

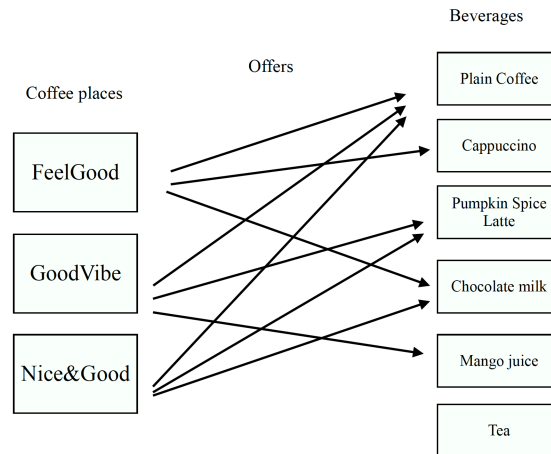
# Foundations of Knowledge Representation

## Description Logic: Reasoning with Data

**Problem 1.** We say that an atomic role  $R$  is satisfiable w.r.t. a TBox  $\mathcal{T}$  if there exists a model  $\mathcal{I}$  of  $\mathcal{T}$  such that  $R^{\mathcal{I}} \neq \emptyset$ .

- Write a satisfiable  $\mathcal{ALC}$ -TBox such that role  $R$  is unsatisfiable w.r.t.  $\mathcal{T}$ .
- Reduce the problem of checking satisfiability of an atomic role w.r.t. an  $\mathcal{ALC}$ -TBox to the problem of concept satisfiability w.r.t. an  $\mathcal{ALC}$ -TBox.

**Problem 2.** Consider the following interpretation of three coffee places and some beverages they offer:



Do the following:

- Formalize the queries 1-3 in the language of conjunctive queries.

Query1: All beverages offered by some coffee place.

Query2: All beverages offered by FeelGood and Nice and Good.

Query3: The coffee place that offers Cappuccino.

- Provide the answers to those queries given the interpretation above.
- Construct two additional queries: one that yields  $\{\text{FeelGood}, \text{Nice\&Good}\}$  as the only answers and one that yields  $\{\text{PlainCoffee}, \text{PumpkinSpiceLatte}, \text{MangoJuice}\}$  as the only answers.

**Problem 3.** Consider the following TBox  $\mathcal{T}$ :

$$\exists \text{hasFather}.\top \sqsubseteq \text{Person} \quad (1)$$

$$\exists \text{hasFather}^{\neg}.\top \sqsubseteq \text{Person} \quad (2)$$

$$\text{Person} \sqsubseteq \exists \text{hasFather} \quad (3)$$

Consider also the following ABox  $\mathcal{A}$ :

$$\mathcal{A} = \{\text{Person}(\text{John}), \text{Person}(\text{Nick}), \text{Person}(\text{Toni}), \\ \text{hasFather}(\text{John}, \text{Nick}), \text{hasFather}(\text{Nick}, \text{Toni})\}$$

Provide the certain answers to the following queries:

$$q_1(x, y) : \text{hasFather}(x, y)$$

$$q_2(x) : \exists y. \text{hasFather}(x, y)$$

$$q_3(x) : \exists y_1, y_2, y_3. \text{hasFather}(x, y_1) \wedge \text{hasFather}(y_1, y_2) \wedge \text{hasFather}(y_2, y_3)$$

$$q_4(x, y_3) : \exists y_1, y_2. \text{hasFather}(x, y_1) \wedge \text{hasFather}(y_1, y_2) \wedge \text{hasFather}(y_2, y_3)$$