Lab: Ontology and Ontology Development in OWL

After this lab you should get a good understanding of ontology, OWL and ontology development, and the ontology development tool, Protégé.

Reading Materials

- Lecture slides
- Guarino, N., Oberle, D., & Staab, S. (2009). What is an ontology?. Handbook on ontologies, 1-17.
- OWL 2 Web Ontology Language Primier.

Submission

You should submit a document containing the answers to the questions in Section 1, 2 and 4. For Task 5, please submit the document with the outcomes from steps 1, 2, 3 and 5, and the file of the OWL ontology. **Note:** Any form of plagiarism, including using AI to generate answers, will result in failing the lab.

1. Ontology Definition

Explain this definition of ontology: *An ontology is an explicit, formal specification of a shared conceptualization.*

2. Web Ontology Language (OWL)

Describe the OWL 2 DL and OWL 2 Full, and the profiles OWL 2 EL, OWL 2 QL, and OWL 2 RL.

3. Using Protégé

Download Protégé. *Note*: no need to do the registration. Choose "No, thanks. I'm already registered". How to use Protégé, please check the document Protégé 5 documentation, especially the Sections Getting Started and guides on Views. Another good resource is the Ontology 101 Tutorial.

4. The Family Ontology

In this task you will get familiar with ontology in OWL, by looking at a family ontology, which the sample ontology used in OWL 2 Web Ontology Language Primer, using the ontology editor, Protégé.
Download the *families_manchester_syntax.owl* in Canvas, and open it in Protégé. Choose "No" when it asks you to "resolve missing import".
Go to the tab `Entities`, take some time to browse the classes, object properties, datatype properties and individuals, understand the ontology and solve the exercises below:

1) Find the classes HappyPerson, JohnsChildren, NarcisticPerson, and Orphan in the ontology, give the descriptions of the classes using DL syntax and natural language.

2) Find the object properties hasSpouse and hasWife, give the descriptions and/or characteristics of the object properties using natural language.

3) Find the classe Teenager in the ontology, give the description of the class in natural language, and the descriptoin and characteristics of the datatype property hasAge.

4) Find the individual John, give its description using natural language.

5) Choose the `HermiT` reasoner from the `Reasoner` menu and click `Start Reasoner`. Then open the `DL Query` tab (from Window → Tabs menu) and set `Query for` to include *Superclasses, Subclasses*, *Instances*. Copy each of the following DL queries (in the Manchester syntax) into the `Query` box, click `Execute`, and write down the answers returned by the reasoner. For each result, explain why it was generated by the reasoning process.

   - Grandfather
   - ChildlessPerson
   - Person and (hasChild min 2 Person)

6) Go back to the `Entities` and browse through the classes, properties, and individuals in the ontology. Observe the changes (highlighted in yellow) introduced by the reasoner. You may notice that the query results above correspond to some of these inferred changes. If you click the `quesiton mark` icon, you can see the explaination provided for the reasoning results. Choose one of the inferred changes for an object property and an individual, and explain why it was inferred by the reasoner.

5. An Ontology for Educational Resources in European Universities

In this task you will develop an ontology from scratch to represent conceptual level knowledge about universities and their education and research resources and activities. By completing this lab, you will learn the typical workflow of ontology engineering, from scoping and requirements gathering to conceptualization, implementation, and reasoning.

1) **Define purpose and scope** Write a short paragraph (3-5 sentences) describing the information that should be included in the ontology. Consider, for example, what entities are relevant (universities, faculties, students, courses, programs, prerequisites, etc.)? What is inside and outside the scope?

2) **Requirements via Competency Questions (CQs)** Prepare 10 competency questions that define the requirements for your ontology. These will guide your modeling decisions. A few example CQs for this domain are provided below, for inspiration.

   - Which universities offer a Master's program in Artificial Intelligence?
   - What programs are available at universities located in Sweden?
   - What are the mandatory courses in a given program?

3) **Conceptualization and Modeling** Follow the steps during the conceptualization:

   - Identify key terms from the CQs and the purpose and scope defined in step 1.
   - Define the classes of the ontology.
   - Define the class hierarchy (taxonomy) of the ontology.
   - Define properties, both object and datatype properties, that relate the classes.
   - Define axioms, including class description and restrictions, and property characteristics.
   - Add a few instances to illustrate how the ontology can represent specific data.

4) **Implementation** Implement the ontology in OWL using Protégé:

   - The IRI of the ontology does not matter, use any "example" IRI you can think of or the one suggested by the tool.
   - You should keep it in mind that the ontology is built using OWL 2 DL. Be careful about what can be or cannot be expressed in OWL 2 DL.
   - Run the HermiT reasoner in Protégé to verify satisfiability and infer class membership and fix any inconsistencies.

- Choose any syntax (RDF/XML, Turtle, etc.) when you save the ontology.
- You do not need to comment your ontology or the elements inside it, although that would normally be a good ontology development practice.

5) **DL Queries** Using the DL Query tab in Protégé, write DL queries to answer 3 CQs you defined in step 2. For each query, provide the DL query and the answers returned by the reasoner.