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Knowledge Representation and Reasoning

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Exercises 4

24–28/11/2024

Problem 1.

Write down the following:

1. An unsatisfiable \mathcal{ALC} -knowledge base \mathcal{K} whose TBox is satisfiable and whose ABox contains only role assertions.
2. An unsatisfiable \mathcal{ALC} -knowledge base whose TBox is empty.
3. An unsatisfiable \mathcal{ALC} -TBox.
4. A satisfiable \mathcal{ALC} -TBox \mathcal{T} such that all the atomic concepts occurring in \mathcal{T} are unsatisfiable w.r.t. \mathcal{T} . Write down a model of \mathcal{T} .
5. A satisfiable \mathcal{ALC} -knowledge base such that all its models contain at least two domain individuals.

Hint: For this exercise, the top concept (\top) and the bottom concept (\perp) are of great help. In the first problem, for instance, you could choose as satisfiable TBox:

$$\mathcal{T} = \{\exists R.\top \sqsubseteq \perp\}$$

Problem 2.

Which of the following statements is true?

1. $A \sqcap \neg A$ is satisfiable.
2. $A \sqcup \neg A$ is satisfiable.
3. $A \sqcap \exists r.B \sqcap \exists r.\neg B$ is satisfiable.
4. $A \sqcap \exists r.B \sqcap \forall s.\neg B$ is satisfiable.
5. $A \sqcap \exists r.B \sqcap \forall r.\neg B$ is satisfiable.
6. $A \sqcap \neg A$ is subsumed by B.
7. B is subsumed by $A \sqcup \neg A$.
8. $A \sqcap \exists r.B$ is subsumed by $A \sqcap \exists r.\top$.
9. $A \sqcap \forall r.B$ is subsumed by $A \sqcap \exists r.B$.

10. $A \sqcap \exists r.B$ is subsumed by $A \sqcap \forall r.B$.

Problem 3.

Extend the knowledge base you built in Problem 2 from the previous Exercise Sheet to capture the following statements. You may use additional features such as number restrictions if needed; you may also need more than one axiom for some of the statements.

1. Cars have between three and four wheels.
2. Bicycles have exactly two wheels.
3. A human who legally controls a car holds a driving license and is an adult (this is a difficult one!).
4. A vehicle is controlled by exactly one human.
5. A thing's parts' parts are that thing's parts.
6. A car with a broken part is broken.
7. Bob controls a car with a wheel that has a broken axle.