

### G53KRR past exam questions and ALC description logic.

In previous years, I used description logic defined in the textbook to set exercises and exam questions. Since now I use ALC, I decided to go through past exam papers and show how the answers would change for ALC. Note that not all of the questions below can be answered using ALC! Here are answers to the questions which do have ALC answers.

- G53KRR 2008 question 5. Given the atomic concepts *Female*, *Male*, roles *Child*, *Sibling* and constant *alice*, define in the description logic above the following concepts:
  1. “Mother of Alice” (someone female whose child is Alice) **Not expressible in ALC**
  2. “Parent” (someone who has a child)  $\exists Child.\top$  where  $\top$  (a universal concept which applies to everything) can be defined as  $Male \sqcup \neg Male$
  3. “Uncle” (someone male who has a sibling who has a child)  $Male \sqcap \exists Sibling.\exists Child.\top$  or  $Male \sqcap \exists Sibling.Parent$ .  
Using the same atomic concepts translate the following sentences in description logic:
    4. Every grandparent is a parent:  $\exists Child.\exists Child.\top \sqsubseteq \exists Child.\top$  or  $\exists Child.Parent \sqsubseteq Parent$
    5. Alice is a grandmother:  $(Female \sqcap \exists Child.\exists Child.\top)(alice)$
- G53KRR 2009 question 4. Express the following concepts and sentences in description logic using constants *john*, *g51prg*, roles *Module* and *Supervision* and atomic concepts *Academic*, *Lecturer*, *Compulsory*:
  - C1 concept of an academic who has some project students:  $Academic \sqcap \exists Supervision.\top$
  - C2 concept of an academic who teaches at least two modules **Not expressible in ALC: can only express at least one**
  - C3 concept of an academic who teaches only compulsory modules:  $Academic \sqcap \forall Module.Compulsory$
  - C4 concept of someone who teaches G51PRG **Not expressible in ALC**
  - S1 a lecturer is an academic who has at least 8 project students and teaches at least 2 modules **Not expressible in ALC: can express has some students and teaches some modules**
  - S2 John teaches at least 3 modules and they are all compulsory **Not expressible in ALC: can only express at least one**
- G53KRR 2010 question 3. Express the following concepts in  $\mathcal{DL}$  using the atomic concepts *Animal*, and *Fish*, and the roles *Tail*, *Leg*, and *Eat*.
  - C1 An animal that has a tail:  $Animal \sqcap \exists Tail.\top$
  - C2 An animal that has a tail and four legs **Not expressible in ALC: can only express has a leg**
  - C3 An animal that eats only fish:  $Animal \sqcap \forall Eat.Fish$
  - C4 An animal that eats only things that themselves eat only fish  $Animal \sqcap \forall Eat.\forall Eat.Fish$

Express the following sentences in description logic using the atomic concepts *Cat*, *Fish*, and *Animal*, the roles *Leg*, and *Eat*, and the constant *tiddles*:

  - S1 Tiddles is a cat who eats only fish:  $(Cat \sqcap \forall Eat.Fish)(tiddles)$
  - S2 Cats are animals that have four legs **Not expressible in ALC: can only express has a leg**
- G53KRR 2011 question 3.

1. Express the following concepts in description logic using atomic concepts *School* and *Female*, roles *Pupil* and *Employee*, and a constant *anne*:
  - (a) A school which has at least 30 pupils. **Not expressible in ALC**
  - (b) A school which has at least 30 pupils and 5 employees. **Not expressible in ALC**
  - (c) A school where all the pupils are girls.  $School \sqcap \forall Pupil.Female$
  - (d) A school where one of the pupils is Anne. **Not expressible in ALC**
2. Express the following sentences in description logic using the atomic concepts *School*, *Female*, *GirlsSchool*, the roles *Pupil* and *Employee*:
  - (a) A girls school is defined as a school where all pupils are girls.  $GirlsSchool \doteq School \sqcap \forall Pupil.Female$
  - (b) In girls schools all employees are female.  $GirlsSchool \sqsubseteq \forall Employee.Female$
- G53KRR 2012 question 6. Given roles *Sister* and *Brother*, define the following concepts:
  1. Someone who has 7 sisters **Not expressible in ALC**
  2. Someone who has 7 sisters and 7 brothers **Not expressible in ALC**
  3. Someone all of whose sisters have 7 brothers **Not expressible in ALC**

Consider the following interpretation  $(D, I)$ :  $D = \{d_1, d_2, d_3\}$ ,  $I(R) = \{\langle d_1, d_2 \rangle, \langle d_1, d_3 \rangle\}$ ,  $I(a) = d_1$  ( $a$  is a constant),  $I(B) = \{d_2, d_3\}$  ( $B$  is an atomic concept). Which of the following sentences are true in this interpretation and why? (the exam had a totally different language, so here I give different questions):

1.  $\forall R.B(a)$  yes: this says that all  $R$ -successors of  $a$  are in  $B$
2.  $\exists R.B(a)$  yes: this says that there is an  $R$ -successor of  $a$  in  $B$
3.  $\exists R.B \sqsubseteq \forall R.B$  yes, because the only element in the domain that satisfies  $\exists R.B$  ( $d_1$ ) also satisfies  $\forall R.B$ .