PURO: Providing Deeper Ontological Background to OWL ontologies and Linked Data Vocabularies (Introductory part)

LAAOS

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Overview of this and subsequent presentations

- Motivations and overview of PURO (*Svátek*)
- PURO modelling primitives (*Homola*)
- Relationship to foundational ontologies (*Vacura*)

- B-Annot: Generic and Dataset-Specific Background Annotation of Linked Data Vocabularies (*Serra*)

- Typed Higher-Order Description Logics and its PURO Compliance (*Kľuka*)

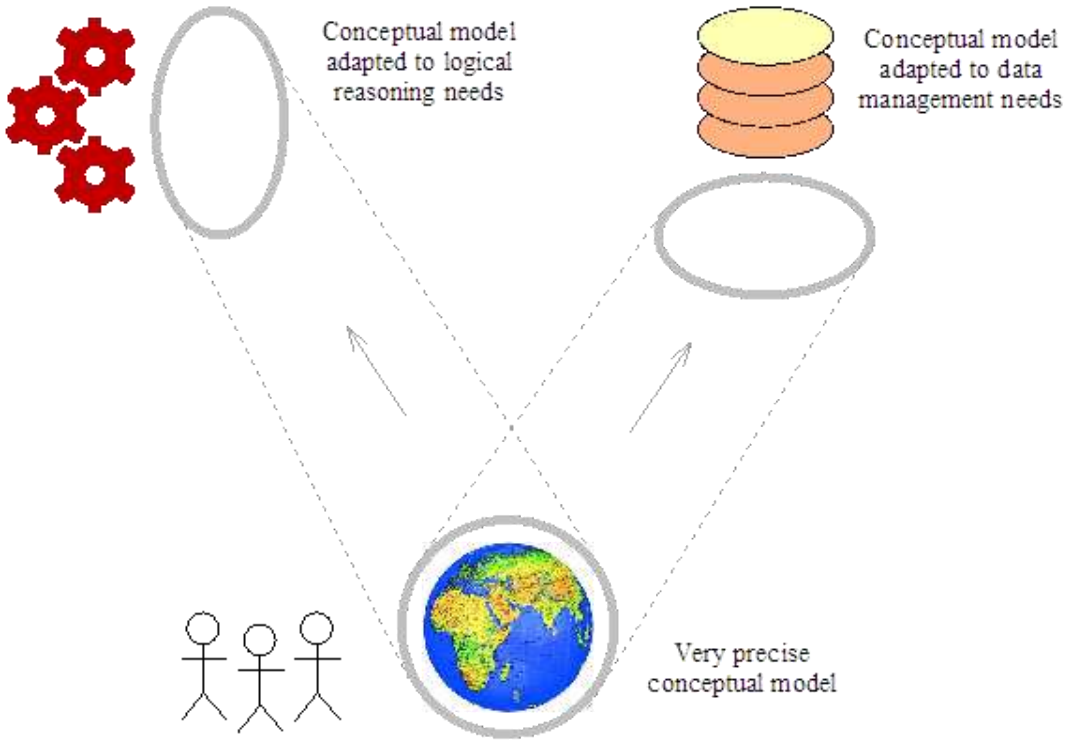
LAAOS and PURO

- The PURO model/methods is a major outcome of the 2-year Czecho-Slovak collaboration project LAAOS
  - Logical Aspects of Adaptable Ontological Schemas
- The project aims at intersection of multiple areas covered by the two collaborating groups (UEP, CU)
  - Ontological modelling
  - Description logics
  - Applied (philosophical) ontology
  - Linked data on the web
  - Semantic web tool design
  - Computational intelligence
- PURO relates to the first five areas
  - 2nd LAAOS sub-project is on using CI techniques (esp. Genetic Algorithms) for generation/selection of ontology transformation patterns aiming at ontology profiling

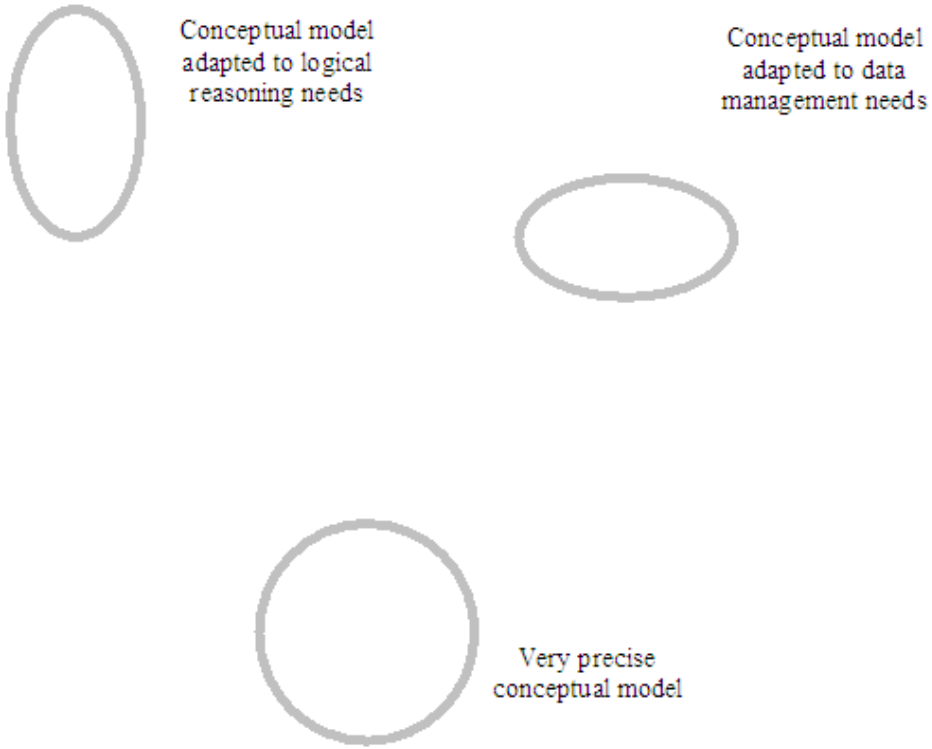
Evolution of ontology engineering

- **1990s:** few models, but rich and carefully crafted both in terms of logics and conceptualization
  - populated by AI knowledge bases
- **2000s:** many new models (thanks to W3C endorsement of OWL and its predecessors)
  - often rich T-box but no or little A-box
- **2010s:** an important subset of ontologies are linked data vocabularies, mostly populated by large data derived from non-semweb resources
  - i.e., large, distributed and heterogeneous A-box
  - usually simple T-box; schema tuned for easy management of data

Conceptualization, logics and data management



Conceptualization, logics and data management



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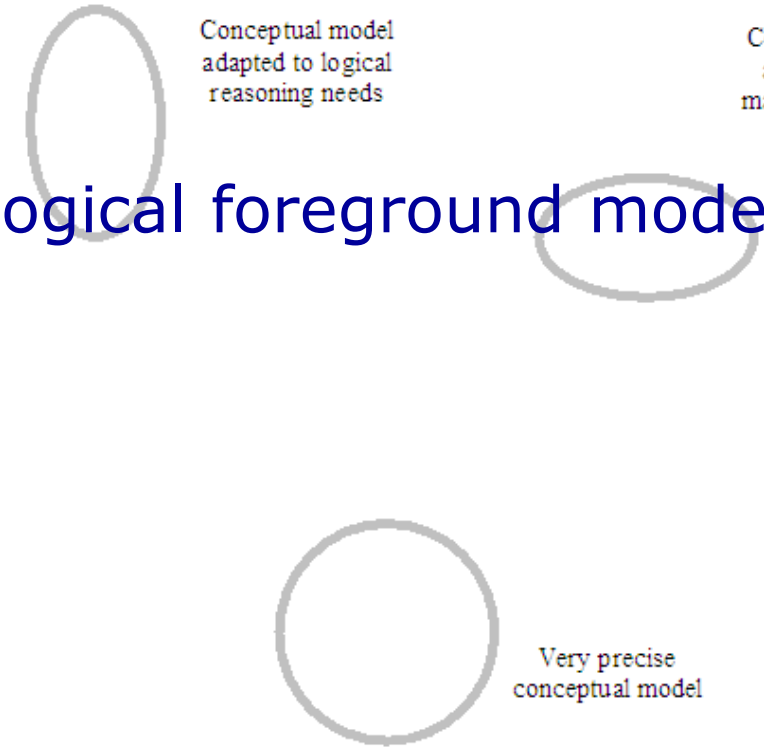

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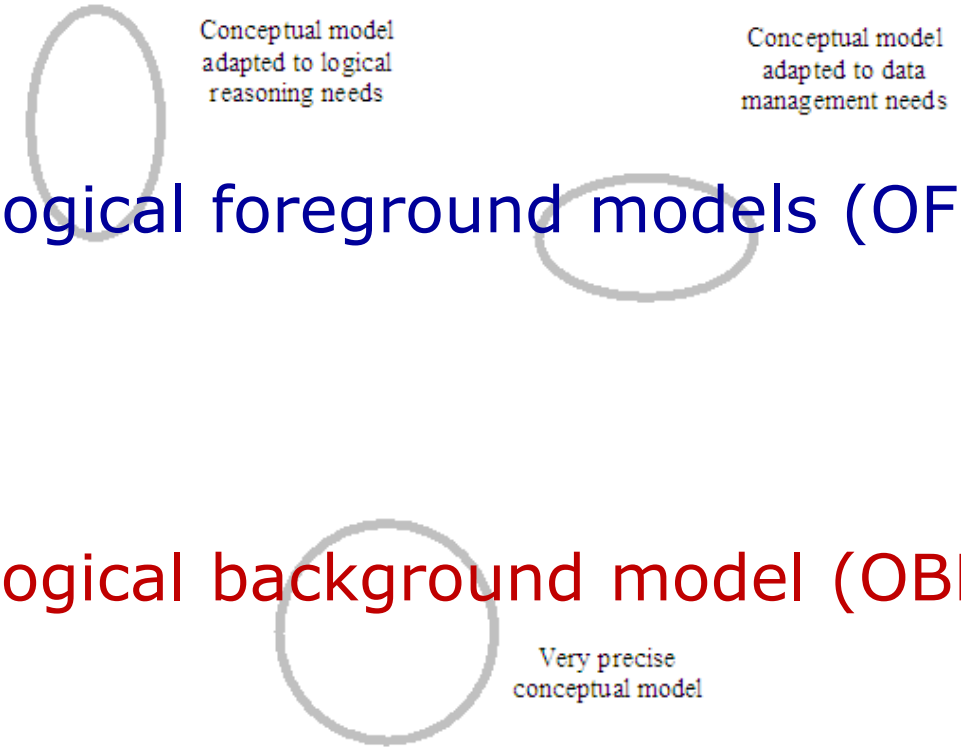
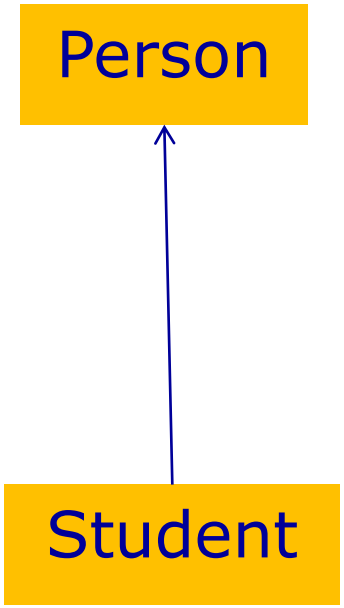


OFM / OBM Languages

- Both kinds of models are expressed using a certain language, containing certain representation primitives
  - Ontological forground model language (OFML)
  - Ontological background model language (OBML)

- As OFML we can consider OWL
  - It subsumes simpler languages used for linked data, such as RDFS
- How about OBMLs?

OntoClean: OBML for taxonomy-centric ontologies



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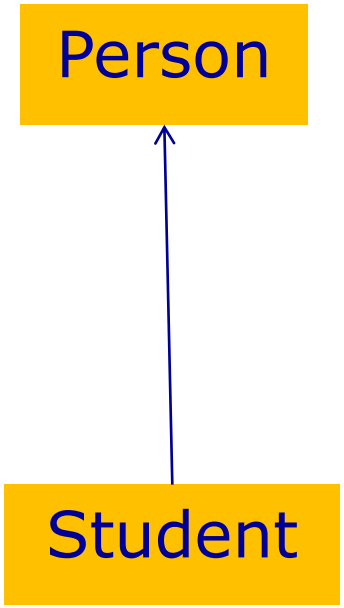

- Rigid class
- Has own identity condition
- Has unity condition

- Anti-rigid class
- No identity condition
- Has unity condition

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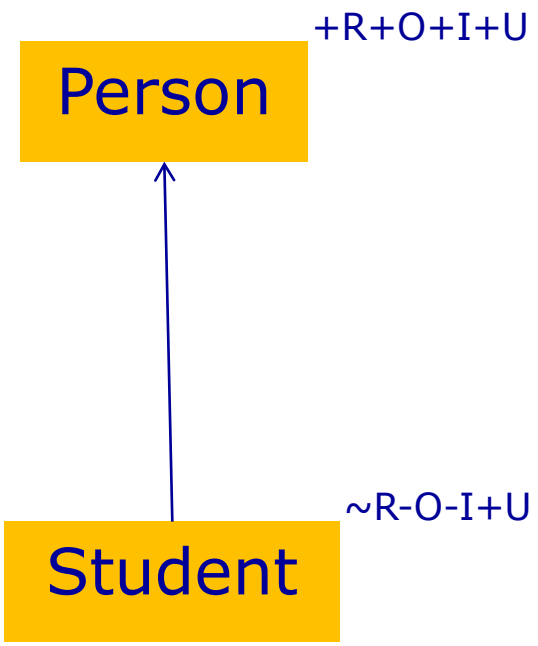

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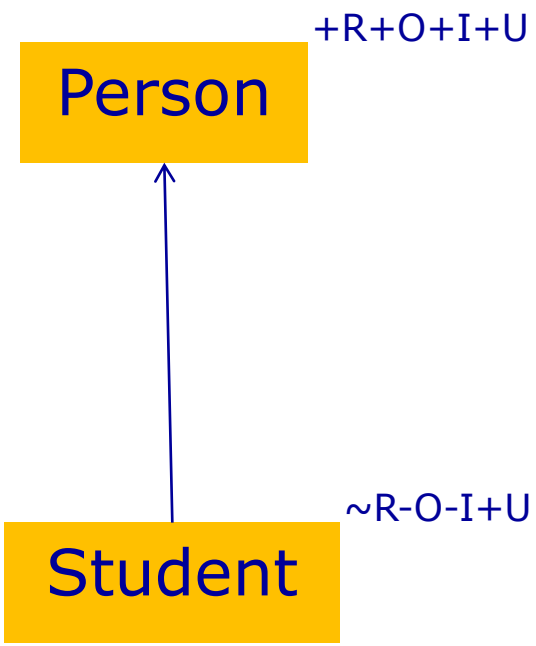

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- Coherence checking: e.g., $P^{\sim R}$ can't subsume Q^{+R}

PURO: OBML for relationship-centric ontologies

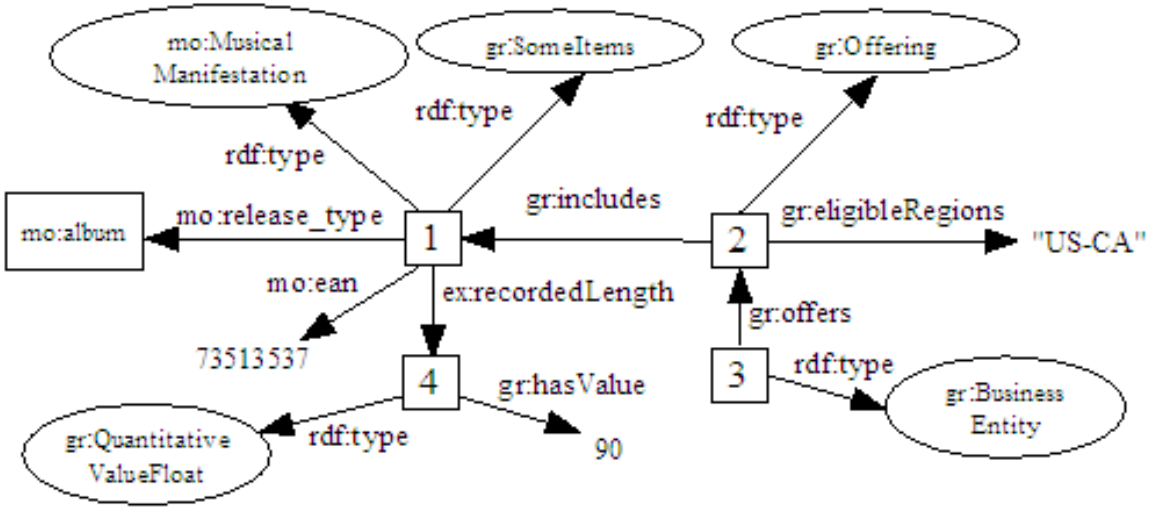
- PU: particulars vs. universals
  - or individuals (that cannot be instantiated) vs. types
- RO: relationships vs. objects

- Why these distinctions?
  - Relatively easy to understand
  - Together similar to the core OWL OFM inventory
    - ✓ individuals vs. classes; classes vs. properties

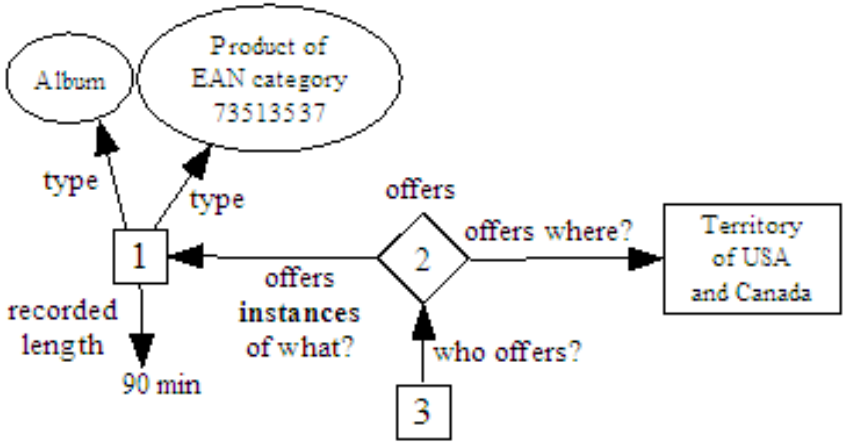
- But also challenges
  - The distinction is sometimes blurry
  - The structure of underlying OFMs is not uniform
  - The OBM structure is best manifested at the A-Box level, while the connection to OFM is required at the T-Box level

OFM vs. OBM („offering a music album“ example)

- OFM graph



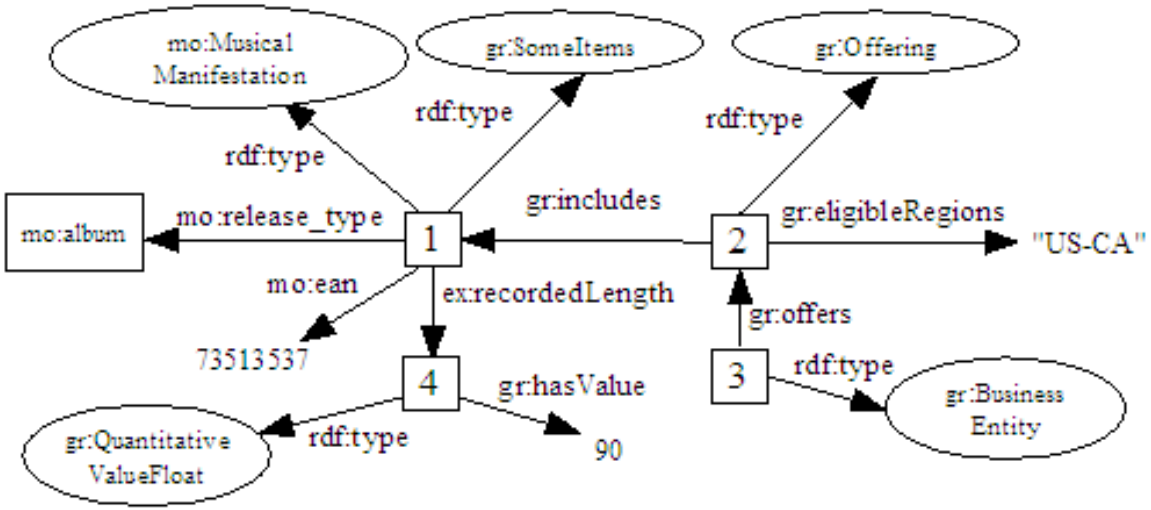
- PURO OBM graph



OFM vs. OBM („offering a music album“ example)

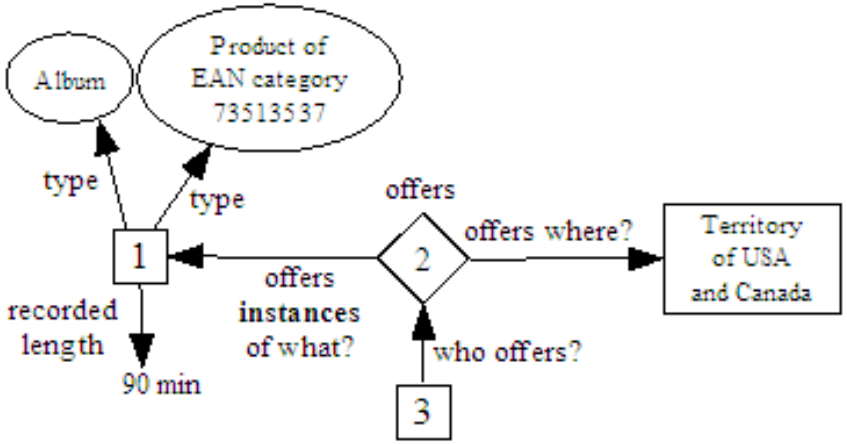
- OFM graph

  OWL A-Box



- PURO OBM graph

  Not OWL!



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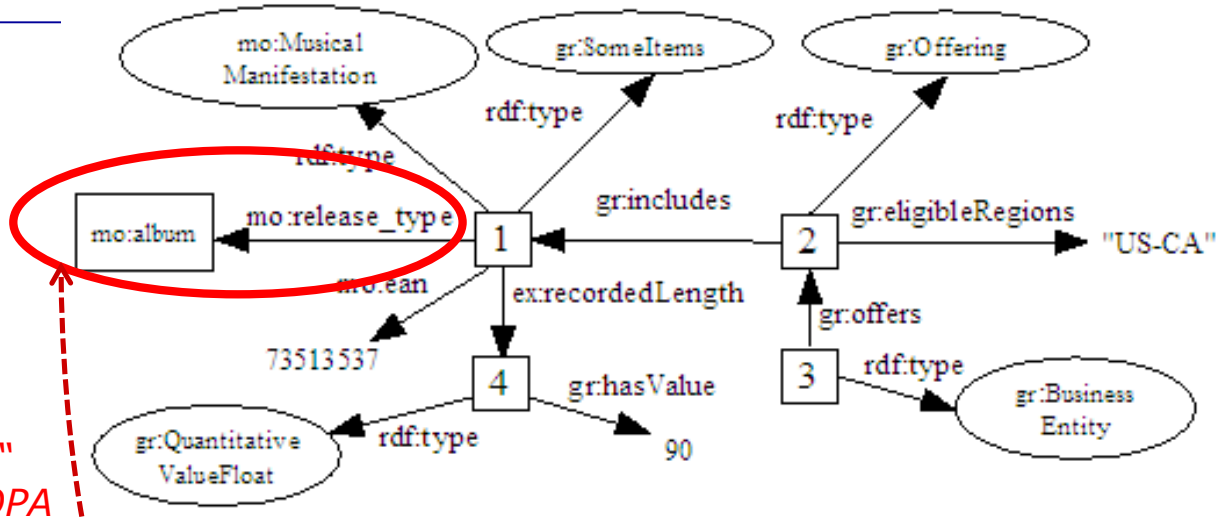
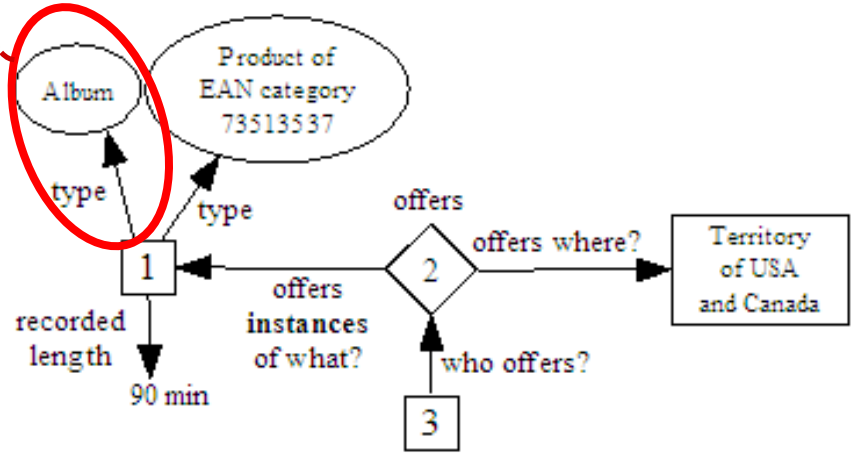


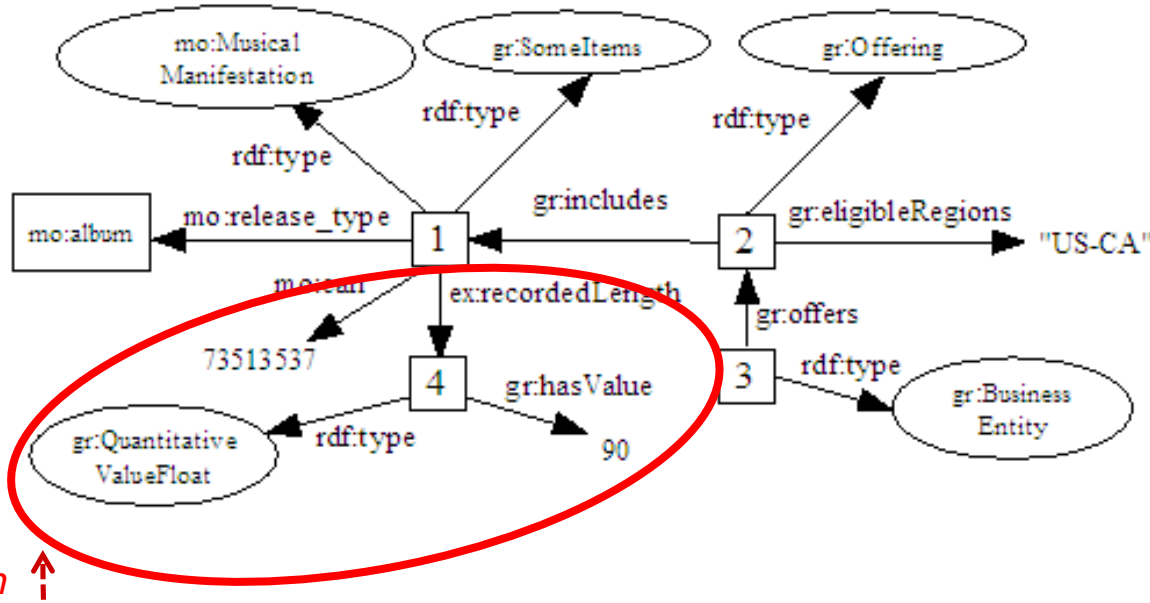
„Instantiation“ manifested as OPA

- PURO OBM graph



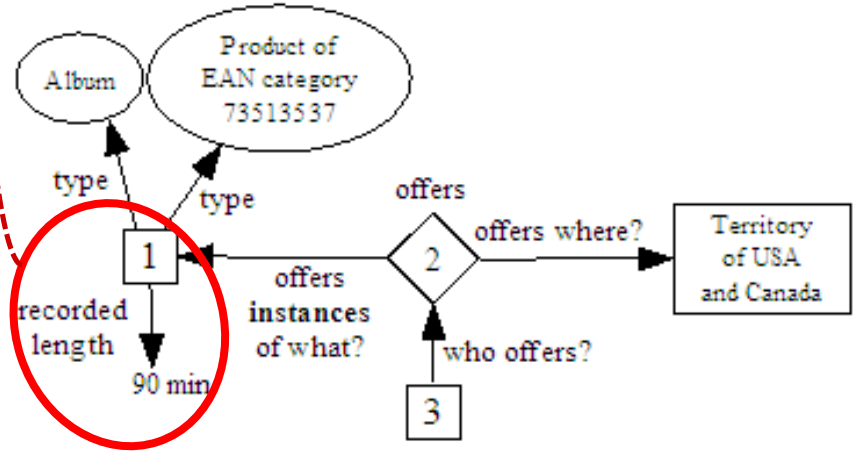
OFM vs. OBM („offering a music album“ example)

- OFM graph



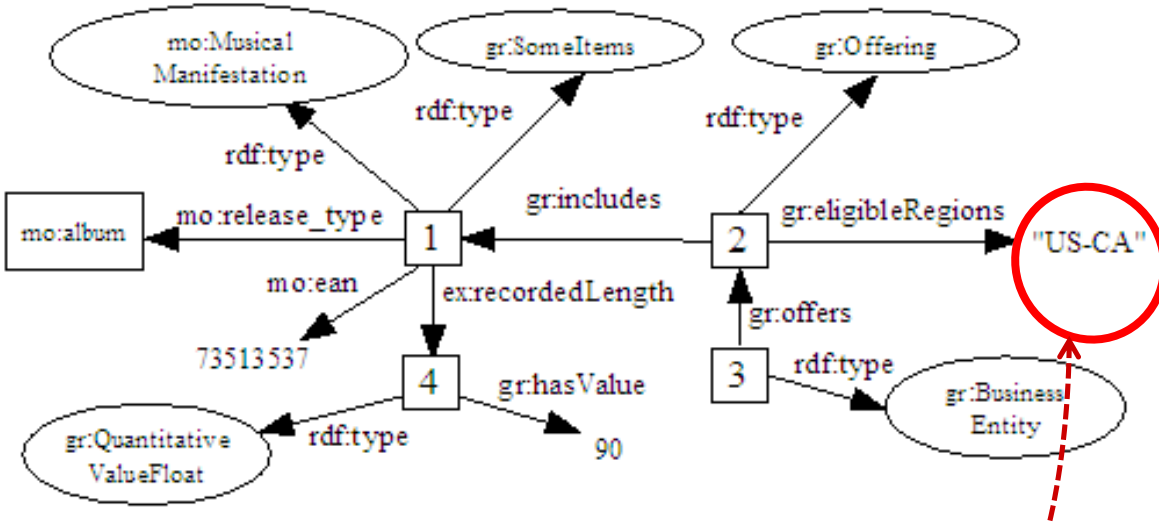
„Valuation“ manifested as chain of OPA+DPA

- PURO OBM graph



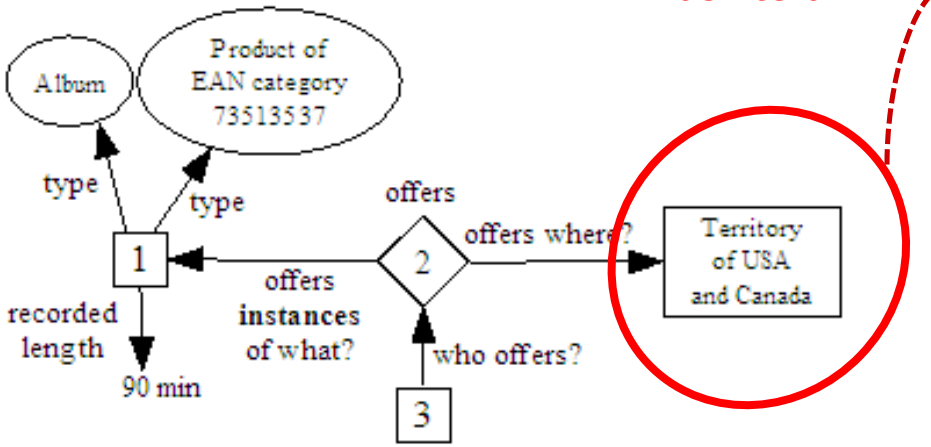
OFM vs. OBM („offering a music album“ example)

- OFM graph



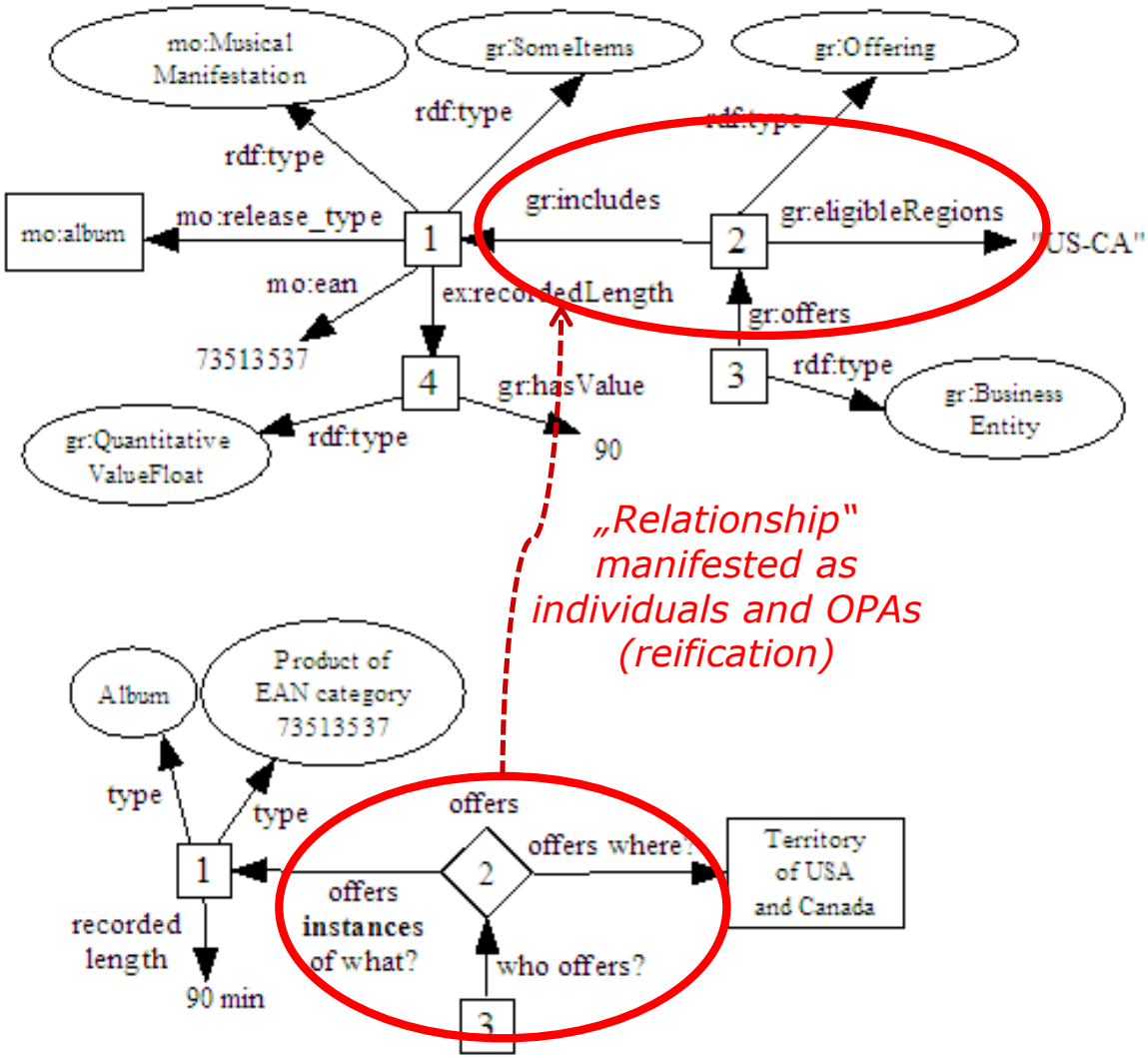
„Object“ manifested as literal

- PURO OBM graph



OFM vs. OBM („offering a music album“ example)

- OFM graph
- PURO OBM graph



Linking OFM and OBM

- OFM can contain links to OBM entities
  - Values of OWL annotation properties
- OBM and OFM can be both meta-modelled inside a common knowledge base
  - the T-box of which is a PURO ontology

Use cases for PURO annotations

- Checking the conceptual coherence
  - of a single vocabulary or of a vocabulary mapping
  - based on the annotations (OFM→OBM)
- Authoring of an OWL ontology starting from OBM
  - choice of OFM based on additional requirements of the designer (DL-enabled ontology, LD vocabulary, HTML-centric vocabulary, …)
- Alternative visualizations of an ontology
- Unifying framework for several logical/structural patterns
- Extraction of 'concise bounded descriptions' (CBD) from RDF data

Ongoing and future work

- Linking the PURO meta-model to higher-order logic
- Annotation experiments for multiple LD vocabularies
- Visualization of PURO OBMs

Thanks for your attention

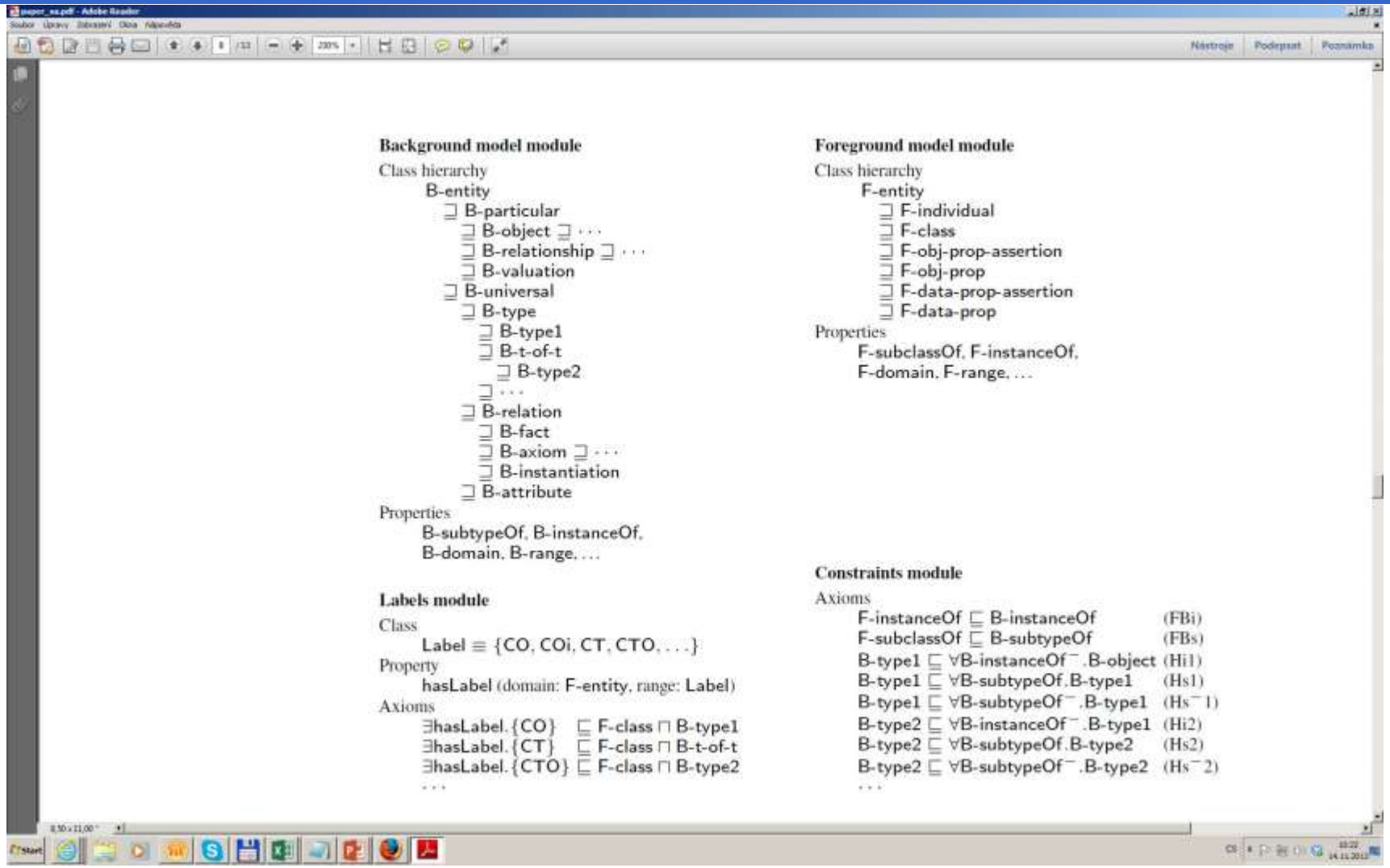
(further talks to follow)

LAAOS

Conceptual coherence checking process

- Annotation of the vocabulary with PURO primitives
- Meta-modelling of the vocabulary entities
  - using individuals: instances of concepts from the PURO (meta-)ontology
- Actual coherence checking, by means of DL consistency checking
  - For P-U incoherency, the meta-modelling individual of an incoherent class becomes instance of a specific 'diagnostic' class

PURO ontology



Background model module

Class hierarchy

- B-entity
  - ⊒ B-particular
    - ⊒ B-object ⊒ ···
    - ⊒ B-relationship ⊒ ···
    - ⊒ B-valuation
  - ⊒ B-universal
    - ⊒ B-type
      - ⊒ B-type1
      - ⊒ B-t-of-t
        - ⊒ B-type2
      - ⊒ ···
    - ⊒ B-relation
      - ⊒ B-fact
      - ⊒ B-axiom ⊒ ···
      - ⊒ B-instantiation
    - ⊒ B-attribute

Properties

B-subtypeOf, B-instanceOf, B-domain, B-range, ...

Labels module

Class

Label ≡ {CO, COi, CT, CTO, ...}

Property

hasLabel (domain: F-entity, range: Label)

Axioms

∃hasLabel.{CO} ⊑ F-class ⊓ B-type1
∃hasLabel.{CT} ⊑ F-class ⊓ B-t-of-t
∃hasLabel.{CTO} ⊑ F-class ⊓ B-type2
...

Foreground model module

Class hierarchy

- F-entity
  - ⊒ F-individual
  - ⊒ F-class
  - ⊒ F-obj-prop-assertion
  - ⊒ F-obj-prop
  - ⊒ F-data-prop-assertion
  - ⊒ F-data-prop

Properties

F-subclassOf, F-instanceOf, F-domain, F-range, ...

Constraints module

Axioms

F-instanceOf ⊑ B-instanceOf	(FBi)
F-subclassOf ⊑ B-subtypeOf	(FBs)
B-type1 ⊑ ∀B-instanceOf⁻.B-object	(Hi1)
B-type1 ⊑ ∀B-subtypeOf.B-type1	(Hs1)
B-type1 ⊑ ∀B-subtypeOf⁻.B-type1	(Hs⁻1)
B-type2 ⊑ ∀B-instanceOf⁻.B-type1	(Hi2)
B-type2 ⊑ ∀B-subtypeOf.B-type2	(Hs2)
B-type2 ⊑ ∀B-subtypeOf⁻.B-type2	(Hs⁻2)
...	