Basics of Description Logic $\mathcal{ALC}$

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1 Crash Course on Protégé

Protégé is an ontology editor for frames (Protégé 3 and lower) and currently especially for OWL (Protege 3) and OWL 2 (Protege 4). It is open-source and downloadable from `http://protege.stanford.edu`.

- Download and install Protégé 4.1[1].
- Install Protégé plugins – `File` → `Check for plugins...`
  - Pellet
  - OWL2Query
  - OWLDiff
- Download the Pizza Ontology from the following URL: `http://www.co-ode.org/ontologies/pizza/2007/02/12/pizza.owl`.
- Run Protégé and open the ontology.
- After opening the ontology you will se an application window with several tabs – explore each of them. Several remarks:

  Active Ontology – here, you can find latest information about ontology metrics and expressiveness (in case of pizza.owl you should see $\mathcal{SHOIN}$).

  Entities/Classes – here, you will probably spend most time when working with Protégé. Left, you can see a taxonomy (TBOX) before classification (Asserted class hierarchy) and after classification (Inferred class hierarchy). V centrální části pak jsou anotace týkající třídy zvolené v levé části a zejména pak její axiomy, ve kterých se tato třída vyskytuje.

  Object/Data Properties/Individuals – contain analogical view as classes.

  OWLViz – shows simple and intuitive visualization of TBox.

[1] You can set HTTP proxy in the file `Protege.lax` by adding/changing the respective line to `lax.nl.java.option.additional=-Dhttp.proxySet=true -Dhttp.proxyHost=proxy.felk.cvut.cz -Dhttp.proxyPort=80`

DL Query – allows posing simple ontological queries, e.g. “Find all subclasses/instances/... of the given class”.

- Try classifying the ontology – go to the menu Reasoner and choose e.g. Pellet, or FaCT++. Look what are the differences before (Asserted class hierarchy) and after (Inferred class hierarchy) the classification.

Next references:

- Ontology Modeling Tutorial with Protégé:
`http://protege.stanford.edu/publications/ontology_development/ontology101.pdf`
- Getting Started with Protégé 4:
`http://protegewiki.stanford.edu/index.php/Protege4GettingStarted`

2 $\mathcal{ALC}$ Practically

Consider the following $\mathcal{ALC}$ ontology :

$$\begin{aligned}
Man &\sqsubseteq Person \\
Woman &\sqsubseteq Person \sqcap \neg Man \\
Father &\equiv Man \sqcap \exists hasChild \cdot Person \\
GrandFather &\equiv \exists hasChild \cdot \exists hasChild \cdot \top \\
Sister &\equiv Person \sqcap \neg Man \sqcap \exists hasSibling \cdot Person
\end{aligned}$$

1. What is the meaning of these particular axioms ? Try to formulate them in natural language.
2. Rewrite last axiom into the semantically equivalent FOPL formula.
3. Consider the following structure:

$$\begin{aligned}
\Delta^{\mathcal{I}} &= Person^{\mathcal{I}} = \{John, Mary\} \\
Man^{\mathcal{I}} &= \{John\} \\
Woman^{\mathcal{I}} &= \{Mary\} \\
Sister^{\mathcal{I}} &= \{\} \\
Father^{\mathcal{I}} &= GrandFather^{\mathcal{I}} = \{John\} \\
hasChild^{\mathcal{I}} &= \{\langle John, John\rangle\} \\
hasSibling^{\mathcal{I}} &= \{\}
\end{aligned}$$

   a) Decide, whether this structure is a model of the ontology. If not, modify it, so that it is. If yes, decide, whether this model can reflect some real setup.

b) We know that $\mathcal{ALC}$ has *tree model property* and *finite model property*. Is the interpretation $\mathcal{I}$ from this example tree-shaped ? If not, find a model that is tree-shaped.

c) Is the interpretation $\mathcal{I}$ finite ? If not, find an interpretation of this ontology that is finite.

4. Using other axioms define concepts:
   - "A father having just sons."
   - "Someone who has at least one sister, but no brother."

5. Let's consider two roles $hasChild$ and $hasSibling$. During knowledge modeling, it is often necessary to specify :

   global domain and range of given role, i.e. statement of the type "By $hasChild$ we connect always a person (instance of the $Person$ class – domain) with another person (instance of the $Person$ class – range)".

   local domain and range of given role, e.g. "Every father having only sons can be connected by $hasChild$ just with man (instances of the Man class – range)".

   Show, in which way it is possible to model global domain and range of these roles in $\mathcal{ALC}$.

6. Create a new ontology in Protégé 4 and insert there all these definition. Verify correctness of your solution of the previous task (e.g. in the DL query tab).