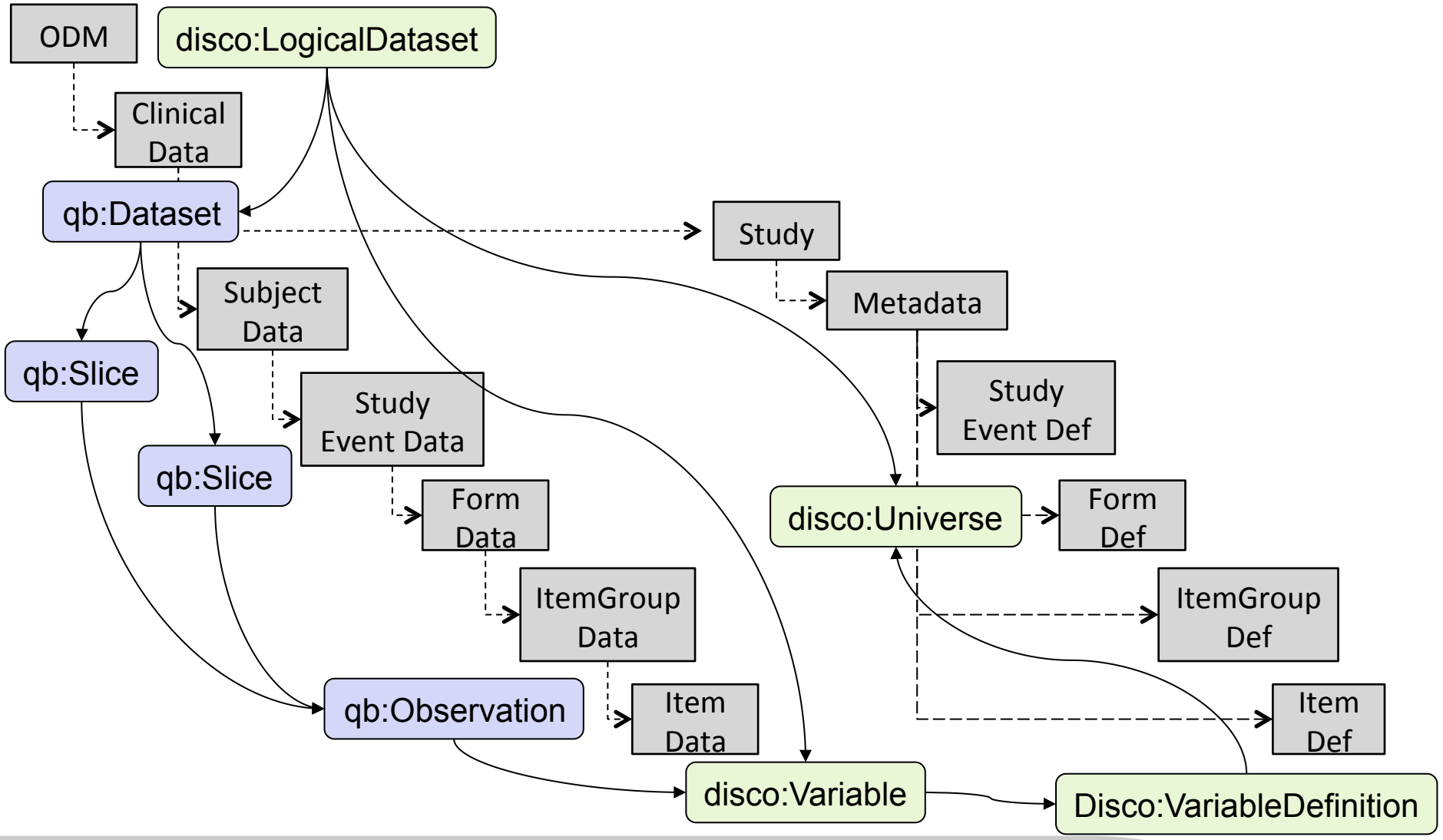
- DDI-RDF Discovery Vocabulary (disco): a metadata vocabulary for documenting research and survey data
  - Derived from the Data Documentation Initiative standards
    - DDI and W3C people
    - two Dagstuhl Seminars
  - Designed as a complement to existing vocabularies developed by W3C community (Dublin Core, SKOS, XKOS, DCAT (data catalogue), RDF Data Cube
- Work in progress

- At least half of it not discussed in this talk - Dataset statistics
  - Useful if we want to attach statistical data to slices …

Disco (study description)



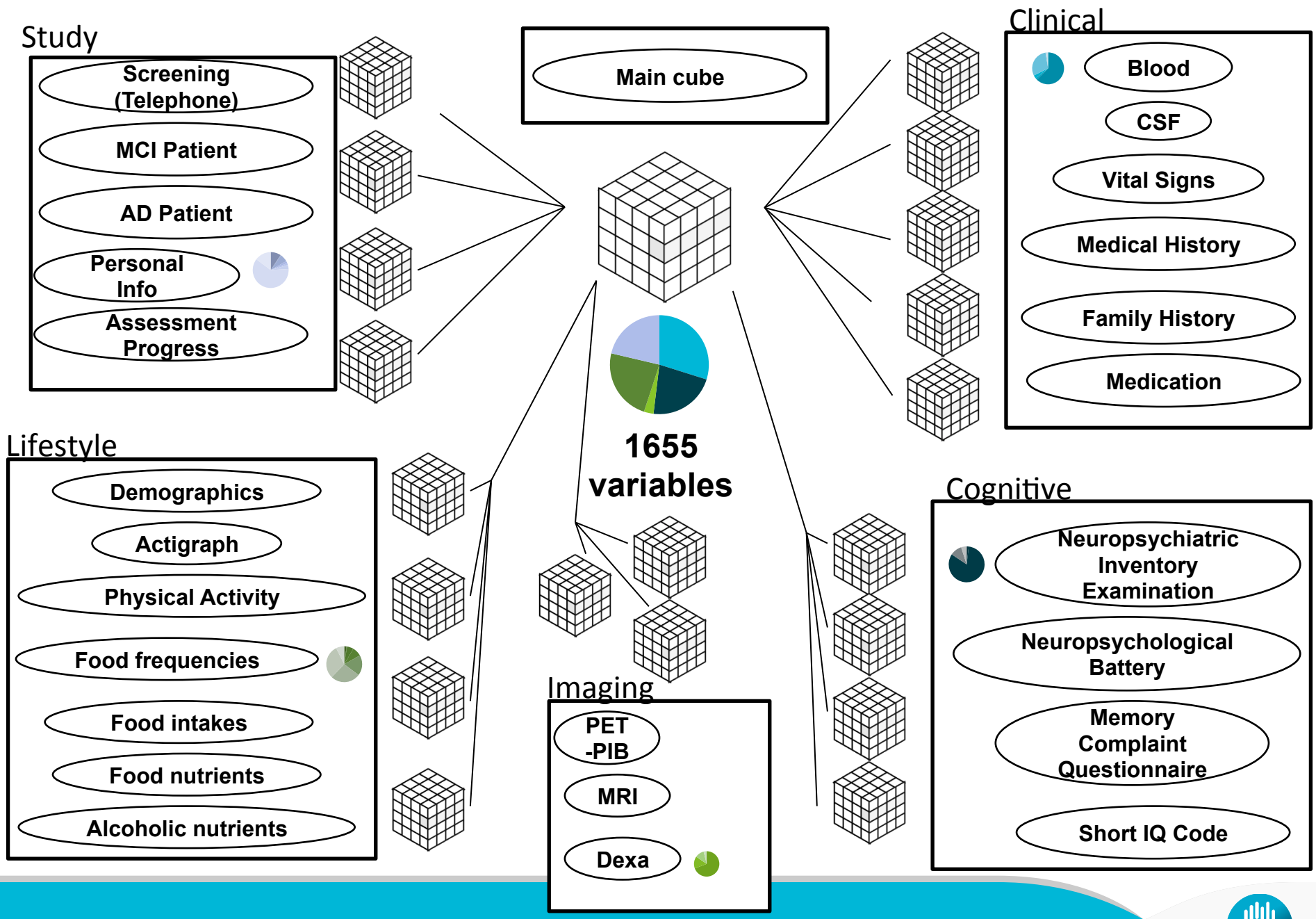
QB, Disco and ODM



Is this a Semantic Stats problem?

Problem – **Solution** – Remaining challenges

- But …
  - We have more than one data cube …
  - 25 after elimination of privacy-sensitive data: patient details, doctor details, …

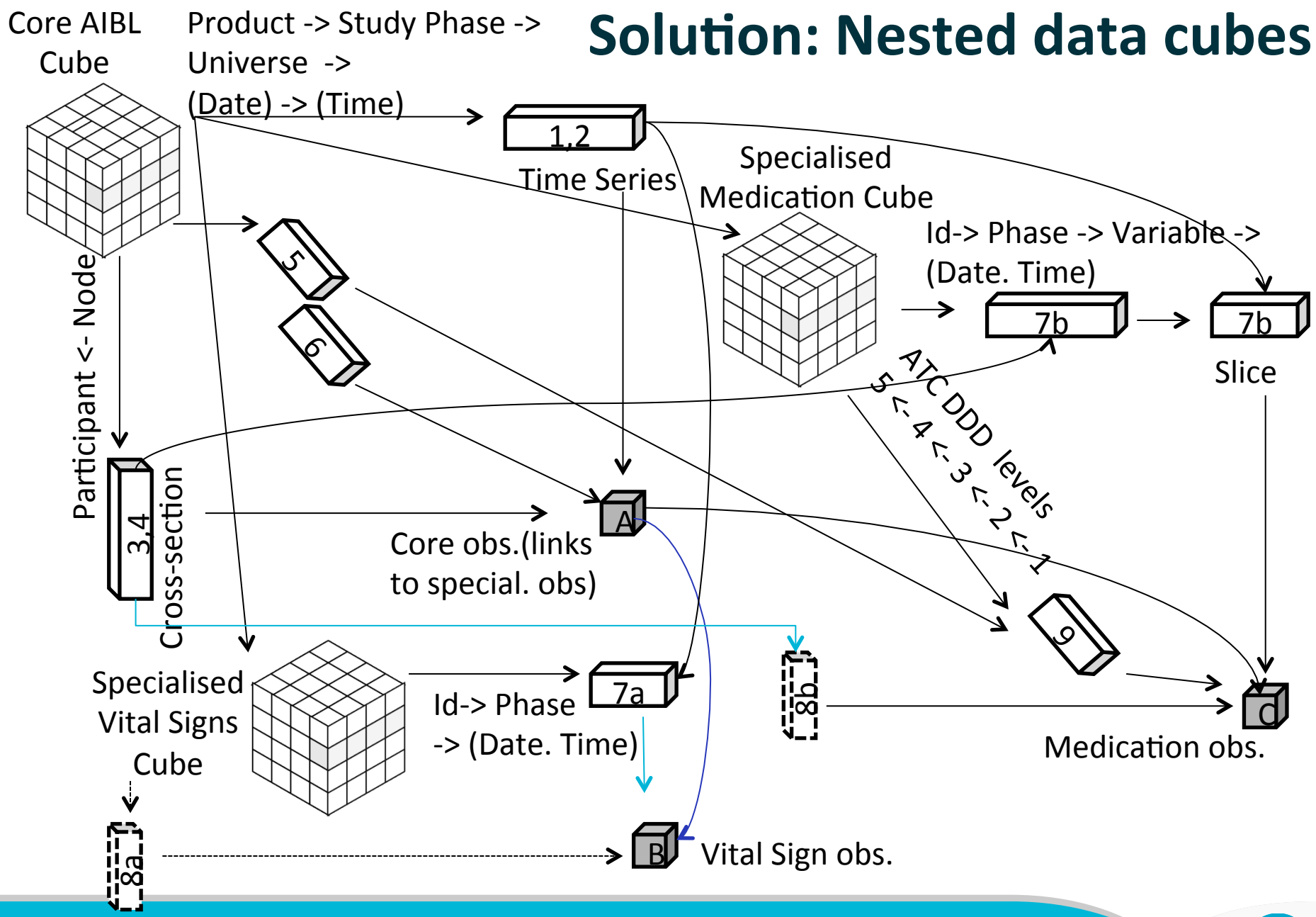

Study
Screening (Telephone)
MCI Patient
AD Patient
Personal Info
Assessment Progress
Main cube
1655 variables
Clinical
Blood
CSF
Vital Signs
Medical History
Family History
Medication
Lifestyle
Demographics
Actigraph
Physical Activity
Food frequencies
Food intakes
Food nutrients
Alcoholic nutrients
Imaging
PET -PIB
MRI
Dexa
Cognitive
Neuropsychiatric Inventory Examination
Neuropsychological Battery
Memory Complaint Questionnaire
Short IQ Code

Is this a Semantic Stats problem?

Problem – **Solution** – Remaining challenges

- Solution: **Nested Data Cubes**
  - Based on big table defining which variables go in which cubes

Solution: Nested data cubes

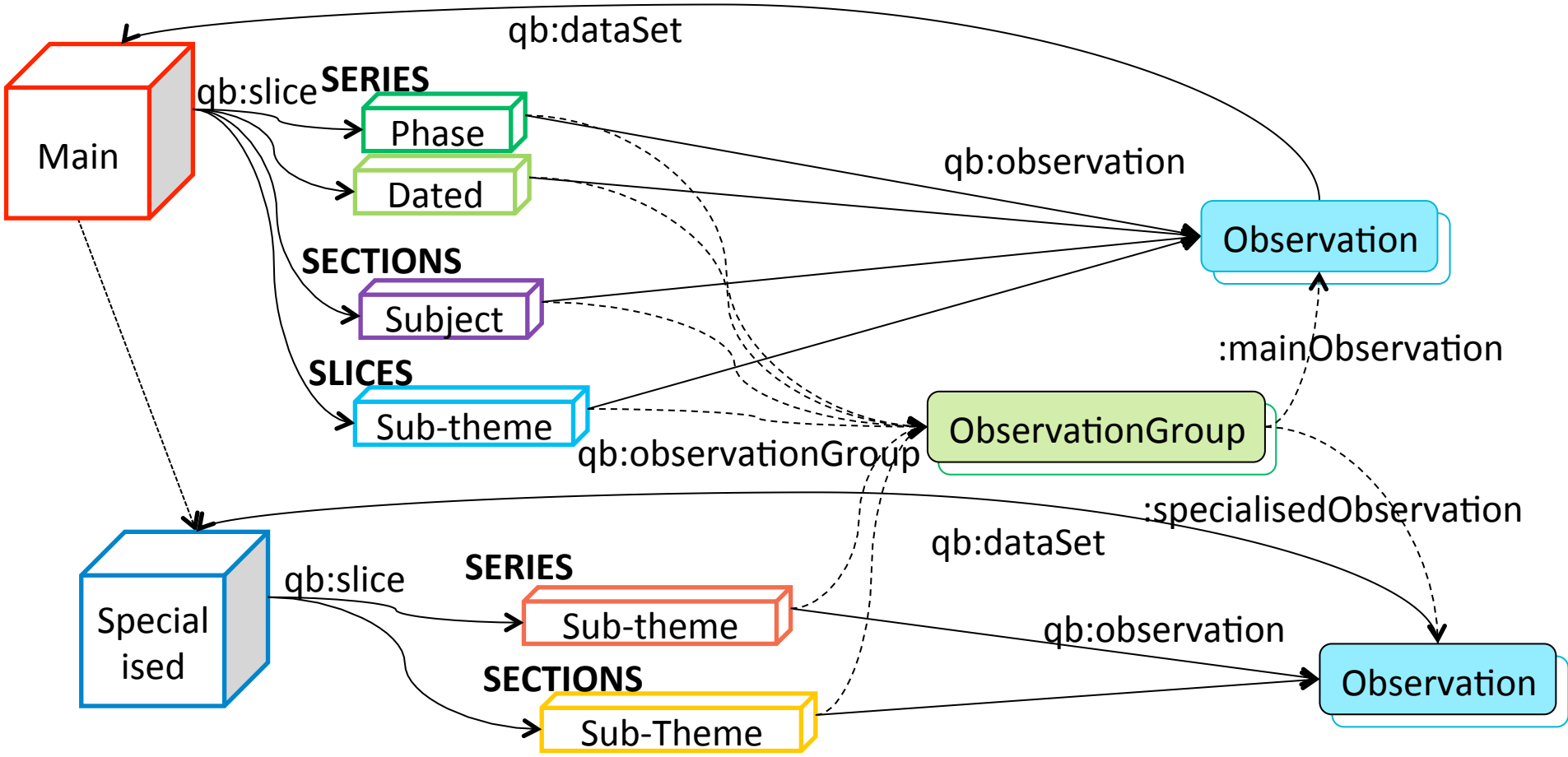


Is this a Semantic Stats problem?

Problem – **Solution** – Remaining challenges

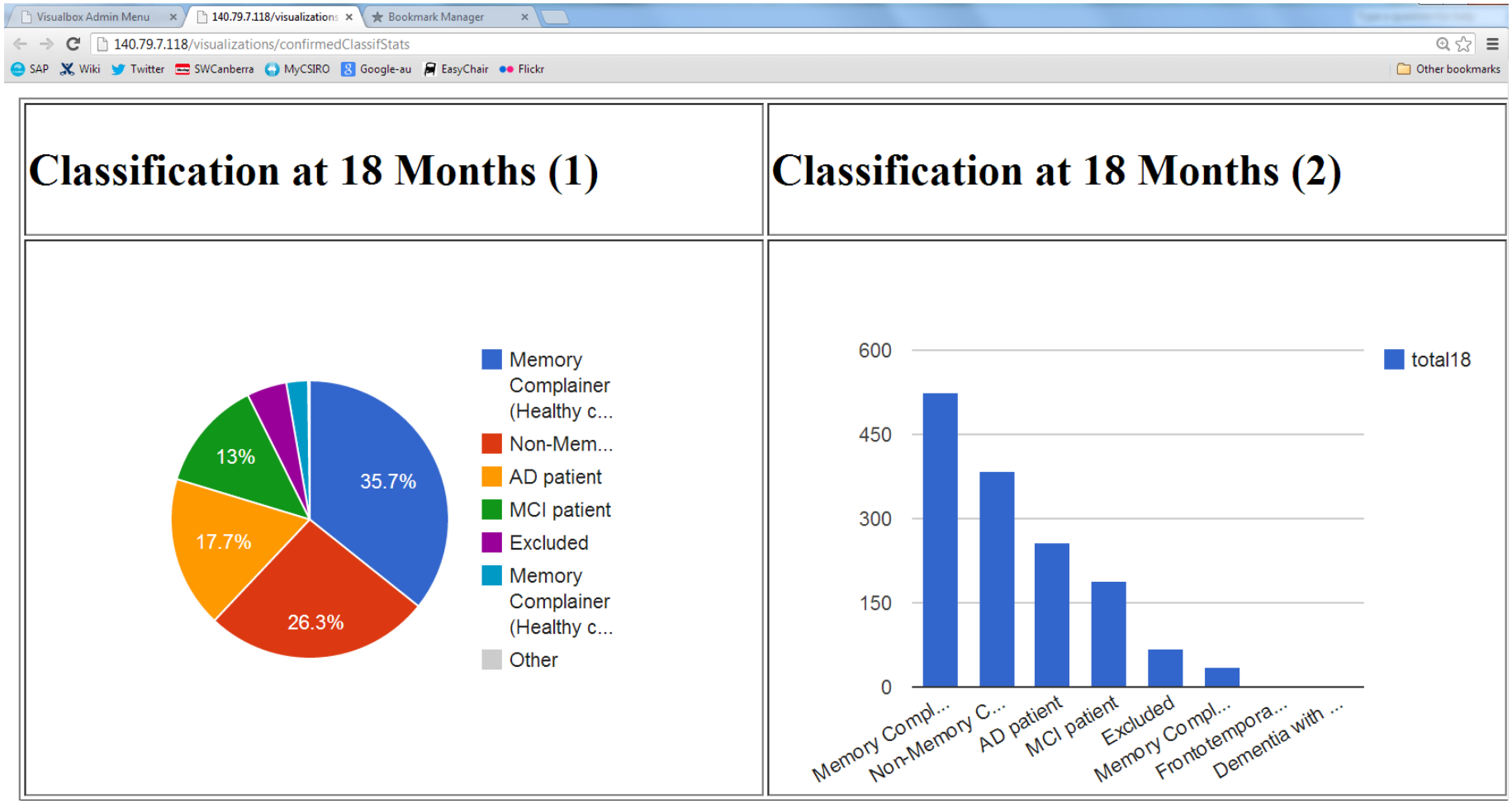
- Solution: Nested Data Cubes **based on RDF Data Cube vocabulary**
  - Maximum compatibility required to be able to reuse tooling developed according to W3C specification
  - Plus URI scheme

Nested Data Cubes with QB



Main cube	URI scheme
Product series (pr)	ROOT/{dataset}/ts/pr/{pr}
Phase series (ph)	ROOT/{dataset}/ts/pr/{pr}/ph/{ph}
Dated series (dt)	ROOT/{dataset}/ts/pr/{pr}/ph/{ph}/dt/{dt}
Product section (pr)	ROOT/{dataset}/cs/pr/{pr}
Node section (nd)	ROOT/{dataset}/cs/pr/{pr}/nd/{nd}
Gender section (gd)	ROOT/{dataset}/cs/pr/{pr}/gd/{gd}
Subject section (su)	ROOT/{dataset}/cs/pr/{pr}/nd/{nd}/su/{su}
Product slices (pr)	ROOT/{dataset}/ds/pr/{pr}
Theme slices (th)	ROOT/{dataset}/ds/pr/{pr}/th/{th}
Sub-theme slices (st)	ROOT/{dataset}/ds/pr/{pr}/th/{th}/st/{st}
Observation groups	ROOT/{dataset}/pr/{pr}/ph/{ph}/su/{su}

Access via SPARQL (+ Visual Box)



Holes

Problem – Solution – **Remaining challenges**

- Survey-originated data more likely to have missing data
  - Rule-based forms: *if X … then display box to enter the value of Y*
  - Cases where the patient is no longer available for the study (deceased patient or “lost”patient)
- Question (specs writer): how can you handle datasets with holes?
  - QB example: issue with some IC constraints (see paper)
- Question (tools developers): can you handle datasets with holes (and help the user to avoid them and understand them)?

Sensitive data

Problem – Solution – **Remaining challenges**

- Need to answer privacy issue with data like AIBL
- Proposal: add different identifiers for each specialised data cube with links at the slice level?
  - To allow browsing /exploration of one data cube at a time with lighter research approval regime (to give enough information for specialist working on data quality issues and for researchers to decide if they need to apply to be granted full access).
  - Question: implementation /access control and performance constraints for queries accessing multiple cubes

Conclusions

Problem – Solution – **Remaining challenges**

- Benefits of semantic statistics vocabularies
- Adoption of SDMX best practices (SDMX guidelines for DSDs Statistical Data and Metadata Exchange 2012)
- Modularity
- Approach reusable for other domains

- Ongoing work on vocabulary mappings (Medications)

- Adoption by Pharma community (FDA/PhUSE)?

Thank you

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