TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Computer Science Institute of Theoretical Computer Science, Chair of Automata Theory

Description Logic

Summer Semester 2019

Exercise Sheet 13

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Exercise 13.1 Consider the database D consisting of the following tables (=relations).

Person	
ID	Name
1001	Ernie
1002	Bert
1003	Kermit
1004	Gonzo

Enrollment	
PersonID	Since
1002	2017
1003	2015
1004	2017

Attendance	
PersonID	CourseID
1001	23
1002	23
1002	25
1003	24

Course	
ID	Title
23	Description Logic
24	Complexity Theory
25	Model Checking

Describe the finite first-order interpretation $\mathcal{I}_D$ that corresponds to D.

Reformulate each of the following SQL queries Q into first-order queries ϕ_Q. Which of the queries ϕ_Q are conjunctive queries? What are the answers to Q on D and what are the answers of ϕ_Q on $\mathcal{I}_D$?

(a)
```
SELECT * FROM Person
```

(b)
```
SELECT Person.Name FROM Person, Attendance, Course
WHERE Person.ID = Attendance.PersonID
    AND Course.ID = Attendance.CourseID
    AND Course.Title = 'Description Logic'
```

(c)
```
SELECT Person.Name FROM Person, Enrollment
WHERE Person.ID = Enrollment.PersonID
AND NOT EXISTS (
    SELECT * FROM Attendance
    WHERE Person.ID = Attendance.PersonID)
```

Exercise 13.2 Consider the $\mathcal{ALC}$ knowledge base $\mathcal{K} \coloneqq (\mathcal{T}, \mathcal{A})$ with

$$\mathcal{T} \coloneqq \{A \sqsubseteq B,\ B \sqsubseteq \exists r.A,\ C \equiv \neg D,\ \exists r.B \sqsubseteq \neg D,\ A \sqsubseteq \forall r.B,\ \forall r.A \sqsubseteq B\} \text{ and}$$
$$\mathcal{A} \coloneqq \{(a,b) : r,\ (b,c) : r,\ (c,a) : r,\ (b,b) : r,\ (c,c) : r,\ A : c\}.$$

What are the certain answers to the following conjunctive queries on $(\mathcal{A}, \emptyset)$? What are the certain answers on $\mathcal{K}$?

(a) $r(x,y) \wedge B(y)$

(b) $\exists y \left(r(x,y) \wedge B(y)\right)$

(c) $\exists x,y \left(r(x,y) \wedge r(y,x)\right)$

(d) $\exists z,w \left(r(x,y) \wedge r(y,z) \wedge r(z,x) \wedge r(z,w) \wedge C(w)\right)$

Exercise 13.3 Consider a modified definition of data complexity for OMQA query entailment, where we do not require the ABox to be simple, i.e., we allow arbitrary ABoxes as input to the entailment problem. Can this affect the data complexity results?

Exercise 13.4 Can one use a reduction from non-k-colorability in graphs to show that the conjunctive query entailment problem in $\mathcal{ALC}$ is coNP-hard w.r.t. data complexity? What if k is fixed?