

Ontology Engineering

What is an Ontology?

A „formal, explicit specification of a shared conceptualisation” of a domain of discourse.

Rudi Studer, V. Richard Benjamins, and Dieter Fensel. Knowledge Engineering: Principles and Methods. IEEE Transactions on Data Knowledge Engineering, 25(1-2):161–197, 1998.

What does this have to do with semantic technologies / everything that you have learned so far in this course?

What is an Ontology?

A „formal, explicit specification of a shared conceptualisation” of a domain of discourse.

Formal	The meaning of the language’s symbols and syntactical constraints is clearly defined
Explicit	Elements are described unambiguously, leaving as little space for interpretation as possible: Properties, characteristics etc. are made explicit.
Conceptualisation	A view of the world; it is an abstract thing inside a human’s heads (or, if it is shared, inside a community’s „head“, and thus language-independent.)

What is an Ontology?

McGuinness, D. L.: Ontologies Come of Age [\[link\]](#)
Fensel, D.; Hendler, J.; Lieberman, H. & Wahlster, W. (ed.)
Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential.
Ch. 5: Ontologies Come Of Age
MIT Press, 2003, 171-194

What is an Ontology?

What does this have to do with semantic technologies / everything that you have learned so far in this course?

- Semantic technologies – RDF(S), OWL – can be used to describe ontologies.
- Ontology is „just another word“ for describing knowledge / data that represent knowledge.
- Disclaimer: If it is just about describing data, you would rather use the term „data schema“.
- When you created ER models, and RDF Schemata, you created (small) ontologies – caveat: Depends a bit on how much focus you put on the „shared“ in the definition.

What is Ontology Engineering?

... the activity (art) of creating an ontology.

What kind of activities are part of ontology engineering?

1. Scope Definition
2. Knowledge Acquisition
3. Informal Modelling – Specifying the Shared Conceptualisation
 - Concepts (Entity Types)
 - Relationships
4. Formal Modelling – Implementing the Specification
 - Becoming more precise: Acquiring more detailed domain knowledge and adding it to the model
 - Using OE best practices, e.g., ontology patterns (implementation aspects)
5. Evaluation

What have you learned so far in this course w.r.t. Ontology Engineering?

Scope Definition	-
Knowledge Acquisition	-
Informal Modelling	ER Models as Language that Focusses on Concepts and Relationships
Formal Modelling	RDF(S) and OWL as formal languages
Evaluation	-

What will you learn w.r.t. OE today?

Scope Definition	✓ (through an example)
Knowledge Acquisition	✓ (limited – mostly theory)
Informal Modelling	✓ (through an example)
Formal Modelling	✓ (through an example)
Evaluation	✓ (limited – mostly theory)

... Plus the Process (Iterative)

Let's create an ontology about Errors in Car Engines

You are an ontology engineer.

Mr. CarEngineEngineer has invited you to create an ontology about errors in car engines.

This ontology will be used as a terminology (to describe errors that happened to customers) and to do very simple „reasoning“ (statistics about errors).

Scope Definition

What is your first task?

- Scope Definition

What questions do you ask?

- Purpose (relationship to systems and stakeholders)
- Available resources (time, money, experts, digital artefacts...)

Result: Scope Definition

- Example: The ontology shall describe the interactions of the caretakers with the animals (in the first round: with lions)

Is this the last time that you will define the scope?

No

Knowledge Acquisition

What is the next task after scope definition?

Knowledge Acquisition

What are your sources of knowledge?

- Domain experts (Zoo director, caretakers)
- Artefacts that contain explicit knowledge (documentation, procedures implemented in SW, ...)

Result: A „bunch“ of unstructured, heterogeneous knowledge

Challenge: Elicit relevant knowledge from domain experts and artefacts.

In what way is the defined scope important at this stage?

The scope definition tells you which questions to ask, what to look for in artefacts

Informal Modelling

What is the next task after scope definition?

Informal Modelling

What questions do you ask?

- What are the relevant concepts?
- What are the relationships between concepts?
 - Think of „standard“ relationships like the „is-a“ (hierarchical) relationship or the „part-of“ relationship
- Attributes/datatype properties: What do you need to know about concepts, e.g., to differentiate between them?

How can you use the results of the two previous stages to help in this phase?

Formal Modelling

What is the next task after scope definition?

Formal Modelling

What do you need to do?

- Decide: Which formalism do you choose?
- Translate informal model to formal model
 - Often you will be missing some information to decide how to formalise some „piece“ of knowlegde – back to knowledge acquisition!
- Flesh out the formal model
 - Use the formal expressions of the chosen language and add details – back to knowledge acquisition!
 - Have the scope of the ontology in mind – use only details, and expressions that are useful for the intended purpose

Evaluation - Scope

- Re-Check the scope regularly
 - Given what you know NOW, does it still seem right?
 - Are there details that you can add?
- The scope definition should help you evaluate the adequacy of your ontology!
- The scope definition should also help you make design decisions!

Evaluation – Knowledge Acquisition

- Weed out acquired knowledge that does not fall into your scope (but don't throw it away in case your scope changes...)
- Pay attention to discrepancies in the acquired knowledge!
- If knowledge acquired from different sources overlaps, you can be confident that it is „valid“
- If knowledge acquired from different sources is complementary, make sure that it is not a single person's view / a view represented only in a single artefact

Evaluation – Informal Model

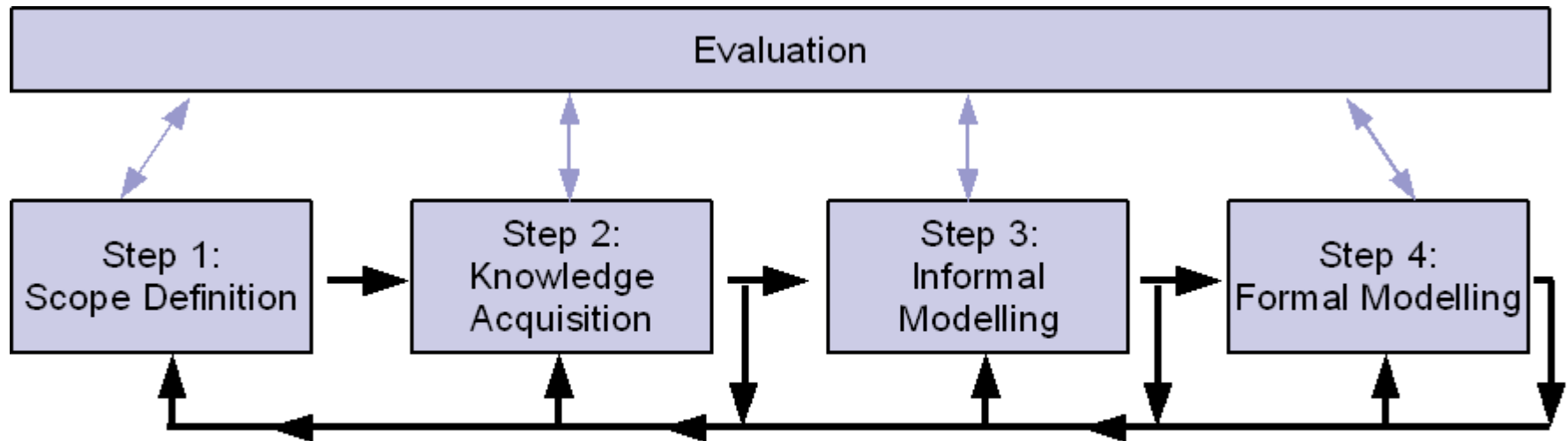
- Verbal descriptions:
 - Check whether verbal descriptions of concepts and relationships are intelligible by people who have not participated in creating the informal model.
- Relationships:
 - Check whether hierarchy/relationships make sense to people who have not participated in creating the informal model.
 - No orphaned concepts!
- Completeness: Cross-check with acquired knowledge whether you have forgotten something relevant.
- Try to use the informal model for the intended purpose.

Evaluation – Formal Model

- Formal correctness (e.g., satisfiability, consistency, compiles ...)
- Does formalisation correspond to domain expert's knowledge?
 - Re-translate formalisation to „normal“ language!
 - Use formal model for the intended purpose, and evaluate the resulting „system“.

Ontology Engineering Process

... the process is messy! Evaluation at each stage, the possibility/necessity to go back to previous stages...



Knowledge engineering activities organised as evolutionary process with evaluation activities in each single phase.

Pammer, V. (PhD Thesis) Automatic Support for Ontology Evaluation - Review of Entailed Statements and Assertional Effects for OWL Ontologies. *Graz University of Technology*, 2010