

Knowledge Representation and Reasoning

Description Logic - Problems 1

14.11.2022

Problem 1. Consider again Problem 3 from Exercise Sheet 1 in which we were asked to design a FOL knowledge base about congenital heart conditions. Write down an \mathcal{ALC} -TBox \mathcal{T} conforming to the same specifications. Use the unary predicates and binary predicates given in Problem 3 as atomic concepts and atomic roles, respectively. Indicate if there any statements from Problem 3 that cannot be expressed in \mathcal{ALC} (you don't need to prove this).

1. Two axioms:

- $\text{VSD} \sqsubseteq \text{CHD}$
- $\text{AS} \sqsubseteq \text{CHD}$

2. $\text{VSD} \sqsubseteq \exists \text{affects}.\text{Septum}$

3. $\text{Septum} \sqsubseteq \text{Tissue} \sqcap (\exists \text{partOf}.\text{LHeart}) \sqcap (\exists \text{partOf}.\text{RHeart})$

It is interesting to note that in \mathcal{ALC} we cannot enforce that LHeart and RHeart are parts of the *same* heart.

4. $\text{Heart} \sqsubseteq \text{Organ}$

5. $\text{GATA4} \sqsubseteq \text{Gene} \sqcap \exists \text{relatedTo}.\text{VSD}$

6. $\text{Heart} \sqcap \exists \text{hasDisPart}.\text{TricValve} \sqsubseteq \exists \text{suffersCondition}.\text{CHD}$.

Problem 2. Build an \mathcal{ALC} knowledge base: capture each of the following statements in a suitable GCI, equivalence axioms, or assertion, using only the concept names

*Vehicle, Boat, Bicycle, Car, Device, Wheel, Engine, Axle, Rotation, Water
Human, Driver, Adult, Child*

and the role names

hasPart, poweredBy, capableOf, travelsOn controls.

1. *Cars are exactly those vehicles that have wheels and are powered by an engine.*
2. *Bicycles are exactly those vehicles that have wheels and are powered by a human.*
3. *Boats are exactly those vehicles that travel on water.*
4. *Boats have no wheels.*
5. *Cars and bicycles do not travel on water.*
6. *Wheels are exactly those devices that have an axle and are capable of rotation.*
7. *Drivers are exactly those humans who control a vehicle.*
8. *Drivers of cars are adults.*
9. *Humans are not vehicles.*
10. *Wheels or engines are not humans.*
11. *Humans are either adults or children.*
12. *Adults are not children.*
13. *Bob controls a car.*
14. *Bob is a human.*
15. *Bob controls QE2.*
16. *QE2 is a vehicle that travels on water.*

Problem 3. *Which of the statements in your answer to Problem 2 are GCIs, equivalence axioms, concept assertions, or role assertions? Moreover, which of these statements are part of the TBox and which are part of the ABox?*