Ontology Engineering

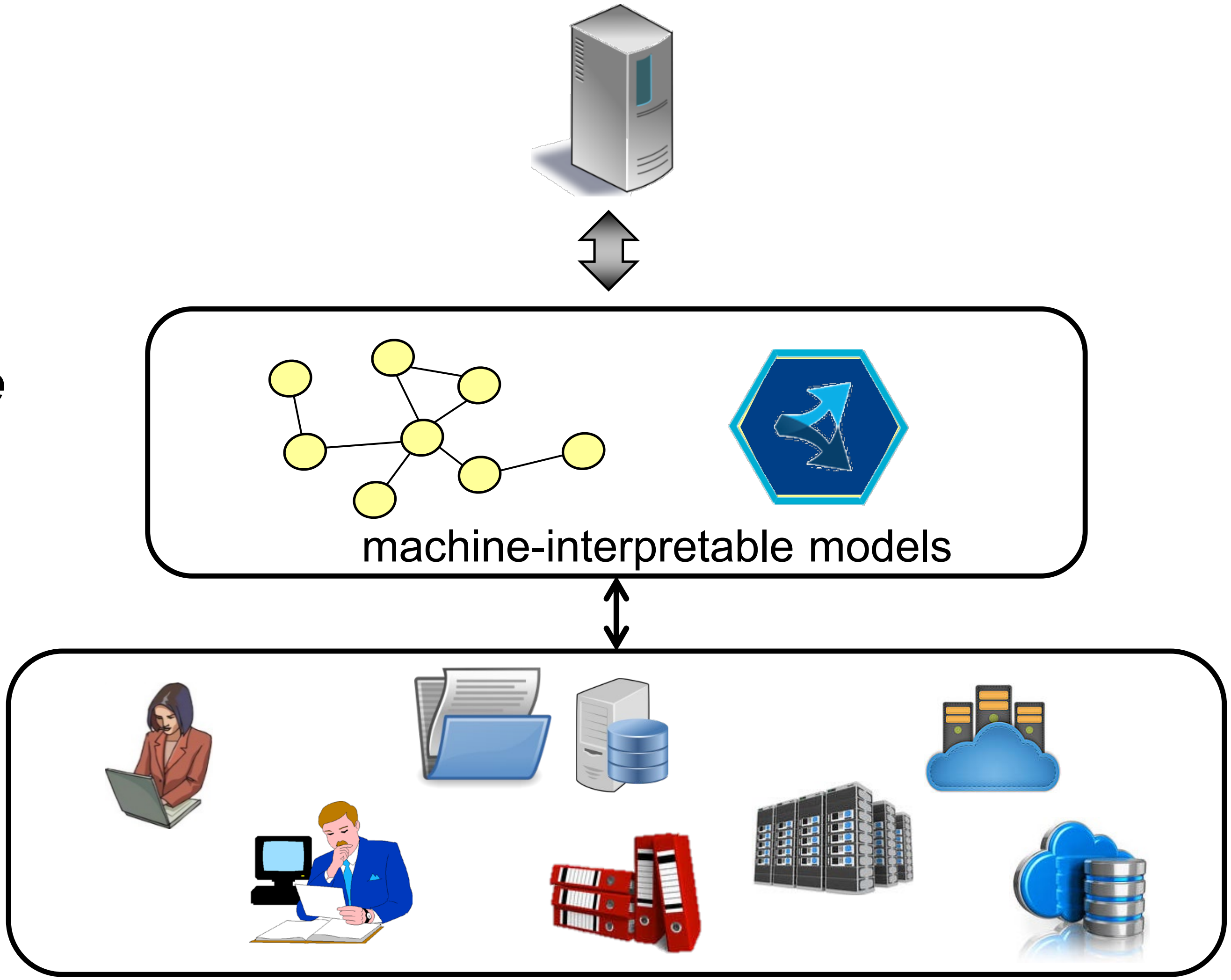
Knut Hinkelmann

Knowledge-Representation and Reasoning

Reasoning

Knowledge Base

Reality



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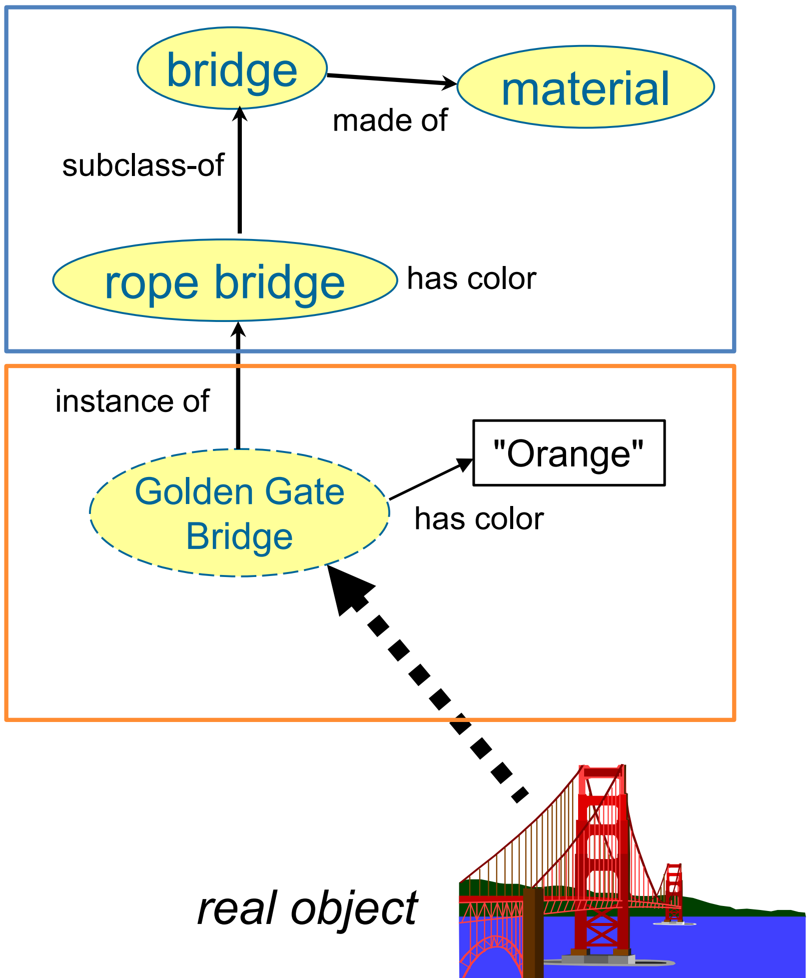
An Ontology – very informal

An ontology is a formal explicit description of concepts in a domain of discourse



- An ***ontology*** consists of
  - Concepts (Classes),
  - Relationships (Object Properties) between concepts
  - Attribute (Data Properties) of concepts
  - Constraints that hold between/for the concepts,

  as a representation of a particular domain
- An ontology together with a set of individual instances constitutes a ***knowledge base***

https://people.cs.uct.ac.za/~mkeet/OEbook/slides/L1IntroOE19.pptx

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ontology engineering

is

knowledge engineering

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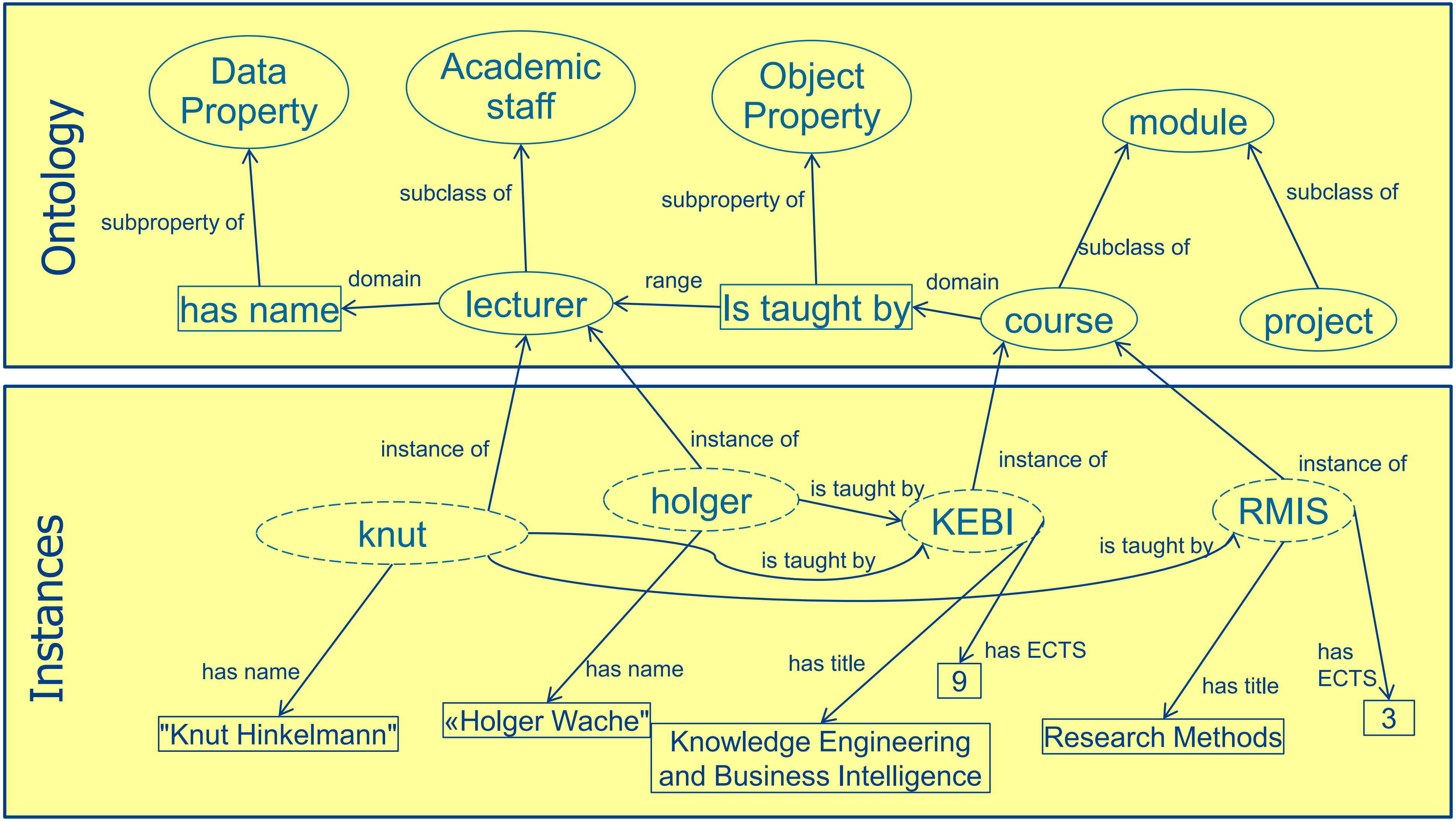
Example of an Ontology



Ontology Representation Formalisms

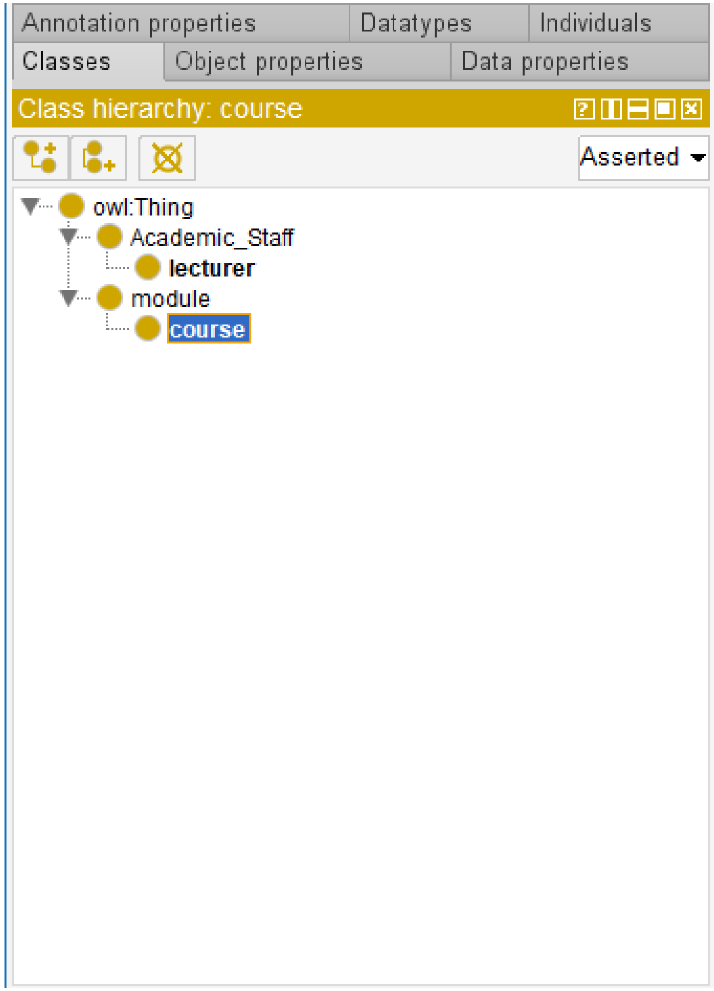
- Representations of Ontologies
  - ***RDF(S)*** ⟵ Our focus
  - OWL
  - Neo4J
  - …

Strategy

- Defining classes in the ontology
- Arranging the classes in a taxonomic (subclass-superclass) hierarchy
- Defining properties and describing allowed values for the properties
- Creating instances and filling the values for properties

Define Classes and Class Hierarchy

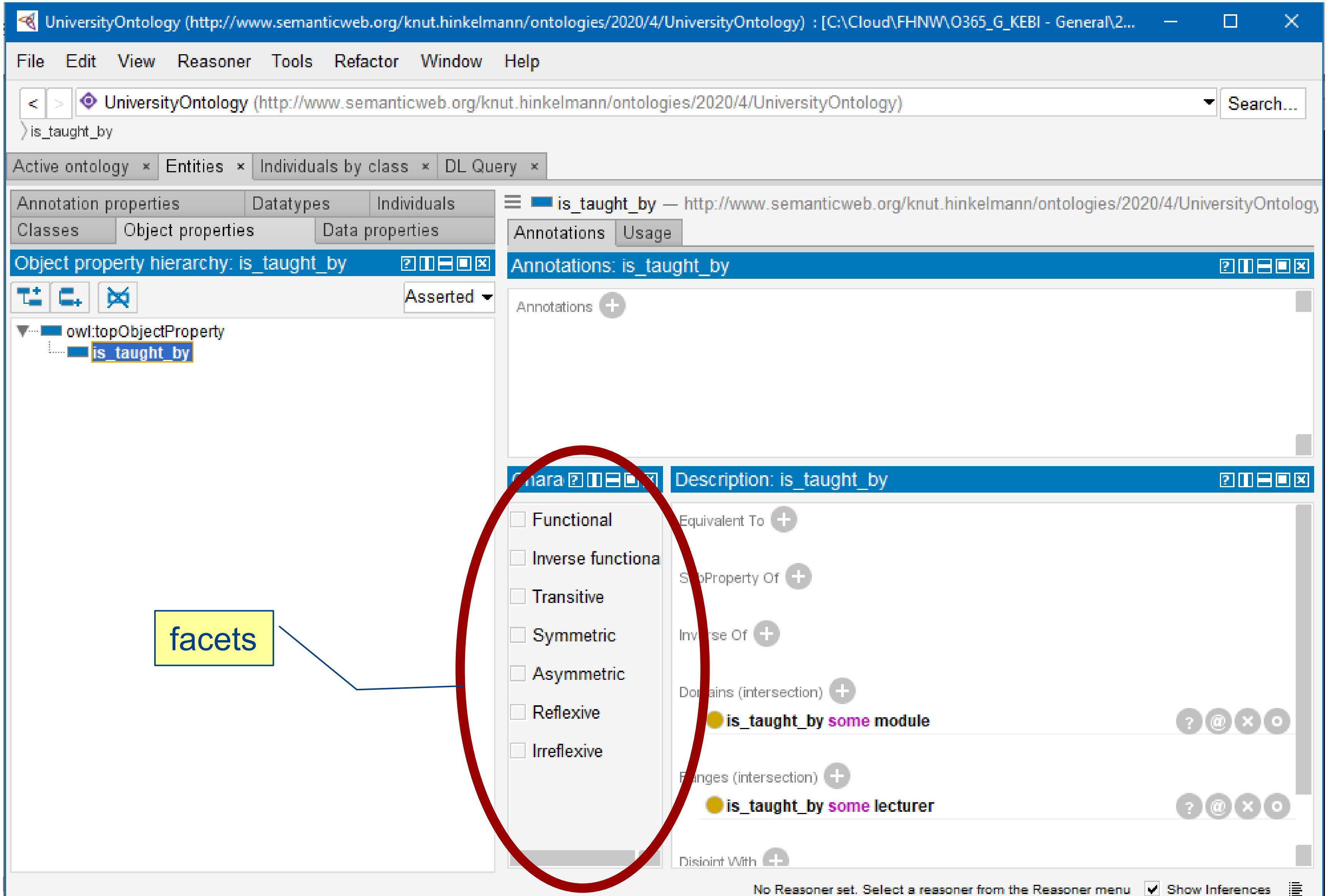
- There are several approaches
  - Top-down: Start with the most general concept, and work your way down
  - Bottom-up: Start with the most specific, ad work your way up
  - Combination



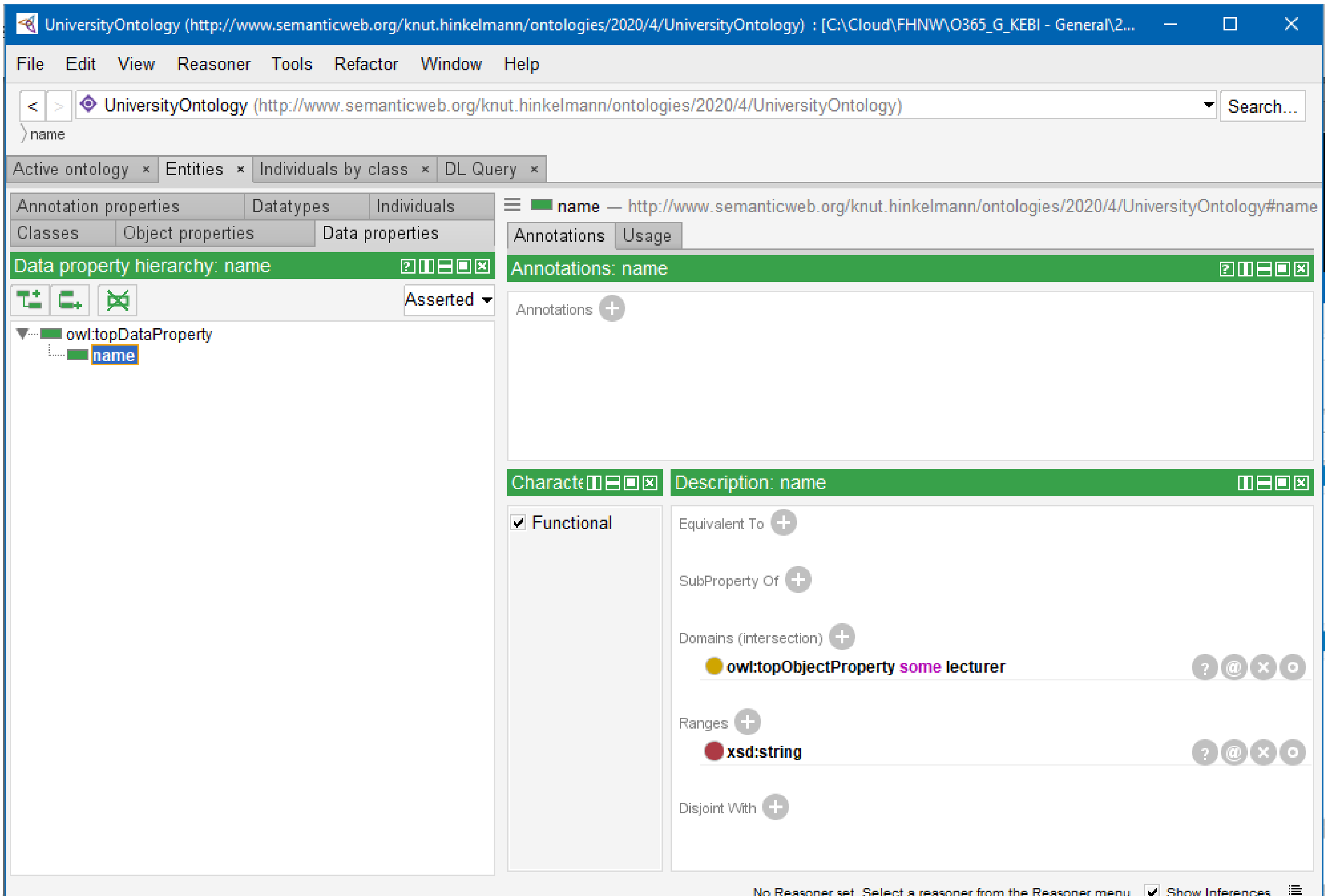
Define Properties of Classes

- Describe the internal structure of concepts
  - Data Properties: Attributes
    - Range are data types like String, Integer, …
  - Object Properties: Relations to other concepts
    - Range are Classes
- Desribe facets: Characteristics of Properties
- Inheritance to Subclasses

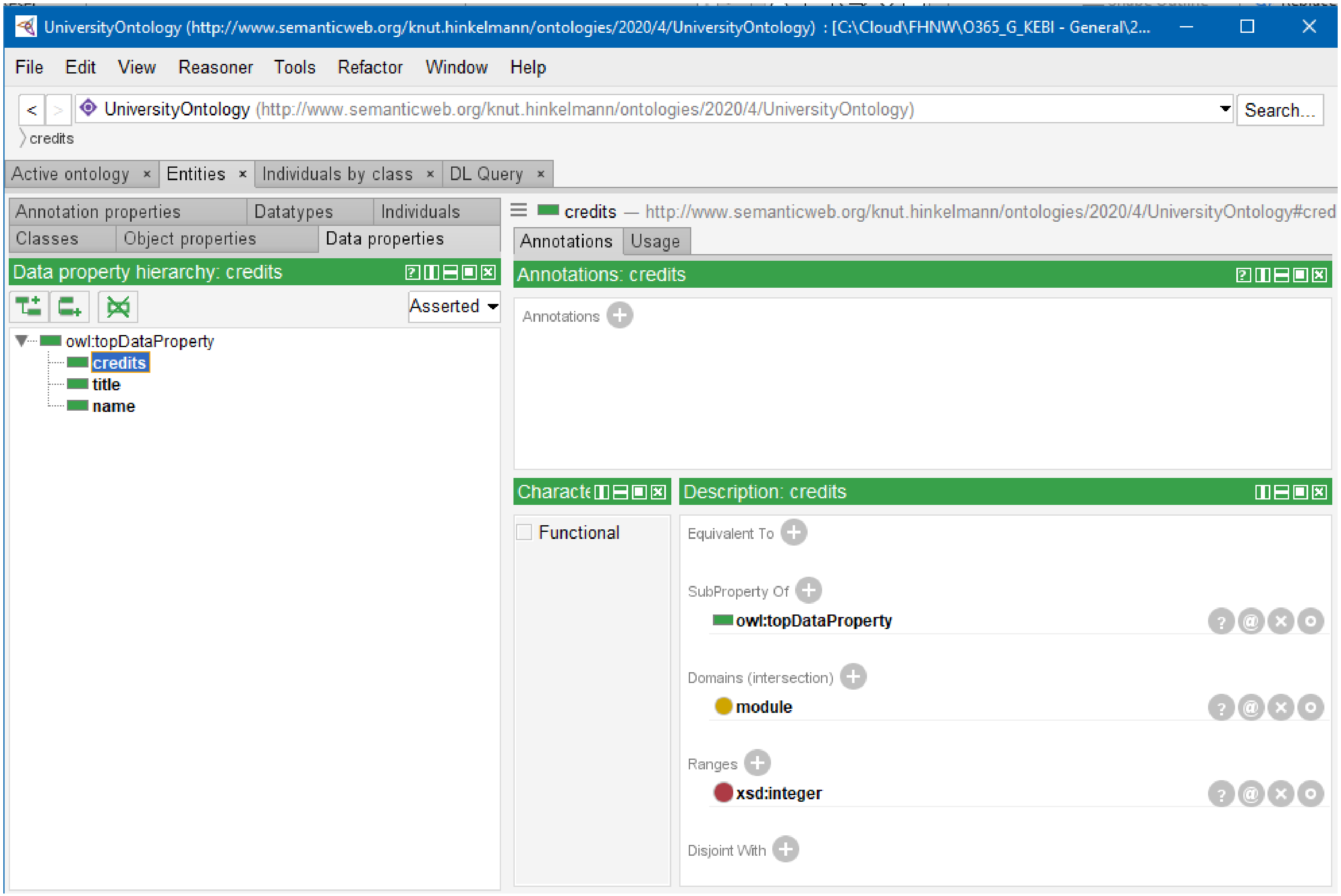
Object Property



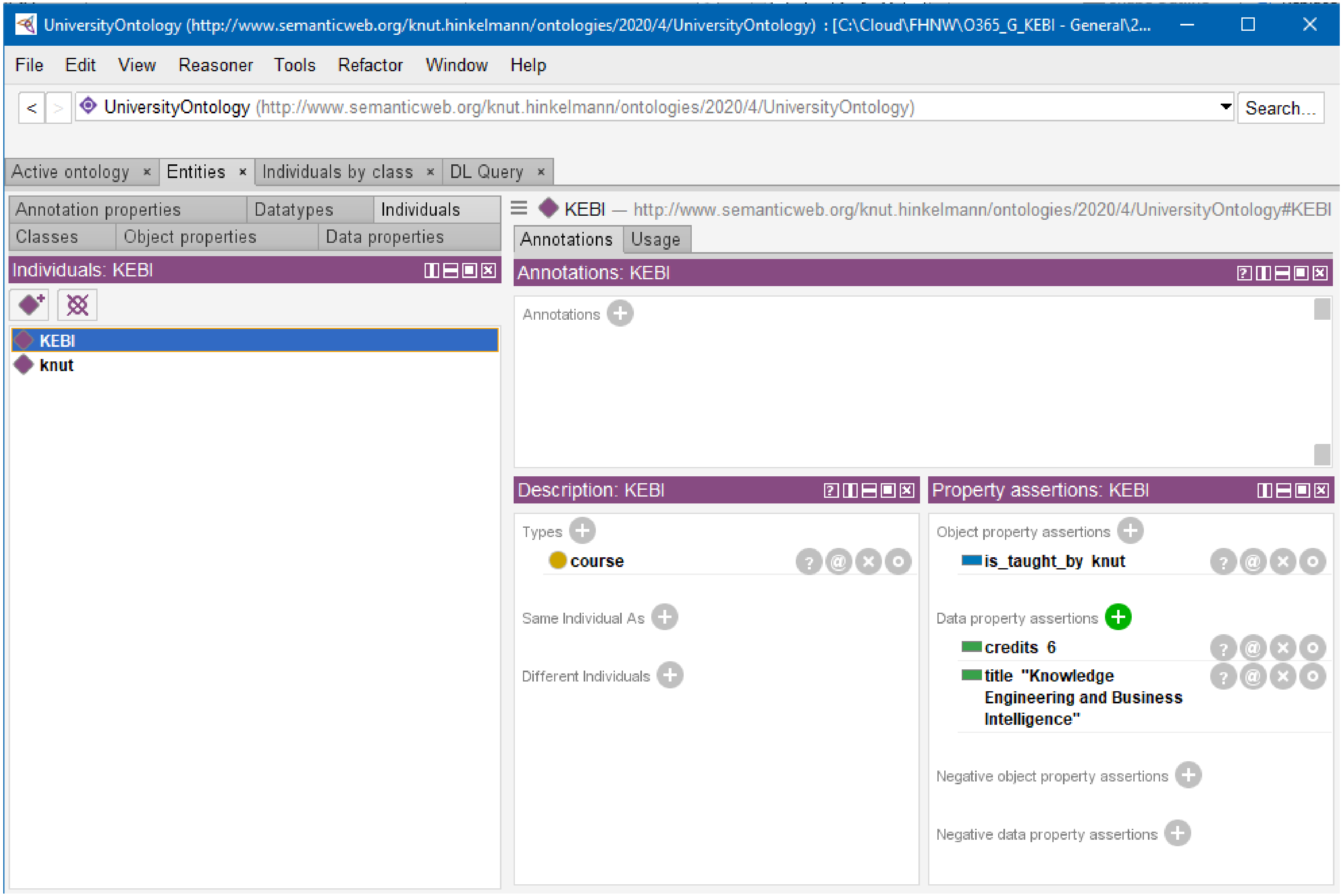
Data Property



Data Property



Instances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Object properties
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Usage
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Types
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Same Individual As
Different Individuals
Property assertions: KEBI
Object property assertions
is_taught_by knut
Data property assertions
credits 6
title "Knowledge Engineering and Business Intelligence"
Negative object property assertions
Negative data property assertions

Querying

- Query Language: SPARQL
  - Variables: ?x
- Elements are denoted as URI
  - Prefixes for Abbrevations
    - Example: PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
- Sample query: Select all lecturers:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX uo: <http://www.semanticweb.org/knut.hinkelmann/ontologies/2020/4/UniversityOntology#>
SELECT ?subject
         WHERE { ?subject rdf:type uo:lecturer }
```

Exercise

- Add new classes: project
  - A project has a supervisor
  - Master Thesis is a project
  - Supervisor is a lecturer
  - A project is performed by a student
- Add new instances

Exercise: Modeling Process Knowledge in an Ontology

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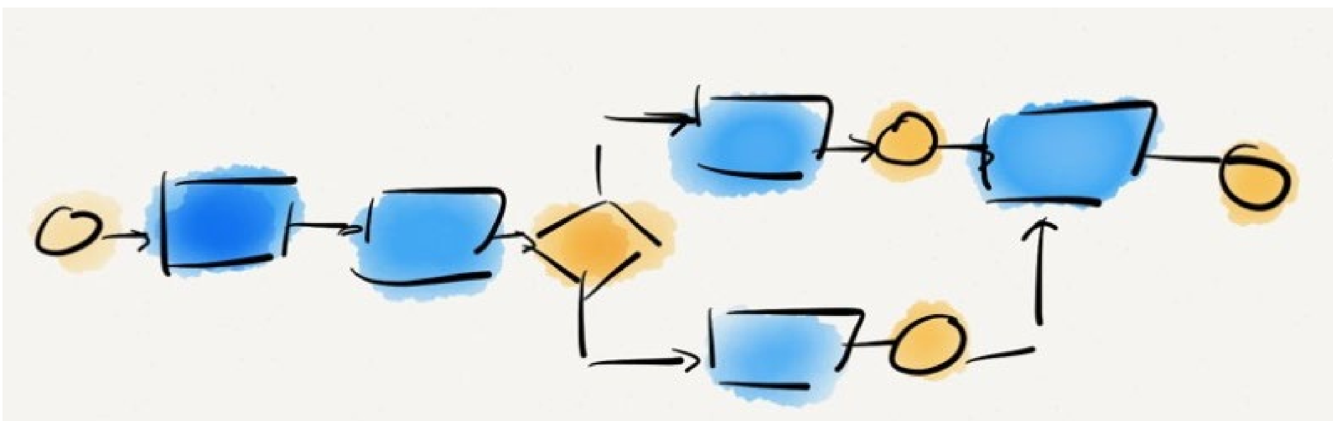
Exercise: Modeling Process Knowledge in an Ontology

- We create a knowledge base for process knowledge
  - Define the ontology
  - Represent knowledge of a process



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Ontology Development 101

1. Determine the domain and scope of the ontology
2. Consider reusing existing ontologies
3. Enumerate important terms
4. Define classes and class hierarchy
5. Define the data and object properties of classes
6. Define the facets of properties
7. Create instances

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Determine the domain and scope of the ontology

- What is the domain that the ontology will cover?
- For what we are going to use the ontology?
- For what types of questions the information in the ontology should provide answers? → Competency questions
- Who will use and maintain the ontology?

Competency Questions

- One of the ways to determine the scope of the ontology is to sketch a list of questions that a knowledge base based on the ontology should be able to answer (Gruninger and Fox 1995)
  - Does the ontology contain enough information to answer these types of questions?
  - Do the answers require a particular level of detail or representation of a particular area?

- Exercise: We want to represent knowledge about
  - the process flow
  - Responsibilies for tasks
- Competency Questions:
  - Who executes task X?
  - Which task is executed after task X?
  - When can task X start?
- Sample process:

The waiter serves the beverages. Then the waiter serves the food. When the guests are finished, the waiter presents the bill.

Consider reusing existing ontologies

- It is always worth considering what others have done, and check if their work can be refined and extended for our particular domain and task
- Mandatory if the system needs to interact with other applications that have already committed to particular ontologies or controlled vocabularies

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Enumerate important terms in the ontology

- What are the terms we would like to talk about?
- What are their properties?
- What would we like to say about those terms?

https://www.menti.com/dkpew59hq4

Define Classes and Class Hierarchy

- Several possible approaches in developing a class hierarchy:
  - Top-down: General to specific concepts
  - Bottom-up: Specific to general concepts
  - Combination: Salient to general and specific concepts
- Classes for
  - Modeling Objects
  - Relations

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Define the properties of classes

- Describe the internal structure of concepts
  - Data Properties: Attributes
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  - Object Properties: Relations to other concepts
    - Range are Classes
- Inheritance to Subclasses

Create Instances

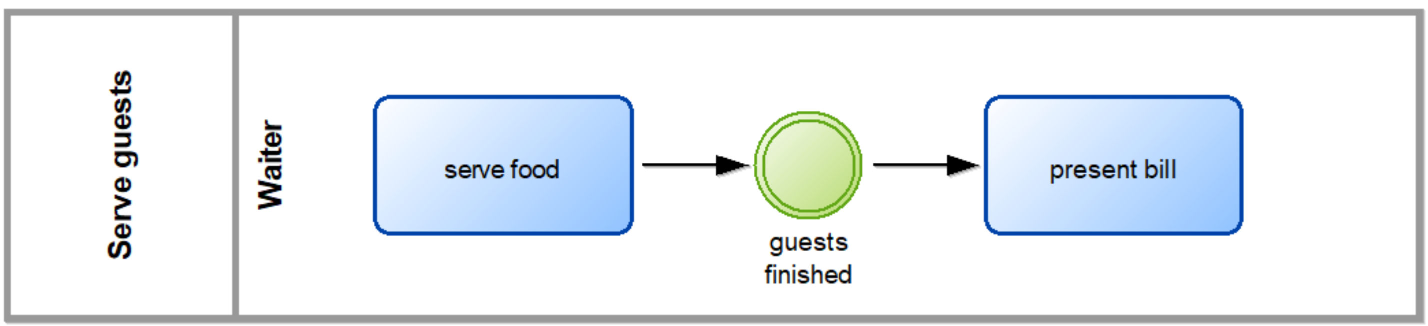
- Model a business process in an ontology

The waiter serves the food. When the guest are finished, the waiter presents the bill.

Conclusion

Modeling Business Processes as ontologies is not adequate for business people

→ Graphical Models



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