1 OWL Axiom for Person

Assume an ontology that contains (at least) the class Human and its two subclasses Man and Woman. Assume two further properties hasFather and hasMother.

1. Define an OWL axiom (p. 39) that *fully* characterizes Human, viz., that it has *exactly one* father of type Man and one mother of type Woman. In order to achieve this, you need different OWL class constructors (p. 36).
2. Together with the non-unique name assumption (p. 40), functional properties as those above sometimes lead to surprising inferences. Give a small example using the above ontology!

2 `rdfs:subClassOf` and `owl:intersectionOf`

Is the denotation of Z in ontologies $\mathcal{O}_1$ and $\mathcal{O}_2$ the same for every interpretation, assuming X and Y have the same denotation in $\mathcal{O}_1$ and $\mathcal{O}_2$?

$\mathcal{O}_1 = \{\mathsf{Z} \equiv \mathsf{X} \sqcap \mathsf{Y}\}$
$\mathcal{O}_2 = \{\mathsf{Z} \sqsubseteq \mathsf{X}, \mathsf{Z} \sqsubseteq \mathsf{Y}\}$

If so, why? If not so, why? Hint: you can use Venn diagrams to explain your choice.

3 Integrity Constraints

Certain relations (e.g., spatio or temporal topological relations) are often anti-reflexive. For instance,

partOf(s,t) $\rightarrow$ ¬partOf(t, s)   e.g., partOf(door, house)
before(s,t) $\rightarrow$ ¬before(t, s)   e.g., before(5am, 5pm)

1. You can NOT write such a rule in SWRL/OWLIM, since negation is restricted to OWL class constructors in the TBox. However, you can rewrite those rules with negation on the RHS such that the new rule essentially captures the semantics of the old rule. This however requires querying for individuals of a very special class after the application of the rewritten rule.
2. Would it be possible to have negation on the LHS of a rule. Would this lead to problems? Explain! Hint: the deductive closure resulting from forward chaining would no longer be unique. Why?
3. Negation on the LHS and the RHS is allowed in SWRL/OWLIM within a specific axiom. Which one?

4 Forward Chaining

Why does the forward chaining algorithm (p. 52) terminate, assuming we are dealing with *safe* entailment rules (p. 48) ?

5 Reducibility to Consistency

On page 41, we said that the basic inference problems are all reducible to (in)consistency. Reformulate subsumption: $\mathsf{C} \sqsubseteq_{\mathcal{O}} \mathsf{D}$. You might again use Venn diagrams to explain your reformulation.

6 Entailment Rules

Page 56 has presented four OWL entailment rules in OWLIM notation. Now, properties in OWL can either be (see pp. 34, 36, 37)

- *datatype properties* of rdf:type owl:DatatypeProperty
  example: hasAge(peter, 42)) or
- *object properties* of rdf:type owl:ObjectProperty
  example: marriedWith(peter, mary)).

Orthogonal to this, properties in OWL are furthermore classified as being transitive, symmetric, *functional*, etc. (p. 35). Write OWL entailment rules that address functional object as well as functional datatype properties (you will probably need inequality constraints over variables; see p. 57). Are these rules different. Why?